Essays in Household Finance

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Essays in Household Finance

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"The PhD School in Economics and Management is an active national and international research environment at CBS for research degree students who deal with economics and management at business, industry and country level in a theoretical and empirical manner".

Forward

This thesis is the result of my doctoral studies as Ph.D. Fellow at the Department of Economics at Copenhagen Business School. I am extremely grateful for this opportunity and the generous financial support associated with this position. This dissertation would not be possible without the help of many individuals and I would like to spend a moment to acknowledge them personally.

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Abstract

This Ph.D. thesis, entitled *Essays in Household Finance,* analyzes the determinants and implications of investment biases, personal experiences in financial markets, and financing disruptions on households, individual investors, and entrepreneurs and small business owners.

The first essay of this thesis, *Once Bitten, Twice Shy: The Role of Inertia and Personal Experiences in Risk Taking,* with Steffen Andersen and Kasper Meisner Nielsen, studies how personal experiences affect individual financial risk taking. An important concern with pre-existing studies on the effect of personal experiences on risk taking is the potential bias resulting from inertia and inattention, which has been shown to be endemic in household finance. If individuals are inert or inattentive, it is difficult to establish whether changes in risk taking are caused by personal experiences or whether the change in risk taking is due to inertia and movements in market prices. To separate the effect of personal experiences from the confounding effect of inertia, we use an identification strategy that relies on a sample of individuals who inherit a portfolio of risky assets as a result of the death of their parents. The main advantage of this identification strategy is that inheritances from estates that hold risky assets alter the active decision from one of choosing to take risk to one of choosing not to take risk. Our measure of experience derives from investments in banks that defaulted following the financial crisis. We classify experiences into first-hand experiences, resulting from personal losses; second-hand experiences, from the losses of close family members; and third-hand experiences, from living in municipalities where banks defaulted. Our results demonstrate that experiences gained personally, aside from inertia or common shocks, explain substantial heterogeneity in individuals' risk taking.

In the second essay of this thesis, *The Effect of Personal Financing Disruptions on Entrepreneurship,* I first document that the literature to date has shown the importance of credit market disruptions on business lending and the borrowing ability of firms. However, anecdotal evidence and survey data suggest that the majority of financing to small businesses comes from personal debt or the individual assets of the firm owner. Therefore, personal financing disruptions may be of great importance in explaining turnover in small business activity. In this essay, I study how idiosyncratic financing shocks experienced directly by entrepreneurs affect the survival of their

firms. Variation in personal wealth and debt financing stem from the solvency of retail banking institutions following the 2007-2009 financial crisis. I find that disruptions to banking relationships first affect entrepreneurs through their retail bank choice which in turn impede their personal borrowing abilities, and significantly reduce the survival rate of their firms. At the same time, changes in personal liquid wealth strongly reduce the rate of entrepreneurial survival, especially for more constrained small business owners. In addition, personal losses have large effects on the intensive margin, as firm owners significantly reduce employed staff. The results of this chapter suggest that personal financing disruptions play an important role in explaining entrepreneurial exit.

The scope of the third and final essay is to propose an initial step in testing some of the mechanisms behind one of the most robust investment biases: the disposition effect. This final essay *Believe it or Not: Expectations Matter for the Disposition Effect* is joint work with Steffen Andersen, Jimmy Martínez-Correa, and Kasper Meisner Nielsen. We study the disposition effect using a unique research design combining experimentally elicited preferences and expectations with observed patterns of trading behavior. We use detailed administrative data to recruit active individual investors and test for optimism, investor sophistication, regret aversion, violations of expected utility theory, and several different measurements of risk aversion. We find that on average, disposition-prone investors expect a market return on a balanced portfolio of assets to be approximately 5 percentage points greater than the expectations of other investors, an economically significant effect relative to a mean expected return of 14 percent. We find no differences in financial sophistication, regret aversion, risk taking behavior, or beliefs about macroeconomic fundamentals. Our results suggest that optimism and expectations may be important aspects of the disposition effect.

Resumé (Abstract - Danish)

I denne Ph.d.-afhandling, *Essays in Household Finance*, undersøger jeg udvikllingen og betydningen af personlige erfaringer på det finansielle marked, finansielle forstyrrelser samt investeringsbias hos husholdninger, individuelle investorer, iværksættere og ejere af mindre virksomheder.

Afhandlingens første artikel, *Once Bitten, Twice Shy: The Role of Inertia and Personal Experiences in Risk Taking*, der er udarbejdet sammen med Steffen Andersen og Kasper Meisner Nielsen, undersøger, hvordan personlige erfaringer påvirker individers finansielle risikobeslutninger. I tidligere studier, der undersøger betydningen af personlige erfaringer for finansielle risikovalg, er betydende faktorer som inerti og uopmærksomhed negligeret. Det er ellers faktorer, som har vist sig at have vedvarende betydning for husholdningers finansielle beslutninger. Det kan være svært at identificere, om de finansielle risikovalg er aktive valg baseret på personlige erfaringer eller blot er passive valg, hvor inerti og markedernes prisudvikling bestemmer de observerede ændringer i individernes finanser. For at adskille effekterne, anvender vi en identifikationsstrategi, der bygger på individer som har arvet en portefølje bestående af højrisiko aktiver som følge af forældrenes dødsfald. Fordelen ved denne identifikationsstrategi er, at arvinger af risikobetonede aktiver har muligheden for at beholde de risikobetonede aktiver eller at omlægge dem til andre mindre risikobetonede aktiver. Vores erfaringsmål er dannet på baggrund af individernes investeringer i banker der gik fallit i kølvandet påden finansielle krise. Vi klassificerer erfaringerne i førstehåndserfaringer i form a personlige tab, andenhåndserfaringer i form af tætte familierelationers tab, tredjehåndserfaringer i form af at bo i en kommune, hvor en bank gik fallit. Vores resultater viser, at personlige erfaringer, udover inerti og generelle stød, forklarer betydelig heterogenitet blandt individers risikobeslutninger.

Afhandlingens anden artikel, *The Effect of Personal Financing Disruptions on Entrepreneurship*, tager udgangspunkt i en dokumentation af den eksisterende litterattur, der viser, at ændringer i kreditmarkederne har betydning for udlån- og låntagningsmulighederne for virksomhederne. Resultater fra både anekdoter og surveydata tyder dog på, at finansieringen af små virksomheder hovedsageligt kommer fra virksomhedsejerens personlige låntagning eller opsparing. Usikkerhed i de personlige finanser kan derfor have stor betydning for små virksomheders overlevelseschancer.

Jeg undersøger, hvordan idiosynkratiske finansieringschok for iværksættere påvirker virksomhedernes overlevelsesmuligheder. Jeg udnytter, variationen i velstand og gæld der stammer fra det udvidede solvenskrav i banksektoren, som blev introduceret som følge af finanskrisen i 2007-2009. Jeg finder, at ændringerne i bankrelationerne i første omgang har betydning for iværksætternes bankvalg, hvilket bevirker i en hæmmende effekt for de personlige lånemuligheder der dermed reducerer virksomheders overlevelsessandsynlighed betydeligt. Især for de mest kreditbegrænsede virksomhedsejere vil virksomhedens overlevelsesrate reduceres markant som følge af ændringer i ejernes personlige likviditet. De personlige tab har ydermere en stor effekt på de overlevende virksomheders størrelser, da virksomhedsejere vil reducere antallet af ansatte betydeligt. Resultaterne indikerer, at ændringer i de personlige finansieringsmuligheder spiller en væsentlig rolle for lukninger af entreprenørvirksomheder.

Tredje og sidste artikel i afhandlingen har til formål, at fremlægge et introducerende skridt mod at teste mekanismerne bag en af de mest underbyggede adfærdsmæssige biaser: *The Disposition Effect*. Denne artikel, *Believe it or Nor: Expectations Matter for the Disposition Effect* er udfærdiget i samarbejde med Steffen Andersen, Jimmy Martínez-Correra og Kasper Meisner Nielsen. Vi introducerer et originalt forskningsdesign der skal belyse the *disposition effect fra nye vinkler*. Forskningsdesignet kombinerer præferencer og forventninger, som vi estimerer ved hjælp af eksperimenter, der derefter kobles på de observerede handelsadfærd. Vi bruger detaljeret registerdata til at rekruttere aktive investorer, hvorefter vi tester deres optimisme, investeringsraffinement, fortrydelsesaversion, overtrædelser af den forventede nytteteori samt flere forskellige mål for risikoaversion. Vi finder, at *disposition*-tilbøjelige investorer i gennemsnit forventer et 5 procentpoint højere afkast på deres porteføljer end andre investorer forventer, hvilket er en økonomisk signifikant effekt i forhold til det gennemsnitlige forventede afkast på 14 procent. Vi finder ingen forskel når det kommer til investeringsraffinement, fortrydelsesaversion, risikovillighed eller forventinger til makroøkonomiske nøgletal. Vores resultater viser, at optimisme og forventninger er vigtige aspekter af *the disposition effect*.

Contents

Introduction

In the last decade there has been substantial support for increasing the oversight and protection of financial decisions for households and consumers.[1] The extent of recent government policy, advances in financial technology, and academic debate aimed at understanding and improving the situation of the individual investor highlights the importance of, and the stakes associated with suboptimal consumer financial decision making. Welfare implications can be substantive for individuals who lack the capacity to manage their finances, and at the same time these individuals may contribute to large negative spillovers which affect the aggregate economy (Campbell (2016)). For example, the existence of individual financial mismanagement can create rents for actors which in turn may distort competition and incentives in the financial services industry (Campbell (2016)). If financial biases are correlated across investor types, such as low income households, they create endogenous risk which can have costly repercussions. Moreover, the presence of these types of investors may stifle financial innovation (Campbell (2006)), and importantly can lead to corrosive mistrust of the financial system in general (Guiso et al. (2008); Guiso et al. (2010); Guiso (2012)).

This Ph.D. thesis consists of three essays in Household Finance, which attempt to shed light on some of the causes of, and repercussions associated with these consumer financial decisions. Each chapter addresses how individuals, households, and small business owners make financial decisions and the factors which can affect the process and the potential outcomes. The essays are written as independent research articles, however taken together, they all reflect upon a related subject within the field of Household Finance. The main theme across the three chapters suggests that individual experiences, unexpected negative shocks, and heterogeneity in expectations about the future can have large and important ramifications on financial decision making. For individuals, these decisions have been shown to have important consequences. For example, shying away from risky asset class participation or holding a sub-optimal financial portfolio can lead to reduced lifetime saving and consumption. Similarly, financial market disruptions may affect the labor

[1] John Y. Campbell in the Ely Lecture at the 2016 AEA Conference references several new pieces of regulation in the United States aimed at increasing consumer financial protection such as 'the Pension Protection Act of 2006, the Credit Card Accountability Responsibility and Disclosure Act (CARD Act) of 2009, and the Dodd-Frank Act of 2010 that created the Consumer Financial Protection Bureau (Campbell (2016)).'

market decisions of business owners, which not only affect individuals and households but also the aggregate economy in terms of job creation and innovation.

The thesis first examines a literature which has shown that significant negative experiences are linked to differences in observed risk taking. A number of researchers have shown that macroeconomic experiences can have large implications for future risk taking and lifetime consumption (e.g., Malmendier and Nagel (2011); Guiso et al. (2013); Knüpfer et al. (2016)). Individual level investment experiences in the stock market also affect future investment decisions (Kaustia and Knüpfer (2008); Kaustia and Knüpfer (2012); Choi et al. (2009); Chiang et al. (2011); Bucher-Koenen and Ziegelmeyer (2013); and Hoffmann and Post (2015)). Collectively, these studies suggest that personal experiences explain substantial variation in individual risk taking. It has also been shown that part of the observed heterogeneity can be driven by differences in trust. Substantial survey evidence documents an unprecedented drop in individuals' trust in financial markets and financial intermediaries that has taken place since the emergence of the Great Recession (Guiso et al. (2010)), and individuals' lack of trust in other people and financial institutions is correlated to risky asset participation (Guiso et al. (2008)). Chapter one shows that experiences that are made individually are a large driver of future financial risk taking. Experiences in the stock market stem from lost investments in stocks of individuals' own retail bank. The results suggest that when investors make negative experiences in the stock market they reduce their share of wealth in risky assets and are more likely to hold larger stocks of cash. Rather than optimally diversifying, these investors shy away from risk taking in the future, which has large repercussions on their lifetime savings and wealth.

A growing literature shows that inertia and inattention are endemic in financial decision making. Consumers are plagued by inertia in their retirement planning and mortgage choice (Choi et al. (2002); Choi et al. (2004); Andersen et al. (2015)), and in their portfolio rebalancing and risk taking (Bilias et al. (2010); Calvet et al. (2009)). As such, it is difficult to analyze the effect of experience on risk taking. If individuals are inert or inattentive, and hence slow to change their initial allocations, it is difficult to establish whether changes in risk taking are caused by personal experiences or whether the change in risk taking is due to inertia and movements in market prices. To overcome this issue, chapter one investigates the effect of experiences on risk taking in a portfolio of inherited stocks. On average, investors with negative experiences actively reduce their allocation of risky assets and move towards holding cash. Chapter one on one hand verifies existing literature by showing that experiences are of substantial importance to future risk taking, on the other hand it extends this stream of the literature it by showing that previous studies may be biased in how they measure the effect of experiences if investors are inert. Finally, the paper adds to the literature by showing that experiences made personally have stronger implications than further removed experiences.

The role of experiences on financial decision making is also related to a literature about how shocks at the financial intermediary level affect real economic activity and firms rather than individual investors and households. For example, researchers have used bank-level shocks to determine if credit market disruptions affect established firms (Gan (2007); Khwaja and Mian (2008); Paravisini (2008); Schnabl (2012); Iyer et al. (2014)). These authors have shown that financial institutions transmit idiosyncratic banking shocks or macroeconomy-wide shocks to borrowing firms, which have strong implications on their ability to borrow and their subsequent employment decisions (Chodorow-Reich (2014). By construction, this literature on bank-specific shocks largely excludes disruptions in personal finance in the outcomes of small business owners and entrepreneurial firms as datasets generally focus on large firms with access to commercial and syndicated loans.

This stream of the literature on exposure to banking shocks naturally motivates chapter two of this thesis. The aim of chapter two is to bridge the gap between personal financing disruptions that affect individual firm owners, and larger credit market disruptions that may affect commercial firms. This chapter highlights that shocks which affect retail banks also have large consequences on personal borrowing and the personal financing channel to firms. In general, chapter two finds that changes in access to debt finance and personal liquidity losses have economically significant effects on firm survival and performance. The essay also shows that these large financing shocks drive entrepreneurs out of their small businesses and into salaried labor positions in larger firms. This finding suggests that large shocks have the ability to change individual employment decisions as well as the aggregate landscape of firms within the economy. This essay is one of the first to approach the question of financing shocks from the angle of personal financing of the entrepreneur him- or herself. Chapter two therefore builds upon the study in chapter one by showing that retail banking disruptions affect not only individual investors, but also small business owners and entrepreneurs.

As chapters one and two show that individuals make large and lasting reactions to experiences, chapter three continues in this fashion by investigating the mechanisms behind individual investors' financial biases. As mentioned, a large literature shows that individuals are relatively inattentive in financial decisions in addition to a large breadth of financial and investment biases. These biases include under-diversification (Barber and Odean (2000)), returns-chasing (Engelberg and Parsons (2011)), overtrading and overconfidence (Barber and Odean (2000); Barber and Odean (2001)), and a reluctance to realize losses (Shefrin and Statman (1985); Odean (1998)), among many other observed biases.[2]

The Disposition Effect, one of the most documented and robust investment biases, describes a well-known trait investors exhibit where they are more likely to sell stocks which have returned a positive return relative to stocks with a negative return. The disposition effect is a non-trivial bias which affects investors' portfolio allocations and therefore has substantial welfare costs in terms lifetime saving and consumption. There is also evidence that it affects aggregate asset pricing (Grinblatt and Han (2005); Goetzmann and Massa (2008)). The investment bias is one of the most robust empirical findings in behavioral finance and has been well documented across stocks, mutual funds, and real estate markets. However, understanding the mechanisms behind what causes this bias has been challenging and a focus of the literature over the course of the last twenty years. The main challenge is that the various mechanisms which have been proposed to drive the bias are inherently challenging to observe empirically.

In this respect, chapter three attempts to test some of the mechanisms behind the disposition effect using a research design which combines experimentally elicited preferences and expectations with observed patterns of real trading behavior. The unique research design in this essay first uses detailed administrative data to identify active individual investors from Denmark, who, in observed portfolio choices exhibited a high degree of disposition effect. Participants are then recruited for laboratory experiments on a number of individual, incentivized, tasks to measure preference behaviors as correlates to the disposition effect. The essay also features a theoretical component, which quantifies the incidence of the disposition effect in investors with prospect theory. The model follows that of Barberis and Xiong (2009)) and allows for investors to use realized gains and losses as reference points. The experimental evidence suggests that the key difference between disposition effected and unaffected investors is in their expectations of future market returns. On average, disposition-prone investors expect a market return on domestic investments to be significantly greater than the expectations of other active investors. There are no differences in

[2]For detailed review articles see Barberis and Thaler (2003) and Barber and Odean (2011).

financial sophistication, literacy, regret aversion, or risk taking between investors. Overall, the results emphasize the role of expectations and investor beliefs in the disposition effect compared to some of the more well studied mechanisms.

In total, the three chapters of this thesis use highly detailed administrative data on asset allocation in order to uncover the causes and repercussions of financial decisions. The chapters investigate financial decision making across various groups in Denmark, ranging from active investors, households, and small business owners. An underlying finding of this thesis suggests that experiences, unexpected shocks, and expectations have important consequences on asset allocation and financial biases, and labor market activity. The findings are important in light of the global financial crisis and subsequent recession, as large macroeconomic events are likely to have triggered individual level experiences with the stock market, financial intermediaries, and about future market returns. This dissertation attempts to analyze the repercussions stemming from these individual experiences.

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Chapter 1 - Once Bitten, Twice Shy: The Role of Inertia and Personal Experiences in Risk Taking

Once Bitten, Twice Shy:

The Role of Inertia and Personal Experiences in Risk Taking*

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Abstract

We study how inertia and personal experiences affect individual risk taking. Our research design relies on active portfolio decisions relating to inheritances to separate the effect of personal experiences from inertia, which otherwise would be observationally equivalent. Experience derives from investments in banks that defaulted following the financial crisis. We classify experiences into first-hand experiences, resulting from personal losses; second-hand experiences, from the losses of close family members; and third-hand experiences, from living in municipalities where banks defaulted. Our results demonstrate that experiences gained personally, aside from inertia or common shocks, explain substantial heterogeneity in individuals' risk taking.

JEL Classification: D03, D14, G11
Keywords: Experiences, Inertia, Risk taking, Financial crisis, Household finance

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1. **Introduction**

In the aftermath of the financial crisis, it seems appropriate to ask whether negative personal experiences during the crisis will result in lower future risk taking, as is evidenced for the generation of Depression babies (Malmendier and Nagel, 2011). We ask more generally whether exposure to first-hand experiences has a differential effect on risk taking relative to economy-wide experiences. Do individuals have to feel the pain themselves, or are common shocks enough to change individual risk taking?

Heterogeneity in revealed risk taking between individuals has been attributed to past experiences of macroeconomic shocks (Malmendier and Nagel, 2011; Guiso, Sapienza, and Zingales, 2013; Knüpfer, Rantapuska, and Sarvimäki, 2016), incidents of corporate fraud (Giannetti and Wang, 2016), and personal experiences in the stock market (Kaustia and Knüpfer, 2008, 2012; Choi et al., 2009; Chiang et al., 2011; Bucher-Koenen and Ziegelmeyer, 2014; and Hoffmann and Post, 2016). Collectively, these studies suggest that personal experiences explain substantial variation in individual risk taking.

An important concern with pre-existing studies on the effect of personal experiences on risk taking is the potential bias resulting from inertia and inattention, which has been shown to be endemic in household finance. If individuals are inert or inattentive, and hence slow to change their initial allocations, it is difficult to establish whether changes in risk taking are caused by personal experiences or whether the change in risk taking is due to inertia and movements in market prices. The problem arises because the effect of inertia is observationally equivalent to the hypothesized effect of personal experiences.

In this study, we separate the effect of personal experiences from the confounding effect of inertia. We use an identification strategy that relies on a sample of individuals who inherit a portfolio of risky assets as a result of the death of their parents. The main advantage of our identification strategy is that inheritances from estates that hold risky assets alter the active decision from one of choosing to take risk to one of choosing not to take risk. If lower risk taking is caused by personal experiences, rather than inertia, we expect individuals to shy away from risk taking even when they receive large inheritances. Inertia, on the other hand, predicts that beneficiaries hold on to the inherited portfolio and, therefore, works in the opposite direction of the hypothesized effect of personal experiences. Thus, lower risk taking in this setting is not caused by inertia or inattention.

To understand the effect of personal experiences on the intensive margin of risk taking, we analyze both the indirect effect on individual risk taking from personal experiences of close family members and individuals living in the same local environment, as well as the direct effect of experiences made by the individual him- or herself. This approach allows us to generate variation in the degree of personal experiences, and examine whether reinforcement learning as documented in Kaustia and Knüpfer (2008) also occurs when experiences are further removed from the individual.[1] We show that events experienced personally have much stronger effects on future risk-taking than events affecting peers and relatives. We provide additional evidence on how individuals learn from personal experiences by examining the effect on portfolio allocations. Reinforcement learning in our setting unfortunately does not cause individuals to change their investment decisions toward a more diversified portfolio allocation. Rather, we find that they shy away from risk taking (and hold cash), as suggested by our title.

We use high-quality administrative register data from Denmark to classify individuals' personal experiences and observe their allocation of liquid wealth into risky assets around inheritances. As a plausible source of negative experiences, we identify individuals who invested in the banks at which they are customers—a common phenomenon in Denmark prior to the financial crisis—some of which defaulted in the aftermath of the crisis.

[1] Kaustia and Knüpfer (2008) show that individuals who subscribe to IPOs and experience high returns are more likely to subscribe to future IPOs than are individuals who experienced low returns. They interpret this result as suggesting that investors overweigh personal experiences, as opposed to observing these high or low returns from afar by just participating in the market, relative to Bayes' rule.

The portfolio compositions of the Danish population prior to the crisis illustrate the apparent trust individuals placed in their banks as a profitable investment. In 2006, 746,465 out of 1,207,278 individuals holding stocks (62%) had invested in the banks at which they are customers. In fact, individuals participating in the stock market on average had allocated 43.1% of their portfolios to the stocks of their banks, and incredibly, 34.5% of all stock market participants held *only* the stock of their retail bank.

The 2007–9 financial crisis had a significant impact on financial institutions in Denmark. Excessive exposure to real estate developers and farm land led to severe write-offs and liquidity needs in many banks. As a consequence of write-offs on non-performing loans, eight publicly traded banks defaulted between 2008 and 2012, resulting in significant losses for 105,016 shareholders, equivalent to 8.7% of all Danes holding stocks in 2006.[2] On average, shareholders lost 36,270 DKK (4,800 EUR), or approximately 15% of their portfolios. Astonishingly, 79,896 of the 105,016 (76%) shareholders were also customers; the defaulted bank acted as their primary bank. If negative experiences affect individuals' future outlook on investments in risky assets, or individuals' prior about the trustworthiness of financial institutions, we hypothesize that individuals with first-hand experiences will be more reluctant to take risk in subsequent periods.[3] Moreover, due to the institutional setting, changes in risk taking cannot be attributed to lost deposits, because temporary provisions by the Danish Financial Supervisory Authority fully insured the vast majority of depositors against defaults.[4] To ensure financial stability, the activities of the defaulting bank were immediately taken over by a government-owned bank holding company, which continues the

[2] More banks have defaulted in the aftermath of the financial crisis, but due to data availability, our focus is on publicly listed banks. Collectively, the 8 defaulted banks held assets worth 141 billion DKK (18.9 billion EUR). See Appendix A for details.

[3] Interestingly, we find a smaller effect on risk taking of negative experiences deriving from non-bank defaults. The difference suggests that (mis-)trust might play a role in explaining the strongly negative effect of bank defaults on risk taking. Unfortunately, non-bank defaults only affect a small number of shareholders, making it difficult to assess the generality of this result.

[4] Depositor insurance in Denmark provided by The Guarantee Fund for Depositors and Investors guarantees 100% of deposits up to 750,000 DKK (100,000 EUR). From October 5, 2008 to September 30, 2010, the Danish government decided to provide unlimited guarantees to depositors. As a result, few customers lost their deposits due to defaults. In Table 9, we exclude individuals who potentially lost deposits, with little effect on our results.

operations. The institutional setting is also helpful in ruling out the possibility that tax laws are driving lower risk taking. Estates are subject to a 15% estate tax for immediate relatives, which is levied on the estate's total net wealth above a threshold, irrespective of the underlying assets or potential unrealized capital gains. The threshold is 242,400 DKK (32,500 EUR) in 2006 and inflated by a price index in subsequent years. Due to the relatively low estate tax and substantial cash holdings, 74% of the estates (or their beneficiaries) hold sufficient cash to settle the estate tax without selling assets. Our results are qualitatively unaffected if we exclude estates that cannot settle the estate tax without selling assets.

To examine the effect by the degree of personal experience, we investigate whether beneficiaries with first-, second-, and third-hand experiences behave differently than do beneficiaries with common experiences when allocating inherited wealth. We define first-hand experiences as the direct effect of losing one's investment in a bank as a result of its default. We define second-hand experiences as the peer effect of having a close relative who is exposed to a first-hand experience; and finally, we define third-hand experiences as the effect of living in the municipality of a defaulted bank. We find that third-hand experiences, without the incidence of a first- or second-hand experience, have a negligible effect on the level of risk taking. Investors with a second-hand experience resulting from losses in the close family reduce their allocation to risky assets by around 1 percentage point, whereas those with first-hand experiences reduce the fraction of liquid wealth allocated to stocks by 6 percentage points. These effects are economically significant given a baseline allocation of liquid wealth to stocks of around 30% for beneficiaries who inherit.

We then decompose the change in risk taking into passive and active components, and find that the lower risk taking is driven by an active choice to sell risky assets. In so doing, we contrast the evidence from the contemporaneous relationship between personal experiences and changes in risk taking, where the effect on risk taking is driven by the passive channel, rather than active changes. This difference highlights the challenge posed by inertia, and confirms the contribution of our identification strategy based on changes in risk taking around inheritances to overcome the confounding effect of inertia or inattention.

A plausible alternative interpretation of our results is that investors with first-hand experiences somehow have a different investment style and are, therefore, less likely to take risk when they inherit. To address this issue we test whether the changes in risk taking around inheritances depend on whether the inheritance was received before or after the bank default. The strength of this strategy is that the timing of the death, and hence the inheritance case, is unrelated to the timing of the bank default. The within-subject differences effectively eliminate the possibility that our results are driven by partial anticipation of inheritances, while the between-subject differences effectively control for the overall effect of the financial crisis on risk taking. Thus, the causal effect of first-hand experiences can be estimated by comparing the changes in risk taking around inheritances, depending on the timing of the inheritance case relative to defaults. Individuals who inherit before they experience a default on average increase their risk taking by 0.8 percentage points. Individuals who inherit after they have experienced a default actively reduce the fraction of liquid wealth allocated to stocks by 6.0 percentage points. The difference equals 6.8 percentage points and is both economically and statistically significant given a baseline allocation of liquid wealth to stocks of around 30% for beneficiaries who inherit.

Investors who trusted their banks by investing in the stock of their retail bank, and subsequently lost a significant fraction of their wealth, are less willing to hold risky assets—even when they receive a significant positive windfall that more than offsets their losses. However, the investment behaviors of their local peers, who witness a deteriorating macroeconomic climate, remain relatively unaffected by these experiences. Our results show that changes in an individual's risk taking are largely shaped by events experienced personally and to a lesser extent by experiences of close relatives or the macroeconomic conditions.

Our paper contributes to the existing literature analyzing limited stock market participation, by focusing and measuring the effect of personal experiences over and above the common experiences of market participants. Stock market participation varies greatly across countries and has increased recently (Guiso, Haliassos, and Jappelli, 2003; Giannetti and Koskinen, 2010), but the overall impression is that participation is still low (Campbell, 2006). Alternative explanations for limited stock market participation are low awareness of the equities market (Guiso and Jappelli, 2005), limited financial literacy (van Rooij, Lusardi, and Alessie, 2011), the presence of one-time or ongoing fixed participation costs (Vissing-Jørgensen, 2002; Andersen and Nielsen, 2011), limited wealth of younger individuals (Constantinides, Donaldson, and Mehra, 2002), presence of income and background risk (Heaton and Lucas, 2000; Gollier, 2001; Guiso and Paiella, 2008), and individuals' lack of trust in other people and financial institutions (Guiso, Sapienza, and Zingales, 2008).[5]

Our study is similar in spirit to Malmendier and Nagel (2011), Brunnermeier and Nagel (2008), and Andersen and Nielsen (2011). First, it shares with Malmendier and Nagel (2011) a focus on the effect of personal experiences on individual risk taking. In contrast to Malmendier and Nagel (2011), we measure the degree of personal experience at the individual level rather than cohort effects based on individuals' ages and the development of the S&P 500 index during their lifetimes. Second, it largely shares an identification strategy with Brunnermeier and Nagel (2008) and Andersen and Nielsen (2011), who examine the effect of inheritance receipts to identify the effect of windfall wealth on an individual's asset allocation. Our study differs from Brunnermeier and Nagel (2008) and Andersen and Nielsen (2011) in that we focus on disentangling the effect of

[5] Our research also contributes to an existing literature focusing on peer and social-effects. Duflo and Saez (2003) find strong positive externalities in Tax Deferred Account retirement plan participation rates of the untreated individuals who work in the same department as treated individuals, compared to a control sample. In the finance literature, entry decisions in the stock market seem to be influenced by family members (Li, 2014; Hellström, Zetterdahl, and Hanes, 2013), as well as by neighborhood and community participation rates (Kaustia and Knüpfer, 2012; Ivkovic and Weisbenner, 2007), language and cultural similarity (Grinblatt and Keloharju, 2001), and sociability and neighborhood interactions (Hong, Kubic, and Stein, 2004). Further, specific asset investments are affected by coworkers (Hvide and Östberg, 2014), and from an institutional perspective, industry peers in the same city (Hong, Kubic, and Stein, 2005).

personal experiences from the effect of inertia on changes in individual risk taking. We show that individuals with negative first-hand experiences *actively* reduce their allocation of liquid wealth to risky assets when their wealth increases.

Finally, our study is related to Choi et al. (2009), Kaustia and Knüpfer (2012), Chiang et al. (2011), Guiso, Sapienza, and Zingales (2013), Bucher-Koenen and Ziegelmeyer (2014), Giannetti and Wang (2016), Hoffmann and Post (2016), and Knüpfer, Rantapuska, and Sarvimäki (2016), who show that personally experienced outcomes in stock markets and 401(k) plans are an important influence in investment decisions. Our study differs from these prior findings by using an identification strategy that disentangles the effect of personal experiences on investment decisions from inertia.

Our results raise the question of how and what individuals learn from their past investment experiences. An appropriate response to the personal experiences documented in this study is to diversify the portfolio. Instead, individuals shy away from risk taking as our title suggests: once bitten, twice shy. One plausible interpretation of the profound effect of first-hand experiences on future risk taking is that individuals subsequently have revised their priors about the trustworthiness of financial institutions. The source of mistrust arising from first-hand experiences in our setting is likely to be particularly severe, because many individuals were advised to invest by their financial advisors, who in many cases, according to the Danish Financial Supervisory Authority (2009), violated their fiduciary duty. In contrast, we find small effects on risk taking for depositors in default banks, who did not invest in the bank, as well as smaller effects of non-bank default on risk taking. One interpretation of this difference is that bank default might cause individuals, who took advice from financial advisors and invested in the default bank, to lower their trust in financial markets. This interpretation also resonates with survey evidence documenting an unprecedented drop in individuals' trust in financial markets and financial intermediaries that has taken place since the emergence of the crisis (Guiso, 2010), and the positive correlation between trust and individual risk taking documented in Guiso, Sapienza, and Zingales (2008).

Our study proceeds as follows: we first illustrate the challenge posed by inertia when measuring changes in risk taking in Section 2. Section 3 describes in detail the construction and sources of our dataset. In Section 4, we discuss the institutional setting in Denmark and the deceptive statistics of the individual investors in our sample. We then consider the effect of personal experiences on stock market participation in Section 5. Section 6 examines how the portfolio allocation is affected by personal experiences, while Section 7 examines three counterfactual experiences with defaults. We discuss the interpretation of our findings in relation to the existing literature and provide robustness checks in Section 8; we then conclude.

2. The challenge of inertia when measuring changes in risk taking

To illustrate the challenge posed by inertia when measuring changes in risk taking, consider the following estimating equation, which relates observed changes in risk taking, $\Delta\alpha$, to household characteristics, X, and contemporaneous personal experiences, E:

$$\Delta\alpha_{t,k} = \beta X_{t-k} + \gamma E_{t-k} \tag{1}$$

Where $\Delta\alpha_{t,k}$ is the observed change in risk taking from period *t-k* to period *t*; $\Delta\alpha_{t,k} = \alpha_t - \alpha_{t-k}$, α_t is the value of risky assets over liquid wealth in period *t*, X_{t-k}, is a vector of (constant or time-variant) household characteristics that determine the desired changes in the level of risk taking, while E_{t-k}, denotes personal experiences between time *t-k* and *t*. In keeping with the literature, personal experiences derive from gains or losses in the stock market.

Now consider the additional effect of inertia, $Inert_{t-k}$, defined as the (counterfactual) change in the risky asset shares that the household would have experienced between *t-k* and *t* due to movements in market prices, rather than through active changes to the allocation of risky assets. If individuals are slow, to a degree φ, at changing their asset allocation, this condition will induce a positive contemporaneous relationship between changes in market prices and risky asset shares, hence $\varphi \geq 0$:

$$\Delta a_{t,k} = \beta X_{t-k} + \gamma E_{t-k} + \varphi Inert_{t-k} \tag{2}$$

If individuals exhibit perfect inertia, ignoring characteristics and experiences, then $\varphi=1$ and the actual change $\Delta\alpha_{t,k}$ equals $Inert_{t-k}$. If households exhibit no inertia at all, and hence rebalance their portfolios immediately following capital gains, then $\varphi=0$.

Inertia poses a challenge to the empirical design, because it is observationally equivalent to personal experiences if investors are passive, hence $Inert_{t-k} = E_{t-k}$ and one would estimate:

$$\Delta a_{t,k} = \beta X_{t-k} + (\gamma + \varphi) E_{t-k} \tag{3}$$

It follows that the estimated effect of experiences on changes in observed risk taking in Equation (1), $\hat{\gamma}$, is biased by the level of inertia, φ. Only in the special case where individuals are fully attentive, $\varphi = 0$, will $\hat{\gamma} = \gamma$ be an unbiased estimate of the effect of personal experiences on the desired level of risk taking. In the case where investors do not actively react to personal experiences, $\gamma = 0$, the estimated effect of experiences on changes in observed risk taking given by the coefficient estimated in a regression such as equation (1) would be misleading. It would be entirely driven by the investor's level of inertia: $\hat{\gamma} = \varphi$.

The above example illustrates two challenges with identifying the effect of personal experiences on changes in observed risk taking. First, part of the relationship is mechanical because negative experiences (from market movements) affect risk taking through the passive price channel. Second, inertia reduces the incidence of active decisions, which makes observing changes in desired risk taking difficult. In other words, inertia exacerbates the mechanical relationship between personal experiences and observed risk taking: if individuals are slow to adjust quantities of risky assets because they are inert, then price changes will dominate the inference on risk taking. To overcome these challenges, we use a natural experiment by which individuals receive a windfall of risky assets due to inheritances. As we outline below, windfalls change quantities and reverse the bias from inertia, as passive individuals would tend to move toward their parents portfolio allocation.

To convincingly show that past personal experiences, rather than confounding inertia or inattention, lead to lower risk taking, we look at the decision to keep inherited stocks. In this setting, an inert individual would passively merge the inherited portfolio with his existing portfolio. Thus, inertia dictates that the change in risk taking is a weighted average of the risk taking before receiving the inheritance, α_k, and the risk taking in the inherited wealth, α_t^i:

$$Inert_{t-k} = (1-\omega)\alpha_k + \omega\alpha_t^i - \alpha_k = \omega(\alpha_t^i - \alpha_k) \tag{4}$$

where the parameter, ω, denotes the fraction of inherited wealth relative to total liquid wealth after inheriting. Rewriting Equation (2) to incorporate the effect of past experiences, E_p, and inertia, $Inert_{t-k}$, from Equation (4) around inheritances received between period *t-k* and *t* yields:

$$\Delta\alpha_{t,k} = \beta X_{t-k} + \gamma E_p + \varphi\omega(\alpha_t^i - \alpha_k) \tag{5}$$

Note that any contemporaneous effect of personal experiences on risk taking is already differenced out because the personal experience, E_p, occurs before period *t-k* (i.e., $p < t\text{-}k$). Equation (5) therefore tests whether past personal experiences affect the desired level of risk taking when individuals receive a windfall of risky assets. As a result, Equation (5) allows us to obtain an unbiased estimate of the effect of personal experiences on risk taking, $\hat{\gamma} = \gamma$.

The main advantage of analyzing changes in risk taking around inheritances is that the experience effect is independent of the inertia effect. One might argue that one could obtain the same degree of independence between personal experiences and risk taking by lagging personal experiences in Equation (2). The main problem with this approach is that inertia will still bias the results, because inertia delays active risk taking. In other words, inertia also poses a challenge when estimating the effect of personal experiences on risk taking in future periods, because the effect of inertia is observationally equivalent to the hypothesized effect of personal experiences. To this end, our research design based on inheritances overcomes this challenge.

3. Data

We assemble a dataset from the universe of the Danish population that focuses on adults aged 20 or above in 2006. Our dataset contains economic, financial, and personal information about the individuals, as well as their deceased parents.[6] The dataset is constructed based on several different administrative registers made available from Statistics Denmark, as explained below.

Individual and family data originate from the official Danish Civil Registration System. These records include the personal identification number (*CPR*), gender, date of birth, *CPR* numbers of family members (parents, children, and thus siblings), and their marital histories (number of marriages, divorces, and widowhoods). In addition to providing individual characteristics, such as age, gender, and marital status, these data enable us to identify all individuals' legal parents. The dataset provides unique identification across individuals, households, generations, and time.

Income, wealth, and portfolio holdings are from the official records at the Danish Tax and Customs Administration (*SKAT*). This dataset contains personal income and wealth information by *CPR* numbers on the Danish population. *SKAT* receives this information directly from the relevant sources; financial institutions supply information to *SKAT* on their customers' deposits and holdings of security investments. Employers similarly supply statements of wages paid to their employees. Through Statistics Denmark, we obtain access to personal income and wealth data from 1990 to 2012. From 2006 to 2012, we additionally have information on individuals' stock and mutual fund holdings by ISIN number at the end of the year. For simplicity, we refer to the joint holdings of stocks and mutual funds as stocks (or risky assets). In addition, we obtain the bank

[6] Demographic, income, and wealth data are comparable to the data from other Nordic countries (Finland: Grinblatt and Kaloharju, 2001, Kaustia and Knüpfer, 2012, and Knüpfer, Rantapuska, and Sarvimäki, 2013; Norway: Hvide and Östberg, 2014; and Sweden: Calvet, Campbell, and Sodini, 2007, 2009). The information on inheritances and the official medical causes of death in our data, however, provides a novel source for indentifying windfalls.

registration number of each individual's primary bank account. This bank registration number comes directly from tax authorities, as it is the bank account associated with the third-party reporting by financial institutions. Thus, we are able to match an individual's bank with his or her portfolio investments. We refer to such overlaps between bank accounts and investments in the same bank as individuals with investments in their own banks.[7]

Causes of deaths are from The Danish Cause-of-Death Register at the Danish National Board of Health (*Sundhedsstyrelsen*). In this dataset, the cause of death is classified according to international guidelines specified by the World Health Organization's (WHO) International Classification of Diseases (ICD-10) system.[8] The sources of these data are the official death certificates issued by a doctor immediately after the death of every deceased Danish citizen. *Sundhedsstyrelsen* compiles these data for statistical purposes and makes it available for medical and social science research through Statistics Denmark. We obtain the cause of death from all Danish citizens who passed away between 2005 and 2011. We use this dataset to identify inheritance cases and classify a subsample of individuals who died suddenly and unexpectedly.

Educational records are from the Danish Ministry of Education. All completed (formal and informal) education levels are registered on a yearly basis and made available through Statistics Denmark. We use these data to measure an individual's education level.

4. Investment decisions and personal experiences

As the starting point of our analysis, we characterize individuals in our sample toward experiences with investments in their own banks. A report on the sales of bank stocks to depositors from the Danish Financial Supervisory Authority (2009) describes the institutional nature of banks

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[7] Individuals who invest in a mutual fund managed by their brokerage bank are not classified as individuals with investment in their banks unless they also hold the stock of the same bank in their portfolios.

[8] WHO's International Classification of Diseases, ICD-10, is the latest in a series that has its origin in the 1850s. The first edition, known as the International List of Causes of Death, was adopted by the International Statistics Institute in 1893. WHO took over the responsibility of ICD at its creation in 1948, and the system is currently used for mortality and morbidity statistics by all Member States. The current ICD-10 standard came into use by Member States in 1994.

as having a tradition of local presence, where local customers support their local banks, even taking part in the annual general meeting. Many of these customers over time built a considerable level of trust in local banking institutions and their advice, and maintained portfolios that contained significant stock holdings in their banks.

In the run-up to the financial crisis, many local banks in Denmark followed an aggressive growth strategy financed by equity issues to depositors. In its report, the Danish Financial Supervisory Authority (2009) concludes that investments in the bank's stocks were often encouraged by direct marketing campaigns with a one-sided focus on benefits such as capital gains, dividends, and banking privileges, with little attention to the inherent risks. Depositors were contacted directly by their bankers and offered to participate in equity issues, and in many cases, offered a loan to finance the purchase. Many depositors seemed to have placed a great deal of trust in this investment advice and purchased stock in their banks without adequately considering the potential risks or their portfolios' lack of diversification (Danish Financial Supervisory Authority, 2009). The tendency for individuals to invest in companies they frequent has been documented in prior literature (Keloharju, Knüpfer, and Linnainmaa, 2012), and is consistent with the view that such investors regard stocks as consumption goods, not just as investments.

According to the Danish Financial Supervisory Authority (2009), the decision to purchase stocks in a bank was driven primarily by the bank's own advice, and customers trusted into this advice, and allocated their entire portfolios to the stocks of their own bank. Tables 1 and 2 provide descriptive overviews of stock market participation and portfolio composition for Danes aged 20 or above in 2006. In 2006, on average, 29.7% of the population participated in the stock market by holding either stocks or mutual funds. As is consistent with prior literature, Table 1 shows that, in the cross-section, stock market participants have significantly higher income and wealth, are more likely to be male, and are older, better educated, and more often married than non-participants.

Table 2 shows the portfolio characteristics in 2006 for all stock market participants, participants who invested in their own banks, and participants who experience a default in the subsequent financial crisis. The market value of the portfolio of the average participant is 328,000 DKK (44,025 EUR), equivalent to 41.1% of their liquid wealth. The average portfolio consists of 2.6 stocks, of which bank stocks account for 0.8. In terms of individual and portfolio characteristics, our sample looks similar to other studies of individual investor behavior in the United States and other Nordic countries (Barber and Odean 2000, 2002; Grinblatt and Keloharju, 2001; Calvet, Campbell, and Sodini 2007, 2009; Hvide and Östberg, 2014).

Interestingly, more than half of all stock market participants hold stocks in their banks (61.8%), and 34.5% of all participants *only* hold stocks in their banks. As a result, the average portfolio weight allocated to bank stocks in general is 47.8%, with the majority of the exposure (43.1% out of 47.8%) tilted toward an individual's own bank.

Figure 1 provides a mapping of headquarters of publicly listed banks and bank defaults across the 98 municipalities in Denmark. Municipalities with a publicly listed local bank between 2006 and 2012 are displayed in light grey, whereas municipalities with a bank default in the aftermath of the financial crisis are shown in black. Figure 1 shows that the presence of a publicly listed local bank and local bank defaults are relatively geographically dispersed.

Table 3 relates the degree of personal experiences to changes in risk taking. The following equation is estimated:

$$\Delta\alpha_{i,t,k} = \beta X_{i,t} + \gamma E_{i,t,k} + \varepsilon_{i,t} \tag{6}$$

where the dependent variable $\Delta\alpha_{i,t,k}$ is the change in risk taking of individual *i* from year *t-k* to *t*, measured as yearly changes, $k=1$. $X_{i,t}$ is a vector of control variables, and $E_{i,t,k}$ is a vector of personal experiences gained between year *t-k* and *t*.

We consider contemporaneous personal experiences of different degrees: *First-hand experience* is an indicator taking the value one for individuals losing their investments in their own banks as a result of the banks' default.[9] *Second-hand experience* is an indicator equal to one if an individual's family member, a parent, sibling, child, in-law, or spouse had a first-hand experience. *Third-hand experience* is an indicator for individuals living in a municipality with a defaulting bank. To avoid spurious correlation arising from overlap in portfolio composition of close family members, we only code the highest degree of personal experience. Thus, if an individual has a first-hand experience, we set second-hand and third-hand experiences equal to zero.[10] The number of first-hand experiences in each year equals the number of shareholders of the banks that defaulted in that year, whereas the number of second- and third-hand experiences depends on the number of family members who are holding stocks, and the number of individuals holding stocks in the municipality of the defaulting banks, respectively.

Results in Column 1 of Table 3 suggest that personal experiences are driving the reduction in risk taking. Individuals with a first-hand experience significantly reduce their individual risk taking, whereas experiences seem to taper as they become further removed from the individual. First-hand experiences reduce the fraction of liquid wealth allocated to stocks by 8.4 percentage points on average. Second-hand experiences reduce the fraction of liquid wealth allocated to stocks by 0.6 percentage points, while the effect of third-hand experiences is both economically and statistically insignificant.

Although these results suggest that future risk taking will be lower as a result of personal experiences, the effect might, as discussed in Section 2, be confounded by inertia. In Column 2, we therefore use the passive change defined as the counterfactual change in risk taking resulting from price movements as our dependent variable. The passive change is calculated by keeping the

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[9] We focus on individuals losing their investments in their own banks, because direct marketing campaigns on bank deposition with a one-sided focus on benefits encouraged this type of investment. As a result, around 80,000 out of 105,000 (76%) investors who invested in a default bank were also customers in the bank.

[10] We note in the data that parents and children relatively commonly invest in the same stock. If children invest in their retail banks, around 15% of their parents have also invested in the same bank, while the unconditional probability is 8%. However, we also note that geography plays a large role in determining portfolio allocations. The conditional probability of investing in the same bank is 22% for individuals living in the same municipality. We address concerns about whether our results are driven by intergenerational overlaps in portfolio allocations in Section 5.

portfolio allocation at the beginning of the year constant, and calculating the counterfactual change in risk taking resulting from market movements at the end of the year. Column 2 in Table 3 reports that personal experiences are highly correlated with passive changes in risk taking. This finding is not surprising, as the variation in both variables results from changes in stock prices while holding the initial portfolio constant. Perhaps more interesting, the dependent variable in Column 3 is the active change in risk taking measured by the difference between the observed change in risk taking and the passive change. We refer to this change as the active change, which reflects that the variation derives from changes in allocations (quantities), rather than market prices. Column 3 finds no contemporaneous correlation between personal experiences and active changes in risk taking.

Finally, Figure 2 summarizes the decomposition of the observed change in risk taking into the passive and active component conditional on the level of personal experiences. Figure 2 highlights the concern that the contemporaneous relationship between personal experiences and risk taking is entirely driven by market prices through the passive channel, while the active change is economically insignificant. The lack of contemporaneous relationship between personal experiences and risk taking could motivate one to investigate the effect of personal experiences on changes in active risk taking in later periods. The main problem with this approach is that inertia will still bias the results. Inertia delays active risk taking, and the effect of inertia is therefore observationally equivalent to the hypothesized effect of personal experiences. Overall, these concerns highlight the need for an identification strategy wherein inertia cannot confound the inference between personal experiences and risk taking.

5. Personal experiences and risk taking around inheritances

To separate the effect of personal experiences from the effect of inertia, we examine the change in risk taking when individuals inherit a portfolio of risky assets.[11] The main advantage of this approach is that it alters the potential bias resulting from inertia. Fully inert individuals will passively merge the inherited portfolio into their pre-inheritance portfolio, and any deviation from this counterfactual post-inheritance portfolio results from an active choice to buy or sell assets.

If personal experiences affect risk taking negatively, we expect that those individuals are more likely to liquidate inherited portfolios and, hence, actively reduce their risk taking relative to individuals without personal experiences.

We use two samples of inheritance cases: a gross sample including all deaths, and in a robustness check, a smaller subsample including only sudden deaths. The main advantage of the latter is that windfalls are to a large degree unanticipated, and individuals *ceteris paribus* should be willing to take risk when they obtain an unexpected windfall. The disadvantage of using sudden deaths is that we obtain a smaller sample, which makes estimating the effect of personal experiences on risk taking with precision more difficult. We show results using all deaths, and have robustness results using sudden deaths in the internet Appendix F.[12]

Panel A in Table 4 summarizes the number of deaths and sudden deaths for which the deceased held stocks. We focus on deaths in the period between 2007 and 2011 because we need to observe the decedents' stock holdings prior to their deaths and identify whether the beneficiaries keep these stocks after the estate is resolved. We observe portfolio holdings at the end of the year,

[11] We do not analyze risk taking around inheritances for estates that do not hold risky assets. We are motivated to exclude these estates primarily because the effect of personal experiences and inertia are observationally equivalent, as risk taking requires an active decision which will bias results toward zero.

[12] To classify sudden deaths, Andersen and Nielsen (2011, 2012) combine relevant ICD-10 codes from related medical literature with a thorough inspection of WHO's detailed classification system. The medical literature defines sudden death as unexpected death that occurs instantaneously or within a few hours of an abrupt change in the person's previous clinical state. We use ICD-10 codes to identify causes of death that are truly sudden and unexpected by beneficiaries.

from 2006 to 2012, which limits the time window during which we can track inherited stocks to between 2007 and 2011.

The starting point of our inheritance sample is deaths that cause a household termination and, hence, an inheritance case. Household terminations occur whenever the last living member of the household dies or, in rare cases, when a couple dies in the same year. To simplify the analysis, we focus on deaths wherein the deceased have offspring, in which case the estate will, by default, be shared equally among the offspring. Estates in Denmark take an average of nine months to resolve, and The Danish Inheritance Act of 1964 requires that estates must legally be resolved within 12 months following the death (Andersen and Nielsen, 2016). Additionally, the net worth of the estate is subject to a 15% estate tax for immediate relatives if the estate's net wealth exceeds 242,400 DKK (32,500 EUR) in 2006. This threshold is inflated by a price index in subsequent years. Furthermore, any unrealized capital gains incurred by the deceased from investments are not directly taxed, and thus beneficiaries have no tax incentives to either keep or liquidate the inherited assets. Because of the relatively low estate tax and substantial cash holdings, 74% of the estates (or their beneficiaries) hold sufficient cash to settle the estate tax without selling assets.

In total, we have 80,939 household terminations between 2007 and 2011, of which 28,040 held stocks prior to their deaths. Each stock-holding estate has 1.72 beneficiaries on average, resulting in a sample of 48,104 beneficiaries who inherited stocks. Our subsample is significantly smaller and contains 8,968 beneficiaries who inherited stocks due to a sudden death.

Panel B of Table 4 reports the portfolio characteristics of the deceased as well as of the beneficiaries. We report the portfolio characteristics of all deaths and sudden deaths conditional on holding stocks prior to the death. On average, deceased individuals held stocks worth 412,500 DKK (55,400 EUR), equivalent to 34.3 percent of their liquid wealth. In the right side of Panel B, we report the portfolio characteristics of all beneficiaries of inheritances resulting from all deaths, and from sudden deaths, conditional on the deceased holding stocks. On average, beneficiaries hold stocks worth 104,300 DKK before they inherit.

In Panel C, we summarize the average beneficiary's allocation to risky assets, which corresponds to 14.3 percent of their liquid wealth. For beneficiaries who experienced a bank default, the average loss is 56,300 DKK (7,600 EUR), whereas the average inheritance of stocks is worth 250,300 DKK (33,600 EUR). Additionally, 93% of all beneficiaries who experienced a default lost significantly less than they received through the inheritance of wealth. Thus, the average beneficiary in our sample would passively take *more* risk after inheriting if they are fully inert.

Table 5 examines the effect of personal experiences on changes in risk taking around inheritances. We estimate the following equation:

$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t} \tag{7}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual i from year t-k to t+k, and year t is the year of inheritance, and k=*1*. $X_{i,t}$ is a vector of control variables, and $E_{i,b}$ is a vector of personal experiences gained before inheriting (i.e., $b<t-k$).

We measure the change in risk taking in a two-year period around the year in which a parent dies to ensure that the estate is settled, and hence that inherited wealth is transferred to the beneficiary. We use a linear regression model and control for income, net wealth, age, gender, education, indicators for being married and having children in the household, as well as year fixed-effects. Standard errors are clustered at the municipality-year level to alleviate the concern that defaults disproportionally affect specific geographic locations. Column 1 of Table 5 reports the results.

To consider the role of different personal experiences on changes in risk taking, we include the three experience indicators. To avoid spurious correlation due to inertia between personal experiences and changes in risk taking, we exclude individuals who inherit in the time period in which they have their first-, second- or third-hand experience. That is, individuals in our analysis either have their first-hand experience before year t-1 or after year t+1, but never between year t-1 and t+1, which is the period over which we measure the change in risk taking around inheritances.[13]

Column 1 in Table 5 shows that first-hand experiences reduce risk taking. Individuals who experienced a default before inheriting reduce their risk taking by 6.1 percentage points. This effect is economically and statistically significant. Second-hand experiences decrease their allocation to risky assets by 1.5 percentage points.[14] This effect is economically significant given that individuals with second-hand experiences did not lose wealth, but it is also smaller than the effect of first-hand experiences. Individuals living in a municipality with a local bank default take marginally less risk, but the effect is not statistically significant.[15] We also find effects of similar magnitude if we restrict the sample to beneficiaries who hold at least two stocks or mutual funds (see Appendix E).

In columns 2 and 3, we further examine whether the effect of personal experiences is driven by passive or active changes. The passive change is calculated as the counterfactual change in the level of risk taking if the beneficiary passively merges the inherited portfolio into his pre-inheritance portfolio and holds it until year t+1. The active change is calculated as the difference between the observed change in risk taking and the passive change. The active change therefore captures changes in the allocation of risky assets by the beneficiary. If our idea of using inheritances to overcome the potential bias of inertia is valid, we expect the effect of the personal experience on observed changes in risk taking to be driven by the active change, rather than the passive change. Columns 2 and 3 in Table 5 report the results.

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[13] Our results are stronger if we alternatively include individuals who inherit in the same period in which they have their personal experiences. In Appendix B, we report results of similar magnitude when we allow individuals to have second- or third-hand experiences before the end of our inheritance window (i.e., $b<t+1$). As explained in Section 2, we do not consider the contemporaneous effect of first-hand experiences on risk taking due to the confounding effect of inertia.

[14] In appendices C and D, we report the source and incidence of second-hand experiences. We find large effects of second-hand experiences deriving from spouse, and siblings, whereas the effects of second-hand experiences of parents, children, and in-laws are modest. Finally, the number of second-hand experiences leads to lower propensity to keep inherited stocks.

[15] In Appendix E, we include interaction terms between personal experiences and the market value of inherited stocks. Consistent with a negative effect of personal experiences on risk taking, we find that interaction terms are negative and statistically significant. While the propensity to keep inherited stocks is increasing with the market value of inherited stocks for beneficiaries in general, it does not hold for beneficiaries with first-hand experiences.

Consistent with our conjecture we find no association between first-hand experiences and passive risk taking in Column 2 of Table 5. If anything, individuals with first-hand experiences would tend to passively take more risk if they were fully inert. Column 3 of Table 3, on the other hand, shows a strong and negative effect of first-hand experiences on active changes in risk taking. Individuals with first-hand experiences actively reduce risk taking by selling inherited stocks. Thus, the change in the observed risk taking in Column 1 is driven by an active choice to take less risk, rather than a passive choice confounded by inertia. Having established that observed changes in risk taking in our setting arise from active decisions, we will for brevity report results using the observed change in risk taking as the dependent variable for the reminder of the analysis.

The underlying changes in risk taking around inheritances subject to an individual's level of experience are displayed in Figure 3. Figure 3 reports the *pre-inheritance* level of liquid assets allocated to stocks at year t-1, and the *counterfactual post-inheritance* level of risk taking if individuals passively merge their inherited portfolios into their existing portfolios. The counterfactual post-inheritance level of risk taking is calculated by merging the portfolios at year t-1, and updating market prices to year t+1. The difference between the pre-inheritance and counterfactual post-inheritance bars reveals that the average beneficiary, irrespective of personal experiences, would increase their allocation to risky assets if they are fully inert. For individuals without a personal experience, the counterfactual passive effect would increase their allocation to stocks from 29.3 to 32.6 percentage points. This consequence is a natural result of the fact that their parents, on average, allocated a higher fraction of their liquid wealth to risky assets. Thus, if individuals are fully inert, they would passively take more risk after inheriting. On the contrary, Figure 3 shows that individuals tend to make active portfolio decisions around inheritances. The *observed post-inheritance* risk taking deviates significantly from the counterfactual post-inheritance level under perfect inertia. On average, individuals without a personal experience actively reduce their allocation to risky assets by 2.2 percentage points to 30.4 percent of their liquid wealth. Although individuals on average undo two-thirds of the passive change (2.2 percentage points active change relative to a 3.3 percentage point passive change), inheritance still results in an increased allocation to risky assets by 1.3 percentage point relative to the pre-inheritance level.

Now contrast the change in risk taking for individuals without personal experiences to those with. Individuals with a first-hand experience before they inherit (i.e., before year *t*-1) would passively increase the allocation to risky assets from the pre-inheritance level of 18.5 percent to 28.5 percent if they are fully inert.[16] Instead, they actively reduce their allocation to risky assets by selling stocks. The observed post-inheritance allocation to risky assets is reduced to 17.6 percent, which is lower than their pre-inheritance level of 18.5 percent. The active change equals a reduction in risk taking by 10.9 percentage points, which is equivalent to 109 percent of the passive change. It follows that the effect of personal experiences on risk taking around inheritance results from an active choice that cannot be attributed to inertia. Finally, Figure 3 also reports the decomposition of changes for individuals with second- and third-hand experiences. Here we also note that the lower levels of risk taking result from active choices rather than inertia.

One concern with our focus on estimating the effect of personal experiences around inheritance is whether inheritances received by beneficiaries with personal experiences are somehow different from those received by beneficiaries without personal experiences. For instance, intergenerational overlaps in portfolio allocation might depend on the investment style of parents and their children. To alleviate this concern, we estimate the effect of personal experiences using a placebo test in which we look at the difference in risk taking depending on the timing of the first-hand experience relative to the inheritance. The strength of the placebo test is threefold. First, the timing of the death, and hence the inheritance case, is unrelated to the timing of the default. Second, the within-subject difference effectively eliminates the possibility that our results are driven by

[16] Note that individuals with first-hand experiences as suggested by Table 3 have lower allocation to stocks pre-inheritance as a result of the negative shock. Despite this finding, the counterfactual post-inheritance level of risk taking of 29.5 percent is close to the 32.6 percent for individuals without personal experiences, because the inherited wealth is significantly larger than the beneficiaries' pre-inheritance wealth.

partial anticipation of inheritances or investment style, while the between-subject difference effectively controls for the overall effect of the financial crisis on risk taking. Third, the placebo test approach is helpful in controlling for differences attributable to investment style and potential intergeneration overlap in portfolio allocation. For instance, individuals who invest in their banks and experience a default might be different from individuals who invest in their banks and do not experience a default. To address these concerns, we estimate the following equation:

$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma_b E_{i,b} + \gamma_a E_{i,a} + \varepsilon_{i,t} \tag{8}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual *i* from year *t-k* to *t+k*, and year *t* is the year of inheritance and *k=1*. $X_{i,t}$ is a vector of control variables, $E_{i,b}$ is a vector of personal experiences gained before the start of the inheritance window (i.e., *b<t-k*), and $E_{i,a}$ is a vector of personal experiences gained after the end of the inheritance window (i.e., *a>t*+k). The difference between γ_a and γ_b allows us to ascertain that our results are not driven by differences in investment style or differences in the inherited portfolio due to intergenerational overlaps in portfolio allocation of children and parents.

Column 1 in Table 6 shows a large difference in the change in risk taking depending on the timing of the inheritance relative to the experience. Individuals who inherit after a first-hand experience reduce their allocation of liquid assets to stocks by 6.0 percentage points, whereas individuals who will experience a first-hand experience in the future increase their exposure to stocks by 0.8 percent. The latter result also serves as a natural placebo test because the timing of the deaths is unanticipated relative to the inheritance. The placebo test suggests that lower risk taking is not an artifact of the investment style or the inherited portfolio, as individuals with investments in their banks increase their exposure to stock when the bank has not yet defaulted.

Column 2 of Table 6 shows similar results, although of smaller magnitude, for individuals with second-hand experiences, whereas the effects for third-hand experiences are economically and statistically insignificant. Finally, Column 4 confirms the results when we include all personal experiences in the same specification.

To illustrate the power of the results in Table 6, Figure 4 shows the changes in the allocation of liquid wealth to stocks for individuals with first-hand experiences conditional on the timing of the first-hand experience relative to the bank default. Individuals with a personal experience after inheritance (i.e., after year $t+1$) tend to make small active changes to their risk taking, while individuals with personal experiences before inheritance (i.e., before year t-1) tend to make large active changes by reducing the allocation to risky assets.

A natural extension of the placebo test in Table 6 is to look into whether the effect of personal experiences decays as risk taking decisions get further removed from the personal experience. Unfortunately, based on the data available, personal experiences in our sample occur either 2, 3, or 4 years before individuals inherit. Thus, we do not have statistical power to ascertain whether the effect of personal experiences decays over time.

In Table 7, we consider the effect of first-hand experiences using a matched sample to effectively rule out that the lower risk taking is driven by local macroeconomic shocks or lower pre- or post-inheritance wealth. We compare the change in the allocation of liquid wealth to stocks using Equation (7) for individuals with first-hand experiences relative to four control groups: (a) beneficiaries who hold stocks; (b) beneficiaries holding stocks who have invested in their banks and live in the default municipality but did not experience a default; (c) beneficiaries holding stocks matched to the same level of pre-inheritance wealth and value of inherited stocks; and, finally, (d) beneficiaries holding stocks matched to the same *post*-inherence levels of wealth and value of inherited stocks. The second control group is made possible by the fact that several of the municipalities with defaults also have other publicly listed local banks. The third (fourth) control group is formed by employing exact matching on the vigintile of pre-inheritance (post-inheritance) wealth distribution, and then selecting the five nearest neighbors based on the value of inherited stocks. We note that we obtain results that are consistent with the prior analysis once we address concerns about the strength of the local macroeconomic shock as well as potential differences in pre- and post-inheritance wealth. Appendix F shows results of similar magnitude for the subsample of sudden deaths. Sudden deaths are a close to random draw of individuals, and effectively rule out concerns about the timing of the inheritance relative to the bank defaults.

To gauge the magnitude of the confounding wealth change in relation to first-hand experiences, we form alternative counterfactuals in Figure 5 by varying the ratio of inherited stocks between the control and treatment groups. In Panel A, we show the effect of first-hand experiences on risk taking when we match on pre-inheritance wealth and the value of inherited stocks, as is done in Column 3 of Table 7. In the second bar of Figure 5, we change the ratio of inherited stocks to 1:2, implying that individuals with first-hand experiences by construction are matched to a counterfactual control group that inherited half the value of stocks. In the following columns, we change the ratio to 1:3, and 1:5. We note that the effect of first-hand experiences remains remarkably stable as we change the ratio. Even when individuals with first-hand experiences inherit stock worth 5 times as much as that of the control group, they are still allocating 4 percentage points less of their liquid wealth to stocks. Panel B repeats the analysis in Panel A, where we alternatively match on post-inheritance wealth and inherited stocks as in Column 4 of Table 7. We note that the results are similar to those in Panel A. Taken as a whole, Figure 5 indicates that the effect of first-hand experiences far dominates the confounding wealth effect.

Finally, we consider the effect of first-hand experiences depending on the fraction of the portfolio lost as a result of the default in Figure 6. We report counterfactual post-inheritance ratio of liquid assets allocated to stocks, the observed post-inheritance ratio, and the active change in the ratio of liquid assets allocated to stocks. All of these ratios are calculated in similar fashion as are those in Figure 5. We split into subsets individuals with first-hand experiences depending on the fraction of their portfolios lost due to default: a) less than 25%, b) 25% to 50%, c) 50% to 75%, and

d) more than 75%. We note that individuals with larger losses tend to reduce risk taking more than individuals with small losses. Individuals who lost less than 25% of their portfolios of risky assets actively reduce risk taking by 5.8 percentage points relative to their liquid wealth, whereas individuals who lost more than 75% reduce their allocation to risky assets by 13.3 percentage points.

6. Personal experiences and portfolio allocation around inheritances

In this section, we shed light on how individuals with personal experience alter their portfolio allocation across assets. We consider the effect of personal experiences on five subcategories of asset classes: directly held stocks, mutual funds, bank stocks, bonds, and cash. The first three assets address whether individuals diversify their portfolios by reducing (increasing) the portfolio allocation to directly held stocks (mutual funds), or whether they shun bank stocks. The two later assets address whether individuals reduce risk taking by increasing their allocation to bond, cash, or both. Table 8 reports the results.

Table 8 shows that individuals with first-hand experiences both reduce their direct stock holding and their holdings of mutual funds. Lower risk taking is, thus, not caused by a desire to diversify the portfolio by increasing the allocation to mutual funds. Rather than responding appropriately to their personal experience by diversifying their portfolios, individuals shy away from risk taking as our title suggests: once bitten, twice shy. In Column 3, we note that close to two thirds of the reduction in the portfolio allocation to directly held stocks is caused by a reduction of the allocation to bank stocks. Although, individuals shun bank stocks, we note that the reduced risk taking is thus not entirely concentrated among bank stocks, as we find an effect for mutual funds as well. Finally, columns 4 and 5 show that individuals with first-hand experiences subsequently allocate a higher share of their portfolio to cash (i.e., bank deposits), while the effect for bonds is negative and statistically insignificant. Overall, Table 8 shows that individuals with personal experiences reduce risk taking by lowering their portfolio allocation to risky assets and increasing the portfolio allocation to safe assets.

To illustrate the change in the portfolio allocation toward safe assets, Figure 7 shows the change in the fraction of liquid wealth in cash around inheritances. We note that, consistent with the results in tables 5 and 8, as well as in Figure 3, individuals with first-hand experiences actively increase their allocation of liquid wealth to cash. While this figure shows the allocation relative to liquid wealth, it should be noted that the level of cash holding is also increasing.

7. Alternative experiences with banks and defaults

One important question that arises from our analysis is whether the effect of personal experiences is driven by financial losses, or whether the losses due to bank defaults are particularly discouraging for future risk taking—perhaps because individuals lose trust in the financial system. In this section we attempt to address this issue by considering three alternative counterfactuals.

The first alternative counterfactual we consider is whether the effect of personal experiences is driven by liquidity constraints. Following the default of their retail banks, individuals with first-hand experiences might reduce risk taking if the default causes them to become liquidity constrained. To address this concern, we identify individuals who are depositors in, but have not invested in, a bank that defaults. We refer to these individuals as having a *first-hand depositor experience*. Column 1 of Table 9 reports the results when we jointly assess the effect of first-hand experiences and first-hand depositor experiences on risk-taking. We note that individuals who were depositors in a default bank, but who had not invested in the default bank, reduce their allocation of liquid wealth to risky assets by 0.1 percentage points. The difference in the change in risk taking between individuals with first-hand experiences and individuals with first-hand depositor experiences is significant at the one-percent level. We conclude that the effect of personal experiences on risk taking is not caused by liquidity constraints.

The second counterfactual experience we consider is whether individuals shy away from risk-taking when they inherit from an estate with bank stocks as opposed to from an estate without bank stocks. Column 2 of Table 9 shows that in both cases individuals reduce their risk taking. Although individuals reduce their risk taking more when they inherit from an estate with bank stocks (6.9 percentage points lower risky asset share), we still find economically significant effects for individuals who inherit from an estate that did not hold stocks. Individuals with first-hand experiences who inherit from an estate without stocks still reduce their allocation of liquid wealth to risky assets by 4.3 percentage points relative to a baseline allocation of liquid wealth to risky assets of around 30 percent.

The third and final counterfactual experience we consider is default of non-bank stocks. In total we have identified 6 non-bank defaults between 2007 and 2011. The 6 non-bank defaults have around 5,000 individual investors, of which 55 receive an inheritance after the default experience. Column 3 in Table 9 compares the effect of personal experiences with bank and non-bank defaults on individual risk taking. The individuals with a first-hand experience with a non-bank default reduce their allocations to risky assets by 2 percentage points, which is significantly lower than the 6.1 percentage point reduction we observe for individuals with first-hand experiences with bank defaults. The difference of 4.1 percentage points is economically as well as statistically significant. Although we find results that suggest that bank defaults have a stronger negative effect on risk taking, the main caveat is the limited number of observations for non-bank defaults, making it difficult to estimate standard errors with precision.

8. Alternative specifications

One may be concerned that under-diversified investors or investors who are financially or liquidity constrained may drive the effect of personal experiences on risk taking. We pursue a series of alternative specifications of personal experiences and control variables in Equation 7 to address these concerns and present the results in Table 10. For brevity, we display the marginal effects and standard errors of our three variables of interest, *first-hand, second-hand,* and *third-hand experience,* while controlling for (unreported) demographic characteristics and time effects. In Panel A, the dependent variable is the observed change in risk taking, whereas the dependent variables in Panel B and Panel C are the passive and active change, respectively.

We begin with our baseline results from Column 1 of Table 5 in Specification (1). In Specification (2), we control for the amount lost for individuals with first-hand experiences. In Specification (3), we control for individuals who have negative or zero net wealth at the time of their inheritances by including an indicator variable for *financially constrained* and its interaction term with *first-hand experience*. In Specification (4), we include a similar variable, *liquidity constrained,* and its interaction term with *first-hand experience*. The variable captures the effect of having less than 10,000 DKK (1,340 EUR) in bank deposits available for immediate consumption.

Specification (5) addresses concerns about the confounding effect of limited depositors insurance. We drop any beneficiaries if they held bank deposits over the amount of the government guarantee and subsequently lost deposits due to the default. For most of the defaults, the government guaranteed all deposits, whereas in a few cases the binding level was 750,000 DKK (around 100,000 EUR). As a result, only 8 beneficiaries in our inheritance sample eventually lost part of their bank deposits due to the default. We note that limited depositor insurance does not affect our results.

We control for unemployment spells in Specification (6) by including an indicator variable that takes the value one if an individual was unemployed at any point during the year of inheritance or the year before. These results are robust if we alternatively measure unemployment as the percentage of the year an individual is unemployed.

In Specification (7), we redefine the *first-hand experience* as an experience that either the beneficiary or his or her spouse had, and redefine *second-hand experience* to exclude the experiences of the spouse in this estimation. In Specification (8), we redefine the *third-hand experience* to include neighboring municipalities to the municipality where the default bank is headquartered. Regardless of the alternative specifications, first-hand experiences affect future risk taking significantly, consistent with our previous findings.

Finally, we have in unreported regressions assessed whether lower risk taking is driven by estate taxes. While the vast majority of estates can settle the estate tax without selling assets, it still remains a possibility that beneficiaries with first-hand experiences due to their wealth loss have to sell assets to incur the estate tax. If we restrict the sample to inheritance cases where either the estate or the beneficiaries hold sufficient cash to settle the estate tax without selling assets, we find results of comparable magnitude.

9. Conclusion

In this study we examine the effect of personal experiences on risk taking in the aftermath of the financial crisis. As a plausible negative personal experience, we identify individuals who followed the advice of their banks and suffered significant investment losses when the bank subsequently defaulted. We show that individuals with negative personal experiences in the stock market take significantly lower risk in the future. We do this using an identification strategy that allows us to separate the effect of individual experiences from the confounding effect of inertia. Our findings provide evidence that first-hand experiences have a causal and sizeable effect on future risk taking, while the magnitude of second- and third-hand effects are substantially smaller.

We show that the degree of personal experiences can explain substantial heterogeneity in individuals' investment decisions.

Our results also document the challenge posed by inertia when estimating the effect of personal experiences on risk taking. In particular, we highlight the concern that the contemporaneous relationship between personal experiences and risk taking is biased by inertia. Because inertia is observationally equivalent to the hypothesized effect of personal experiences, it is problematic to interpret correlations between personal experiences deriving from movement in market prices and risk taking as causal evidence. To overcome this challenge, we rely on changes in risk taking around inheritances, where inertia is no longer observationally equivalent to the hypothesized effect of inertia. Our results show a causal effect of personal experience by oneself on active risk taking of sizeable magnitude.

Our study documents that the financial crisis resulted in lower future risk taking, as is evidenced by the generation of Depression babies. Personal experiences in our study can be measured at the individual level, and our results suggest that cohort effects are driven primarily by first-hand experiences, rather than by common experiences. The welfare costs of the lower levels of risk taking are likely to be substantial and will lead to significantly lower lifetime consumption. The evidence also raises the question of how and what individuals learn from their past investment experiences. An appropriate response to the personal experiences documented in this study is to diversify the portfolio. Rather, individuals seem to shy away from risk taking and react as suggested by our title: once bitten, twice shy.

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Table 1: Individual characteristics

We report descriptive statistics: mean and standard deviation for all individuals in our sample for 2006. For each individual, we observe *risky asset share* (i.e., fraction of liquid assets allocated to stocks and mutual funds), *income after tax*, *net wealth*, *age*, *gender*, *education* (years of schooling), *marital status*, and whether there are *children in the household*. We compare the mean characteristics of stock market participants and non-participants and test whether these differences are significantly different from zero. Corresponding *t*-statistics are reported in square brackets. All amounts are in thousands year-2010 DKK. One EUR is equal to 7.45 DKK. Standard deviations are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels by standard *t*-tests, respectively.

	All	**Stock market participation**		**Difference**
		Yes	**No**	
		(1)	(2)	(1)-(2)
Stock market participation (%)	29.7	100.0	0.0	-
	(45.7)	-	-	-
Risky asset share (%)	12.2	41.1	0.0	-
	(24.1)	(27.8)	-	-
Income after tax (1,000 DKK)	290.4	328.4	274.4	54.0***
	(535.0)	(583.5)	(512.2)	[93.1]
Net wealth (1,000 DKK)	573.6	1236.2	293.2	943.0***
	(5710.7)	(10211.3)	(1423.8)	[152.5]
Age (years)	49.1	54.3	46.9	7.4***
	(17.4)	(17.3)	(17.0)	[400.1]
Gender (% male)	48.9	51.4	47.8	3.5***
	(50.0)	(50.0)	(50.0)	[65.1]
Education (years)	11.4	11.8	11.3	0.5***
	(4.0)	(4.0)	(3.8)	[127.0]
Married (%)	52.8	57.4	50.9	6.4***
	(49.9)	(49.5)	(50.0)	[118.9]
Children in household (%)	31.3	24.3	34.2	-9.9***
	(46.4)	(42.9)	(47.4)	[-197.1]
N	4,060,510	1,207,278	2,853,232	

Table 2: Portfolio characteristics

We report descriptive statistics of individuals' portfolio characteristics: mean and standard deviation for all individuals who hold stocks in 2006. We report *risky asset share*, *market value* of shareholdings, and the composition of the portfolio including the *number of stocks* and *number of bank stocks*; and whether or not the individual *invested in own banks stock*, an indicator equal to one for individuals who *only invested in own bank stock*, the *fraction in bank stocks* relative to all shareholdings, and an indicator equal to one for individuals who *invested in mutual funds*. We compare the mean characteristics of individuals who invest in their own banks, depending on whether or not the bank defaults between 2008 and 2012, and test whether these differences are significantly different from zero. Corresponding *t*-statistics are reported in square brackets. All amounts are in thousands year-2010 DKK. Standard deviations are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels by standard *t*-tests, respectively.

	All	**Invested in own bank**	**Future default bank experience**		**Diff.**
			Yes	**No**	
			(1)	(2)	(1)-(2)
Risky asset share (%)	41.1	40.0	42.7	39.7	3.0***
	(27.8)	(28.4)	(28.9)	(28.3)	[27.4]
Market value (1,000 DKK)	327.7	345.6	368.2	343.1	25.1
	(9495.2)	(11873.7)	(3942.1)	(12428.6)	[0.5]
Number of stocks	2.6	2.6	2.8	2.6	0.2***
	(3.1)	(3.3)	(4.3)	(3.1)	[19.3]
Number of bank stocks	0.8	1.2	1.4	1.1	0.2***
	(0.7)	(0.5)	(0.9)	(0.4)	[114.5]
Invested in own bank stock (%)	61.8	100.0	100.0	100.0	-
	(48.6)	-	-	-	-
Only invested in own bank stock (%)	34.5	58.8	53.4	56.0	-2.6***
	(47.5)	(49.7)	(49.9)	(49.6)	[-13.4]
Fraction in bank stocks (%)	47.8	71.4	76.4	70.8	5.5***
	(46.1)	(38.9)	(35.5)	(39.2)	[36.4]
Fraction in own bank stock (%)	43.1	69.6	73.4	69.2	4.2***
	(46.0)	(39.7)	(37.3)	(39.9)	[26.9]
Invested in mutual funds (%)	44.4	32.6	27.7	33.1	-5.4***
	(49.7)	(46.9)	(44.8)	(47.1)	[-29.5]
N	1,207,278	746,465	72,463	674,002	

Table 3: The effect of personal experiences on changes in risk taking

This table relates the degree of personal experiences to changes in risk taking. The following equation is estimated:

$$\Delta\alpha_{i,t,k} = \beta X_{i,t} + \gamma E_{i,t,k} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha_{i,t,k}$ is the change in risk taking of individual *i* from year *t-k* to *t*, measured as yearly changes, $k=1$. In Column 1 the dependent variable is the *observed change* in the fraction of liquid assets allocated to stocks and mutual funds from year *t-1* to year *t*. In columns 2 and 3, the dependent variable is the change in the *passive* and the *active* component of the observed change in the risky asset share. The passive component of the observed change in risky asset share is the counterfactual change in risky asset share due to changes in stock prices from year *t-1* to *t*, while keeping holdings constant at the year *t-1* allocation. The active component is the observed change in risky asset share less the change due to the passive component. $X_{i,t}$ is a vector of control variables, and $E_{i,t,k}$ is a vector of personal experiences gained from year *t*-1 to *t*. We consider the following personal experiences: *First-hand experience* is an indicator for personal experiences due to the loss of investments in a defaulted bank. *Second-hand experience* is an indicator for first-hand experiences in the immediate family (parent, sibling, child, or spouse). *Third-hand experience* is an indicator for individuals who are living in a municipality with a bank default. For each individual, we code the highest degree of personal experience and set lower degrees of personal experiences (if any) to zero. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). Standard errors are in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively, using standard errors clustered at the level of municipality-year.

Dependent variable	**Observed change**	**Passive change**	**Active Change**
	(1)	(2)	(3)
First-hand experience	-0.084***	-0.085***	0.001
	(0.015)	(0.014)	(0.001)
Second-hand experience	-0.006***	-0.003**	-0.004***
	(0.001)	(0.001)	(0.001)
Third-hand experience	-0.002	0.001	-0.003***
	(0.001)	(0.002)	(0.001)
Control variables	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes
Pseudo R^2	0.051	0.064	0.015
N	6,835,546	6,835,546	6,835,546

Table 4: Inheritance characteristics

This table reports descriptive statistics for inheritance cases from 2007 to 2011 subject to whether the estate holds stocks, and whether the estate's beneficiaries have first-hand experiences. Panel A reports the total number of estates and beneficiaries for all deaths and sudden deaths. Sudden deaths are defined as household terminations where the cause of death is sudden and unanticipated. Panel B reports portfolio characteristics of estates with stocks and beneficiaries associated with these estates. We observe the year-end market value of shareholdings and risky asset share. Panel C reports the inheritance characteristics of the beneficiaries who inherit stocks subject to their prior first-hand experiences *First-hand experience* is an indicator for personal experiences due to the loss of investments in a defaulted bank. *Second-hand experience* is an indicator for first-hand experiences in the immediate family (parent, sibling, child, or spouse). *Third-hand experience* is an indicator for individuals who are living in a municipality with a bank default. *Inheritance offsets loss from default* is an indicator taking the value one when the value of inherited stocks exceeds the lost investment from default. All amounts are in thousands year-2010 DKK. One Euro is equal to 7.45 DKK.

A. Household terminations	**All deaths**	**All deaths with stocks**	**Sudden deaths**	**Sudden deaths with stocks**
Number of estates	80,939	28,040	14,683	5,262
Number of beneficiaries	141,469	48,104	25,261	8,968

B. Portfolio characteristics	**Estates with stocks**		**Beneficiaries who inherit stocks**	
	All deaths	**Sudden deaths**	**All**	**Sudden deaths**
Market value of stocks (1,000 DKK)	412.5	375.3	104.3	101.7
	(4238.0)	(1588.2)	(894.2)	(502.4)
Risky asset share (%)	34.3	33.9	14.3	14.9
	(23.2)	(23.5)	(24.6)	(24.9)
N	28,040	5,262	48,104	8,968

C. Inheritance characteristics	**Personal experience**			
	First-hand	**Second-hand**	**Third-hand**	**None**
Market value of stocks before inheritance (1,000 DKK)	150.0	86.6	185.2	102.4
	(426.8)	(372.8)	(2362.4)	(838.8)
Market value of inherited stocks (1,000 DKK)	250.3	186.4	487.1	222.9
	(1358.8)	(437.7)	(6483.7)	(1745.4)
Lost investment from default (1,000 DKK)	56.3	-	-	-
	(162.8)			
Fraction of portfolio lost (%)	62.5	-	-	-
	(40.7)			
Inheritance offsets loss from default (%)	91.6	-	-	-
	(630.2)			
N	331	1,113	1,111	45,549

Table 5: Personal experience effects on risk taking

This table reports the effect of personal experiences on changes in risk taking around inheritances. We estimate the following equation:

$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual i from year t-k to t+k, and year t is the year of inheritance and k=1. In Column 1, the dependent variable is the *observed change* in the fraction of liquid assets allocated to stocks and mutual funds from year t-1 to year t+1. In columns 2 and 3, the dependent variable is the change in the *passive* and the *active* component of the observed change in the risky asset share. The passive component of the observed change in risky asset share is the counterfactual change in risky asset share due to changes in stock prices from year t-1 to t, while keeping holdings constant at the year t-1 allocation. The active component is the observed change in risky asset share less the change due to the passive component. $X_{i,t}$ is a vector of control variables, and $E_{i,b}$ is a vector of personal experiences gained before the start of the inheritance window, i.e., b<t-1. Individuals with personal experiences within the inheritance window are excluded from the sample. *First-hand experience* is an indicator for personal experiences due to the loss of investments in a defaulted bank. *Second-hand experience* is an indicator for first-hand experiences in the immediate family (parent, sibling, child, or spouse). *Third-hand experience* is an indicator for individuals who are living in a municipality with a default bank. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also includes the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively, using standard errors clustered at the level of municipality-year.

Dependent variable	**Observed change**	**Passive change**	**Active change**
	(1)	(2)	(3)
First-hand experience	-0.061***	0.038	-0.068***
	(0.013)	(0.024)	(0.020)
Second-hand experience	-0.015***	-0.027***	0.007
	(0.001)	(0.010)	(0.008)
Third-hand experience	-0.001	-0.002	0.006
	(0.005)	(0.008)	(0.009)
Control variables	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes
Pseudo R^2	0.160	0.105	0.142
N	48,104	48,104	48,104

Table 6: Timing of personal experience effects on risk taking

This table reports the effect of personal experiences on changes in risk taking around inheritances. We estimate the following equation:

$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma_b E_{i,b} + \gamma_a E_{i,a} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual i from year t-k to t+k, and year t is the year of inheritance, and k=1. $X_{i,t}$ is a vector of control variables, $E_{i,b}$ is a vector of personal experiences gained before the start of the inheritance window, i.e., b<t-1, and $E_{i,a}$ is a vector of personal experiences gained after the end of the inheritance window, i.e., a>t+1. Individuals with personal experiences within the inheritance window are excluded from the sample. The dependent variable is the *observed change* in the fraction of liquid assets allocated to stocks and mutual funds from year t-1 to year t+1. *First-hand experience before inheritance* is an indicator for individuals who experienced the default of their own banks before they inherited. *First-hand experience after inheritance* is an indicator for individuals who experienced the default of their own bank after they inherited. *Second-hand experience before inheritance* is an indicator for first-hand experiences in the immediate family before they inherited (parent, sibling, child, or spouse). *Second-hand experience before inheritance* is an indicator for first-hand experiences in the immediate family after they inherited (parent, sibling, child, or spouse). *Third-hand experience before inheritance* is an indicator for individuals who are living in a municipality with a default bank before inheritance. *Third-hand experience after inheritance* is an indicator for individuals who are living in a municipality with a default bank after inheritance. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also includes the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively, using standard errors clustered at the level of municipality-year.

Dependent variable	**Observed change**			
	(1)	(2)	(3)	(4)
First-hand experience before inheritance	-0.060***			-0.061***
	(0.013)			(0.013)
First-hand experience after inheritance	0.008			0.001
	(0.014)			(0.016)
Second-hand experience before inheritance		-0.015***		-0.015***
		(0.007)		(0.007)
Second-hand experience after inheritance		0.010		0.011
		(0.008)		(0.009)
Third-hand experience before inheritance			0.003	-0.001
			(0.005)	(0.003)
Third-hand experience after inheritance			-0.006*	-0.006*
			(0.003)	(0.003)
Control variables	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes
Pseudo R^2	0.160	0.160	0.160	0.161
N	48,104	48,104	48,104	48,104

Table 7: Matched sample estimate of the effect personal experiences on risk taking

This table reports the effect of personal experiences on risk taking using a matched sample approach. We estimate the following equation:

$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual *i* from year *t-k* to *t+k*, and year *t* is the year of inheritance and *k=1*. $X_{i,t}$ is a vector of control variables, $E_{i,b}$ is a vector of personal experiences gained before the start of the inheritance window, i.e., b<*t*-1. Individuals with personal experiences within the inheritance window are excluded from the sample. The dependent variable is the *observed change* in the fraction of liquid assets allocated to stocks and mutual funds from year *t-1* to year *t+1*. The treatment group consists of investors with first-hand experiences before the start of the inheritance window, while the control group is a matched sample of beneficiaries without first- or second-hand experiences. In Column 1 the matched control group consists of stock market participants, while the control group in Column 2 includes investors in banks with third-hand experiences (individuals who are living in a municipality with a bank default). In Column 3 the control groups consist of individuals who hold stocks and are from the same vigintile of the pre-inheritance wealth distribution. In Column 4, the control group consists of individuals who hold stocks and are from the same vigintile of the post-inheritance wealth distribution. Among the matches in columns 3 and 4, we use the five closest neighbors based on the value of inherited stocks. *First-hand experience* is an indicator for individuals who experienced the default of their own banks before inheritance. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also includes the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	**Observed change**			
Control group	Stock market participants	Invested in own bank & third-hand experience	Pre-inheritance wealth & inherited wealth	Post-inheritance wealth
	(1)	(2)	(3)	(4)
First-hand experience	-0.065***	-0.092***	-0.070***	-0.067***
	(0.016)	(0.013)	(0.016)	(0.018)
Control variables	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes
Pseudo R^2	0.252	0.330	0.260	0.285
N	1,272	517	1,272	1,272

Table 8: Effect of personal experiences on portfolio allocation

This table reports the effect of personal experiences on the portfolio allocation to different asset classes. We estimate the following equation:

$$\Delta\alpha^{c}_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha^{c}_{i,t,2k}$ is the change in the fraction of liquid wealth allocated to asset class subcategory c of individual i from year t-k to t+k, and year t is the year of inheritance and $k=1$. We consider the following subcategories of asset classes in columns 1 through 5: *directly held stocks*, *mutual funds*, *bank stocks*, *bonds,* and *cash*. Allocations to subcategories of asset classes are all measured relative to liquid wealth. *First-hand experience* is an indicator for personal experiences due to the loss of investments in a defaulted bank. *Second-hand experience* is an indicator for first-hand experiences in the immediate family (parent, sibling, child, or spouse). *Third-hand experience* is an indicator for individuals who are living in a municipality with a default bank. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, we include the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively, using standard errors clustered at the level of municipality-year.

Dependent variable	**Observed change in allocation to …**				
	Directly held stocks	Mutual funds	Bank stocks	Bonds	Cash
	(1)	(2)	(3)	(4)	(5)
First-hand experience	-0.038***	-0.023**	-0.025***	-0.017	0.078***
	(0.011)	(0.011)	(-0.009)	(0.016)	(0.024)
Second-hand experiences	-0.012**	-0.003	-0.017***	-0.001	0.016*
	(0.006)	(0.004)	(0.005)	(0.004)	(0.009)
Third-hand experiences	0.001	0.001	-0.001	-0.006	0.005
	(0.005)	(0.003)	(0.006)	(0.005)	(0.007)
Control variables	Yes	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.107	0.056	0.082	0.012	0.120
N	48,104	48,104	48,104	48,104	48,104

Table 9: Alternative personal experiences deriving from banks and defaults

Each column of this table introduces alternative personal experiences deriving from banks and defaults. We estimate the following equation:

$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual *i* from year *t-k* to *t+k*, and year *t* is the year of inheritance and *k=1*. The dependent variable is the *observed change* in the fraction of liquid assets allocated to stocks and mutual funds from year *t-1* to year *t+1*. $X_{i,t}$ is a vector of control variables, and $E_{i,b}$ is a vector of personal experiences gained before the start of the inheritance window, i.e., b<*t-1*. Individuals with personal experiences within the inheritance window are excluded from the sample. *First-hand experience* is an indicator for individuals who experienced the default of their own bank. *First-hand depositor experience* is an indicator for individuals who were depositors, but did not hold stocks, in a default bank. *First-hand experience & estate with bank stocks* is an indicator for individuals who experienced the default of their own banks and inherit from an estate that hold bank stocks. *First-hand experience & estate without bank stocks* is an indicator for individuals who experienced the default of their own banks and inherit from an estate that did not hold bank stocks. *Non-bank default experience* is an indicator for individuals who experienced the default of a non-bank. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, we include the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	**Observed change**		
Specification	Bank depositor	Bank vs. non-banks stocks	Non-bank defaults
	(1)	(2)	(3)
First-hand experience	-0.060***		-0.061***
	(0.013)		(0.013)
First-hand depositor experience	-0.001		
	(0.011)		
First-hand experience & estate with bank stocks		-0.069***	
		(0.016)	
First-hand experience & estate without banks stocks		-0.043*	
		(0.025)	
Non-bank default experiences			-0.020
			(0.037)
Control variables	Yes	Yes	Yes
Year effects	Yes	Yes	Yes
Pseudo R^2	0.160	0.166	0.160
N	48,104	48,104	48,104

Table 10: Alternative specifications

Each column of this table represents an alternative specification of our main regressions (Table 5) by including new control variables or using alternative definitions of the variables of interest. We estimate the following equation: $\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t}$

where $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual *i* from year *t-k* to *t+k*, and year *t* is the year of inheritance and *k=1*. The dependent variable in Panel A is the change in risk taking measured by the observed change in the fraction of liquid assets allocated to stocks and mutual funds. The dependent variable in Panel B is the change in the passive component of the risky asset share, and in Panel C, the change in the active component of the risky asset share. $X_{i,t}$ is a vector of control variables, and $E_{i,b}$ is a vector of personal experiences gained before the start of the inheritance window, i.e., $b<t-1$. Individuals with personal experiences within the inheritance window are excluded from the sample. Specification (1) reports our baseline results from columns 1, 2, and 3 of Table 5 to facilitate a comparison to the results in columns 2 to 9 of panels A, B, and C, respectively. In specifications (2), (3), and (4), we add controls for *fraction of wealth lost*, an indicator for *financially constrained* individuals who have negative net wealth, and an indicator for *liquidity constrained* with less than 5,000 DKK (670 EUR) in bank deposits, respectively. In Specification (5), we drop beneficiaries if their bank deposits exceeded the amount covered by the government depositor insurance system. In Specification (6), we control for unemployment spells by including an indicator for individuals who are unemployed during the year or the year before. In Specification (7), we redefine the *first-hand experience* to the household level by including the experience of the spouse, and redefine *second-hand experience* to exclude the experiences of the spouse. Finally, in Specification (8) we redefine the *third-hand experience* to include neighboring municipalities to the municipality where the default bank was headquartered. Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Specification	Baseline	Fraction of wealth lost	Financially constrained	Liquidity constrained	Depositors insurance	Unemploy-ment spells	Household experience	Extended third-hand experience
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A. Observed change								
First-hand experience	-0.061***	-0.053**	-0.047***	-0.044***	-0.062***	-0.061***	-0.029**	-0.063***
	(0.013)	(0.025)	(0.014)	(0.013)	(0.013)	(0.013)	(0.012)	(0.013)
Second-hand experience	-0.015**	-0.015**	-0.015**	-0.015**	-0.015**	-0.015**	-0.012*	-0.016**
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Third-hand experience	0.001	0.001	0.002	0.002	0.001	0.001	0.002	0.005
	(0.005)	(0.005)	(0.005)	(0.005)	-(0.005)	(0.005)	(0.005)	(0.005)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.160	0.160	0.160	0.161	0.160	0.160	0.160	0.161
N	48,104	48,104	48,104	48,104	48,096	48,104	48,104	48,104

B. Passive change								
First-hand experience	0.038	0.012	0.040	0.038**	0.032	0.038	0.044**	0.037
	(0.024)	(0.038)	(0.024)	(0.019)	(0.024)	(0.024)	(0.018)	(0.024)
Second-hand experience	-0.027**	-0.027**	-0.027**	-0.028***	-0.027**	-0.027**	-0.030***	-0.027**
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)
Third-hand experience	-0.002	-0.002	-0.002	-0.003	-0.002	-0.003	-0.002	0.004
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.105	0.105	0.105	0.115	0.105	0.106	0.105	0.105
N	48,104	48,104	48,104	48,104	48,096	48,104	48,104	48,104
C. Active change								
First-hand experience	-0.068***	-0.068**	-0.057***	-0.051***	-0.062***	-0.068***	-0.043***	-0.067***
	(0.020)	(0.029)	(0.017)	(0.015)	(0.019)	(0.020)	(0.014)	(0.020)
Second-hand experience	0.007	0.007	0.007	0.008	0.007	0.007	0.011	0.007
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Third-hand experience	0.006	0.006	0.006	0.007	0.006	0.007	0.008	-0.002
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.004)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pseudo R^2	0.142	0.142	0.142	0.151	0.142	0.143	0.160	0.142
N	48,104	48,104	48,104	48,104	48,096	48,104	48,104	48,104

Figure 1: Location of local banks and incidences of bank defaults in Denmark

This map shows the location of publicly trading retail banks and incidences of bank defaults across municipalities in Denmark from 2006 to 2012 based on bank headquarters. Municipalities in which a retail bank defaulted between 2008 and 2012 are displayed in black. Municipalities with a surviving publicly listed bank are displayed in grey. Municipalities without a publicly listed retail bank are shown in the lightest grey.

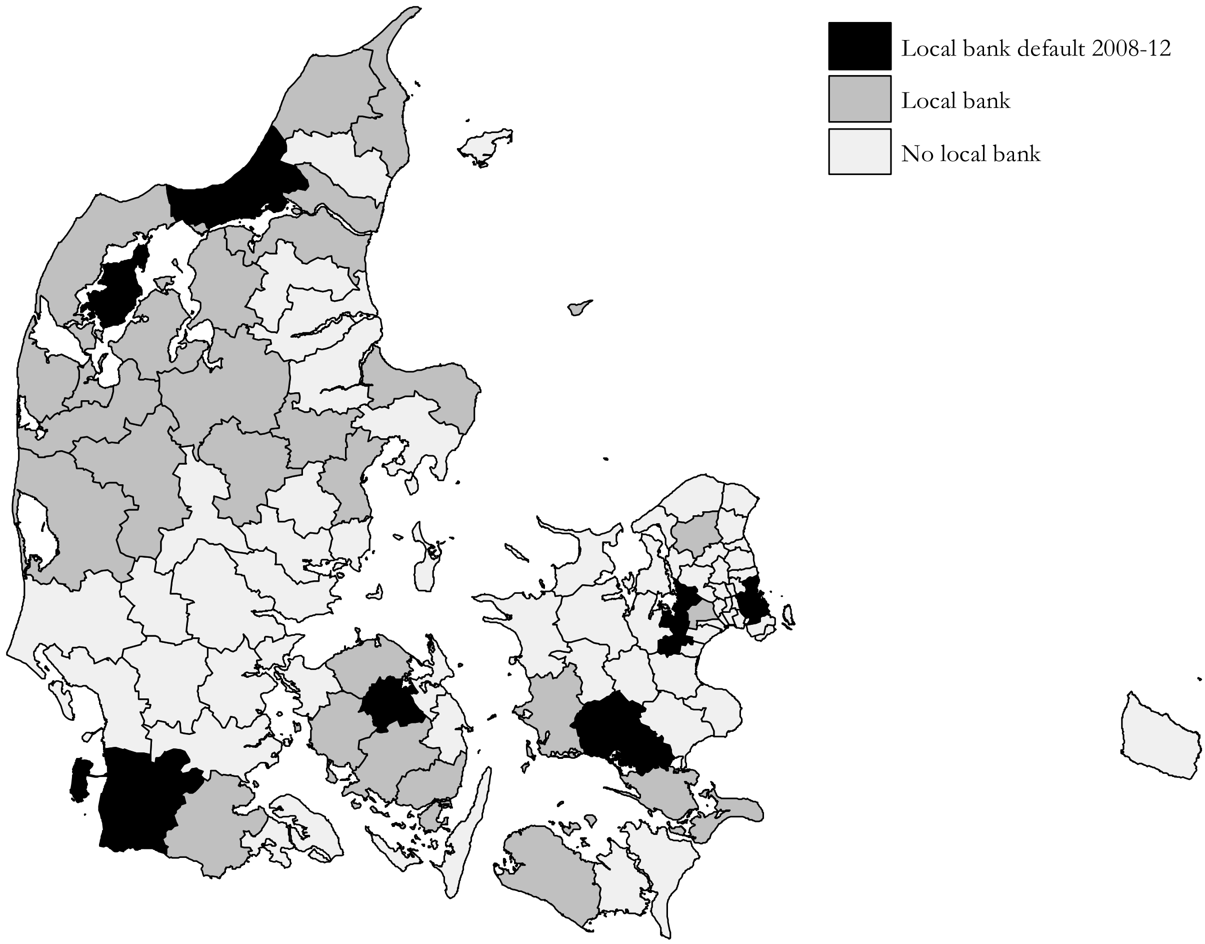


Figure 2: Degree of experience and portfolio rebalancing

This graph decomposes the year-to-year change in the fraction of liquid assets allocated to stocks and mutual funds into the active and passive change of the risky asset share. The passive component of the risky asset share is given by the changes in prices, holding constant the underlying assets, while the active component is the observed actual risky asset share less the passive component. The graph shows the average changes for all participants depending on their degree of personal experience. *First-hand* experiences derive from personal losses, *second-hand* experiences from losses in the close family, and *third-hand* experiences from living in municipalities where banks defaulted.

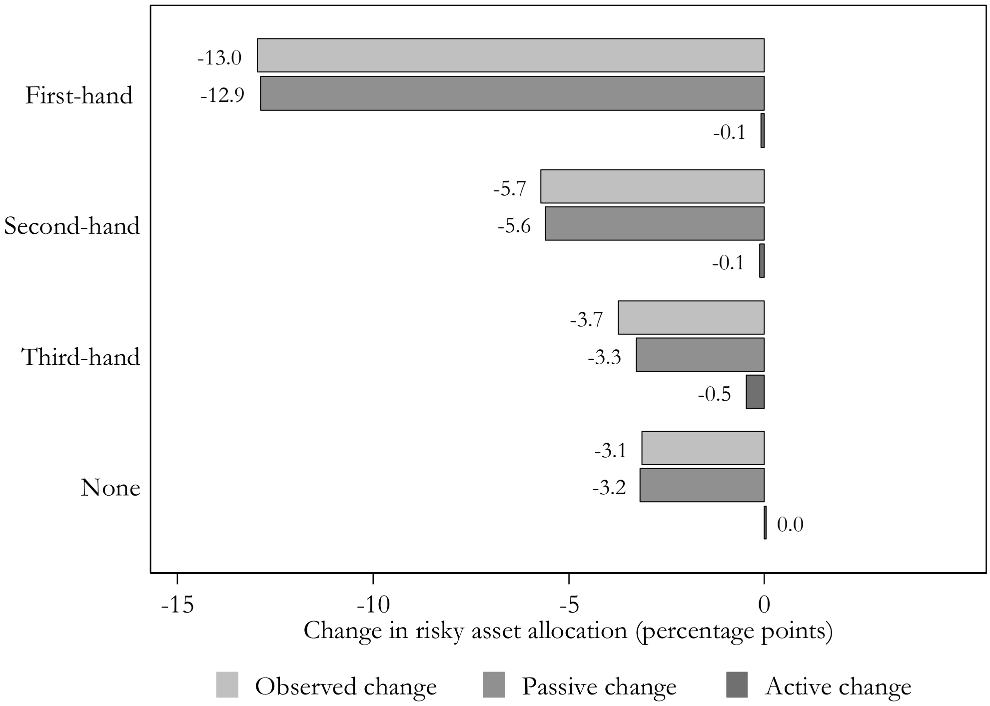


Figure 3: Degree of experience and portfolio rebalancing around inheritances

This graph decomposes the change in the fraction of liquid assets allocated to stocks and mutual funds around inheritances into the counterfactual passive and active changes. We report the pre-inheritance ratio of liquid assets allocated to stocks and mutual funds, the counterfactual post-inheritance ratio of liquid assets allocated to stocks and mutual funds, the observed post-inheritance ratio, and the active change in the ratio of liquid assets allocated to stocks and mutual funds. The counterfactual post-inheritance level of risk taking is calculated by merging the beneficiaries' portfolios with the inherited portfolio in year *t*-1, and updating it with market prices in year *t*+1. The active change is calculated as the difference between the observed post-inheritance risk taking and the counterfactual post-inheritance level. *First-hand* experiences derive from personal losses, *second-hand* experiences from losses in the close family, and *third-hand* experiences from living in municipalities where banks defaulted.

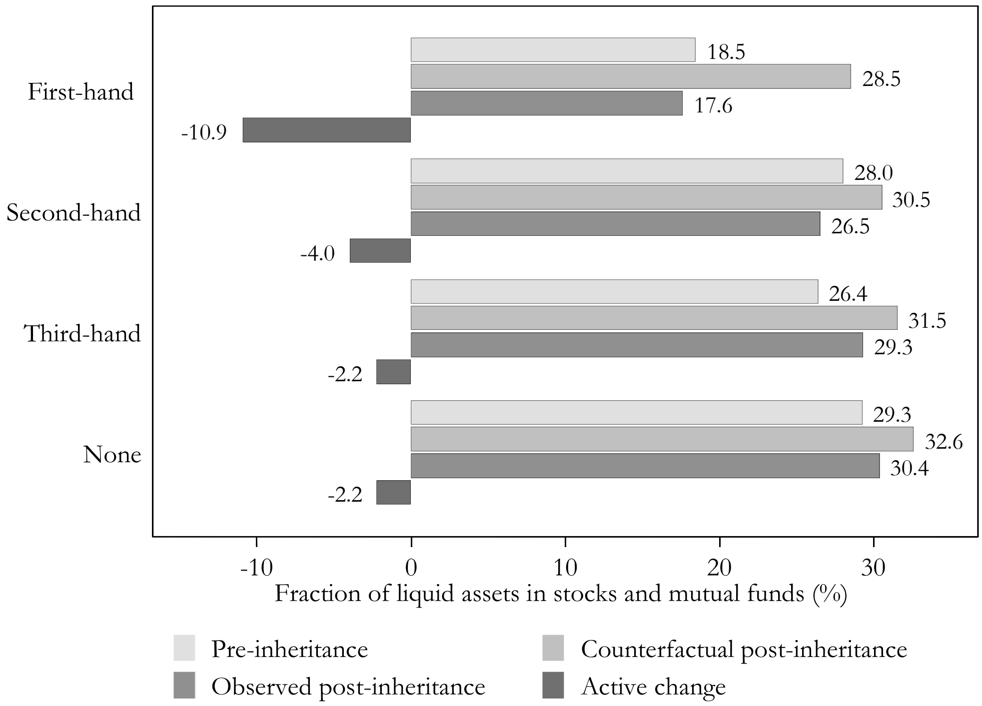


Figure 4: Timing of inheritance relative to personal experience

This figure shows the effect of personal experiences on risk taking conditional on the timing of the inheritance relative to the personal experiences. *Inheritance before default* is a placebo-test, whereas *inheritance after default* is the treatment effect. *First-hand experiences* derive from personal losses, *second-hand experiences* from losses in the close family, and *third-hand experiences* from living in municipalities where banks defaulted. We report counterfactual post-inheritance ratio of liquid assets allocated to stocks and mutual funds, the observed post-inheritance ratio, and the active change in the ratio of liquid assets allocated to stocks and mutual funds. The counterfactual post-inheritance level of risk taking is calculated by merging the beneficiaries' portfolios with the inherited portfolio in year *t-1*, and updating it with market prices in year *t+1*. The active change is calculated as the difference between the observed post-inheritance risk taking and the counterfactual post-inheritance level.

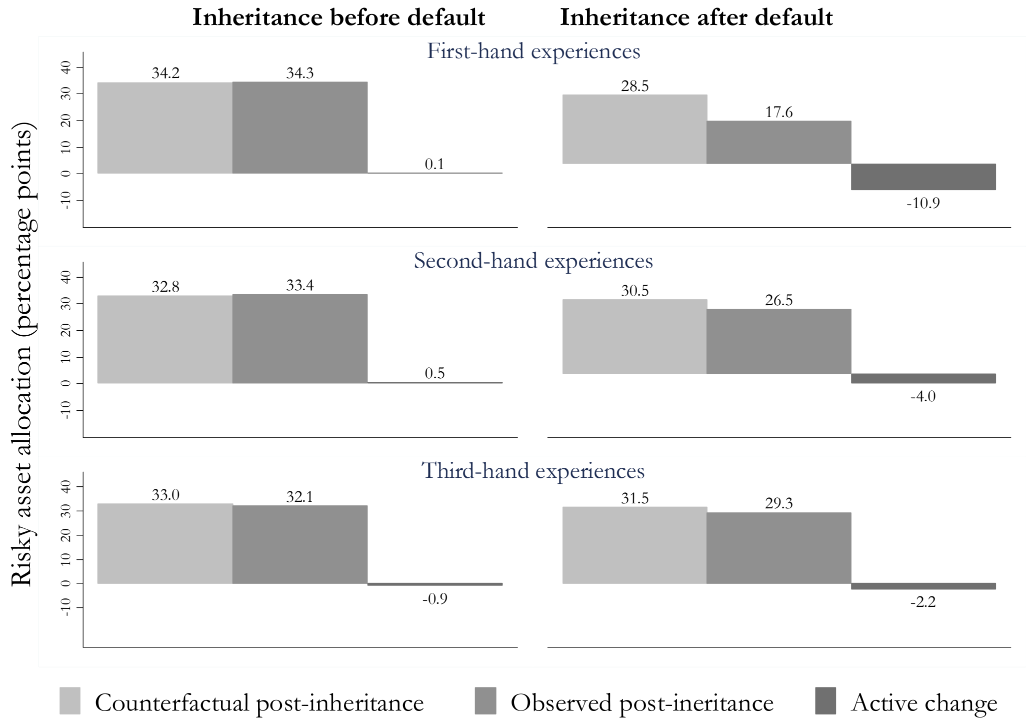
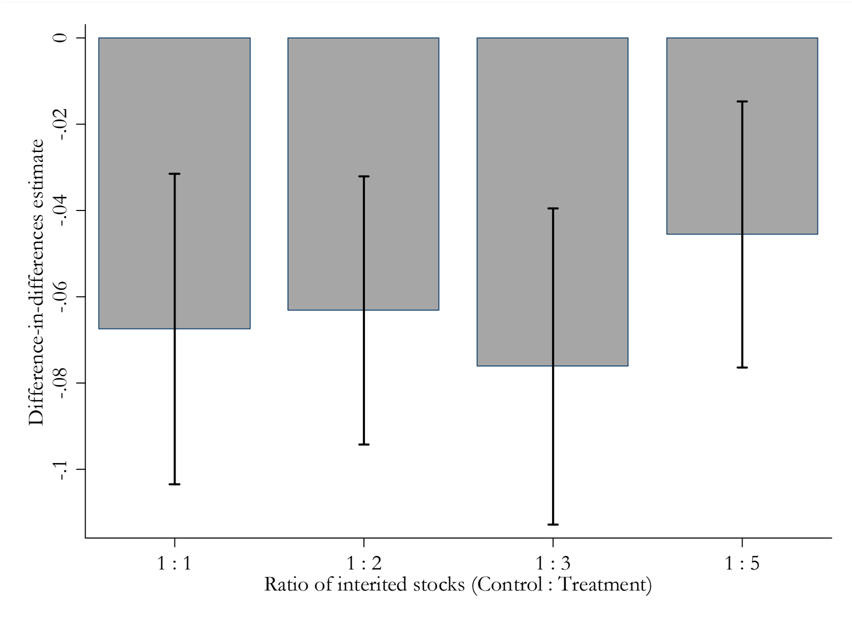


Figure 5: Estimates matching on inherited wealth

These graphs show the change in risky assets for a beneficiary with first-hand experiences from personal losses (i.e., individuals who lost their investments due to the default of their own banks) compared to individuals who did not have a first-hand experience, matched in Panel A (Panel B) to the same post-inheritance (pre-inheritance) wealth. In addition, we vary the ratio of inherited stocks and mutual funds between control and treatment. In the first bar (1:1), the treatment and control group inherit the same value of stocks and mutual funds. In the second bar, we change the ratio of inherited stocks to 1:2, implying that individuals with first-hand experiences by construction are matched to a counterfactual control group that inherited half the value of stocks. In the following columns, we change the ratio to 1:3 and 1:5 in similar fashion.

Panel A: Matching on post-inheritance wealth



Panel B: Matching on pre-inheritance wealth

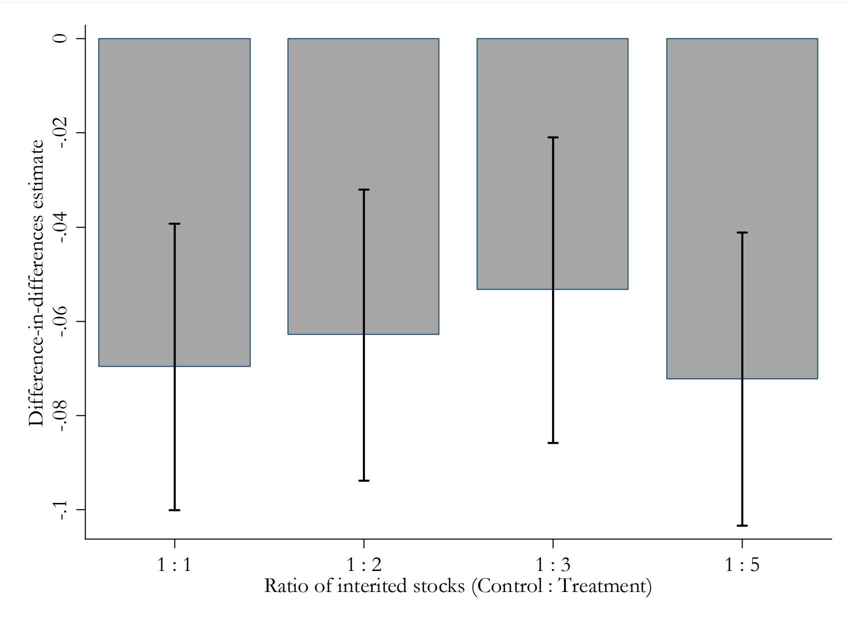


Figure 6: First-hand experience and fraction of portfolio lost

This figure shows the effect of first-hand experiences on risk taking depending on the fraction of portfolio lost. We report counterfactual post-inheritance ratio of liquid assets allocated to stocks and mutual funds, the observed post-inheritance ratio, and the active change in the ratio of liquid assets allocated to stocks. The counterfactual post-inheritance level of risk taking is calculated by merging the beneficiaries' portfolio with the inherited portfolio in year *t-1*, and updating it with market prices in year *t+1*. The active change is calculated as the difference between the observed post-inheritance risk taking and the counterfactual post-inheritance level. We report these ratios for individuals with first-hand experiences who due to the default lost a) less than 25%, b) 25% to 50%, c) 50% to 75%, and d) more than 75% of their portfolios of risky assets.

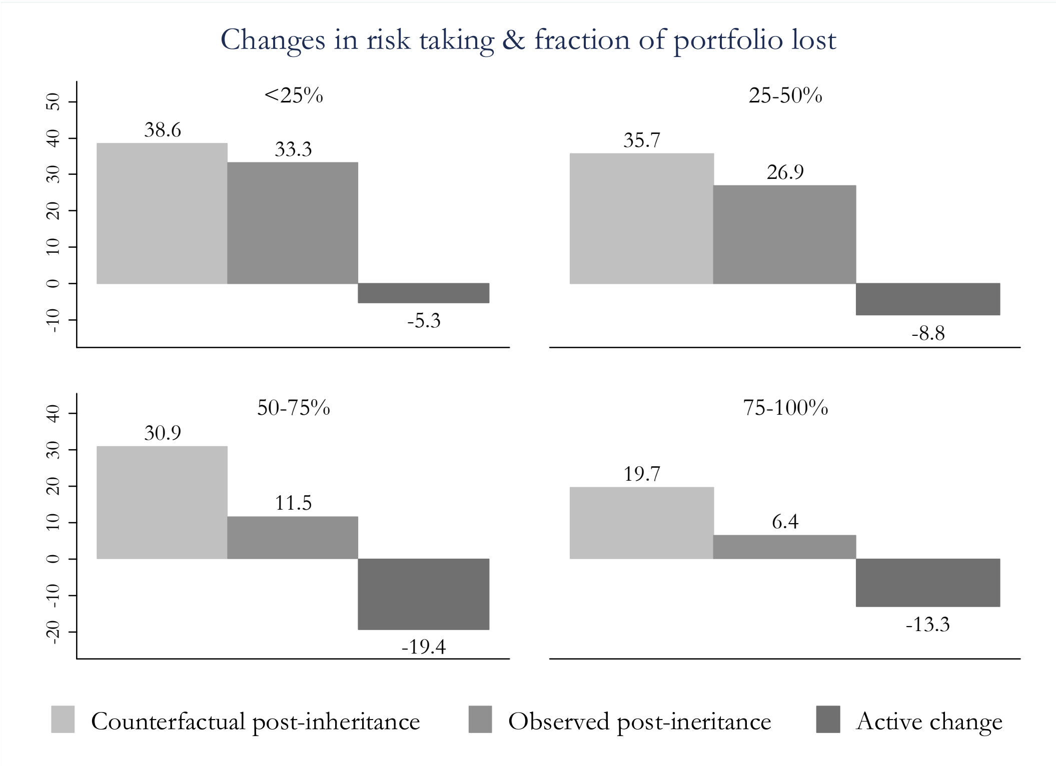
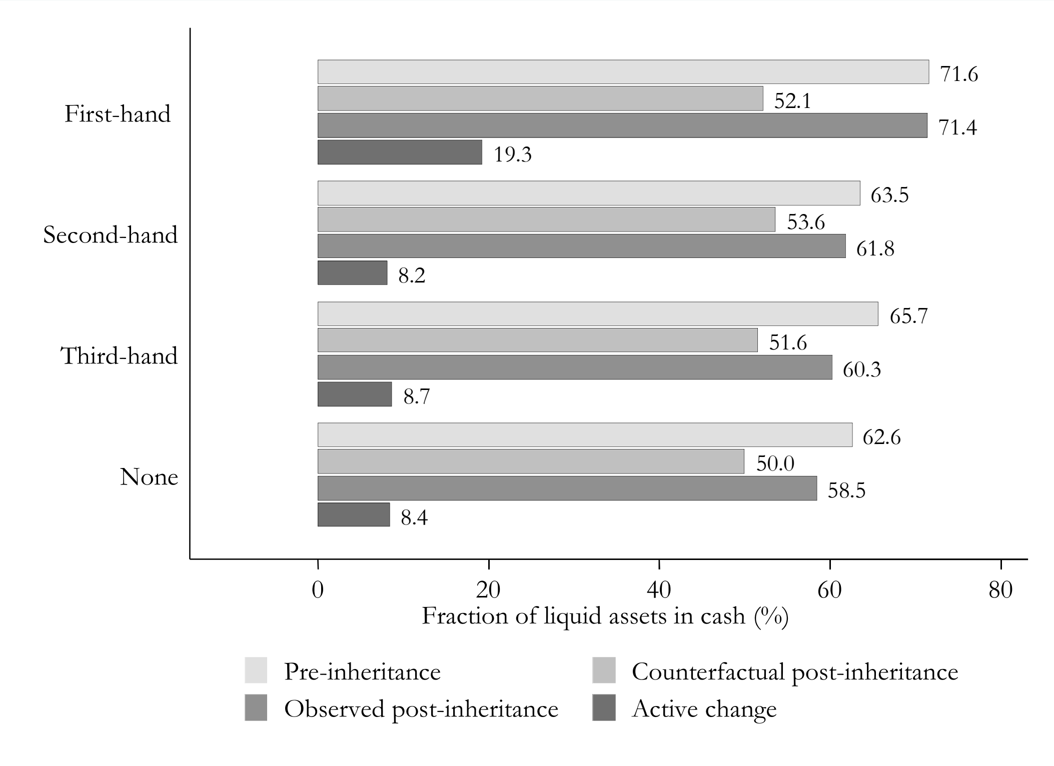


Figure 7: Degree of experience and cash holdings (bank deposits) around inheritances

This graph shows the change in the fraction of liquid assets allocated to cash (bank deposits) around inheritances subject to the individual's degree of experience. We report the pre-inheritance ratio of liquid assets allocated to cash, the counterfactual post-inheritance ratio of liquid assets allocated to cash, the observed post-inheritance ratio, and the active change in the ratio of liquid assets allocated to cash. The counterfactual post-inheritance level of cash is calculated by merging the beneficiaries' portfolios with the inherited portfolio in year *t-1*. The active change is calculated as the difference between the observed post-inheritance cash and the counterfactual post-inheritance level. *First-hand* experiences derive from personal losses, *second-hand* experiences from losses in the close family, and *third-hand* experiences from living in municipalities where banks defaulted.



Online Appendix for "Once Bitten, Twice Shy:
The Role of Inertia and Personal Experiences in Risk Taking
by
Steffen Andersen, Tobin Hanspal, and Kasper Meisner Nielsen

The following tables and figures are included in this appendix:

- **Appendix A: List of default banks, 2008–2012**
  This table shows the chronology of bank defaults in Denmark in the aftermath of the financial crisis.

- **Appendix B: The effect of personal experiences on risk taking**
  This table presents results for the alternative specification where we allow second- and third-hand experiences to occur before the end of our inheritance window. As a result, the specifications are identical to the specifications in Table 5, but the number of observations increase from 48,104 to 52,331 when we include beneficiaries that gain a second- or third-hand experience during the inheritance window.

- **Appendix C: Source and incidence of second-hand experiences**
  This figure plots the distribution of the sources of second-hand experiences and the number of incidences per individual.

- **Appendix D: Alternative second-hand experiences definitions**
  This table reports estimates of the marginal effect on the propensity to keep inherited stocks by i) decomposing the effect of second-hand experiences into its source (parents, siblings, spouse, children, and parent in-laws), and ii) the propensity to keep inherited stocks as a function of the number of second-hand experiences per individual.

- **Appendix E: The effect of personal experiences and the value of inherited stocks**
  This table presents results for the alternative specification where we include interactions between personal experiences and the market value of inherited stocks. Column 1 is identical to the baseline specification in Table 5, and Column 3 restricts the sample to individuals with at least two stocks in their portfolios when they inherit, whereas even numbered columns include the interaction term between personal experiences and the market value of inherited stocks, respectively.

- **Appendix F: Personal experience and risk taking using inheritance due to sudden deaths**
  This table presents results for our matched sample using inheritances due to sudden deaths. The table is comparable to Table 7, which is based on all deaths.

Appendix A: List of default banks, 2008–2012

This table lists the chronological order of defaults of publicly listed banks from 2008 to 2012. *Location of headquarters* is the city of the bank's headquarters. *Assets* are in DKK billions at the end of the year in the year before the default. *Number of shareholders* is the number of individual shareholders in our data at the beginning of the year of default.

Bank	Location of headquarters	Date of default	Assets DKK bn.	Number of shareholders
Roskilde Bank	Roskilde	24-08-2008	42.0	18,550
EBH Bank	Fjerritslev	28-11-2008	10.4	6,315
Fionia Bank	Odense	23-02-2009	32.8	18,716
Capinordic Bank	Hellerup	11-02-2010	1.7	2,108
Amagerbanken	Copenhagen	06-02-2011	28.3	40,649
Fjordbank Mors	Nykøbing Mors	24-06-2011	13.2	8,540
Max Bank	Næstved	09-11-2011	9.8	13,047
Tønder Bank	Tønder	04-11-2012	2.8	3,650

Source: Danish Financial Supervisory Authority and authors' own calculations.

Appendix B: The effect of personal experience on risk taking

This table reports the effect of personal experiences on changes in risk taking around inheritances. We estimate the following equation:

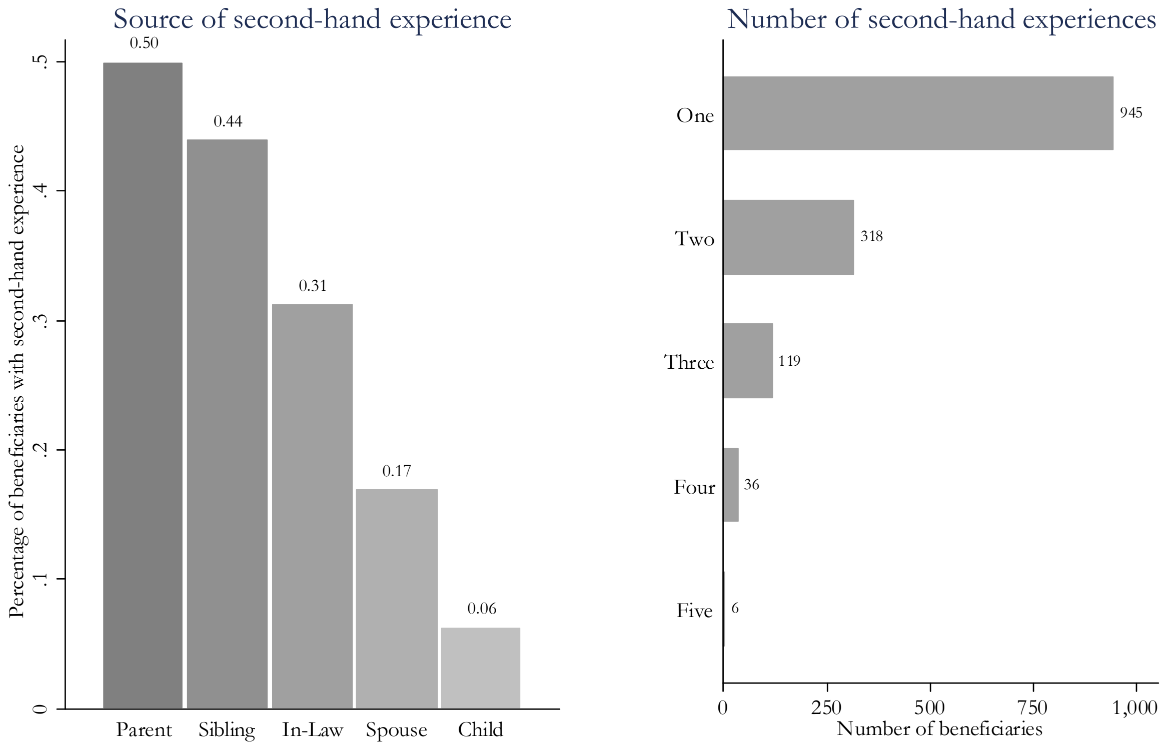
$$\Delta\alpha_{i,t,2k} = \beta X_{i,t} + \gamma E_{i,b} + \varepsilon_{i,t}$$

where the dependent variable $\Delta\alpha_{i,t,2k}$ is the change in risk taking of individual *i* from year *t-k* to *t+k*, and year *t* is the year of inheritance and *k=1*. In Column 1, the dependent variable is the *observed change* in the fraction of liquid assets allocated to stocks from year *t-1* to year *t+1*. In columns 2 and 3, the dependent variable is the change in the *passive* and the *active* component of the observed change in the risky asset share. The passive component of the observed change in risky asset share is the counterfactual change in risky asset share due to changes in stock prices from year *t-1* to *t*, while keeping the stockholding constant at the year *t-1* allocation. The active component is the observed change in risky asset share less the change due to the passive component. $X_{i,t}$ is a vector of control variables, and $E_{i,b}$ is a vector of personal experiences. *First-hand experience* is an indicator for personal experiences due to the loss of investments in a defaulted bank gained before the start of our inheritance window (i.e., b<*t*-a). *Second-hand experience* is an indicator for first-hand experiences in the immediate family (parent, sibling, child, or spouse) before end of our inheritance window (b<*t*+1). *Third-hand experience* is an indicator for individuals who are living in a municipality with a default bank before the end of our inheritance window (b<*t*+1). Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also includes the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively, using standard errors clustered at the level of municipality-year.

Dependent variable	**Observed change**	**Passive change**	**Active change**
	(1)	(2)	(3)
First-hand experience	-0.060***	0.036	-0.066***
	(0.013)	(0.023)	(0.019)
Second-hand experience	-0.014***	-0.031***	0.013***
	(0.001)	(0.008)	(0.006)
Third-hand experience	-0.001	0.005	-0.001
	(0.001)	(0.006)	(0.006)
Control variables	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes
Pseudo R^2	0.159	0.103	0.139
N	52,331	52,331	52,331

Appendix C: Source and incidence of second-hand experiences

This figure reports the source and incidence of second-hand experiences among all beneficiaries who inherit stocks. The left side of the top panel presents the distribution of second-hand experiences by source. The right side of the top panel shows the distribution of the number of second-hand experiences.



Appendix D: Alternative second-hand experiences definitions

The dependent variable is an indicator for whether the beneficiary keeps inherited stocks. In columns 1 and 3, we separate out the family relations that make up our definition of second-hand experiences. We include variables that indicate whether a *Spouse, Parent, Child, Sibling*, or *In-law* of the beneficiary had a first-hand experience with a defaulting bank. In columns 2 and 4, we consider the effect at the household level; we define *Household experience* as a first-hand experience had by either the beneficiary or his or her spouse. We therefore redefine *Second-hand experience* to exclude the experiences of the spouse in this estimation. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see tables 1 and 6 for further description). *Number of second-hand experiences* is a count of the number of second-hand experiences in the close family. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also include the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Specification	**Source of second-hand experience**	**Number of second-hand experiences**
	(1)	(2)
First-hand experience	-0.061***	-0.043***
	(0.013)	(0.014)
Spouse experience	-0.017	
	(0.014)	
Parent experience	-0.001	
	(0.006)	
Child experience	-0.009	
	(0.017)	
Sibling experience	-0.052***	
	(0.014)	
In-law experience	0.028**	
	(0.010)	
Third-hand experience	0.001	0.001
	(0.005)	(0.003)
Number of second-hand experiences		-0.010***
		(0.004)
Household experience		
Second-hand experience		
Control variables	Yes	Yes
Year effects	Yes	Yes
Pseudo R^2	0.161	0.160
N	48,104	48,104

Appendix E: The effect of personal experiences and the value of inherited stocks

This table presents results for the alternative specification where we include interactions between personal experiences and the market value of inherited stocks. In Column 1, we include the marked value of inherited stocks (in million DKK), and column 2 includes interaction effects between personal experiences and the market value of inherited stocks. Columns 3 and 4 present results for the subsample of beneficiaries holding at least two stocks. *Market value of inherited stocks* is the market value of the inherited stocks in millions year-2010 DKK. *Stock market participant* is an indicator for beneficiaries who hold stocks. *Invested in own bank* is an indicator for beneficiaries who invested in their own bank. *First-hand experience* is an indicator for personal experiences due to the loss of investments in a defaulted bank. *Second-hand experience* is an indicator for first-hand experiences in the immediate family (parents, siblings, children, or spouses). *Third-hand experience* is an indicator for beneficiaries who are living in a municipality with a bank default. *Future personal experience* is an indicator for beneficiaries who encounter a first-hand experience in a subsequent period. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, *log. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also includes the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Sample	**All**		**At least 2 stocks**	
	(1)	(2)	(3)	(4)
First-hand experience	-0.061***	-0.069***	-0.098***	-0.131***
	(0.013)	(0.015)	(0.032)	(0.037)
Second-hand experience	-0.015**	-0.011	-0.017	0.009
	(0.007)	(0.007)	(0.023)	(0.025)
Third-hand experience	0.002	0.001	-0.031**	-0.030**
	(0.005)	(0.005)	(0.013)	(0.013)
First-hand experience*		0.043		0.115
Value of inherited stock		(0.041)		(0.071)
Second-hand experience*		-0.020***		-0.078***
Value of inherited stock		(0.007)		(0.029)
Third-hand experience*		0.000		-0.000
Value of inherited stock		(0.001)		(0.000)
Control variables	Yes	Yes	Yes	Yes
Year effects	Yes	Yes	Yes	Yes
Pseudo R^2	0.161	0.161	0.295	0.296
N	48,104	48,104	5,666	5,666

Appendix F: Personal experience and risk taking using inheritance due to sudden deaths

This table reports a matched sample estimate test of the effect of personal experiences on risk taking. The dependent variable is the change in the fraction of liquid wealth allocated to stocks in a window from year -1 to +1 around the year of inheritance. The treatment group consists of investors with first-hand experiences or future first-hand experiences due to one of the three bank defaults in 2011, while the control group is a matched sample of beneficiaries without first- or second-hand experiences. In Column 1, the matched control group consists of stock market participants, while the control group in Column 2 includes investors in banks with third-hand experiences (individuals who are living in a municipality with a bank default). In Column 3, the control groups consist of individuals who hold stocks and are from the same vigintile of the pre-inheritance wealth distribution. In Column 4, the control group consists of individuals who hold stocks and are from the same vigintile of the post-inheritance wealth distribution. Among the matches in columns 3 and 4, we use the five closest neighbors based on the value of inherited stocks. *First-hand experience* is an indicator for individuals who experienced the default of their own banks before inheritance. Control variables include: *market value of inherited stocks*, *stock market participation*, *invested in mutual funds*, *invested in own bank*, l*og. of income*, *age*, *gender*, *education*, *married*, and *children in household* (see Table 1 for further description). To control for inertia, Column 1 also includes the counterfactual change in the level of risk taking if individuals are fully inert (see Equation 4). Standard errors are in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively, using standard errors clustered at the level of municipality-year.

Dependent variable	**Observed change**			
Control group	Stock market participants	Invested in own bank & third-hand experience	Pre-inheritance wealth & inherited wealth	Post-inheritance wealth
	(1)	(2)	(3)	(4)
First-hand experience	-0.068***	-0.039*	-0.068**	-0.046*
	(0.015)	(0.022)	(0.028)	(0.027)
Control variables	Yes	Yes	Yes	Yes
Year fixed-effects	Yes	Yes	Yes	Yes
Pseudo R^2	0.238	0.363	0.344	0.352
N	1,344	279	384	384

Chapter 2 - The Effect of Personal Financing Disruptions on Entrepreneurship

The Effect of Personal Financing Disruptions on Entrepreneurship*

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Abstract

Credit market disruptions have been shown to affect business lending and the borrowing behavior of firms. For small businesses however, financing is most often supplied by the owner's assets and by debt financed from personal loans. This paper studies how idiosyncratic financing shocks experienced directly by entrepreneurs affect the performance of their firms. Variation in access to debt financing and personal wealth losses stem from the solvency of retail banking institutions following the 2007-2009 financial crisis. I find that retail bank disruptions reduce personal borrowing and increase the rate of firm exit. Personal wealth losses from investments in delisted bank stocks strongly reduce the rate of entrepreneurial survival, especially for less experienced and more financially constrained small business owners. I also find large effects at the intensive margin, as firm owners significantly reduce employed staff after experiencing personal wealth losses. My results suggest that disruptions to personal sources of firm financing play an important role in explaining entrepreneurial exit.

JEL Classification: L26, D14, G01, G11, G21, G33
Keywords: Entrepreneurial Finance; Financial crisis; Bank defaults

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1 Introduction

How access to finance affects the growth and survival of firms is a fundamental question of entrepreneurial finance. There is ample evidence suggesting that credit market disruptions affect commercial lending and the borrowing ability of firms. However, for small businesses and early-stage ventures even in advanced economies, financing is most often supplied by principal owner equity through the owner's personal balance sheet and debt financing from personal loans and credit cards. As such, quantifying the effect of shocks to the personal financing channel of firms is vital for a comprehensive understanding of how credit supply shocks affect the real economy, especially during times of financial crisis.

Previous literature has investigated how shocks to the financial health of banks are transmitted to firms and the affect on economic activity. Researchers have studied this by using variation in bank-branch consolidation and measuring aggregate local market outcomes,[1] with bank-firm matched data and detailed information on commercial lending,[2] and by examining larger firms with access to syndicated loan and capital markets.[3] By construction, the literature on bank-specific shocks largely excludes disruptions in personal finance in the outcomes of small business owners and entrepreneurial firms. Given the relative importance of small and medium-sized firms in the economy, it seems natural to ask how disruptions to retail banking and personal wealth affect the prospects of these enterprises.[4] One reason why this channel may have been previously overlooked is because sources of personal financing are often correlated with characteristics of the owner and potential determinants of firm performance, and a causal relationship is therefore difficult to identify. Furthermore datasets linking firm owners, their personal financial market experiences, and the outcomes of their firms are difficult to obtain.

In this paper, I take a first step in investigating how firms respond to idiosyncratic financing shocks experienced directly by small business owners. I use administrative data on firm owners which include detailed information on their personal assets and their retail banking relationships, merged to a comprehensive dataset on labor market activity. I identify bank-specific shocks by using variation in the solvency of retail banking institutions in Denmark following the 2007-2009

[1] Berger and Udell (1998); Peek and Rosengren (2000); Ashcraft (2003); Greenstone et al. (2014); Nguyen (2014); Black and Strahan (2002); Adelino et al. (2014)

[2] Gan (2007); Khwaja and Mian (2008); Paravisini (2008); Degryse et al. (2011); Schnabl (2012); Iyer et al. (2014)

[3] Chodorow-Reich (2014)

[4] Small and medium-sized enterprises constitute for more than half of private sector employment in the OECD area, and more than 90 percent of firms employ less than 10 workers (OECD (2009)).

financial crisis. This period was characterized by extensive banking consolidation and bankruptcies, exposing entrepreneurs and small business owners to differential, potentially exogenous personal financing disruptions.

In the years preceding the financial crisis, many Danish banking institutions turned to international capital and money markets which increased their exposure to market fluctuations. As the financial crisis unfolded and triggered a flight to liquidity, several financial institutions found themselves on the verge of bankruptcy. As a result of write-offs on domestic real estate investments, thirteen retail banks defaulted between 2008 and 2012, eight of which were publicly traded on the Copenhagen Stock Exchange. These banks were taken over by a state-owned financial supervisory authority. An additional twelve troubled banks resolved their liquidity needs in private merger and acquisition activity. This variation in the outcomes of retail banks across deposit customers allows me to estimate the effect of changes in access to personal debt financing on the survival of a small business owner's firm, while the variation across stock investors in publicly traded retail banks allows me to identify the effect of unexpected changes in personal liquid wealth.

Small business owners who were deposit customers in exposed banks held insured savings accounts in retail banks that were likely unable to supply additional credit to its client base in the short run following their default. These depositors were in turn more likely to move their account to another retail bank. I document the significance of this unexpected shock on debt accumulation for small business owners: the average exposed entrepreneur decreased his level of personal borrowing by more than 70,600 DKK ($12,800 USD) relative to comparable unexposed small business owners in the years following the default of his personal retail bank.[5]

To understand how changes in personal liquid wealth may affect entrepreneurial survival, I turn to a sample of small business owners who held retail bank stock investments outside of their own bank in the years leading up to the financial crisis. As an attempt to increase capital, many of the retail banks in Denmark followed an expansionary policy consisting largely of selling stock to individual investors since the year 2000 (Danish Financial Supervisory Authority (2009)). These investments were relatively common among Danish investors. Prior to the financial crisis, 60% of investors held an investment portfolio containing the stocks of a retail banking institution. As several retail banks in Denmark filed for bankruptcy, they exposed investors to additional, unexpected, investment losses. Portfolios of exposed and unexposed investors were therefore similar

[5] 1 USD = 5.5 DKK.

in composition and risk. Furthermore, these investments made up a significant amount of individual financial wealth, exposed entrepreneurs lost liquid assets from investments equal to 343,800 DKK ($62,500 USD) at the mean and held approximately 30% less liquid wealth in the years after the financial crisis.

My results suggest that changes in access to debt finance and liquidity losses have economically significant effects on firm survival and performance. I find that an unexpected closure of a firm owner's personal bank increases the rate of bank-separation, leads to a large decrease in the level of personal borrowing, and as such, increases the probability of firm exit by approximately 2 percentage points. Changes in personal liquid wealth holdings of the firm owner stemming from lost investments increases the rate of firm exit for entrepreneurs holding investment accounts by approximately 5 percentage points, an economically meaningful result given a baseline rate of exit of approximately 16 percent. This effect is accentuated for less experienced and more financially constrained entrepreneurs. For entrepreneurs who started a firm in the years prior to the financial crisis, a one-standard-deviation increase in the ratio of losses to pre-crisis liquidity increases the probability of firm exit by almost 7 percentage points, or a 41 percent increase. A complete loss of liquid wealth for a new small business owner translates into a near 40 percent chance of firm failure. Furthermore, I find that entrepreneurs are significantly more likely to enter into salaried labor after losing substantial liquid wealth holdings suggesting that these disruptions can have long lasting consequences.

Consistent with the conjecture that firm owners may attempt to reduce costs prior to firm-closure, I find that personal wealth losses of entrepreneurs result in significant intensive margin decisions. Conditional on remaining in business, firm owners reduce employment by approximately 0.72 fewer workers after being exposed to financial losses, a substantial decrease given the average firm in the sample consists of 4.8 employees.

A challenge is to establish whether these disruptions affect small business owners via a channel of consumer credit supply or whether local banking defaults are correlated with a demand shock which results in firm closure. To overcome this challenge I compare affected and unaffected *neighboring* entrepreneurs located within the same local parish and find comparable results while controlling for the fact that these entrepreneurs are subject to the same changes in local market demand. As an additional robustness exercise, I focus on a subsample of firm owners whose firms are located in municipalities outside of where their retail bank is located and obtain similar results.

These results expand upon existing literature which question the importance of the credit supply channel by asking if financial institutions transmit bank-specific shocks to firms. Schnabl (2012) analyzes how credit availability effects business lending to borrowing firms in Peru using the 1998 Russian default as an exogenous shock to bank-to-bank international lending liquidity. Similarly, Khwaja and Mian (2008) use cross-bank changes in liquidity stemming from nuclear tests in Pakistan to show that firm borrowing of corporate loans is heavily reliant on bank liquidity. Iyer et al. (2014) uses the unexpected freeze of European interbank market to investigate the change of commercial and industrial loans to non-financial public firms in Portugal. Finally, Paravisini (2008) shows that an increase in government funding to local banks in Argentina increases total borrower debt without decreasing bank profitability. In addition, many researchers have used bank mergers as credit supply shocks to state-, county-, and even census track-level local markets and have considered the aggregate effects on rates of entrepreneurship and lending outcomes (Berger and Udell (1998); Peek and Rosengren (2000); Ashcraft (2003); Greenstone et al. (2014); Nguyen (2014), and Black and Strahan (2002)). Results generally point to the finding that bank consolidation in local markets and less banking competition reduce aggregate lending outcomes and firm activity.

Related to personal financing, several prominent studies have shown that owner's wealth is an important determinant of start-up activity (Evans and Jovanovic (1989); Gentry and Hubbard (2004); Blanchflower and Oswald (1998)) and on performance and survival (Holtz-Eakin et al. (1994); Hvide and Møen (2010); Andersen and Nielsen (2012); Nanda (2011)). In general, the literature has questioned the presence of financing constraints and whether initial wealth allows individuals from the general population to form a business, and the conditional performance of the venture. Surprisingly, there seems to be little evidence of how changes in owners' ability to provide financing may have effects that propagate ongoing firm dynamics and alter the survival or performance of established firms. One notable exception is Holtz-Eakin et al. (1994) who find that a sizable inheritance is correlated with a marginally higher propensity for an existing sole-proprietor to remain in business. At the same time, the previous literature has focused almost exclusively on positive wealth shocks such as inheritances or gains in housing wealth while financial losses have yet to be studied.

Finally, my results are related to a literature on entrepreneurial performance. Studies on entrepreneurial performance and firm survival have focused on the initial start-up conditions of the firm and on inherent characteristics of the firm's owner. For example, human capital endowments and demographic characteristics (Cooper et al. (1994); Shane and Stuart (2002); Van Praag (2003)), and prior experience of the owner (Lafontaine and Shaw (2016); Bayus and Agarwal (2007)). Recent research has considered how macroeconomic events may affect firm performance, e.g., the Great Recession (Cowling et al. (2012); Cowling et al. (2015); Zarutskie and Yang (2015)), and entry conditions and the business cycle (Fairlie (2013); Moreira (2016)). A number of studies have considered the capital structure of the firm at the onset of creation and its effect on performance or survival. Firms that self-finance and take on external debt seem to have higher rates of survival (Reid (1991)), initial outside debt seems to be correlated with higher firm revenues later in the firm's lifecycle (Robb and Robinson (2012)), early start-up loans have a strong impact on survival (Fracassi et al. (2013)), and firms supported by lending programs fare better with higher rates of growth (Brown et al. (2015)).

I contribute to the existing literature by showing that personal financing disruptions, aside from shocks which affect commercial and business lending, can have large effects on the survival and growth of entrepreneurial firms. My analysis looks specifically at firm outcomes and performance rather than intensive margin changes in borrowing and lending. In addition, I focus on smaller, entrepreneurial firms and small business owners in an advanced European country and use high quality, complete, administrative data from Denmark eliminating sources of measurement error.

The study proceeds as follows: In Section 2 I discuss the motivation and institutional background. The following section discusses in detail the sources of data and the sample. In Section 4, I discuss the identification strategy and empirical approach. Section 5 discusses the results and follows with additional specifications and robustness checks. The final section concludes.

2 Background

2.1 Characteristics of Entrepreneurial Finance

While the sources of funding available to early stage firms include government loan programs, lending from friends and family, and private equity and venture capital, for most new firms the majority of capital financing comes from debt via personal loans made to the owner, commercial loans, and personal and business credit cards (Robb and Robinson (2012)). At the same time, survey evidence from the Kauffman Firm Survey suggests that more than 75% of firms are financed by at least some degree of owner equity. Of these firms, owners provide on average $40,500 of financing (Robb and Robinson (2012)). Equity investments therefore make up a substantial fraction of household wealth for established small businesses, as pointed out by Moskowitz and Vissing-Jorgensen (2002), households with entrepreneurial equity on average invest more than 70% of their wealth in their own business. Berger and Udell (1998) show that smaller enterprises (less than 20 employees) finance their firms with a larger share of principal owner equity compared to larger firms (45% compared to 27%), and owner equity as a means of firm financing increases with the age of the firm while commercial and personal bank debt decrease.[6] Robb and Robinson (2012) find that for smaller businesses owner equity constitutes approximately one-third of total financial capital in a firm's first year of business and a sizable fraction of initial and subsequent capital injections during operations.

Robb and Robinson (2012) also suggest that entrepreneurial firms are heavily reliant on outside debt, defined as debt issued by an outside institution such as a retail bank. Distinguishing rather between whether the debt is a claim on business assets or the owner's personal assets, more than 50 percent of the average firm's early financial capital stems from personal debt. Additionally, at the extensive margin approximately 26 percent of firms use business lending and business credit cards, while 20 and 31 percent of entrepreneurs use personal bank loans and personal credit cards, respectively.[7] Evidence from Robb and Robinson (2012) shows that entrepreneurs rely heavily on personal sources of financing in the early stages of their firms.

If performance and survival of early stage firms is reliant on personal sources of financing, shocks that affect this channel should have a large detrimental effect on small businesses. Unexpected changes in the owner's balance sheet will likely affect the owner's ability to supply the firm with ongoing capital injections via equity. Similarly, if growth or survival of a small firm is reliant on personal debt financing, external credit shocks affecting the owner's ability to obtain personal bank loans may affect the firm as well. In addition, it is possible that facing personal financing shocks, entrepreneurs may choose to withdraw equity or liquidate a venture in order to support existing commitments.

For small businesses, shocks that affect these personal financing channels can be somewhat separable. Changes in personal wealth should have limited affect on a business owner's ability to secure lines of credit from his bank, as entrepreneurs are most likely to pledge their personal assets

[6] See Table 1 in Berger and Udell (1998) for more information.

[7] Appendix A.2 reclassifies the results presented in Table 4 of Robb and Robinson (2012).

as outside collateral for debt financing, which in most cases is their home (Parker (2009)). These personal wealth changes however, would likely have large implications on the ability to supply the firm with capital. Inversely, changes in access to bank loans and available credit should hamper an entrepreneurs ability to obtain debt financing to fund an existing venture without directly affecting his liquidity position.

2.2 The Danish Retail Banking Sector

In the years preceding the financial crisis, Danish banking institutions saw a fundamental shift in the way that they accessed financing to lend to their customer base.[8] As a result of widespread deposit deficits, the retail banking sector turned to international capital and money markets in order to raise liquidity through new channels of financing. This in turn, increased their level of exposure to international financial market fluctuations (Rangvid et al. (2013)). Prior to the financial crisis, it seemed as though there was little concern that market financing may 'dry up.'

The stability of US financial institutions was tested in the fall of 2008 with the default of Lehman Brothers. While the direct spillover effects were limited, this effectively cut off Danish retail banks from this source of international capital that they had grown accustomed to. At the same time, many Danish banking institutions held sizable investments in domestic real estate and farmland, and as the financial crisis unfolded in the United States, asset values in these markets crumbled. This triggered a flight to liquidity, and some banks experienced the contraction more severely than others. A group of small and medium-sized financial institutions were hit particularly hard and there was considerable variation in the banks that were affected, and how severely affected banks were hit (Rangvid et al. (2013)). Many banks found themselves in a precarious situation and on the verge of defaulting on their obligations. As a result of write-offs on real estate investments, thirteen retail banks defaulted, eight of which were publicly held, between 2008 and 2012. These thirteen default banks were taken over by a state-owned financial supervisory authority, while an additional twelve troubled banks consolidated with existing banks in private arrangements.[9]

[8] A feature of the banking environment in Denmark is an abundance of smaller, publicly held retail banks. In addition to the five largest retail banks (Danske Bank, Nykredit, Nordea Bank, Sydbank, and Jyske Bank), many smaller, local, retail banks are also publicly held and traded on the Copenhagen Stock Exchange. The majority of these local retail banks are members of the *Lokale Pengeinstitutter* (The Association of Local Banks, Savings Banks and Cooperative Banks in Denmark). These banks made up a pre-crisis market share of approximately 25 percent among small and medium-size commercial businesses and hold a similar market share among individual retail bank customers. Today, small, large, savings, and cooperative banks work in accordance with the same laws and rules and operate in the same market.

[9] Refer to Appendix A.1 for additional information.

The municipalities where the troubled banks were headquartered were distributed throughout Denmark, as shown in Figure A.1.

3 Data

I access administrative register data encompassing the universe of all legal Danish residents and assemble a dataset of individuals spanning 2002 to 2012. My dataset contains economic, financial, and personal information about all individuals. The dataset is constructed based on several different administrative registers made available from Statistics Denmark.

Individual-level data originate from the official Danish Civil Registration System. These data provide individual characteristics, such as age, gender, and marital status, and give unique identification across individuals and time. Educational records are from the Danish Ministry of Education. All completed (formal and informal) education levels are registered annually and made available through Statistics Denmark. Income, wealth, and employment status are from the official records at the Danish Tax and Customs Administration (SKAT). This dataset contains personal income and wealth information by CPR numbers on the Danish population. SKAT receives this information directly from the relevant sources; financial institutions supply information to SKAT on their customers' deposits and holdings of investments. Employers similarly supply statements of wages paid to their employees.

From SKAT, I gain access to a database of NEM-ID accounts. This data contain the 4-digit registration number of each individual's primary retail banking account at year-end, from 2005-2012. I map these registration numbers into retail banks across Denmark using a hand-collected database. In addition, I obtain access to ISIN-level stocks and mutual funds from 2006-2012 for all equity market participating Danish individuals. This data provides year-end information on the specific composition and the value of individual investment portfolios held outside of pension accounts.

3.1 Entrepreneurship Data

The above datasets are complemented with a matched employer-employee panel dataset drawn from the Integrated Database for Labor Market Research in Denmark (IDA). In this register database, entrepreneurship and self-employment are defined by *primær arbejdsstilling*, or primary occupation. For each individual, I observe the annual primary occupation as designated in the last week of November. The dataset allows me to identify entrepreneurs precisely, distinguishing between self-employment and part-time work. The administrative designation of employment removes measurement error typically contained in survey data.[10] I define *self-employed* individuals as individuals who have a primary occupation code of *individual tax payer* or *employer* who employ no other individuals in the firm. Most importantly, *entrepreneurs*, are defined as individuals with a primary occupation of *employer* and employ at least one other individual in the firm, similar to the definition used in Jensen et al. (2014), Nanda (2008), Nanda and Sørensen (2010), and Nanda (2011), among others. By definition these individuals are owners of ventures with unlimited liability (UL), which encompass approximately 63 percent of new Danish enterprises (Statistics Denmark (2016)).

The data do not allow me to identify firm owners with limited liability (LL). This is however, unproblematic for my analysis as LL entrepreneurs are characterized as employees within their company, rather than employers employing others (Nanda and Sørensen (2010)). Therefore throughout the analysis I compare exposed UL firm owners with unexposed UL firm owners, rather than a sample consisting of various types of firm owners. The weakness of this is that the external validity of the analysis is reduced, as I cannot characterize personal financing and owners of firms with limited liability. To that end, I use firm owners, small business owners, and entrepreneurs interchangeably but the sample likely consists of small owner-managed businesses rather than technology start-ups. Finally, because I use the IDA database on UL firm owners, I do not observe the business assets or revenues of the firm, only the individual assets of the firm owner him- or herself.[11]

3.2 Sample

To be included in the final dataset, individuals must have a full record for each year for inclusion, including a retail bank account. I then exclude any individuals who have missing employment information during any year as well as individuals with incomplete education records. Finally, I limit the sample to individuals over the age of 25 and under the age of 60 in order to avoid entrepreneurs retiring from their businesses or withdrawing equity out in pre-retirement years.

[10] See Jensen et al. (2014) for a more in depth discussion of this dataset.
[11] In a future project I plan to extend this analysis to LL firms where firm asset and revenue data is more widely available, however this is outside the scope of this paper.

This dataset results in 1,643,542 individuals, 30,082 (1.83 percent) of whom are entrepreneurs who employ other individuals in the year 2006. Appendix A.3 also shows these entrepreneurs have an average firm size of 4.8 employees.

Table 1 reports summary statistics for all individuals in the sample in the year 2006. The table divides individuals by their primary employment; Column 1 focuses on all individuals in the sample, Column 2 on self-employed individuals, Column 3 on entrepreneurs that employ at least one other individual, and Column 4 on individuals who are in traditionally salaried labor employment. Consistent with the existing literature, entrepreneurs are more likely to be male, married, and have more children than their salaried counterparts. Additionally, they have significantly higher income with a higher standard deviation, and have accumulated more net wealth – while holding significantly higher levels of debt stemming from their mortgage and personal bank loans. In fact, entrepreneurs have approximately ten-fold the amount of personal bank debt as salaried employees. This highlights the relative importance of personal banking loans on the balance sheets of entrepreneurs.[12]

4 Empirical Strategy

If the performance of entrepreneurial firms is related to the firm owner's ability to obtain debt financing or available liquid wealth, the relationship can be summarized by the following,

$$y_{it} = \beta_0 + \beta_1 \Delta credit_{it} + \beta_2 \Delta liquidity_{it} + \lambda X_{it} + \epsilon_{it} \tag{1}$$

where i indexes individual-entrepreneurs, t indexes the calendar year, and y_{it} is the dependent variable measuring the performance of entrepreneur i's firm. The vector X consists of individual-entrepreneur financial and demographic characteristics. Estimating Equation 1 directly could lead to bias as access to credit and available liquidity measures may be correlated with unobservable characteristics captured in ϵ_{it}, which could influence the outcomes of their entrepreneurial firms. Moreover, firm performance could affect the level of liquid assets or credit an entrepreneur has access to.

[12] Personal bank loans may include a top-up loan to facilitate initial mortgage down-payments. These are discussed in further detail in Jensen and Johannesen (2015), however they are not unique to entrepreneurs and are not what drives the differences between entrepreneurs and salaried individuals. In later analysis I show that personal bank loans are a key factor for individuals who own substantial traditional housing assets and are therefore unlikely to be affected by these products.

To test the role of personal disruptions to debt financing and personal liquidity on firm outcomes, the ideal experiment would randomly allocate established entrepreneurs into three groups, one as a control group, one where entrepreneurs are made constrained in their access to credit, and finally one where liquid wealth is taken away from entrepreneurs. This type of experiment is likely to be infeasible, however the Danish banking environment during the financial crisis proves to be a next-best research design. The heterogeneous exposure to changes in debt finance and personal liquidity allows me to estimate the causal effect on firm survival summarized by a multiple-treatment difference-in-differences specification, given by the following reduced-form equation:

$$y_{it} = \alpha_t + \rho_i + \gamma exposed^j_{it} + \beta X_{it} + \epsilon_{it}, \tag{2}$$

where α_t and ρ_i are year and individual-entrepreneur fixed effects, respectively, which account for variation across the sample years and time-invariant differences between individuals. $Exposed^j_{it}$ proxies a change in either access to credit, or available liquid wealth, indicated by superscript j. For variation in access to credit across entrepreneurs, I define *unexposed* and *exposed depositors* as bank customers in retail banks which either remain solvent or go on to default between 2008 and 2012. I identify unexpected personal wealth losses, unrelated to an entrepreneur's firm, with investment losses in the stock market. I define *investors*, as entrepreneurs who held investments in publicly traded retail banks outside of the bank in which they have a deposit account. Investors who are *unexposed* and *exposed* are determined by whether the bank they hold investments in remained solvent or defaulted during the financial crisis. Superscript j therefore indexes whether the proxy is used for depositors or investors. I refer to these different sample groups as *depositors* and *investors* throughout the remainder of the analysis for simplicity. As $exposed^j_{it}$ takes the value of one in post-default periods, γ provides the average treatment effect of exposure after the default occurs compared to unexposed entrepreneurs (i.e. the difference-in-differences estimate).[13]

To demonstrate these proxies, consider the following relationships;

$$credit_{it} = \sigma_t + \tau_i + \beta_1 exposed\ depositor_{it} + \eta X_{it} + \epsilon_{it} \tag{3}$$

$$liquidity_{it} = \sigma_t + \tau_i + \beta_2 exposed\ investor_{it} + \eta X_{it} + \epsilon_{it} \tag{4}$$

[13] In order to address potential serial correlation across time common in DD estimations with several pre- and post time periods as noted in Bertrand et al. (2004), I cluster all standard errors at the pre-crisis primary retail bank level.

Equation 3 specifies an entrepreneur's access to debt financing. Customers of exposed retail banks held a personal deposit account at a bank which was unlikely to be able to supply additional credit to its client base in the short run following the onset of the crisis. These customers experienced their bank default and become taken over by *Finansiel Stabilitet* (FS), a Danish state-owned banking organization. These state-induced takeovers were initiated relatively discreetly in order to prevent banking runs and a speculative environment.

Immediately following the bankruptcy announcements, customers were directed to alternate retail banking branch locations to facilitate daily operations. In the medium term, the defaulted banks were supported by the state and day-to-day activities returned to a pre-bankruptcy norm. Previously, FS maintained a passive role in advising banks on their borrowing and lending arrangements. Once the affected banks began default discussions, FS took an active role in all activities of the exposed banks in an effort to provide security to depositors. Deposits of exposed bank customers were guaranteed by the state, and therefore the effect of bank defaults on personal wealth holdings was limited.[14] However, the default of an entrepreneur's bank may directly affect the bank's ability to supply capital in the form of personal bank loans. Additionally, customers of default banks may choose to move their account to another, more stable bank. If an entrepreneur moves to a new bank this may impede his or her ability to borrow, as it has been well documented that borrower-lender relationships affect credit availability, term rates, and collateral requirements (Petersen and Rajan (1994); Berger and Udell (1998)). As personal loans play a large role in debt financing for small firms, a natural proxy for $credit_{it}$ is the total personal bank loan stocks of an individual entrepreneur.

Equation 4 studies the relationship between exposure to retail bank defaults and entrepreneurs' liquidity position. As an attempt to increase capital stocks, many of the retail banks in Denmark followed an expansionary policy consisting largely of selling stock to individual investors since the year 2000 (Danish Financial Supervisory Authority (2009)). These investments were common among Danish investors, as described in Andersen et al. (2016), more than 60 percent of all investors held these assets in their portfolio. As these banks defaulted, the value of their traded shares quickly deteriorated until they held zero value and exposed investors to additional losses in a declining market.

[14] Depositor insurance in Denmark is provided by The Guarantee Fund for Depositors and Investors and guarantees 100% deposits up to 750,000 DKK (100,000 EUR). Notably relevant for this study, the Danish government decided to provide unlimited guarantees to depositors from October 5, 2008 to September 30, 2010.

To demonstrate, Figure 1 plots a simple index of market returns in log terms of different types of investments held in the portfolios of market participants. The gray line, plots the average market returns of all equities outside of the Danish banking sector over time. The black solid line, plots the returns of the equities of retail banking institutions which defaulted throughout the crisis, whose total value eventually diminishes to zero. These equities were eventually delisted from the Copenhagen Stock Exchange (CSE). Finally the dashed line plots the market returns for *unexposed* bank investors, these are retail banking equities which remained solvent throughout the crisis, noting that while the value decreases in comparison to all other equities, they retain a significant portion of their value compared to defaulting banks. Comparing the difference between the solid and dashed lines serves as variation in personal liquid wealth losses, while holding constant the investment style of the investor. In fact, as shown in Figure 2 the ex-post returns for a market-capitalization weighted portfolio of retail bank stocks which remain solvent compared to a portfolio bank stocks which end up in default had near identical risk and market returns in the 36 months preceding the financial crisis. The figure plots the distribution of monthly returns for the two portfolios containing retail banking stocks weighted by market capitalization from January 2005 to December 2007.[15] A Kolmogorov-Smirnov test suggests that the distributions of monthly returns are not statistically different from each other, not surprising considering the correlation between monthly returns for the two portfolios during that same time period was more than 90 percent.

For the average investor, these delisted investments were a significant loss to liquid wealth. Appendix A.5 provides a tabulation of the distribution of losses for unexposed and exposed investors. The table states the mean, 25th, 50th, and 75th percentiles of total investment losses, total losses as a percentage of savings, as a percentage of liquid wealth, and as a percentage of net wealth. Columns 1-4 compare the values of exposed investors to Columns 5-8 of unexposed investors. The table shows that on average, unexposed bank-investor entrepreneurs lost 49,700 DKK ($9,000 USD) in the declining market following the financial crisis, while exposed entrepreneurs lost on average 343,800 DKK ($62,500 USD), or 30 percent of pre-crisis savings, and 22 percent of financial wealth.

In general, this identification strategy has several strengths. Firstly, for small businesses, personal and business expenditures are likely to overlap considerably, but stock investments are generally a financial instrument held in personal accounts and separately from an entrepreneur's

[15] December 2007 is an accepted starting date for the Great Recession (NBER), however similar distributional plots for varying time periods show qualitatively the same result, as does using an equally weighted portfolio.

firm. Therefore a shock to personal investments serves as an ideal proxy for understanding the effect of changes in personal financial liquidity on firm performance. Secondly, because variation comes from the specific bank, and not in the type of investment, I compare investors with similar investment styles and portfolios with similar risk-return structures who are exposed to idiosyncratic variation from the delisted equities. Finally, as previously stated these investments made up a significant fraction of the liquid wealth held by entrepreneurs in the sample. It should also be noted that the related literature has shown that individual investors are likely to be under-diversified, hold on to losing investments, invest in local assets, and are sluggish to update their portfolio or to realize returns.[16] This suggests that it is not surprising, per se, that individuals may have let their portfolios containing defaulting bank stocks diminish instead of actively rebalancing away from these assets.

4.1 Descriptive Characteristics of Bank Depositors and Investors

The validity of estimates obtained by Equation 2 rests on the assumption that entrepreneurs who are exposed to banking defaults are similar to unexposed entrepreneurs, and selection into these two groups is near random. Therefore I pay particular attention to testing for differences in observable characteristics between entrepreneurs, controlling for fixed and time-varying demographic and financial characteristics, and examining the common pre-crisis trend in outcomes.

Table 2 focuses on the depositor sample of entrepreneurs in 2006 and compares entrepreneurs whose primary retail bank goes on to default during the financial crisis with entrepreneurs whose retail bank remains solvent. Column 4 presents the differences between *exposed* and *unexposed* depositors and the results of an unpaired t-test. In terms of observable demographic and financial characteristics exposed and unexposed entrepreneurs appear to be similar. Entrepreneurs who later become exposed to their retail bank defaulting are slightly more likely to be married, but the economic significance of this difference is questionable. In Table 3, I focus on a sample of entrepreneurs who invest in retail bank stocks outside of their own bank prior to the financial crisis. Columns 3 and 4 show that demographic, financial, and portfolio characteristics of *unexposed* and *exposed* investors are incredibly similar, with the differences and significance of the two groups displayed in Column 5. Column 5 suggests that the differences between the two groups is economically and statistically insignificant. This includes important indicators of background

[16] Please see Barberis and Thaler (2003), Kaustia (2010), and Andersen et al. (2016) for related literature reviews.

consumption such as mortgage loan-to-value, non-mortgage bank debt, and number of children. It also includes measures of investment style and risk taking such as the number of assets in an entrepreneur's portfolio and their allocation of financial wealth in risk-bearing assets. In total, Tables 2 and 3 suggest that the samples of entrepreneurs are well balanced.

In addition, Table 4 tests for correlation between entrepreneurship and bank and investment choice across a more general sample. In Columns 1-4 the sample consists of all individuals in 2006, while in Columns 5 and 6 the sample consists of bank investors. The dependent variable is an indicator variable which takes the value of one if the individual is an entrepreneur in the year 2006. The variable of interest is *bank that later defaults*, which designates a retail bank which goes on to default during the financial crisis. If entrepreneurs were systematically selecting into retail banks which were destined to default, this would be problematic for my identifying assumptions. Coefficients state the odds ratio from a logistic regression. Moving across columns while adding demographic control variables there seems to be no systematic correlation between entrepreneurship and having a retail bank which goes on to default in the years following the financial crisis. In Columns 5 and 6 the variable of interest is *bank investment default*, which indicates an investment in a bank which goes on to default during the financial crisis. Again, this variable tests if there is observable correlation between investment choice for entrepreneurs prior to the financial crisis. The insignificant coefficient suggests that the degree of correlation is not meaningful. It is likely that the balance sheet of retail banks was not necessarily an important selection criteria among retail bank customers and investors prior to the financial crisis.[17]

Previous literature suggests that banks and their customers often form relationships which likely benefit both parties in future transactions. Borrowers with longer banking histories and thus stronger relationships benefit from greater credit availability and lower collateral requirements (Petersen and Rajan (1994); Berger and Udell (1995)). Lenders also benefit, banks with prior relationships to a borrower have a much higher likelihood of securing subsequent loan business from the borrower compared to a new borrower lacking such a relationship (Bharath et al. (2007)). Panel A of Table 5 suggests that retail banks in Denmark form such relationships with customers and banking choice may be sticky. The table shows the unconditional probability that a bank customer in a given year remains a customer of the same bank in the following year. Column 1 focuses on customers of the 5 largest retail banks, Column 2 excludes the five largest retail

[17] Appendix Table A.4 presents bank level characteristics of the main types of banks in Denmark.

banks and Column 3 features customers of banks which go on to default during the financial crisis. The table shows that prior to the financial crisis the rate of continuing a banking relationship is approximately 90 percent. Moreover, this proportion does not significantly vary between customers at different types of banks. In Column 3, it is clearly shown that as the financial crisis unfolds, banks which default are associated with an increased separation rate between deposit customers and their banks.

Panel B of the table simply states the cumulative proportion of entrepreneurs who remain in their pre-crisis bank. Part of the aggregate separation may be mechanical due to the bank ceasing to exist. However, as the total proportion of customers who remain with a defaulted bank from 2005 to 2012 is near 15 percent (also shown graphically in Figure 3), a significant number of customers remain in a bank even after it has defaulted and remains in a state of resolution. The majority of exposed customers switched into a new bank, and given the previous literature on relationship banking, were likely impeded by a lack of historical relationships in borrowing from the new bank. Table 5 also shows perhaps more surprisingly, that as banks default, customers of other, similar banks (Column 2) remain customers of those banks. This suggests some level of inertia in bank choice as customers refrain from moving their account to one of the largest banks which could potentially be deemed to be more safe as the financial crisis progressed.

5 Results

5.1 The Effect of Bank Defaults on Channels of Financing

How does exposure to retail bank defaults contribute to the hypothesized channels of personal financing? Table 6 outlines the results from Equations 3 and 4. Columns 1 and 2 test the relationship between debt financing via personal bank loans and exposure to bank defaults for the depositor sample of entrepreneurs. The sample consists of individuals who were entrepreneurs at any point prior to 2007. The dependent variable is personal bank debt measured in 1,000 DKK at year-end. Personal bank debt includes all personal bank loans, credit card debt, and student loans. I focus the sample in Table 6 on entrepreneurs who own substantial housing assets (approximately 72 percent of the sample) in order to mitigate the role of small banking loans aimed to facilitate initial housing purchases.[18] Additionally, the sample focuses on bank customers who

[18] In an unreported analysis I test this on the full sample and find qualitatively similar results.

do not hold equity investments in bank stocks and therefore unexposed to investment losses. The variable of interest is *exposed depositors* which indicates if an entrepreneur is a bank customer at a bank which defaults and takes the value of one in the periods after the default. Columns 1 and 2 suggest that after exposure to a bank default, depositors on average hold over 70,600 DKK ($12,800 USD) less in bank loans, a substantial decrease in personal borrowing. This result contributes to contemporaneous research on banking shocks and imputed measures of consumption for non-entrepreneurs, for example Jensen and Johannesen (2015) find similarly that Danish customers of distressed banks reduced consumption and borrowing after the financial crisis.[19]

Moving first to Columns 7 and 8, I test the relationship between default exposure and personal liquid wealth as outlined Equation 4. The dependent variable is the log of liquid wealth holdings at year end. Liquid wealth consists of the sum of year-end market value of stocks, bonds, and bank deposits. As in the previous columns the sample consists of all individuals who are or were entrepreneurs at any period before 2007, in this case the sample is restricted to investors who held retail bank stock investments outside of the bank which they were a deposit customer at any time between 2005-2007. The variable of interest is *exposed investor* which provides the effect of a banking default on liquid wealth holdings compared to similar entrepreneur-investors unaffected by defaulting bank stocks. Column 8 includes individual-entrepreneur fixed effects. The coefficient is significantly estimated at approximately -0.32 suggesting that investors with investments in banks which default are exposed to substantial losses in their liquid wealth. On average, exposed investors hold 32% less liquid wealth after their bank defaults compared to investors who held investments in retail banks which remain solvent. After controlling for fixed-effects and the time trend, this is an approximate average reduction of 234,000 DKK ($42,000 USD).

Finally, Columns 3-4 and 5-6 show that the hypothesis laid out earlier holds relatively well. Exposed depositors are less affected by their liquid wealth assets, but largely in personal debt via their access to bank credit. Similarly, exposed investors are affected via their supply of liquid wealth rather than their access to bank lending. Figure 4 plots these analyses in an event study allowing one to verify assumptions about similar slopes and the common trend between exposed

[19] The authors find a decrease of approximately 7,300 DKK at a mean value of 141,000 DKK, or a 5.2% effect for customers of banks with an above median ratio of loans to deposits. For entrepreneurs of default banks, I find a similar effect but much larger in levels, i.e., 70,600 DKK decrease at a mean value of 1,557,800 DKK or 4.5%. However, Jensen and Johannesen (2015) find that across the general sample of individuals, exposure to a banking default is not associated with a decrease in borrowing. In an unreported table I verify their result and similarly find that individuals from the *general population* are not effected negatively by banking defaults, however I find that *small business owners* do indeed dramatically decrease borrowing after exposure to a defaulting banking institution.

and unexposed groups. The top panel plots a dynamic model of the specification in Column 2 (left) and Column 4 (right). The plotted coefficients represent $exposed_i^j \times year_t$ indicating the interaction between exposure to a retail bank defaulting and the time-trend. This provides the difference in borrowing (left) and liquidity (right) between unexposed and exposed bank depositors at each year leading up to the financial crisis until 2011. The bottom panel plots the same analysis for bank investors, i.e., Column 6 (bottom-left) and Column 8 (bottom-right). The figures show that pre-crisis, the difference between exposed and unexposed entrepreneurs is not significantly different from zero, confirming assumptions about the common pre-trend. For bank depositors, exposed entrepreneurs decrease their borrowing post-crisis however hold a similar pattern of liquidity compared to unexposed entrepreneurs. For investors, the inverse holds: exposed entrepreneurs significantly decrease their liquidity position, however remain unaffected in their level of borrowing.[20]

5.2 Firm Exit and Access to Debt Financing

The previous section shows that bank depositors exposed to their own personal bank defaulting are more likely to switch banks and take on less personal bank debt. As debt finance is an important characteristic of small businesses, this exposure may have had significant effects on a firm's survival.

In Table 7 I investigate this relationship as outlined in Equation 2. The dependent variable is an indicator for exiting entrepreneurship, conditional on being an entrepreneur in the current period. The main variable of interest is *exposure to bank default* which indicates entrepreneurs with exposure to their primary retail bank defaulting. The variable takes the value of one if year t is after the year of default for exposed entrepreneurs and zero if otherwise. Year and individual-entrepreneur fixed effects, α_t and ρ_i, account for differences across types of entrepreneurs over time. X, a vector of time-varying individual demographic and financial characteristics includes *log wealth, log income*, and if the entrepreneur has a *child* or purchases a *house* in year t.[21] Because of the staggering of the banking defaults over time, entrepreneurs who go on to experience a default later, are included as a control group for earlier defaults.

Columns 1-4 begin by considering a full sample of entrepreneurs who are exposed and unexposed

[20] Appendix A.7 presents this model in full detail.

[21] In specifications without individual fixed effects X includes *age, age^2, male, marriage status, education length in years, log wealth, log income*, and *child in the household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. In these specifications, I also control for the year that the firm was established.

to the banking defaults. In Column 1 the average effect from exposure to a primary retail bank defaulting increases the probability of exiting entrepreneurship by 1.6 percentage points and is marginally significant at the 90 percent level. As discussed previously, there were a number of troubled banks, which rather than defaulting, found themselves in private merger and acquisition arrangements. Entrepreneurs exposed to this variation serve as a natural placebo test. If the default of a small business owner's retail bank inhibits their ability to take on debt as shown previously, a retail bank which results in a merger likely results in less of a disruption to personal borrowing. Effected bank depositors were integrated with an established bank, and were arguably less impacted in their ability to take on personal debt, as the relationship between borrower and lender was more likely to remain intact. The variable *exposure to bank merger* takes the value of one for entrepreneurs whose retail bank merged with another established retail bank in post-merger years. The effect of a bank merger should have a limited effect on available bank credit, and as expected does not have a significant effect on the firm's survival rate. This supports evidence from (Sapienza (2002)) who shows that in-market mergers have a positive effect on small businesses. In Column 3 and 4 the two exposure variables are jointly estimated with and without individual-entrepreneur fixed effects. The inclusion of individual-entrepreneur fixed effects increases the average treatment effect of a default personal bank, suggesting that exposed entrepreneurs are approximately 2.5 percentage points more likely to exit from their firm relative to comparable unexposed entrepreneurs. This effect is economically meaningful as the average rate of exit is 19 percent. At the same time, exposure to retail banks which result in merger agreements with better-off banks do not increase firm exit.

The full sample specification in Columns 1-4 may be confounded by the fact that individuals who lose access to personal bank loans may be also be affected by losses in personal wealth stemming from the banking defaults. In Columns 5-8 I therefore remove from the sample entrepreneurs with investments in banks that eventually default, as the changes in personal financial wealth stemming from changes in investments may be a confounding factor to their firm's financial decisions.[22] Once removing these individuals and considering the solely the effect of changes in access to credit, Column 8 suggests that exposure to retail banks which default do indeed increase the probability of firm exit.

[22] I should note that if the sample is restricted to entrepreneurs who do not invest in any stocks over all years the significance of the result fades, however this sample selection is too restrictive to draw conclusions about the role of personal bank credit.

Similar research from the United States uses bank merger and acquisition activity following banking law liberalization. Results suggest that bank-branch closures reduce small business lending (Berger et al. (1998); Nguyen (2014)) and decrease employment (Greenstone et al. (2014)). However, Black and Strahan (2002) find a positive effect of banking consolidation on entrepreneurial activity, arguing that larger bank's diversification strengths may outweigh smaller bank's relationships strengths. Strahan and Weston (1998) find that mergers have little effect on small business lending, and if anything the relationship may be positive. A weakness of this existing literature is that data is aggregated at the locality level and measuring the true relationship between borrower and lender is problematic. Sapienza (2002) uses individual loan contract data on small businesses in Italy and finds that borrowing and lending rates increase after small mergers but decrease after large mergers.

Compared to the existing literature this analysis focuses on the *personal* accounts of entrepreneurs and is at the individual firm owner-level rather than that of the firm. Therefore, a firm owner may have his or her own personal savings held in an affected bank, while the firm's finances may be held at a different bank. However, given the small size of firms in the sample,[23] firm owners may hold their personal and business accounts in the same local banking institution. In addition, the above studies based on aggregated data which find a decline in small business activity may be confounded by a decrease in lending to individuals from the general population who would like to become entrepreneurs rather than established or existing firms. To that end, in Appendix A.6 I test the effect of an individual's primary retail bank defaulting on his or her propensity to *enter* entrepreneurship. Here I find an approximately 0.9% decrease in the probability to entering entrepreneurship after the bank default, perhaps more comparable to the existing literature.

A challenge is to establish whether the banking defaults affected small business owners via a channel of consumer credit supply or through a demand shock which resulted in firm closure. I address this in Table 8 by controlling for the local area in which effected entrepreneurs are located. In Columns 1 and 4 the sample contains exposed entrepreneur depositors matched with unexposed entrepreneurs in the same municipality. Columns 2 and 5 match exposed entrepreneurs to unexposed entrepreneurs in the same parish. Parishes are ideal for this analysis as they present a reasonably small local area and essentially allow for matching at the neighborhood level. The

[23] The median number of employees in firms in my sample is 3, as noted in Appendix A.3.

median parish in in 2006 had a total population of only 1,107 individuals. Matching is based on 5 nearest neighbor exact matching on municipality or parish, five-year age cohort, pre-crisis wealth, gender, and marital status. Finally, in Columns 3 and 5 I focus on an exclusive subsample of entrepreneurs whose firm is located in a municipality outside of the municipality in which they reside in. Matching exposed and unexposed entrepreneurs in tight geographic locations allows me to hold constant any change in local market demand. The coefficients of interest across columns reveal a highly similar story as to the effect shown in the previous table in magnitude.

5.3 Firm Exit and Changes in Personal Wealth

As demonstrated in Table 7, disruptions in entrepreneurs ability to obtain personal loans may have a negative impact on firms' survival via a channel of debt financing. In the years following the financial crisis and in the face of weakened consumer demand, additional personal wealth losses may limit the ability of firm owners to supply personal equity to their firms especially for small businesses operating at the margin. This could increase the probability that entrepreneurs shut down their firms either due to a lack of ongoing capital, or to diversify their streams of income.

To analyze the effect of personal losses to liquid wealth on firm exit rates, I again turn to the econometric model specified in Equation 2. In this case, $exposed_{it}^{j}$ now proxies changes in liquidity with investment losses from delisted bank stocks due to their default. In Table 9 the dependent variable is an indicator variable for exiting entrepreneurship, conditional on being an entrepreneur in the previous period. The variable *personal wealth losses* takes the value of one if year t is after the bank default year for the exposed group of investors and provides the average difference in the probability of firm exit after investment losses compared to unexposed bank-investor entrepreneurs. In Columns 1 and 2 the sample is unrestricted to all exposed and unexposed bank-investor entrepreneurs. The coefficient of the variable *personal wealth losses* suggests that entrepreneurs who were exposed to above median liquid wealth losses are approximately 5.4 percentage points more likely to exit from entrepreneurship compared to other bank-investor entrepreneurs unaffected by wealth losses. In Column 2 adding individual fixed effects slightly increases the estimate to 5.8 percentage points. This is an economically meaningful result, given a mean pre-crisis rate of exit of 16 percent. A 5.8 percentage point increase therefore corresponds to a marginal effect of 36 percent.

In Columns 3 and 4 entrepreneurs who hold investments in their own retail bank are excluded in order to disentangle the effects of loss of access to debt financing and losses in personal wealth. Removing these individuals from the sample increases the average effect. Exposed entrepreneurs are approximately 6 percentage points more likely to exit from their firm in the years following the liquidity losses. To further distinguish between these two channels, in Columns 5 and 6 the sample contains entrepreneurs who *either* lost access to their retail bank, or lost liquidity due to wealth losses from default bank investments. Unexposed entrepreneurs have a retail bank which defaulted, therefore they lose potential access to debt finance and hold investments in other retail banks which do not default. Exposed entrepreneurs on the other hand have a retail bank which remains solvent, thus they continue to have access to debt finance, however they hold investments in a retail bank which defaults. This sample provides a powerful indication of the effect on wealth losses, as it holds constant the sample of investors with similar investment styles and compares bank-investors who lost access to debt finance compared to entrepreneurs who only lost financial wealth. The coefficient of the difference-in-differences variable suggests that entrepreneurs who lost liquid wealth are approximately 6 percentage points more likely to exit from their venture after experiencing the loss in liquidity.[24]

To verify the pre-crisis common trend between exposed and unexposed investors I plot a dynamic version of the model in Figure 6. Panel A plots the effect of retail bank default exposure on the effect of firm exit for the depositor sample discussed in the previous section. Panel B plots the interaction term between $exposed_i^j$ and yearly time dummies stemming from Column 4 in Table 9. The dynamic version of this model is also shown in detail in Column 2 of Appendix A.8, along with a Wald test of joint significance for pre- and post-crisis time periods. The results suggest that pre-crisis, the difference in the probability of exit for exposed and unexposed entrepreneurs does not statistically deviate from zero, however post-crisis the the effect of liquidity losses has a large and statistically significant effect on probability of firm exit. To summarize, Table 9 suggests that losses in liquidity significantly increase the rate of entrepreneurial exit by roughly 5 to 6 percentage points, while the effect remains stable across samples and specifications.[25]

[24] The results presented thus far are also robust to alternative definitions of entrepreneurship. In an unreported analysis I create a dataset consisting of entrepreneurs *and* self-employed individuals and find qualitatively similar results. If the sample consists of *only* self-employed individuals, the effect of bank defaults and investments losses fades. This can potentially be explained if self-employed individuals are more likely to be consultants and/or work in less capital intensive businesses.

[25] In an unreported robustness check, I exclude from the sample investors who invest in the largest bank related equities in Denmark (e.g., Danske Bank) and focus the sample solely on *local* retail bank investors. This specification improves upon the match of exposed and unexposed investors. I find the results to be similar to the results presented.

In order to examine the heterogeneous effects of personal wealth losses on entrepreneurship, in Table 10 I split the sample by the length of time the firm has been in operation. Columns 1-3 focus on a sample of established entrepreneurs. Established entrepreneurs began their firm at any time prior to 2002, while in Columns 4-6 the sample consists of new entrepreneurs who started their first venture in the years prior to the financial crisis before 2002-2007. Each column represents the various samples discussed previously. Established entrepreneurs are far from immune to liquidity shocks. The average entrepreneur who started their firm well before the financial crisis is approximately 5 percentage points more likely to exit after losing an above median fraction of liquid assets. Columns 4-6 suggest that this effect is significantly greater for new entrepreneurs. Entrepreneur's who started their firm just prior to the financial crisis are 9-12 percentage points more likely to exit after experiencing liquidity losses. These results confirm existing cross-sectional evidence such as Berger and Udell (1995) and Robb and Robinson (2012), suggesting that owner provided equity may be more crucial for younger firms in the earlier stages of their life-cycle.

The results thus far suggest that an unexpected decrease in personal liquid wealth plays an important role in determining exit from entrepreneurship, especially for younger, less experienced small business owners. In order to quantify this effect across the distribution of losses, I turn to a DD specification with a continuous treatment variable.

$$y_{it} = \alpha_t + \sigma_c + \gamma(exposed_{it} * \phi_{i,2006}) + \beta X_{it} + \epsilon_{it} \tag{5}$$

where α_t and σ_c are year and bank-treatment cohort fixed effects. Note that in specifications without individual-entrepreneur fixed effects the bank-treatment fixed effect is necessary to identify γ. As previous, $exposed_{it}$ indicates entrepreneurs with exposure to investment losses stemming from retail bank investments and $\phi_{i,2006}$ is the share of liquid wealth (i.e. the year-end market value sum of bank savings, bond holdings, and stock investments) invested in retail bank stocks prior to the financial crisis. γ provides the average treatment effect of exit from entrepreneurship for exposed entrepreneurs after the default of their bank investment at varying levels of pre-crisis investment in stocks which go on to default. The results from this specification are presented graphically in Panel A of Figure 5, showing the effect of the size of lost investment on the probability of exiting. The x-axis plots the fraction of liquid wealth lost from an investment in a default bank for exposed entrepreneurs after the banking defaults. The left panel of the first figure includes all entrepreneurs while the right-hand size focuses solely on new entrepreneurs who started their establishment in the years before the financial crisis. The results suggest that the probability to exit is an increasing function of the size of lost wealth; when entrepreneurs experience a complete loss of their liquid wealth the probability that they exit from their firm increases by nearly 40 percent.

5.4 Firm Exit Hazard Rates

The results from the previous section suggest that exposure to liquid wealth changes have large effects on exit from entrepreneurial firms. However, there are several dimensions of the data that warrant additional analysis prior to making conclusions regarding firm survival. In previous linear specifications I estimated the probability of firm exit at year t, while controlling for the year that the entrepreneur started-up the firm. It may be more reasonable to estimate the survival or hazard rate of entrepreneurial-firm i, conditional on the length of time in years τ that the firm has survived. In this case, the Cox proportional hazard model is a reasonable choice as it allows estimation of the baseline hazard without making any assumptions about it's shape over time.[26] In addition, the hazard class of models are particularly well suited to handle the right-censored nature of entrepreneurial firm survival and competing reasons for exit.

While the identification strategy outlined in Section 4 remains similar, the econometric model changes to the form,

$$\lambda_i(\tau|exposed_i^j, X) = \lambda_{i,0}(\tau)\exp\{\beta_1 exposed_i^j + \beta_2 after_t + \gamma(exposed_i^j \times after_t) + X'\beta\}$$

where τ is the length in years entrepreneur i has been the owner of the current firm. The coefficient γ, represents a shift in the baseline hazard, $\lambda_{i,0}(\tau)$, due to bank default exposure either affecting the entrepreneur via debt financing or via his liquid wealth in time periods after the year 2008. X is a vector of control covariates which includes indicator variables for the entrepreneur's municipality of residence. As in the linear probability models, I allow the baseline hazard to vary between calendar year in order to identify γ.[27]

[26] In an unreported table, I estimate the model using a Weibull distribution which allows for duration dependence in the shape parameter ρ, i.e., whether the probability of firm exit is increasing or decreasing as τ increases. The results from the Weibull model suggest a slight positive duration dependence, and the hazard rates and standard errors are comparable to the results presented in Table 11.

[27] As demonstrated by Ai and Norton (2003) the coefficients of interaction terms in non-linear models do not translate directly to difference-in-differences estimates as in linear models. Instead, in non-linear estimations, difference-in-

There are two sources of left-censoring that need to be addressed. The first is that I exclude entrepreneurs who began their firm after 1990 and shut down prior to the study period beginning in 2002. This is a trivial exclusion as it occurs by construction. The second is more serious and pertains to entrepreneurs who started their firm prior to 1990 and remain entrepreneurs after 2002 such that they are included in the study period. Because of data limitations if entrepreneurs started their firm before 1990, I will only capture the start year as 1990. To address this source of data censoring I also present results of a subsample limited to entrepreneurs who began their firm after 1990.

Table 11 presents the results of the model specified above. Columns 1-5 focus on the depositor sample of entrepreneurs while Columns 6-8 features the bank investor sample of entrepreneurs. In Column 1 the variable of interest is *exposure to bank default* which presents the coefficient γ. All exponentiated coefficients are presented as proportional increases or decreases to the hazard of firm exit relative to one. If the coefficient is greater (smaller) than one, the difference from 1.0 indicates the percentage increase (decrease) in the probability of exit given a one-unit increase in the explanatory variable. Thus, exposure to a retail bank closure because of its default increases the hazard of firm exit by approximately 11 percent. Columns 2 and 3 test the relationships of exposure to retail banks involved in merger and acquisition activity rather than default. As previously mentioned, this works as a placebo test and as expected, I find no effect on the hazard of exit from exposure to merger activity.

As in the linear probability model of Table 7, in Columns 4 and 5 I focus the sample on bank depositors only, thus removing entrepreneurs who may be impacted in their liquid wealth holdings via investments in the banks which they hold deposits. Column 5 accounts for the left-censoring issue that some entrepreneurs began their firms prior to 1990 by excluding these individuals. The results of Columns 4 and 5 confirm the results presented previously, once accounting for changes in financial wealth, exposure to bank defaults have an apparent but small effect on the probability of exit.

Columns 6-8 suggest that exposure to financial losses of the entrepreneur strongly influence the hazard of his or her firm. The coefficient of *personal wealth losses* suggests exposure to liquidity losses increases the probability of firm exit by 29 to 47 percent, in line with the effect presented in the previous linear specification.

differences should be evaluated using the full underlying model. To account for this, I compute each coefficient as described based on the conditional probability including all covariates held at their mean values.

5.5 Post-Exit Outcomes

The results thus far suggest that contractions in personal liquidity are linked to higher levels of exit for entrepreneurial firms throughout the Great Recession. However, entrepreneurial survival is challenging to measure for a number of reasons. On one hand, entrepreneurs in the sample are defined by employing at least one additional individual in the firm. Therefore, if changes in labor inputs occur at the intensive margin it may look like the entrepreneur is shutting down his venture, when actually he or she is downsizing. Secondly, the shutdown decision for an entrepreneur is complicated in the sense that entrepreneurs close businesses for a number of reasons. A venture may be abandoned in order to start a new, more promising venture, or the decision could in fact be driven by under-performance (Parker (2009)). Survey data from the US suggests that many entrepreneurs deemed their venture to be successful upon closure (Headd (2003); Bates (2005)) and only about 10-15 percent of entrepreneurial closures result in bankruptcy (Baird and Morrison (2005)).[28]

If firm owners were to close down their ventures in order to immediately start new ventures, there should be no effect on the results presented thus far, as their employment designation would remain within the definition of entrepreneurship. Furthermore, if they downsize their firm and move to a self-employed status without employing other individuals in the previous tables they would appear as exiting, potentially misleading the interpretation of the results. The data does not allow one to determine if the exit was voluntary or out of necessity, however for non-censored observations I can see the labor market activity of the entrepreneur after firm-exit. I therefore designate the below outcomes following firm-exit,

$$outcome_k = \begin{cases} 1 & \text{unemployment or labor market exit} \\ 2 & \text{enter salaried position in labor market} \\ 3 & \text{self-employment/downsize in the same firm} \\ 4 & \text{start-up new firm} \end{cases}$$

The subhazard function of exit outcome k, is then given by the following,

[28] See Parker (2009) for additional references.

$$\hat{\lambda}_{ik}(\tau|exposed^j_{it}, X) \quad = \hat{\lambda}_{i,k,0}(\tau)\exp\{\beta_1 exposed^j_i + \beta_2 after_t + \gamma(exposed^j_i \times after_t) + X'\beta\}$$

I estimate the above equation as specified in Fine and Gray (1999) which is the analogous to the Cox proportional hazard for competing risks in that it makes no assumption about the distribution of the baseline hazard function.

Table 12 presents the result of competing risk hazard regressions where the columns represent the various possible post-exit outcomes. In Column 1, entrepreneurs close their venture and enter into a state of unemployment or exit the labor market completely. In Column 2, entrepreneurs enter into a non-ownership, salaried position, at a new firm after exiting from their venture. In Column 3, entrepreneurs remain in the current venture, however either downsize their employees and/or take on a self-employment designation discussed in Section 3.1. Finally, in Column 4, entrepreneurs exit their venture to start up a new entrepreneurial firm. Panel A presents the results across the bank depositor sample and considers the effect of financing disruptions on each one of these outcomes, while taking into consideration the three remaining competing risk outcomes. The subhazard outcomes after changes in credit availability due to a retail bank defaulting show that there is a marginally effect where exposed entrepreneurs are more likely to predict exit to unemployment. For the remainder of the post-exit outcomes there is no significant difference between exposed and unexposed entrepreneurs.

In Panel B, I consider the effects of lost liquidity due to default bank investments on each of the four outcomes while treating each other outcome as a competing risk. If losses in liquidity effect an owners ability to supply equity investments to a firm, it is unlikely that exposed entrepreneurs will exit their venture in order to start-up a new venture. On the other hand if personal losses are substantial, an entrepreneur may withdraw equity from the firm to support previous commitments. Therefore, a firm owner may be more likely to seek an employment contract which could offer a more stable source of income. Panel B suggests that entrepreneurs exposed to liquidity losses are almost twice as likely to exit a firm and enter into a salaried labor contract compared to unexposed entrepreneurs. This suggests that size of the income shock is significantly large as it affects not only their decision to close their venture, but also their choice of future employment. As entrepreneurs in my sample are classified by employing others, it is unlikely that my results can be interpreted as

Taylor (1999), who suggests that self-employment may be a transitory state between employment spells. In fact, Panel B shows that liquidity losses increase the probability that an entrepreneur downsizes or remains self-employed, and these results are both statistically significant.

5.6 Intensive Margin Decisions

As shown, changes in access to debt financing and personal wealth affect the extensive margin of firm operations. However, it is logical to assume that if disruptions affect the ability to supply capital to the firm rather than via some other channel, firm owners may attempt to reduce the variable costs associated with labor inputs prior to ceasing operations. In Table 13 I focus on changes at the intensive margin for small business owners. I ask if employers reduce employee headcount when facing an unexpected decline in access to debt financing, or a decrease in their personal liquid wealth.

Columns 1 and 2 consider the effect of losses in access to debt financing due to the default of the entrepreneur's retail bank, while Columns 3 and 4 focus on the effect of losses in personal liquid wealth. In both cases, the sample represents entrepreneurs who employ at least one other individual in year t, and for this analysis, I exclude entrepreneurs who employ a number of employees greater than the 99th percentile. The results from this table suggests that wealth losses drive changes at the intensive margin, however changes in access to financing have a limited effect. This is in contrast to a recent literature examining the effect of credit market disruptions on employment (Chodorow-Reich (2014). However, Greenstone et al. (2014)), finds a limited effect in smaller businesses perhaps more comparable to this analysis. On the other hand, personal losses in liquid wealth holdings have a large and significant effect. Firm owners who lose a significant source of personal liquidity operate smaller firms after they experience personal losses.[29] On average, exposed employers reduce their number of employees by approximately 0.26 to 0.72 employees after experiencing financial wealth losses. This is a substantial decrease considering the average number of employees in these small firms is 4.8. These results are presented graphically in Figure 7.[30]

[29] This effect could be driven by employers actively reducing staff, by employers simply choosing not to renew employment contracts, or alternatively by employees selecting out of certain ventures.

[30] Appendix A.8 presents the dynamic version of Table 13 which the figures are based on.

5.7 Heterogeneity in Households

The decision to exit from a small business is likely to vary considerably from household to household. Table 14 questions whether the relative importance of income within the household plays a role in exit from firms for exposed entrepreneurs. The dependent variable continues to be an indicator variable for exiting entrepreneurship, conditional on being an entrepreneur in the last period. The variables *exposure to bank default* and *personal wealth losses* are defined as previous. Columns 1 and 2 focuses on the depositor sample of entrepreneurs while Columns 3 and 4 focus on the investor sample. In Columns 1 and 3 the sample consists of married entrepreneurs whose income share to the total household is less than 50 percent. In Columns 2 and 4 married entrepreneurs income share within the household is greater than or equal to 50 percent. For bank depositors, it appears that the relative share of income to the household does not impact firm exit. For bank investors on the other hand, firm owners who contribute a large share of income to the total household, are much more likely to exit from their firm after experiencing personal wealth losses from defaulting bank investments. The effect of losses in personal wealth causes firm exit for owners whose businesses have a larger relative importance in the households' total income. This result is shown graphically in Panel B of Figure 5.

Similarly, in Table 15, the sample is divided into terciles such that Column 1 (2) (3) includes the bottom (middle) (top) third of the distribution. Panel A separates this for *net wealth* while Panel B separates *total sources of debt*. Again, for the depositor sample there appears to be a limited effect of heterogeneity across households on the propensity to exit from a firm once exposed to their own bank defaulting. For investors, the results from Panel A suggest that entrepreneurs outside of the top third of the distribution of wealth are more impacted by personal wealth losses. Panel B shows that investors with high debt are almost 10 percentage points more likely to exit from their firm after exposure to personal wealth losses from lost investments. These results suggest that, unsurprisingly, more financially constrained small business owners are affected by personal wealth losses.

6 Alternative Mechanisms

A robust finding of this analysis shows that large losses in personal wealth drive firm exit for small business owners. The main channel that has been discussed so far suggests that this casual effect is rooted in limited financing as a barrier to firm survival. However, this liquid wealth shock may also cause changes in risk taking behavior which in turn could affect the desire of an individual to continue with an entrepreneurial firm. There is a large literature that suggests that entrepreneurs may perceive risk differently from salaried individuals (see Åstebro et al. (2014) and Koudstaal et al. (2015) for recent discussions). In addition, recent evidence suggests that these differences may be attributable to entrepreneurs' willingness to risk losses (Koudstaal et al. (2015)). I cannot exclude the possibility that large wealth losses change the beliefs entrepreneurs hold about future sources of risk. This is especially difficult to disentangle empirically, for example Andersen et al. (2016) show that the effect of investment losses and portfolio inertia are observantly equivalent, therefore it is difficult to separate the experience shock from changes in risk taking particularly when investors are inactive. Nonetheless, Andersen et al. (2016) find that negative experiences in the stock market made individually do reduce future financial risk taking.

In particular, two results presented thus far suggest that alternative mechanisms may be of importance. I have shown that large investment losses seem to drive entrepreneurs into salaried labor rather than into a new entrepreneurial venture. This could suggest that these small business owners are less comfortable taking on additional income risk in the future and therefore seek an alternative occupation. This supports a potential change in attitudes toward risk. Similarly, exposed entrepreneurs who are the breadwinners within their household are more affected by financial losses compared to those who contribute a smaller share of income. This could suggest that small business owners may need to actively liquidate the firm in order to support commitments and not necessarily because their firm is constrained in capital. At the same time, changes at the intensive margin for small business imply that financing shocks have real effects aside from these other mechanisms. Likely, the results presented in this analysis are a combination of all of these factors and personal financing disruptions affect the survival of firms through a myriad of complex mechanisms.

7 Conclusion

Much of the previous literature on financing for small businesses has focused on the initial starting conditions of entrepreneurs, liquidity constraints, and the capital structure of the firm. The previous research on how credit market disruptions affect firms focus on larger firms and shocks to commercial and business lending. In contrast, this paper studies how personal financing disruptions experienced directly by the individual entrepreneur can have large causal effects on the survival rate of their businesses during operations. I use detailed administrative data on individual entrepreneurs matched with data on their banking relationships and personal assets to estimate the effects of changes in access to debt financing and personal liquid wealth on firm performance and survival rates. The wave of banking defaults that occurred throughout the Great Recession in Denmark serves as variation between small business owners and their borrowing ability, as well as changes in personal liquid asset positions.

My results suggest that for established entrepreneurs, access to personal debt financing is an important attribute to firm survivorship. At the same time, a decrease in the personal liquidity of a small business owner substantially increases the hazard of firm exit. This effect is accentuated for newer and more constrained entrepreneurs. In addition, I find that entrepreneurs are more likely to enter into salaried labor after losing substantial liquid wealth holdings. Finally, losses of individual wealth affect intensive margin decisions as well. Affected firm owners are more likely to employ fewer individuals after losses in personal wealth. Particularly in times of economic crisis, personal wealth and personal borrowing play a key role in entrepreneurial decision making. In the future, it will be interesting to examine how entrepreneurs are affected by changes in access to *informal* lending, and if changes in assets within the household, or social-networks of entrepreneurs affect their firm's outcomes.

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8 Tables and Figures

Table 1: Employment Choice and Summary Statistics

The following table reports summary statistics for all individuals in the sample in the year 2006. Column 1 presents all individuals in the sample and Column 2 includes *self-employed* individuals. Column 3 focuses on *entrepreneurs* that employ at least one other individual, while Column 4 focuses on individuals who are in traditional salaried labor employment or temporarily outside of the labor market. The last column presents the differences between salaried and entrepreneurial individuals in the sample. *Age* is measured in years for each individual in 2006. *Married* indicates if the individual is married in the year 2006. *Number of children* is the total number of children of any age currently living in the same household. *University education* is an indicator variable taking the value of one if an individual has a high school and university education. *Total income* measures the income received by the individual from all sources, while *liquid wealth* is the sum of bank deposits, stocks, and bonds at year-end 2006 market values, and *bank deposits* is year-end personal bank savings. *Positive housing assets* indicates if an individual owns real estate (market value greater than 500,000 DKK). *Total value of property* is the sum of current value debt and equity of all housing investments and *Mortgage value* is the year-end value of outstanding mortgage debt. *Mortgage LTV* is the ratio of outstanding mortgage debt to total housing assets. *Value of debt* is the total outstanding value of debts. *Bank loans* is the value of retail banking loans. All amounts are in thousands at the year-end 2006 and deflated to year-2010 DKK. All variables are presented at the individual level unless otherwise indicated. Standard deviations are in parentheses and t-statistics are reported in brackets. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively.

	Full sample				
	All	Self-employ	Entrepreneurs	Salaried	Differences
	(1)	(2)	(3)	(4)	(3) - (4)
Age	41.30	41.18	42.70	41.28	1.42***
	(7.29)	(7.33)	(6.84)	(7.29)	[33.53]
Male	0.51	0.57	0.75	0.50	0.25***
	(0.50)	(0.49)	(0.43)	(0.50)	[86.46]
Married	0.61	0.54	0.72	0.61	0.10***
	(0.49)	(0.50)	(0.45)	(0.49)	[36.38]
Number of children	1.10	1.07	1.36	1.10	0.26***
	(1.09)	(1.18)	(1.18)	(1.08)	[41.88]
University education	0.25	0.19	0.16	0.26	-0.10***
	(0.43)	(0.39)	(0.37)	(0.44)	[-37.79]
Total income	378.67	313.55	743.11	376.85	366.26***
	(350.47)	(442.37)	(1750.47)	(232.52)	[186.47]
Liquid wealth	139.81	197.59	451.80	128.57	323.23***
	(321.17)	(556.46)	(927.53)	(260.51)	[191.98]
Value of bank deposits	85.44	116.48	264.72	79.17	185.55***
	(173.22)	(288.41)	(497.06)	(142.52)	[202.28]
Positive housing assets	0.56	0.48	0.80	0.56	0.23***
	(0.50)	(0.50)	(0.40)	(0.50)	[80.48]
Total value of property	848.43	1367.64	3660.93	747.31	2913.62***
	(1487.39)	(3107.50)	(5963.21)	(842.85)	[422.61]
Mortgage value	534.22	805.02	2508.57	471.21	2037.36***
	(996.30)	(1997.37)	(4333.27)	(537.10)	[432.23]
Mortgage loan to value	0.68	0.66	0.76	0.68	0.08***
	(0.67)	(0.57)	(1.09)	(0.66)	[18.92]
Total value of debt	773.90	1182.51	4559.31	662.51	3896.80***
	(2976.72)	(3961.26)	(18565.95)	(1080.78)	[236.86]
Bank loans	204.71	337.38	1491.75	167.37	1324.38***
	(1555.52)	(1903.17)	(10046.86)	(536.28)	[150.49]
Observations	1,643,542	126,634	30,082	1,486,826	-

Table 2: Summary Statistics of Bank Depositors

The following table reports summary statistics for entrepreneurs in the sample in the year 2006. Column 1 presents all *entrepreneurs* in the sample, Column 2 focuses on *unexposed entrepreneurs* who have a retail banking institution in 2006 which did not default in the following financial crisis. Column 3 is comprised of *exposed entrepreneurs* who have a retail banking institution in 2006 which goes on to subsequently default in 2008-2012. The last column presents the differences between exposed and unexposed entrepreneurs. *Age* is measured in years for each individual in 2006. *Married* indicates if the individual is married in the year 2006. *Number of children* is the total number of children of any age currently living in the same household. *University education* is an indicator variable taking the value of one if an individual has a high school and university education. *Total income* measures the income received by the individual from all sources, while *liquid wealth* is the sum of bank deposits, stocks, and bonds at year-end 2006 market values, and *bank deposits* is year-end personal bank savings. *Positive housing assets* indicates if an individual owns real estate (market value greater than 500,000 DKK). *Total value of property* is the sum of current value debt and equity of all housing investments and *Mortgage value* is the year-end value of outstanding mortgage debt. *Mortgage LTV* is the ratio of outstanding mortgage debt to total housing assets. *Value of debt* is the total outstanding value of debts. *Bank loans* is the value of retail banking loans. All amounts are in thousands at the year-end 2006 and deflated to year-2010 DKK. All variables are presented at the individual level unless otherwise indicated. Standard deviations are in parentheses and t-statistics are reported in brackets. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively.

	Entrepreneurs			
	All	Unexposed	Exposed	Differences
	(1)	(2)	(3)	(2) - (3)
Age	42.70	42.71	42.60	-0.11
	(6.84)	(6.85)	(6.76)	[-0.59]
Male	0.75	0.75	0.77	0.02
	(0.43)	(0.43)	(0.42)	[1.43]
Married	0.72	0.71	0.74	0.03**
	(0.45)	(0.45)	(0.44)	[2.53]
Number of children	1.36	1.36	1.36	-0.00
	(1.18)	(1.18)	(1.18)	[-0.14]
University education	0.16	0.16	0.17	0.01
	(0.37)	(0.37)	(0.37)	[0.51]
Total income	743.11	746.66	673.95	-72.71
	(1750.47)	(1788.51)	(662.88)	[-1.55]
Liquid wealth	451.80	450.98	467.87	16.90
	(927.53)	(926.87)	(940.43)	[0.68]
Value of bank deposits	264.72	265.52	249.22	-16.29
	(497.06)	(498.24)	(473.53)	[-1.23]
Positive housing assets	0.80	0.80	0.81	0.01
	(0.40)	(0.40)	(0.39)	[1.29]
Total value of property	3660.93	3652.32	3828.49	176.17
	(5963.21)	(5959.63)	(6032.07)	[1.10]
Mortgage value	2508.57	2499.39	2687.31	187.92
	(4333.27)	(4329.74)	(4399.12)	[1.62]
Mortgage loan to value	0.76	0.76	0.77	0.01
	(1.09)	(1.11)	(0.66)	[0.16]
Total value of debt	4559.31	4544.37	4850.14	305.77
	(18565.95)	(18911.39)	(9627.86)	[0.62]
Bank loans	1491.75	1483.03	1661.48	178.45
	(10046.86)	(10249.03)	(4589.20)	[0.66]
Observations	30,082	28,612	1,470	-

Table 3: Summary Statistics of Bank Investors

The following table reports summary statistics for all individuals in the sample in the year 2006. Column 1 presents all *entrepreneurs* in the sample, Column 2 focuses on all entrepreneurs who hold a positive amount of retail banking investments in 2006. Column 3 focuses on *unexposed entrepreneurs* who hold investments in retail banks in 2006 which did not default in the following financial crisis. Column 4 is comprised of *exposed entrepreneurs* who hold investments in retail banking institutions in 2006 which goes on to subsequently default in 2008-2012. The last column presents the differences between exposed and unexposed entrepreneurs. *Age* is measured in years for each individual in 2006. *Married* indicates if the individual is married in the year 2006. *Number of children* is the total number of children of any age currently living in the same household. *University education* is an indicator variable taking the value of one if an individual has a high school and university education. *Total income* measures the income received by the individual from all sources, while *liquid wealth* is the sum of bank deposits, stocks, and bonds at year-end 2006 market values, and *bank deposits* is year-end personal bank savings. *Positive housing assets* indicates if an individual owns real estate (market value greater than 500,000 DKK). *Total value of property* is the sum of current value debt and equity of all housing investments and *Mortgage value* is the year-end value of outstanding mortgage debt. *Mortgage LTV* is the ratio of outstanding mortgage debt to total housing assets. *Value of debt* is the total outstanding value of debts. *Bank loans* is the value of retail banking loans and *Value of stock holdings* is the market value of year-end stock holdings outside of pension contributions. *Risk share* is the fraction of liquid assets held in stock investments and *Unique stocks in portfolio* is the number of unique assets in the stock market portfolio including mutual funds. All amounts are in thousands at the year-end 2006 and deflated to year-2010 DKK. Bank loans and Total debt are winsorized at the 99th percentile. All variables are presented at the individual level unless otherwise indicated. Standard deviations are in parentheses and t-statistics are reported in brackets. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively.

	Entrepreneurs				
	All	Bank investors	Unexposed	Exposed	Differences
	(1)	(2)	(3)	(4)	(3) - (4)
Age	42.70	43.76	43.81	43.49	-0.32
	(6.84)	(6.77)	(6.77)	(6.73)	[-1.43]
Male	0.75	0.81	0.80	0.82	0.02
	(0.43)	(0.40)	(0.40)	(0.39)	[1.27]
Married	0.72	0.74	0.74	0.73	-0.02
	(0.45)	(0.44)	(0.44)	(0.45)	[-1.04]
Number of children	1.36	1.36	1.36	1.33	-0.04
	(1.18)	(1.20)	(1.21)	(1.19)	[-0.94]
University education	0.16	0.20	0.20	0.22	0.02
	(0.37)	(0.40)	(0.40)	(0.41)	[1.12]
Total income	743.11	943.34	912.97	1128.19	215.22
	(1750.47)	(3135.85)	(1115.95)	(7881.99)	[0.88]
Liquid wealth	451.80	782.55	789.65	739.36	-50.29
	(927.53)	(1256.51)	(1265.21)	(1201.88)	[-1.25]
Value of bank deposits	264.72	351.43	355.41	327.21	-28.20
	(497.06)	(597.63)	(603.72)	(558.78)	[-1.50]
Positive housing assets	0.80	0.87	0.87	0.85	-0.01
	(0.40)	(0.34)	(0.34)	(0.35)	[-1.13]
Total value of property	3660.93	5780.88	5815.97	5567.28	-248.69
	(5963.21)	(7650.27)	(7681.69)	(7456.21)	[-1.00]
Mortgage value	2508.57	3836.21	3860.45	3688.66	-171.79
	(4333.27)	(5498.23)	(5526.72)	(5321.68)	[-0.96]
Mortgage loan to value	0.76	0.73	0.73	0.75	0.02
	(1.09)	(1.00)	(1.01)	(0.92)	[0.67]
Total value of debt	3768.10	5588.72	5612.06	5446.61	-165.44
	(5712.43)	(7241.19)	(7266.15)	(7089.06)	[-0.70]
Bank loans	1134.51	1557.84	1563.52	1523.27	-40.25
	(1681.26)	(2103.63)	(2105.08)	(2095.44)	[-0.58]
Value of stocks	191.12	564.80	533.07	757.98	224.91
	(3067.54)	(5904.89)	(5935.52)	(5713.88)	[1.18]
Risk share	0.15	0.43	0.43	0.45	0.02*
	(0.29)	(0.35)	(0.35)	(0.35)	[1.86]
Unique stocks in portfolio	0.94	2.59	2.59	2.59	0.00
	(2.42)	(3.75)	(3.75)	(3.78)	[0.01]
Observations	30,082	7,449	6,398	1,051	-

Table 4: Determinants of Entrepreneurship and Bank Choice

The following table presents cross-sectional odds ratios of determinants of entrepreneurship in the year 2006. The dependent variable takes the value of one if the individual is an entrepreneur and zero if otherwise. *Bank that later defaults* is an indicator variable taking the value of one if the individual has a retail bank account at one of the banks that goes on to later default from 2008-2012. *Bank investment default* takes the value of one if an individual holds equity investments in a bank which goes on to default during the financial crisis. *Mass primary bank* indicates whether or not the individual has one of the top-five largest Danish retail banks. *Small primary bank* indicates whether or not the individual has one a bank with number of customers in the bottom 25 percent of the distribution, while *Co-op primary bank* indicates whether or not the individual has one of six Danish cooperative retail banks. Columns 1-4 include the full sample while in Columns 5 & 6 the sample includes bank investors. In estimations where noted I control for *age, age^2, male, marriage status, education length in years, log wealth, log income*, indicator variables for *financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. In these specifications, I also control for the year that the firm was established. Industry controls are based on the 2-digit NACE classification in 2006. Coefficients are the odds ratio after a logistic regression. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors are in parenthesis.

	Full sample				Bank investors	
	(1)	(2)	(3)	(4)	(5)	(6)
Bank that later defaults	1.0389	0.9671	0.9486	0.9528		
	(0.0559)	(0.0447)	(0.0430)	(0.0431)		
Mass primary bank		0.8205***	0.8523***	0.8522***		0.8171***
		(0.0159)	(0.0246)	(0.0246)		(0.0335)
Small primary bank			1.0591*	1.0541		0.9369
			(0.0333)	(0.0339)		(0.0417)
Co-operative bank				1.0503		0.9619
				(0.0380)		(0.1575)
Bank investment default					1.0181	0.9918
					(0.0502)	(0.0557)
Control variables	No	Yes	Yes	Yes	No	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.1485	0.2281	0.2282	0.2282	0.1842	0.2876
Observations	1,642,578	1,642,578	1,642,578	1,642,578	235,387	235,387

Table 5: Deposit Customer Bank Separations

The following table reports the unconditional proportion of individuals in the sample who continue with the same primary retail bank from year to year. Each row corresponds to the proportion of individuals who continue to keep their same primary retail bank in the following year. Column 1 focuses on individuals who have a one of the top-five largest Danish retail banks in 2005. Column 2 includes all individuals with primary retail banks outside of the top-five largest and retail banks which default throughout the financial crisis. Column 3 focuses on only individuals with primary retail banks which go on to default from 2008-2012. Panel A presents the year-to-year unconditional probability while Panel B presents the cumulative proportion of individuals continuing with their 2005 bank.

Panel A: Year-to-year

	Type of customer		
Continue with same bank (%)	Large bank (1)	Local bank (2)	Default bank (3)
2005-2006	89.82	89.76	90.23
2006-2007	93.02	92.82	94.29
2007-2008	93.69	94.18	90.49
2008-2009	90.61	94.19	67.48
2009-2010	94.39	95.26	88.81
2010-2011	93.61	94.58	87.37
2011-2012	92.29	94.95	75.10

Panel B: Cumulative

	Type of customer		
Continue with same bank (%)	Large bank (1)	Local bank (2)	Default bank (3)
2005-2005	100.00	100.00	100.00
2005-2006	89.82	89.76	90.23
2005-2007	83.80	83.57	85.32
2005-2008	78.93	79.14	77.58
2005-2009	71.90	75.32	49.86
2005-2010	68.49	72.48	42.69
2005-2011	64.70	69.32	34.82
2005-2012	59.63	66.58	14.71

Table 6: The Effect of Banking Default Exposure on Channels of Financing

The following table analyzes the effect of a exposure to bank defaults on bank lending and liquid wealth holdings. In Columns 1-2 & 5-6 the dependent variable is the total amount of bank loans in 1,000 DKK held by an entrepreneur at the end of the year, while in Columns 3-4 & 7-8 the dependent variable is the log of the market value, year-end sum of liquid wealth. Liquid wealth includes bank deposits, stock assets, and investment bond assets. The variable *exposed depositor* indicates whether the entrepreneur had a retail bank which defaulted in the years after the financial crisis. The variable takes the value of one in all post-default years. Similarly, the variable *exposed investor* indicates whether the entrepreneur held equity investments in a retail bank which defaulted in the years after the financial crisis, again the variable takes the value of one in post-default years. In Columns 1-4 the sample includes all individuals who were entrepreneurs at least for one year prior to 2007 and excludes investment account holders, i.e., the sample of bank depositors. In Columns 5-8 the sample includes all individuals who were entrepreneurs at least for one year prior to 2007 and held retail bank investments between 2005-2007, i.e., bank investors. In all specifications I control for calendar year fixed effects. In Columns 1, 3, 5, & 7 the specifications also include bank-cohort controls, and demographic controls including the following: *age, age*^{2}*, male, marriage status, education length in years, log wealth, log income*, and *child in household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. In these specifications, I also control for the year that the firm was established. In Columns 2, 4, 6 & 8 the specifications include individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	Bank depositors				Bank investors			
	Bank loans (1000 DKK)		Log (liquid wealth)		Bank loans (1000 DKK)		Log (liquid wealth)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposed depositor	-208.2543**	-70.6171**	-0.1232	-0.1036				
	(92.4209)	(30.7461)	(0.0749)	(0.0871)				
Exposed investor					41.3860	-10.6130	-0.3504***	-0.3200***
					(121.8386)	(64.7234)	(0.0860)	(0.0683)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.1021	0.6954	0.1079	0.4967	0.0845	0.6979	0.1560	0.5750
Observations	351,170	351,170	351,170	351,170	97,950	97,950	97,950	97,950

Table 7: Firm Exit and Access to Debt Financing

The following table analyzes the effect of a change in individual access to bank credit availability on the propensity to exit entrepreneurship. The dependent variable is an indicator variable for *exiting* entrepreneurship, conditional on being an entrepreneur in the last period. The variable *exposure to default bank* indicates whether the entrepreneur has a primary retail bank which goes on to default during the financial crisis. The variable takes the value of one if year t is after the year of default and zero if otherwise. The variable *exposure to bank merger* indicates whether the entrepreneur has a primary retail bank which rather than default, was included in an independent merger and/or acquisition with another retail bank. The variable takes the value of one in post-merger years. In Columns 1-4 the sample includes all entrepreneurs while Columns 5-8 feature a sub-sample which discards entrepreneurs who hold stock investment accounts. In all specifications I control for calendar year effects. In Columns 1-3 & 5-7 the specifications also include bank-cohort controls, and demographic controls including the following: *age*, age^2, *male, marriage status, education length in years, log wealth, log income*, and *child in household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. In these specifications, I also control for the year that the firm was established. In Columns 4 & 8 the specifications include individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	Full sample				Bank depositors			
Pr(exit)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposure to default bank	0.0160*		0.0171**	0.0250***	0.0113		0.0114	0.0233**
	(0.0087)		(0.0082)	(0.0084)	(0.0118)		(0.0118)	(0.0113)
Exposure to bank merger		0.0043	0.0068	0.0001		-0.0007	0.0006	-0.0036
		(0.0067)	(0.0068)	(0.0127)		(0.0048)	(0.0047)	(0.0104)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	No	No	No	Yes	No	No	No	Yes
R^2	0.0477	0.0477	0.0477	0.2912	0.0482	0.0482	0.0482	0.2915
Observations	276,692	276,692	276,692	276,692	261,680	261,680	261,680	261,680

Table 8: Firm Exit, Access to Debt Financing, and Local Market Demand

The following table analyzes the effect of a change in individual access to bank credit availability on the propensity to exit entrepreneurship. The dependent variable is an indicator variable for *exiting* entrepreneurship, conditional on being an entrepreneur in the last period. The variable *exposure to default bank* indicates whether the entrepreneur has a primary retail bank which goes on to default during the financial crisis. The variable takes the value of one if year t is after the year of default and zero if otherwise. The variable *exposure to bank merger* indicates whether the entrepreneur has a primary retail bank which rather than default, was included in an independent merger and/or acquisition with another retail bank. The variable takes the value of one in post-merger years. In Columns 1-3 the sample includes all entrepreneurs while Columns 4-6 feature a sub-sample which discards entrepreneurs who hold stock investment accounts. Columns 1 & 4 contain a sample where exposed entrepreneur depositors are matched with unexposed entrepreneurs in the same municipality, Columns 2 & 5 match exposed entrepreneurs to unexposed entrepreneurs in the same parish. Matching is based on 5 nearest neighbor exact matching on municipality or parish, five-year age cohort, pre-crisis wealth, gender, and marital status. Columns 3 & 5 focuses on an exclusive subsample of entrepreneurs whose firm is located in a municipality outside of the municipality in which they live in. In all specifications I control for calendar year effects and individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

		Full sample			Bank depositors	
	Municipality	Parish	Outside	Municipality	Parish	Outside
Pr(exit)	(1)	(2)	(3)	(4)	(5)	(6)
Exposure to default bank	0.0209**	0.0221**	0.0468***	0.0195*	0.0206*	0.0510**
	(0.0100)	(0.0099)	(0.0173)	(0.0108)	(0.0124)	(0.0225)
Exposed to bank merger	0.0024	-0.0106	-0.0507**	-0.0031	-0.0154	-0.0515**
	(0.0226)	(0.0179)	(0.0234)	(0.0188)	(0.0199)	(0.0239)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.2909	0.2907	0.3291	0.2897	0.2902	0.3286
Observations	66,023	59,168	49,215	56,944	50,465	46,946

Table 9: Firm Exit and Changes in Personal Wealth

The following table analyzes the effect of a change in personal liquid wealth on the propensity to exit entrepreneurship stemming from Equation (2). The dependent variable is an indicator variable for *exiting* entrepreneurship, conditional on being an entrepreneur in the last period. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank and incurred *above median* financial losses. The variable takes the value of one if year t is after the bank default year and zero if otherwise. In Columns 1 & 2 the sample includes all entrepreneurs who invest in retail bank stocks, while in Columns 3 & 4 entrepreneurs who incurred financial losses by investing in their own deposit bank are excluded. In Columns 5 & 6 the sample contains entrepreneurs who *either* lost access to their retail bank, or lost liquidity due to wealth losses from default bank investments. In all specifications I control for year time effects. In Columns 1, 3, & 5 the specifications also include default year-cohort controls, and demographic controls including the following: *age, age*^{2}*, male, marriage status, education length in years, log wealth, log income*, and *child in household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. In these specifications, I also control for the year that the firm was established. In Columns 2, 4 & 6 the specifications include individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	All entrepreneurs					
	Bank investors		Depositors excluded		Access to credit	
Pr(exit)	(1)	(2)	(3)	(4)	(5)	(6)
Personal wealth losses	0.0543***	0.0583***	0.0637***	0.0603***	0.0657***	0.0586***
	(0.0102)	(0.0137)	(0.0101)	(0.0081)	(0.0124)	(0.0123)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	No	Yes	No	Yes	No	Yes
R^2	0.0357	0.2800	0.0347	0.2795	0.0389	0.2745
Observations	69,114	69,114	62,785	62,785	11,732	11,732

Table 10: Firm Exit, Changes in Personal Wealth, and Heterogeneity in Experience

The following table analyzes the effect of a change in individual liquid wealth on the propensity to exit entrepreneurship stemming from Equation (2). The dependent variable is an indicator variable for *exiting* entrepreneurship, conditional on being an entrepreneur in the last period. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank and incurred *above median* financial losses. The variable takes the value of one if year t is after the bank default year and zero if otherwise. Columns 1-3 focus on the a sample of established entrepreneurs. Established entrepreneurs began their firm at any time prior to 2002, while in Columns 4-6 the sample consists of new entrepreneurs who started their first venture in the years prior to the financial crisis, 2002-2007. In Columns 1 & 4 the sample includes all entrepreneurs who invest in retail bank stocks, while in Columns 2 & 5 entrepreneurs who incurred financial losses by investing in their own deposit bank are excluded. In Columns 3 & 6 the sample contains entrepreneurs who *either* lost access to their retail bank, or lost liquidity due to wealth losses from default bank investments. In all specifications I control for year time effects. All specifications include individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	Established entrepreneurs			New entrepreneurs		
	Bank investors	Depositors excluded	Access to credit	Bank investors	Depositors excluded	Access to credit
Pr(exit)	(1)	(2)	(3)	(4)	(5)	(6)
Personal wealth losses	0.0489***	0.0563***	0.0446***	0.0981***	0.1294**	0.1552***
	(0.0117)	(0.0209)	(0.0139)	(0.0362)	(0.0580)	(0.0519)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.2527	0.2559	0.2366	0.2639	0.2581	0.2744
Observations	38,013	34,671	6,361	19,400	17,394	3,548

Table 11: Hazard of Firm Exit: Single Risk

The following table analyzes the the effect of exposure to bank defaults on firm exit as shown in the hazard specification of Equation 6. The dependent variable is the baseline hazard $\lambda_{i,0}(\tau)$ of firm exit after τ years. The variable *exposure to default bank* indicates whether the entrepreneur has a primary retail bank which goes on to default during the financial crisis. The variable takes the value of one if calendar year t is after 2008 and zero if otherwise. The variable *exposure to bank merger* indicates whether the entrepreneur has a primary retail bank which rather than default, was included in an independent merger and/or acquisition with another retail bank. The variable takes the value of one in post-merger years. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank. The variable takes the value of one in post-default years. In Columns 1-5 the sample includes bank depositors. Columns 4 & 5 further restrict the sample to bank depositors who do not hold investment accounts. Columns 6-8 focus on a sample of bank-investor entrepreneurs. In Column 8 I discard investors who hold deposit accounts in banks which default. Columns 5 & 8 restrict the sample to entrepreneurs who started their firm after 1990 in order to account for left-censoring of a number of observations. All specifications also include default year-cohort controls, and demographic controls including the following: *age*, *age*^{2}, *male, marriage status, education length in years, log wealth, log income*, and *child in household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. Regression coefficients are estimated with a Cox proportional hazard model and shown in hazard ratios. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	Bank depositors					Bank investors		
	Full Sample			Depositors Only		Full Sample	Excluding Depositors	
Pr(exit)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposure to bank default	1.1164***		1.1171***	1.0895*	1.1009*			
	(0.0489)		(0.0490)	(0.0501)	(0.0535)			
Exposure to bank merger		1.0002	1.0047	0.9735	0.9753			
		(0.0641)	(0.0636)	(0.0604)	(0.0561)			
Personal wealth losses						1.2916***	1.3168***	1.4700***
						(0.0828)	(0.1253)	(0.1353)
Left censoring	No	No	No	No	Yes	No	No	Yes
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	231,971	231,971	231,971	219,343	188,252	50,118	45,471	36,800

Table 12: Hazard of Firm Exit: Competing Risks

The following table analyzes the the effect of exposure to bank defaults on firm exit as shown in the competing risk specification of Equation 6. The dependent variable is the baseline subhazard $\hat{\lambda}_{i,k,0}(\tau)$ of firm exit after τ years which results in exit-outcome k. For both panels, in Column 1, entrepreneurs exit their venture and enter into a state of unemployment or exit the labor market completely. In Column 2, entrepreneurs enter into a non-ownership, salaried position, at a new firm after exiting from their venture. In Column 3, entrepreneurs remain in the current venture, however either downsize their employees and/or take on a self-employment designation. Finally, in Column 4, entrepreneurs exit their venture to start up a new entrepreneurial firm. Panel A presents the results across the bank depositor sample (excluding depositors who hold investment accounts) and considers the effect of an entrepreneur's primary retail bank defaulting on each one of these outcomes, while taking into consideration the remaining three remaining competing risk outcomes. Panel B focuses on the bank investor sample excluding investors who hold deposit accounts at a bank which defaults. The variable *exposure to default bank* indicates whether the entrepreneur has a primary retail bank which goes on to default during the financial crisis. The variable takes the value of one if calendar year t is after 2008 and zero if otherwise. The variable *exposure to bank merger* indicates whether the entrepreneur has a primary retail bank which rather than default, was included in an independent merger and/or acquisition with another retail bank. The variable takes the value of one in post-merger years. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank. The variable takes the value of one in post-default years. All specifications also include default year-cohort controls, and demographic controls including the following: *age, age*^{2}*, male, marriage status, education length in years, log wealth, log income*, and *child in household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. Regression coefficients are estimated with a Fine and Gray proportional competing risk hazard model and shown in subhazard ratios. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

Panel A:

	Bank depositors			
	Unemployment	Labor market	Self-employment	New start-up
	(1)	(2)	(3)	(4)
Exposure to bank default	1.3748*	1.0563	0.9901	0.9179
	(0.1796)	(0.0926)	(0.1271)	(0.1007)
Exposure to bank merger	1.1454	0.9596	0.9619	1.097
	(0.1490)	(0.7916)	(0.0644)	(0.0989)
Control variables	Yes	Yes	Yes	Yes
Observations	110,679	111,150	100,884	109,045

Panel B:

	Bank investors			
	Unemployment	Labor market	Self-employment	New start-up
	(1)	(2)	(3)	(4)
Personal wealth losses	0.8351	1.8093***	1.6483*	0.8633
	(0.2281)	(0.2177)	(0.2928)	(0.1233)
Control variables	Yes	Yes	Yes	Yes
Observations	51,381	51,481	47,110	50,459

Table 13: The Effect of Banking Default Exposure on Intensive Margin Decisions

The following table analyzes the effects of exposure to bank defaults and changes in personal liquid wealth on the change in employees employed by an entrepreneur. The dependent variable is the number of employees, conditional on being an entrepreneur at time t. The variable *exposure to bank default* indicates whether an entrepreneur has a personal retail bank which defaults during the financial crisis. The variable takes the value of one in post-default years. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank and incurred *above median* financial losses. The variable takes the value of one if year t is after the bank default year and zero if otherwise. In Columns 1 & 2 the sample includes all entrepreneurs who have a retail bank, in Column 2 I exclude entrepreneurs who also hold equity investments. In Columns 3 & 4 the sample focuses on entrepreneurs who hold investments in retail bank equities. Column 4 excludes entrepreneurs who also have a retail bank which defaults. All specifications control for calendar year fixed effects and individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at the entrepreneur's 2-digit industry classification and shown in parenthesis.

	Bank depositors		Bank investors	
Number of employees	(1)	(2)	(3)	(4)
Exposure to bank default	-0.1031	-0.1395		
	(0.0963)	(0.0871)		
Personal wealth losses			-0.2611**	-0.7246***
			(0.1285)	(0.2427)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
R^2	0.7698	0.7690	0.7993	0.8009
Observations	284,698	269,231	70,779	64,323

Table 14: Firm Exit, Banking Default Exposure, and Household Heterogeneity

The following table analyzes the effects exposure to bank defaults and changes in personal liquid wealth on the propensity to exit entrepreneurship stemming from Equation (2). The dependent variable is an indicator variable for *exiting* entrepreneurship, conditional on being an entrepreneur in the last period. The variable *exposure to bank default* indicates whether an entrepreneur has a personal retail bank which defaults during the financial crisis. The variable takes the value of one in post-default years. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank and incurred *above median* financial losses. The variable takes the value of one if year t is after the bank default year and zero if otherwise. Columns 1 & 2 focuses on the depositor sample of entrepreneurs while Columns 3 & 4 focus on the investor sample. In Columns 1 & 3 the sample consists of married entrepreneurs whose income share to the total household is less than 50 percent. In Columns 2 & 4 married entrepreneurs income share within the household is greater than or equal to 50 percent. All specifications control for calendar year fixed effects and individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at the entrepreneur's 2-digit industry classification and shown in parenthesis.

	Bank depositors		Bank investors	
Income share	Low	High	Low	High
	(1)	(2)	(3)	(4)
Exposure to bank default	0.0283	0.0034		
	(0.0223)	(0.0158)		
Personal wealth losses			0.0146	0.0653***
			(0.0553)	(0.0110)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
R^2	0.2948	0.2844	0.2834	0.2739
Observations	48,879	164,428	9,318	42,438

Table 15: Firm Exit, Changes in Personal Wealth, and Heterogeneity in Wealth and Debt

The following table analyzes the effects exposure to bank defaults and changes in personal liquid wealth on the propensity to exit entrepreneurship stemming from Equation (2). The dependent variable is an indicator variable for *exiting* entrepreneurship, conditional on being an entrepreneur in the last period. The variable *exposure to bank default* indicates whether an entrepreneur has a personal retail bank which defaults during the financial crisis. The variable takes the value of one in post-default years. The variable *personal wealth losses* indicates whether the entrepreneur held stock investments in a default bank and incurred *above median* financial losses. The variable takes the value of one if year t is after the bank default year and zero if otherwise. In Columns 1-3 the sample includes all entrepreneurs who have a retail bank excluding entrepreneurs who also hold equity investments. In Columns 4-6 the sample focuses on entrepreneurs who hold investments in retail bank equities excluding entrepreneurs who also have a retail bank which defaults. The sample is divided into terciles such that Column 1 (2) (3) includes the bottom (middle) (top) third of the distribution. Panel A separates this for *net wealth* while Panel B separates *total sources of debt*. All specifications control for calendar year fixed effects and individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at the entrepreneur's 2-digit industry classification and shown in parenthesis.

Panel A: Wealth

	Bank depositors			Bank investors		
	Bottom	Middle	Top	Bottom	Middle	Top
	(1)	(2)	(3)	(4)	(5)	(6)
Exposure to bank default	0.0061	0.0411	-0.0085			
	(0.0227)	(0.0260)	(0.0261)			
Personal wealth losses				0.0819*	0.0497*	0.0007
				(0.0433)	(0.0298)	(0.0548)
R^2	0.2837	0.2383	0.2544	0.2528	0.2505	0.2656
Observations	80,648	75,324	77,666	19,227	19,348	20,023

Panel B: Debt

	Bank depositors			Bank investors		
	Bottom	Middle	Top	Bottom	Middle	Top
	(1)	(2)	(3)	(4)	(5)	(6)
Exposure to bank default	0.0148	0.0026	0.0314			
	(0.0174)	(0.0234)	(0.0215)			
Personal wealth losses				0.0382	0.0280	0.0995**
				(0.0354)	(0.0242)	(0.0457)
R^2	0.2798	0.2620	0.2406	0.2752	0.2519	0.2463
Observations	76,479	78,142	79,017	19,240	19,060	20,298

Figure 1: Index of Market Returns

The following figure plots an index of market returns for investors in the sample using micro-data on year-end portfolio holdings at the individual asset level. The solid dark line plots of an index of returns for retail bank stocks which go on to default throughout the financial crisis. The dashed line plots the index for bank stocks which remain solvent and do not default during the crisis, the solid gray line plots a portfolio of all other stocks. The portfolio is indexed to year 2006.

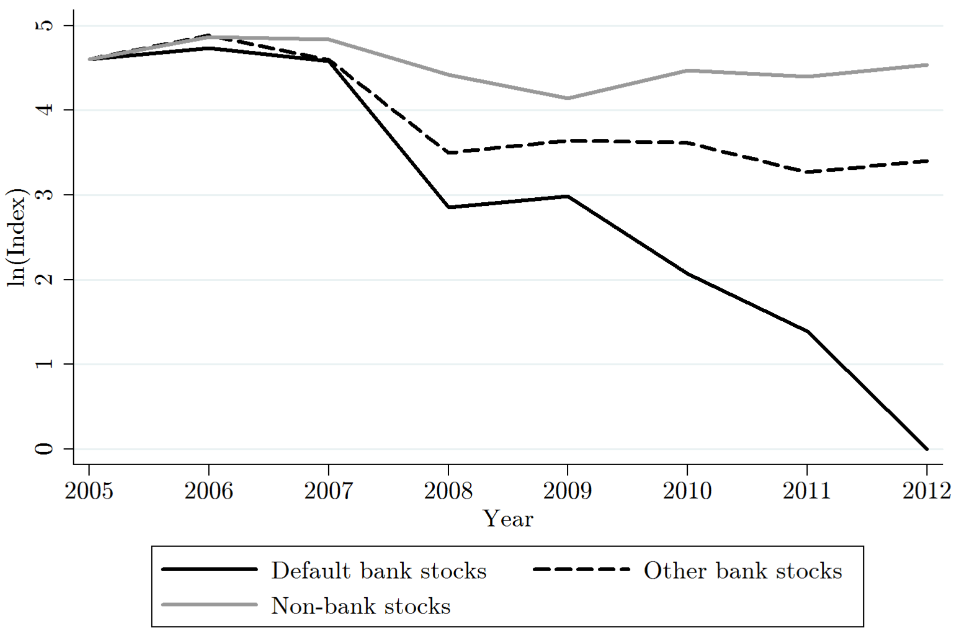
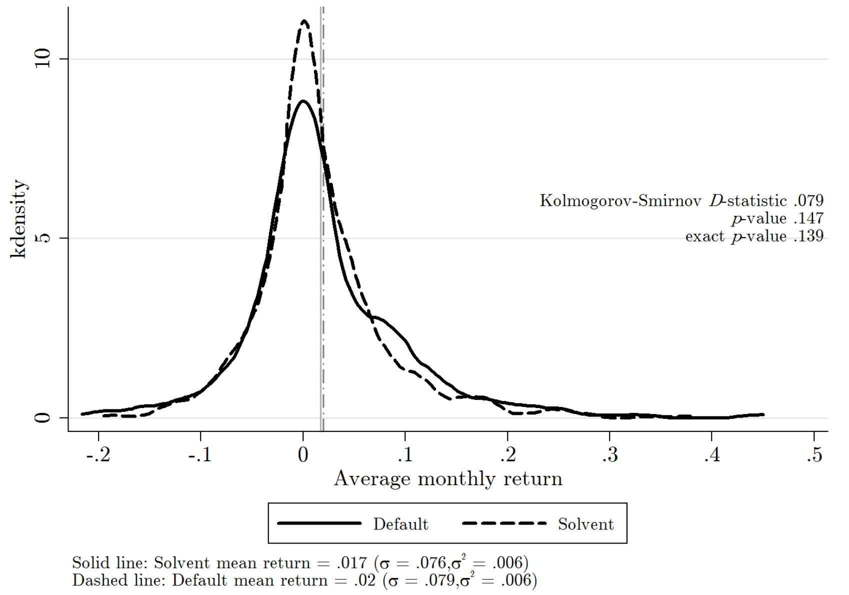


Figure 2: Ex-Post Investment Returns

The following figure plots the distribution of monthly returns for Danish retail bank stocks between January 1st, 2005 and December 1st, 2007. The dashed line plots the the distribution for monthly returns for a market capitalization-weighted portfolio of retail bank stocks which remain solvent following the financial crisis while the solid line plots a portfolio of retail bank stocks which default between 2008-2012. The vertical lines provide the mean return for each distribution. A Kolmogorov-Smirnov test (at right) is performed to test if the two distributions statistically differ.



The following figure plots the monthly returns for Danish retail bank stocks between January 1st, 2005 and December 1st, 2007. The dashed line plots monthly returns for a market capitalization-weighted portfolio of retail bank stocks which remain solvent following the financial crisis while the solid line plots a portfolio of retail bank stocks which default between 2008-2012. Pearson's correlation coefficient for the two series is shown at bottom.

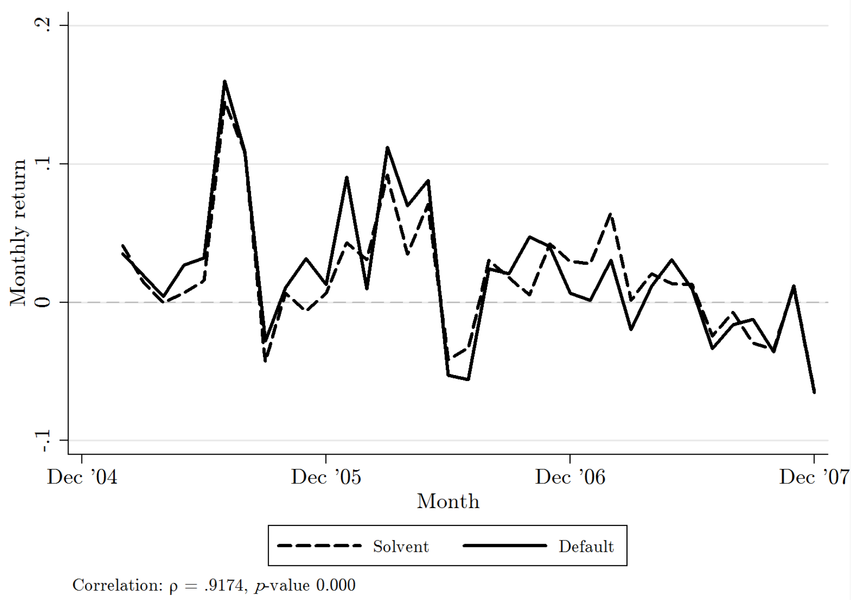


Figure 3: Deposit Customer Bank Separations

The following figure shows the unconditional proportion of individuals in the sample who continue with the same primary retail bank from 2005 to year t. Each bar corresponds to the proportion of individuals who continue to keep their same primary retail bank in the current year. The light gray bars focus on individuals who have one of the five largest Danish retail banks in 2005. The darker gray bars include all individuals with primary retail banks outside of the top-five largest and retail banks which default throughout the financial crisis. The black bars focus on only individuals with primary retail banks which go on to default from 2008-2012.

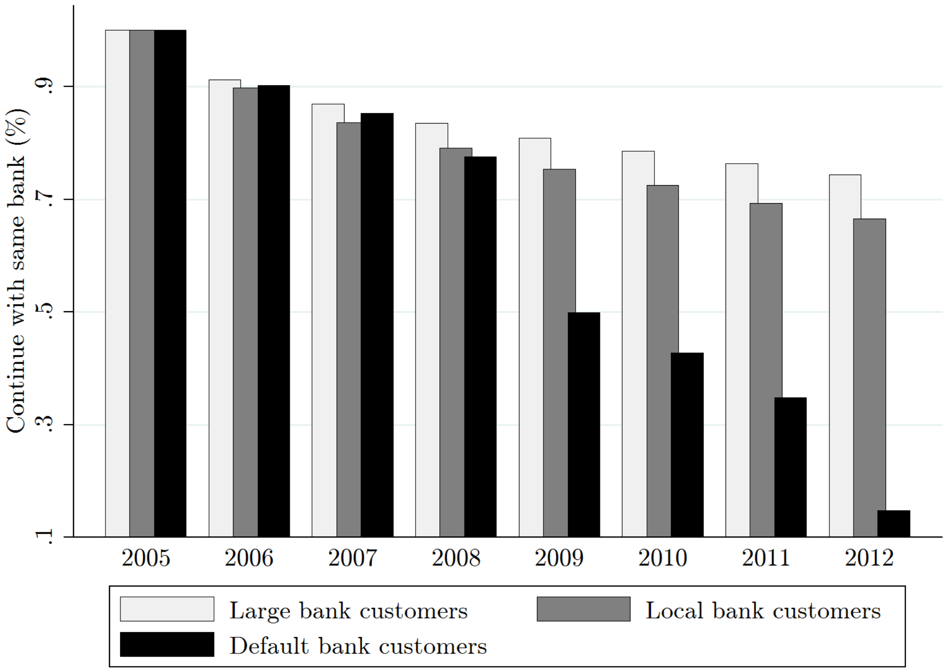
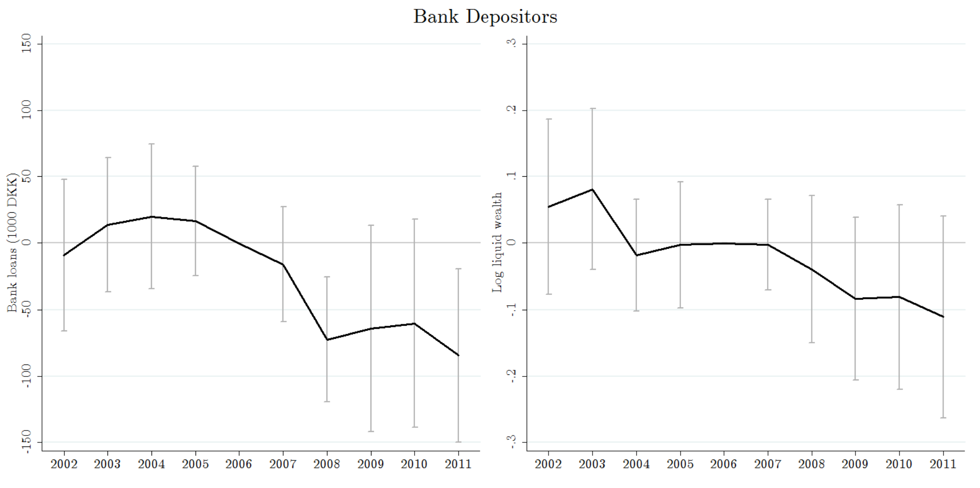


Figure 4: The Effect of Banking Default Exposure on Channels of Financing

The following figure shows an event study plot of the specification in Columns 2 (top-left panel) & 4 (top-right panel) from Table 6. The y-axis states personal bank loans (left) and the log of liquid wealth (right). The x-axis is the year. The solid line is the coefficient of the interaction term between *Exposed* entrepreneurs and year dummies, therefore providing the difference-in-differences estimate. The sample consists of individuals who were entrepreneurs before 2007 and are bank-depositors, while those with investment accounts are excluded. 95% Confidence intervals are shown.



The following figure shows an event study plot of the specification in Columns 6 (bottom-left panel) & 8 (bottom-right panel) from Table 6. The y-axis states personal bank loans (left) and the log of liquid wealth (right) . The x-axis is the year. The solid line is the coefficient of the interaction term between *Exposed* entrepreneurs and year dummies, therefore providing the difference-in-differences estimate. The sample consists of individuals who were entrepreneurs before 2007 and are bank-investors, while those with deposit accounts in default banks are excluded. 95% Confidence intervals are shown.

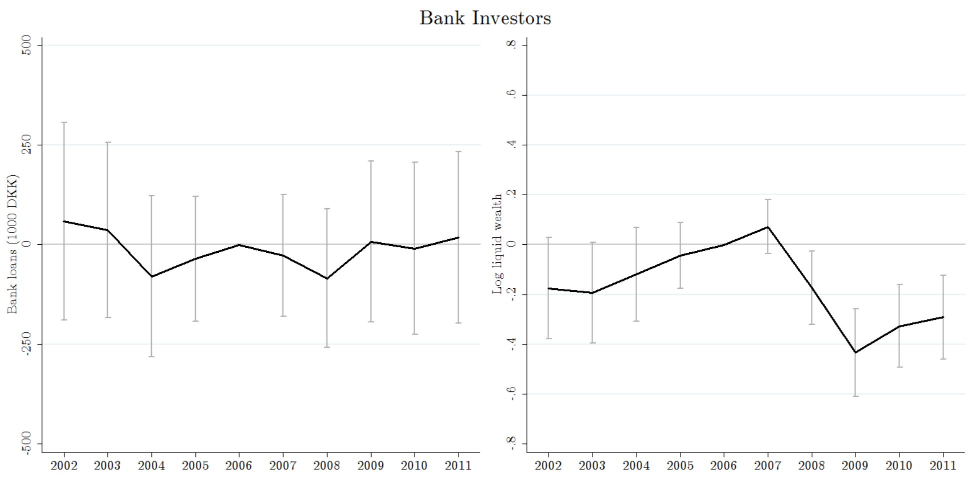


Figure 5: Firm Exit and Size of Wealth Loss

The following figures plots Equation 5 where the left panel consists of all entrepreneurs and the right panel includes entrepreneurs who began their firm in the years preceding the financial crisis, 2002-2007. The y-axis states the probability of exiting from entrepreneurship and the x-axis plots the fraction of liquid wealth lost from an investment in a default bank for *exposed* entrepreneurs after the banking defaults. 95% confidence intervals are shown.

The following figures plots an unreported regression stemming from Table 14. The sample consists of married entrepreneurs who held investments in a retail banking institution prior to the financial crisis. The y-axis states the probability of exiting from entrepreneurship and the x-axis plots the share of the entrepreneur's income to the total household income for *exposed* entrepreneurs after the banking defaults. 95% confidence intervals are shown.

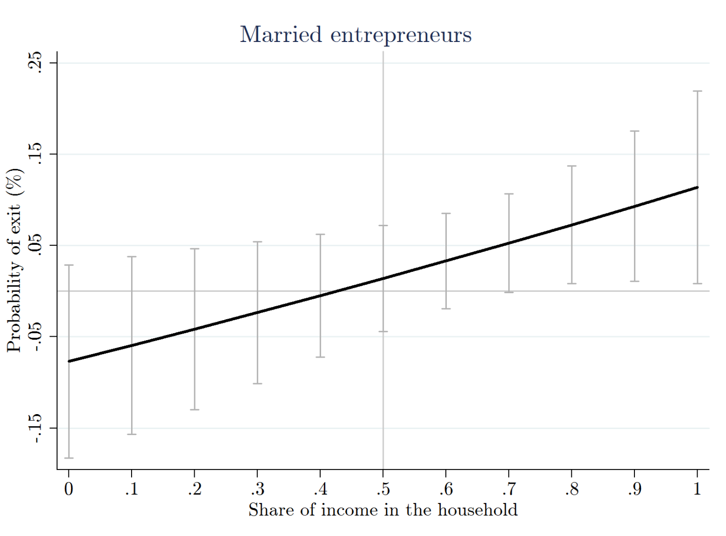
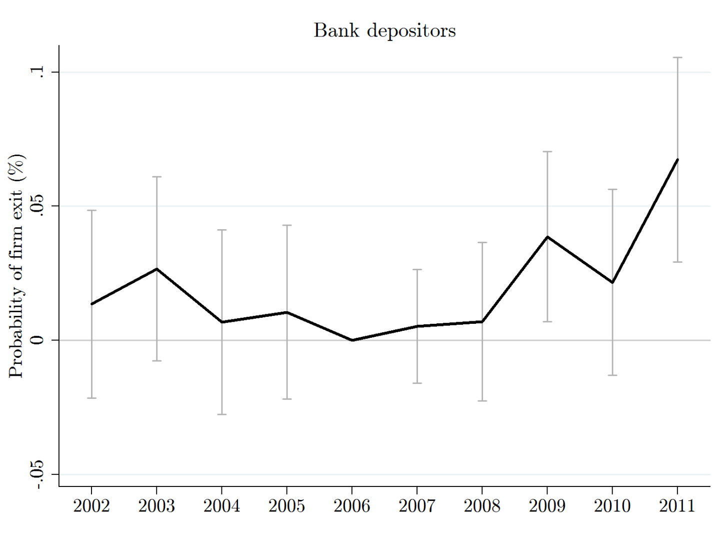


Figure 6: Firm Exit, Access to Debt Financing, and Changes in Personal Wealth - Dynamic Model

The following figure shows an event study plot of the specification in Column 8 from Table 7. The solid line is the coefficient of the interaction term between *exposed* entrepreneurs and year dummies, therefore providing the difference-in-differences estimate. The y-axis states the difference in probability of firm exit in a given year between exposed and unexposed entrepreneurs. The x-axis is the year. The sample consists of individuals who are entrepreneurs and bank-depositors, while those with investment accounts are excluded. 95% Confidence intervals are shown.



The following figure shows an event study plot of the specification in Column 4 from Table 9. The solid line is the coefficient of the interaction term between *exposed* entrepreneurs and year dummies, therefore providing the difference-in-differences estimate. The y-axis states the difference in probability of firm exit in a given year between exposed and unexposed entrepreneurs. The x-axis is the year. The sample consists of individuals who are entrepreneurs and bank-investors, while those with deposit accounts in default banks are excluded. 95% Confidence intervals are shown.

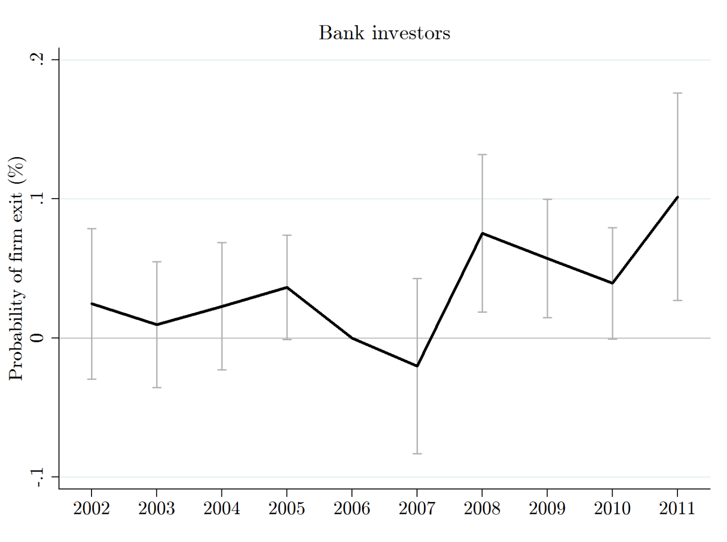
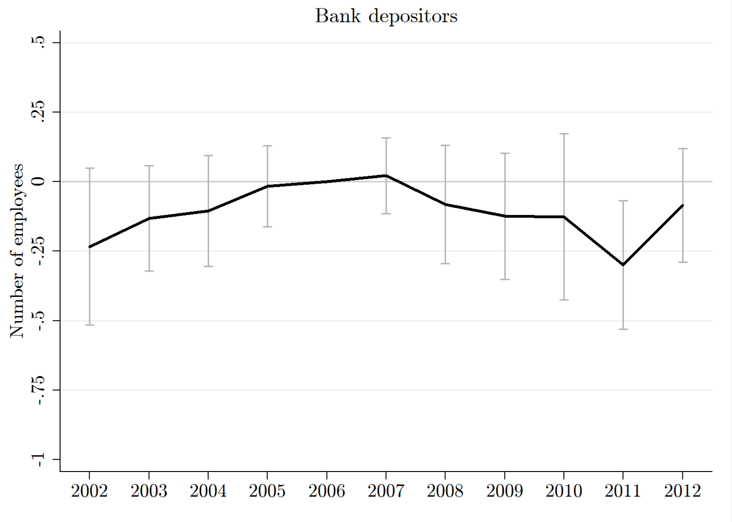
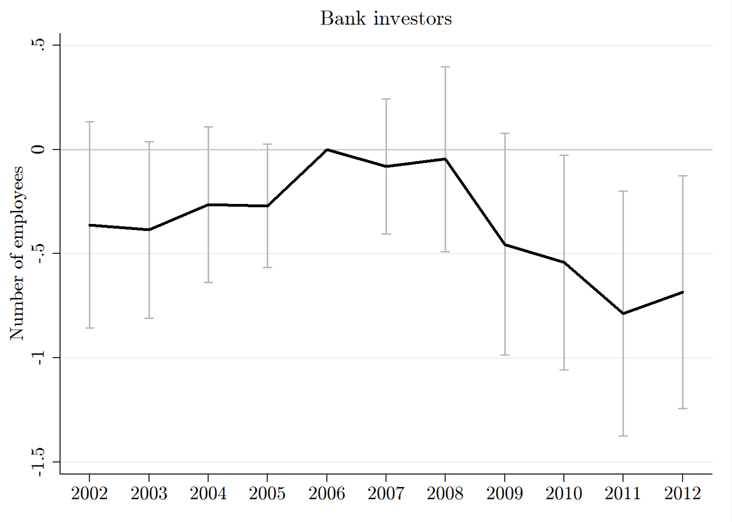


Figure 7: The Effect of Banking Default Exposure on Intensive Margin Decisions - Dynamic Model

The following figure shows an event study plot of the specification in Column 2 from Table 13. The solid line is the coefficient of the interaction term between *exposed* entrepreneurs and year dummies, therefore providing the difference-in-differences estimate. The y-axis states the difference in number of employees employed by the entrepreneur in a given year between exposed and unexposed entrepreneurs. The x-axis is the year. The sample consists of individuals who are entrepreneurs and bank-depositors, while those with investment accounts are excluded. 95% Confidence intervals are shown.



The following figure shows an event study plot of the specification in Column 4 from Table 13. The solid line is the coefficient of the interaction term between *exposed* entrepreneurs and year dummies, therefore providing the difference-in-differences estimate. The y-axis states the difference in number of employees employed by the entrepreneur in a given year between exposed and unexposed entrepreneurs. The x-axis is the year. The sample consists of individuals who are entrepreneurs and bank-investors, while those with deposit accounts in default banks are excluded. 95% Confidence intervals are shown.



9 Appendix

Table A.1: Retail Bank Defaults and Mergers Throughout the Great Recession

The following table outlines the Danish retail banks that faced liquidity challenges after the onset of the 2007-2009 financial crisis. Each of the following troubled banks either defaulted and were taken over by the state-owned *Finansiel Stabilitet*, or found a private solution (e.g. merger or acquisition). If the bank merged or was acquired the table states the overtaking or surviving retail bank. The municipality and whether the bank was publicly held by investors is also indicated below. Data comes from the author's own research as well as Buchholst and Rangvid (2013).

Year	Troubled bank	Outcome	Publicly held	Municipality	Surviving bank
2008	BankTrelleborg	Merged	No	Slagelse	Sydbank
2008	Roskilde	Defaulted	Yes	Roskilde	NA
2008	Bonusbanken	Merged	No	Herning	Vestjysk Bank
2008	Sparekassen Spar Mors	Merged	No	Morso	Morso Bank
2008	EBH Bank	Defaulted	Yes	Jammerbugt	NA
2008	Localbanken I Nordsaelland	Merged	No	Hillerd	Handelsbanken
2008	Forstaedernes Bank	Merged	No	Taastrup	Nykredit
2008	Ringkjobing Bank	Merged	No	Skjern	Vestjysk Bank
2009	Lokken Sparekasse	Defaulted	No	Hjrring	NA
2009	Gudme Raachou	Defaulted	No	Kobenhavn	NA
2009	Fionia Bank	Defaulted	Yes	Odensee	NA
2010	Capinordic	Defaulted	Yes	Gentofte	NA
2010	Finansbank	Merged	No	NA	Sparekassen Lolland
2010	EIK Banki	Defaulted	No	Farroe Islands	NA
2010	Skaelsor Bank	Merged	No	Slagelse	Max Bank
2011	Amagaerbanken	Defaulted	Yes	Kobenhavn S	NA
2011	Sparekassen Midtfjord	Merged	No	Vesthimmerland	Sparekassen Himmerland
2011	Fjordbank Mors	Defaulted	Yes	Morso	NA
2011	Max Bank	Defaulted	Yes	Naestved	NA
2011	Sparekassen Limfjorden	Merged	No	Thisted	Sparekassen Vendsyssel
2012	Sparekassen Farso	Merged	No	Vesthimmerland	Den Jyske Sparekassen
2012	Sparekassen Ostjylland	Defaulted	No	Favrskov	NA
2012	Aarhus Lokalbank	Merged	No	Aarhus	Vestjysk Bank
2012	Spar Salling Sparekasse	Defaulted	No	Skive	NA
2012	Tonder Bank	Defaulted	Yes	Tonder	NA

Table A.2: Descriptive Sources of Financing

The following table uses data from the Kauffman Firm Survey presented in Table 4 of Robb and Robinson (2012). I maintain the scheme of financing that the authors suggest by designating between owner, insider, and outsider, equity or debt. Differing from the authors, I additionally classify sources of financing by whether the financing is held by the business directly or rather by the owner of the business, i.e, *business* or *personal.* The far right columns calculate the average percent of total firm financing that each source contributes to (intensive margin) and the percentage of firms that stated they use each source of financing (extensive margin).

Source	Description	Avg. % of financial capital	Firm take up rate
Owner equity	Personal investment	29%	78%
Owner debt	Personal credit cards and non-bank loans	4%	31%
Insider equity	Family and friends equity	2%	4%
Insider debt	Family and friends loans	6%	12%
Outsider equity	Government or VC equity	16%	5%
Outsider debt:			
Personal	Personal bank loans	20%	19%
Business	Business loans and CCs	23%	26%

Table A.3: Entrepreneurship and Small Business Owners

Panel A presents the rates of entrepreneurship across the years in the sample. Panel B provides statistics on the number of employees employed by entrepreneurs across the years in the sample. Percentiles are composed of the 5 closest observations due to regulations about data security.

Panel A: Number of entrepreneurs

	2005	2006	2007	2008	2009	2010	2011	2012	Total
All individuals	1,643,542	1,643,542	1,643,542	1,643,542	1,643,542	1,643,542	1,643,542	1,643,542	13,148,336
Entrepreneurs	29,398	30,082	30,177	27,265	25,628	25,191	25,095	24,730	217,566
Entrepreneur bank investors	7,553	7,449	7,302	6,480	6,134	6,084	6,027	5,911	52,940

Panel B: Number of employees

	2005	2006	2007	2008	2009	2010	2011	2012	Total
Mean	4.8	4.8	4.9	5.6	5.4	5.4	6.2	6.4	5.4
p10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
p50	3.0	3.0	3.0	3.0	3.0	2.0	3.0	3.0	2.9
p90	11.0	11.0	11.0	11.0	10.0	10.0	10.0	10.0	10.5

Table A.4: Bank Characteristics

The following table provides bank-level information about deposit customers by different segments of retail banks in Denmark. The columns of Panel A divide all retail banks in the sample by the large, local, and default designation used in Table 5. In Panel B banks are distinguished by the size classification introduced by the National Bank of Denmark and *Finansiel Stabilitet*. Group 1 (Column 1) includes banks which hold over 50 billion Danish krone in assets (Column 1), Group 2 (Column 2) includes banks which hold between 10 and 50 billion Danish krone in assets, Group 3 (Column 3) includes banks which hold between 250 million and 49 billion Danish krone in assets, and Column 4 includes all Danish banks with assets less than 250 million Danish krone. The rows contain information on the *average number of depositors*, the *share of entrepreneurs* and *self-employed* individuals in each bank. The *average deposit balance* and *average loan balance* (all sources of personal bank debt, excluding mortgages) in 1000 DKK of depositors per bank, as well as the *market share of depositors* captured by the classification type of the bank. In Panel B the *number of default banks* simply tallies up the number of banks that defaulted by group classification.

Panel A: Bank type

	Bank type		
	Large bank (1)	Local bank (2)	Default bank (3)
Average number of depositors	200,581	4,009	6,093
Share of entrepreneurs (%)	1.85	2.36	2.58
Share of self-employed (%)	3.71	4.10	4.53
Average deposit balance	100.21	87.55	95.81
Average loan balance	219.46	201.60	252.89
Market share of depositors (%)	61.02	26.34	4.08
Observations	5	108	12

Panel B: FS grouping

	Bank type			
	FS Group 1 (1)	FS Group 2 (2)	FS Group 3 (3)	FS Group >3 (4)
Average number of depositors	238,180	24,665	4,209	916
Share of entrepreneurs (%)	1.79	1.99	2.72	1.76
Share of self-employed (%)	3.81	4.01	4.27	3.86
Average deposit balance	102.90	99.42	91.93	78.23
Average loan balance	217.00	206.98	220.28	177.43
Market share of depositors (%)	57.97	12.01	19.46	2.01
Number of default banks	0	3	9	0
Observations	4	9	76	36

Table A.5: Investments and Losses from Banking Defaults

The following table provides a tabulation of the distribution of losses for *exposed* and *unexposed* bank investors. All investors included held investments in publicly traded retail banks. *exposed* investors held stocks of retail banks which defaulted, while *unexposed* investors held stocks which remained solvent. I present the mean, 10th, 50th, and 90th percentiles of total losses, losses as a percentage of savings in 2006, as a percentage of liquid wealth in 2006, and as a percentage of net wealth. Columns 1-4 compare the values of exposed investors to columns 5-8 of unexposed investors. Percentiles are composed of the 5 closest observations due to regulations about data security.

	Exposed				Unexposed			
Size of liquidity shock	Mean	p25	p50	p75	Mean	p25	p50	p75
Losses (1,000 DKK)	-343.85	-78.68	-25.76	-11.45	-49.73	-43.91	-18.16	-6.44
Percentage of savings (%)	-30.27	-50.69	-12.50	-3.19	-20.10	-22.95	-6.09	-1.56
Percentage of liquid wealth (%)	-21.40	-30.72	-9.14	-2.73	-13.19	-15.85	-4.70	-1.25
Percentage of net wealth (%)	-30.92	-100.00	-5.26	-1.01	-24.40	-22.87	-2.35	-0.49

Table A.6: Firm Entrance and Access to Debt Financing

The following table analyzes the effect of a change in access to bank credit availability on the propensity to enter entrepreneurship stemming from Equation (2). The dependent variable is an indicator variable for *entering* entrepreneurship, conditional on not being an entrepreneur in the last period. The variable *exposure to default bank* indicates whether the individual has a primary retail bank which goes on to default during the financial crisis. The variable takes the value of one if year t is after the year of default and zero if otherwise. Panel A represents a specification where all individuals are included in the sample while in Panel B exposed individuals are matched to unexposed individuals who live in the same municipality as the defaulting bank. In both panels Columns 1 & 2 include all individuals while Columns 3 & 4 focus on the bank depositor sample. In all specifications I control for calendar year fixed effects. In Columns 1 & 3 the specifications also include default year-cohort controls, and demographic controls including the following: *age, age^2, male, marriage status, education length in years, log wealth, log income*, and *child in household, financial education, stock market participation, holding a positive loan balance, receiving unemployment benefits, holding positive housing wealth balance* (in either debt or equity), and if the individual is an *immigrant*. In these specifications, I also control for the year that the firm was established. In Columns 2 & 4 the specifications include individual fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors are clustered at the pre-crisis primary bank level are in parenthesis.

Panel A:

	All individuals			
	Full sample		Bank depositors	
Pr(enter)	(1)	(2)	(3)	(4)
Exposure to default bank	-0.0010***	-0.0009***	-0.0010***	-0.0009***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	No	Yes	No	Yes
R^2	0.0016	0.2460	0.0016	0.2236
Observations	16,158,728	16,158,728	10,564,249	10,564,249

Panel B:

	Local exposure			
	Full sample		Bank depositors	
Pr(enter)	(1)	(2)	(3)	(4)
Exposure to default bank	-0.0009***	-0.0010***	-0.0011***	-0.0010***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Individual fixed effects	No	Yes	No	Yes
R^2	0.0017	0.2318	0.0019	0.2099
Observations	3,922,799	3,922,799	2,528,184	2,528,184

Table A.7: The Effect of Banking Default Exposure on Channels of Financing: Dynamic Model

The following table states a dynamic version of the difference-in-differences model in Equations (3) and (4) and Table 6 where $exposed_i^j$ is interacted with year-dummies in order to test lags and leads of the effect of banking default exposure. In Columns 1 & 3 the dependent variable is the total amount of bank loans in 1,000 DKK, while in Columns 2 & 4 the dependent variable is the log of the market value, year-end sum of liquid wealth. The coefficients state the difference between exposed and unexposed bank depositors (Columns 1-2) and exposed and unexposed bank investors (Columns 3-4) at varying years across the sample. Year 2006 is omitted. Pre- and post-crisis test are Wald tests for joint significance of pre-crisis periods (2002-2005) and post-crisis periods (2007-2011), the values displayed in the table state the p-values of these tests. All specifications include individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	Bank depositors		Bank investors	
	Bank loans	Liquid wealth	Bank loans	Liquid wealth
	(1)	(2)	(3)	(4)
$2002 \times exposed_i^j$	-24.7021	0.0300	58.4429	-0.1751
	(31.0940)	(0.0766)	(150.2760)	(0.1232)
$2003 \times exposed_i^j$	-4.5936	0.0851	36.1650	-0.1929
	(29.1435)	(0.0741)	(133.5564)	(0.1227)
$2004 \times exposed_i^j$	16.2110	-0.0415	-79.4794	-0.1195
	(26.8254)	(0.0693)	(122.7937)	(0.1149)
$2005 \times exposed_i^j$	6.0448	0.0166	-35.3909	-0.0434
	(23.4175)	(0.0641)	(95.1308)	(0.0801)
$2007 \times exposed_i^j$	-21.1532	0.0002	-27.3123	0.0723
	(24.1552)	(0.0621)	(92.8866)	(0.0661)
$2008 \times exposed_i^j$	-49.1930*	-0.0365	-84.2947	-0.1726*
	(29.6366)	(0.0702)	(105.8445)	(0.0895)
$2009 \times exposed_i^j$	-67.5873**	-0.0408	7.2738	-0.4332***
	(29.8271)	(0.0711)	(122.5285)	(0.1068)
$2010 \times exposed_i^j$	-55.6564*	-0.0253	-9.5658	-0.3267***
	(33.2805)	(0.0713)	(131.1709)	(0.1013)
$2011 \times exposed_i^j$	-68.7237**	-0.0618	18.0143	-0.2914***
	(33.7224)	(0.0730)	(130.9474)	(0.1019)
Pre-crisis test p-value	0.4454	0.3178	0.1955	0.5880
Post-crisis test p-value	0.2489	0.9461	0.7420	0.0002
Control variables	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
R^2	0.6975	0.4304	0.6979	0.5749
Observations	250,400	250,400	97,950	97,950

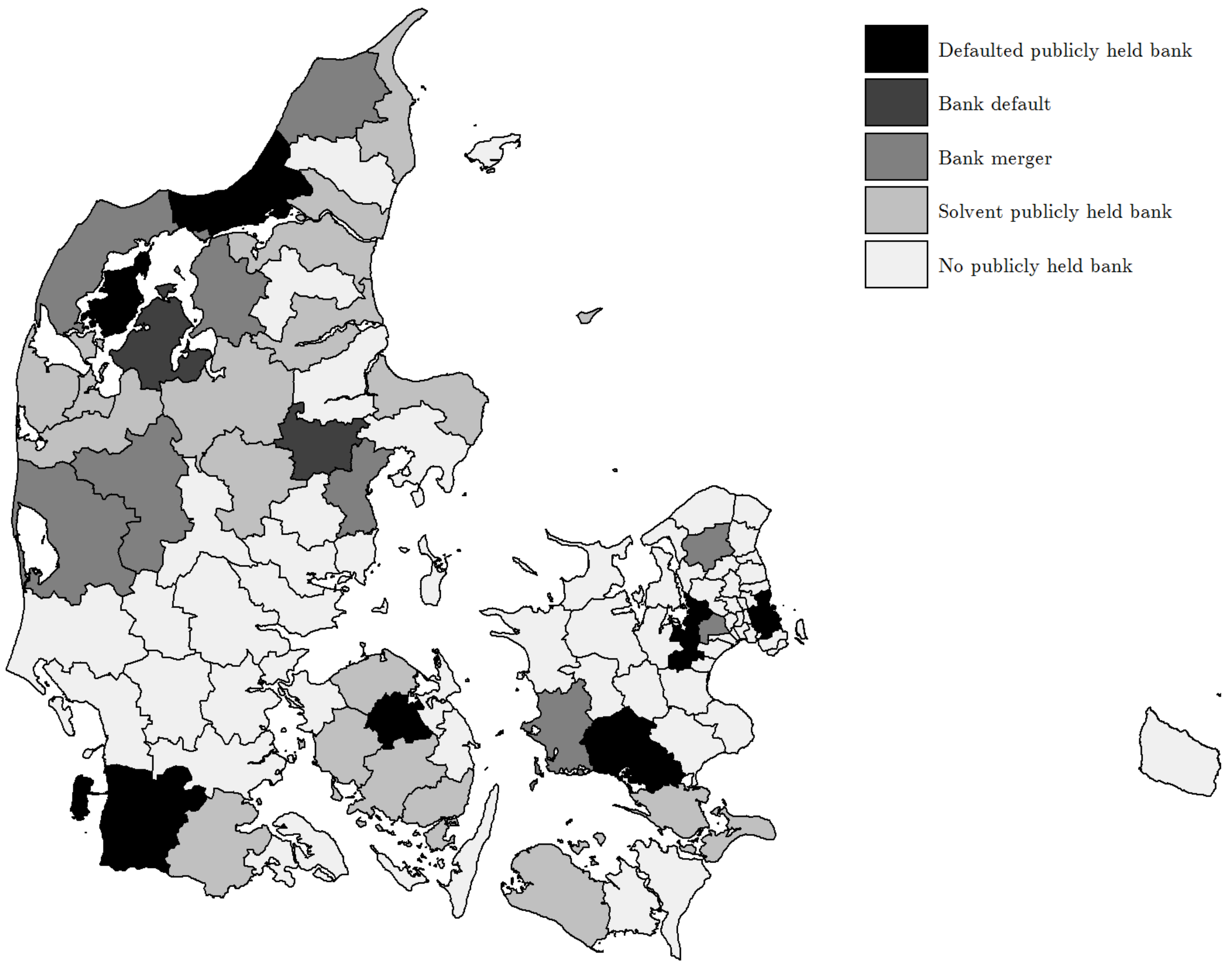
Table A.8: Firm Exit, Intensive Margin Decisions, and the Effect of Default Exposure: Dynamic Model

The following table states a dynamic version of the difference-in-differences model in Equation (2) and Tables 9 & 13 where $exposed_i^j$ is interacted with year-dummies in order to test lags and leads of the effect of banking default exposure. In Columns 1 & 2 the dependent variable the probability of exiting entrepreneurship in year conditional on being an entrepreneur in the last period, while in Columns 3 & 4 the dependent variable is the number of employees employed by the entrepreneur in year t. The coefficients state the difference between exposed and unexposed bank depositors (Columns 1 & 3) and exposed and unexposed bank investors (Columns 2 & 4) at varying years across the sample. Year 2006 is omitted. Pre- and post-crisis test are Wald tests for joint significance of pre-crisis periods (2002-2005) and post-crisis periods (2007-2011), the values displayed in the table state the p-values of these tests. All specifications include individual-entrepreneur fixed effects and the following time-varying demographic controls: *log wealth, log income,* and if the entrepreneur has a *child* or purchases a *house* at time t. Regression coefficients are estimated with OLS. ***, **, and * indicate significant at the 1, 5, and 10 percent levels, respectively. Robust standard errors clustered at the pre-crisis primary bank level are in parenthesis.

	Pr(exit)		Number of employees	
	Depositors	Investors	Depositors	Investors
	(1)	(2)	(3)	(4)
2002 × $exposed_i^j$	0.0077	0.0244	-0.4023*	-0.4648
	(0.0210)	(0.0238)	(0.2138)	(0.2798)
2003 × $exposed_i^j$	0.0335	0.0093	-0.1311	-0.5092**
	(0.0208)	(0.0219)	(0.1483)	(0.2393)
2004 × $exposed_i^j$	0.0041	0.0220	-0.1633	-0.2893
	(0.0210)	(0.0233)	(0.1394)	(0.2346)
2005 × $exposed_i^j$	0.0028	0.0366	-0.1068	-0.1699
	(0.0195)	(0.0231)	(0.1283)	(0.1717)
2007 × $exposed_i^j$	-0.0036	-0.0208	-0.0193	-0.1839
	(0.0207)	(0.0255)	(0.1135)	(0.1811)
2008 × $exposed_i^j$	-0.0019	0.0756***	-0.2424	-0.1511
	(0.0207)	(0.0282)	(0.1488)	(0.2287)
2009 × $exposed_i^j$	0.0299	0.0571**	-0.2079	-0.4211*
	(0.0218)	(0.0269)	(0.1553)	(0.2430)
2010 × $exposed_i^j$	0.0060	0.0392	-0.2773	-0.5622**
	(0.0215)	(0.0261)	(0.2085)	(0.2361)
2011 × $exposed_i^j$	0.0399*	0.1018***	-0.3616**	-0.7060***
	(0.0229)	(0.0297)	(0.1692)	(0.1554)
2012 × $exposed_i^j$			-0.1694	-0.6674***
			(0.2075)	(0.2330)
Pre-crisis test p-value	0.4666	0.5276	0.4399	0.2911
Post-crisis test p-value	0.2808	0.0003	0.0245	0.0002
Control variables	Yes	Yes	Yes	Yes
Individual fixed effects	Yes	Yes	Yes	Yes
R^2	0.2955	0.2806	0.7468	0.7994
Observations	145,371	69,114	150,347	70,779

Figure A.1: Location of Local Banks and Incidence of Bank Defaults in Denmark

This map shows the location of publicly trading retail banks and incidences of bank defaults across municipalities in Denmark from 2006 to 2013 based on bank headquarters. Municipalities with a surviving publicly listed bank are displayed in light gray. Municipalities in which a troubled bank was involved in a merger or acquisition after the financial crisis are shown in darker gray. Municipalities in which a publicly traded retail bank defaulted between 2008 and 2012 are displayed in black. The two municipalities in which a bank defaulted that was not publicly traded are shown in the darkest gray. Finally, municipalities without a publicly listed retail bank are shown in the lightest gray.



Chapter 3 - Believe it or Not: Expectations Matter for the Disposition Effect

Believe It or Not: Expectations Matter for the Disposition Effect*

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Abstract

In this paper we propose an initial step in testing some of the mechanisms behind the disposition effect using a research design which combines experimentally elicited preferences and observed patterns of trading behavior. We use detailed administrative data to recruit active individual investors and test for optimism, investor sophistication, regret aversion, violations of expected utility theory, and several different measurements of risk aversion. Our sample consists of investors who exhibited a high degree of disposition effect in observed portfolio choices and a control group of active investors. We find that on average, disposition-prone investors expect a market return on a balanced portfolio of assets to be approximately 5 percentage points greater than the expectations of other investors, an economically significant effect relative to a mean expected return of 14%. We find no differences in financial sophistication, regret aversion, risk taking behavior, or beliefs about macroeconomic fundamentals. Our results suggest that optimism and expectations may be important aspects of the disposition effect.

JEL Classification: G02, G11, D84, D81
Keywords: Disposition effect, Subject beliefs, Expectations, Risk taking, Household finance

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1. **Introduction**

Why are many investors reluctant to realize losses? The Disposition Effect, originally termed by Shefrin and Statman (1985), describes the tendency for investors to sell winning stocks and hold onto poorly performing investments rather than realizing their losses. The investment bias is one of the most robust empirical findings and has been well documented across many asset classes such as stocks (Shefrin and Statman (1985); Odean (1998); Grinblatt and Keloharju (2001)), mutual funds (Frazzini (2006); Jin and Scherbina (2011)), real estate markets (Genesove and Mayer (2001)), in individual investors and finance professionals alike (Coval and Shumway (2005); Locke and Mann (2005); Barber, Lee, Liu, and Odean (2007); Jin and Scherbina (2011)), and in controlled laboratory experiments (Weber and Camerer (1998)). Furthermore the bias has been found to be relatively stable across time as an individual trait (Seru, Shumway, and Stoffman (2010)).[1]

Understanding what explains the disposition effect has proven to be a difficult task as the various mechanisms which have been proposed to drive the bias are inherently challenging to observe. Since early references to the disposition effect, prospect theory, mental accounting, regret aversion, and self-control have been identified as important mechanisms (Shefrin and Statman, 1985). Investor beliefs and expectations have been mentioned in the literature, most often in regards to a belief in mean-reversal, and in general the literature has "almost always attributed the disposition effect to investor preferences rather than beliefs (Ben-David and Hirschleifer, 2012)." Theoretical and survey evidence support the conjecture that investors regret admitting that they have made a poor investment choice and thus continue to hold losing assets. Prospect theory and loss aversion have been the *de facto* mechanisms behind the bias, however theoretical tests of prospect theory find the presence of the disposition effect under certain conditions and reject it under others.

[1] For a complete literature review please see Kaustia (2010).

In this paper we propose an initial step in testing some of the mechanisms behind the disposition effect using a research design which combines experimentally elicited preferences and expectations with observed patterns of real trading behavior. We first use detailed administrative data to identify active individual investors from Denmark, who, in observed portfolio choices exhibited a high degree of disposition effect. We match these investors to a group of control investors who have similar demographic and financial characteristics apart from a disposition to hold onto losing equities. We then recruit laboratory experiment participants from these two samples and test a number of individual, incentivized, tasks which allows us to measure preference behaviors as correlates to the disposition effect. Our experimental design elicits subjective beliefs via a Quadratic Scoring Rule (QSR) from each individual, allowing us to precisely measure beliefs and expectations about financial markets and the economy, as well as investor sophistication and literacy. In addition, using a battery of lottery tasks with varying risky outcomes, we identify a measure of regret aversion, violations of expected utility theory, and several different measurements of risk aversion.

Our experimental results suggest that the key difference between these two investor groups is in their expectations of future market returns. On average, disposition-prone investors expect a market return on a balanced portfolio of assets to be approximately 5 percentage points greater than the expectations of other active investors, a statistically and economically meaningful effect relative to a mean expected return of 13.7%.[2] We find no differences in financial sophistication or literacy between investors. Investors with the disposition effect appear marginally more regret averse, however we cannot rule out that the effect is driven by other important correlates. Turning to the vast literature on prospect theory, we find that the average investor significantly deviates

[2] Specifically, the belief elicitation task was used to measure investor's expectations of the annual percentage change in the OMX20 Index from October 2014 to October 2015, elicited during our experimental sessions in April 2015. Obviously, we would have liked to elicit beliefs about specific assets held by specific investors to identify beliefs about winning and losing stocks, but this is challenging for anonymity reasons. Our focus rather is on the OMX20 which should capture expectations about the general domestic stock market in Denmark. We note additionally in Appendix A.1 that the composition of the OMX20 Index remained unchanged over this time period.

from expected utility theory, however find little difference between these two groups of investors.[3] In addition, the differences in expectations cannot be explained by differences in financial literacy or beliefs about other macroeconomic fundamentals such as aggregate unemployment or economic growth. Finally, we show that our measures of market beliefs are closely connected to real world investment behavior. A 10 percent increase in market expectations predicts that individuals hold approximately 5.9 percentage points more of their liquid wealth in individual stock holdings.

To further understand how beliefs can drive investors to realize gains but continue to hold onto losing equities, we turn to a number of theoretical exercises where we quantify the incidence of the disposition effect in investors with prospect theory. We follow Barberis and Xiong (2009) and allow for investors to use realized gains and losses as reference points. We find that increasing the (subjective) probability of a positive state by reasonable levels consistent with our experimental results significantly increases the incidence of the disposition effect. The addition of probability weighting on outcomes has little effect. Overall, our results emphasize the role of expectations and investor beliefs in the disposition effect compared to some of the more well studied mechanisms.

While the role of expectations of portfolio returns has been discussed since the early references of the disposition effect (Odean, (1998); Andreassen, (1988)), previous research has been unable to disentangle the interrelated nature of preferences for risk and subjective beliefs over uncertain returns. Measuring expectations is inherently important in understanding general behavior (Manksi, 2004) and beliefs about financial outcomes may contain substantial information but may depart from traditional rational expectations models (Greenwood and Shleifer, 2014). If investors do indeed extrapolate returns and act on their beliefs it seems puzzling that discussion about investor's subjective beliefs related to the disposition effect has often been treated informally in previous research. Our results therefore provide an important contribution to the literature on the

[3] We do not specifically investigate Prospect Theory in an experimental test for a number of reasons. Firstly, simulating losses and gains in a laboratory setting have proven to be challenging. Secondly, the focus of the literature to date has been on prospect theory, and therefore we focus on additional behavioral correlates of the disposition effect in the lab and impose prospect theory theoretically.

disposition effect and other behavioral biases. To the best of our knowledge this paper is the first to explicitly measure the link between investor's expectations and their investment biases using experimental data elicited via incentivized tasks, combined with administrative data on actual stock market transactions.

Our research is related to a very large body of literature on the disposition effect. In general, the existing literature has suggested that rational explanations fail to explain the disposition effect. Therefore theoretical and empirical research has focused on the behavioral anomalies that best explain the bias, most notably loss aversion and prospect theory as described by Kahneman and Tversky (1979). For example Barberis and Xiong (2009) reaffirm from Odean (1998) that the most obvious explanations, information based trading, rebalancing, and transaction costs, fail to capture important features of the data found in disposition effected investors. However, the authors find that the disposition effect is not explained by prospect theory when losses and gains are defined by annual returns, but only with realized gains and losses. Conversely, Hens and Vlcek (2011) specify a simple model of investment decisions with prospect theory, and find that the disposition effect is present under many conditions when the disposition effect is measured ex-post, (i.e., the investor's original risky asset was endowed upon him), and the effect is rather limited when determined ex-ante (i.e., the investor actively purchases the asset).

While many plausible explanations for the disposition effect have surfaced, to date little formal attention has been given to heterogeneity in subjective beliefs. If investors are optimistic about future returns of their portfolio, they may rationally choose to hold on to investments they expect to rebound. Alternatively, an investor holding losing assets may convince himself that the market will rebound in his favor as a means to avoid emotional pain felt by losing investments. Through either one of these channels, if optimistic investors are more prone to the disposition effect, we define this as an *ex-ante* optimism effect. On the other hand, investors in our experimental tasks may be more optimistic about market returns as a way to rationalize previous losses. This we refer to as an *ex-post* rationalization effect. We discuss these two effects in greater detail alongside a theoretical exercise in Section 7. Without a repeated panel of experimental tasks, it proves difficult to separate which direction the causality runs and whether investors are truly acting on beliefs or rationalizing their past behavior. As our experimental tasks take place such that a significant length of time has passed after their level of disposition effect is initially measured, we posit that we capture expectations which should be removed from previous portfolio decisions speaking in favor of an *ex-ante* effect. However, as a conservative measure we interpret our results as correlative and leave causality statements for future research.

The remainder of the paper is structured as follows: In Section 2 we discuss in detail the potential mechanisms for the disposition effect that have been highlighted in the existing literature. In Section 3 we discuss the experimental procedures and follow in Section 4 with a detailed overview of our sources of data, our measures of the disposition effect, and the subject pool of our analysis. Section 5 and 6 continue with a discussion of our experimental results and robustness checks, respectively. In Section 7 we present a theoretical framework for understanding our results. The final section concludes.

2. **Background**

In this section we review some of the mechanisms behind the disposition effect that have been most prevalent in the literature to date.

Beliefs, Expectations, and Mean Reversal:

The role of expectations of portfolio returns has been discussed since the early references of the disposition effect. For example, Odean (1998) suggests *"investors might choose to hold their losers and sell their winners not because they are reluctant to realize losses but because they believe that today's losers will soon outperform today's winners."* The role of beliefs most notably enters with the idea of mean reversal when investors misestimate probabilities of future price change. Kadous, Taylor, Thayer, and Young (2014) experimentally test the role of mean reversal and rule this out as an explanation for the disposition effect (as have previous empirical tests such as Odean (1998) and Kaustia (2010)).

Ben-David and Hirschliefer (2012) empirically test the role of beliefs, in a more general sense. They suggest that the beliefs drive a speculative motive in trades and this can induce either the disposition effect or the opposite result. Closely related to our analysis, Meng and Weng (2016) build on the model set forth by Barberis and Xiong (2009) on annual and realized gains and losses as reference points and integrate an expectation-based reference point as originally developed by Kőszegi and Rabin (2006). When references points are set by expectations of future wealth rather than initial wealth, the disposition effect occurs frequently among investors with prospect theory-like preferences.

A challenge with the expectations or beliefs based approach to the disposition effect is identifying which way the causality runs. Investors who show disposition in their trading behavior may do so because of their beliefs, however they may exhibit beliefs which rationalize their trading behavior. As suggested by Kaustia (2010, p19), *"the disposition effect may help explain why investors are overly optimistic about their future performance (Barber and Odean, 2001), but do not appear to know their actual historical performance (Goetzmann and Peles, 1997; Glaser and Weber, 2007)… investors [may] want to have an overly optimistic picture of their investment performance and realizing more gains allows them to achieve this self-justification."* Beliefs and expectations are clearly related to a broader literature in finance about the role of optimism in economic behavior. Which can lead to overreaction to news in asset returns (Barberis, Shleifer, and Vishny, 1998), and has been found to be a correlate of individual portfolio choice and saving decisions (Puri and Robinson, 2007).

Regret Aversion and Emotions:

Regret is defined as an emotional feeling associated with the 'ex-post knowledge that a different past decision would have fared better than the one chosen (Thaler, 1993).' This is a salient feature of the behavioral literature discussed by Thaler (1993), Tversky and Kahneman (1992), Shefrin and Statman (1984), and Loomes and Sugden (1982). While the idea of regret has long been used to explain the disposition effect, there is little empirical evidence that supports it. O'Curry Fogel and Berry (2006) find survey evidence of investors feeling regret about holding on to a losing stock compared to selling a winning stock too early. Muermann and Volkman (2007) show theoretically that when investor's reference points are based on the *ex-post* optimal decision and they have limited information about alternative equity returns, the disposition effect is present in a model of dynamic portfolio choice with feelings of regret or pride in investment decisions. As with other theoretical approaches to the disposition effect with prospect theory, the result is not robust to variations of this setting.

Another emotional explanation for the disposition effect has been disutility or realization utility. Similar to regret, 'investors avoid realizing losses because they dislike admitting that past purchases were mistakes (Chang, Solomon, and Westerfield, 2015).' In a recent experimental application, Chang, Solomon, and Westerfield (2015) show that when investors can delegate blame to others, the disposition effect reverses, suggesting that 'the urge to maintain self-esteem is a key driver of the effect.' In a theoretical application Barberis and Xiong (2012) show that realization utility may be an important determinant of asset pricing anomalies including the disposition effect. Their model assumes that investors have elements of myopia and narrow framing and view their investing experience as a series of separate episodes during each of which they either made or lost money. The primary source of utility then comes in a burst when a gain or loss is realized. Frydman, Barberis, Camerer, Bossaerts, and Rangel (2011) find neurological evidence of this effect. Ingersoll and Jin (2013) build on this model by including prospect theory and giving investors an S-shaped utility function. In their model, marginal realization utility decreases in the magnitude of gains and losses, such that lifetime utility can be increased by realizing frequent gains and less-frequent but larger losses. This result contributes to a dynamic disposition effect.

Prospect Theory:

In one of the earliest tests, Shefrin and Statman (1985) attribute the disposition effect to several behavioral mechanisms, 1) Prospect Theory, 2) Mental Accounting, 3) Regret Aversion, and 4) Self-Control. As such, the literature in the field has focused on these four behavioral pillars to explain the bias. Odean (1998) followed up with a systematic test of the disposition effect using trade-level data and suggested a number of rational explanations for the bias such as tax-deference, rebalancing, and transaction costs. The empirical evidence he provides rejects these rational explanations and suggests that prospect theory can consistently explain the bias. Prospect theory and loss aversion have therefore become the most popular explanations of the disposition effect, especially in the theoretical literature. Gomes (2005) in a relatively early theoretical work shows that a model of portfolio choice with loss aversion leads to the presence of the disposition effect, however the model is purely a static setting and therefore the investor is endowed with the asset from the first time period. Conversely, Hens and Vleck (2011) show that when an investor must decide at the onset whether or not to purchase the asset, it's not necessarily clear if an investor with prospect theory like preferences would even buy the asset, and if so, the presence of the disposition effect is rather seldom. Similarly, Barberis and Xiong (2009) distinguish between the reference point of realized gains and losses in a portfolio choice model with probability weighting and find that when returns are computed annually (as often done in the literature) there is a limited presence of the disposition effect. The bias is however shown in investment decisions when returns are computed over a reference point relative to the per-period cost basis of the asset. Hendersen (2012) on the other hand models the choice to 'give up' and realize losses (gains) relative to a breakeven point under prospect theory. She finds investors realize gains when they are small, but wait until losses are large thereby triggering a disposition in their trading behavior. As mentioned, Meng and Weng (2016) build on Barberis and Xiong (2009) and integrate an expectation-based reference point.

Empirical tests regarding the disposition effect and prospect theory are also mixed. Lehenkari and Perttunen (2004) show that Finnish stock investors are loss-averse but do not exhibit the disposition effect. Kaustia's (2010) findings using a similar dataset suggest that prospect theory is unlikely to explain the disposition effect (along with other explanations for the bias) for a similar reason: investors are likely to hold on to both winning and losing assets. Frazzini (2006) and Brown, Chappel, Da Silva Rosa, and Walter (2006) find empirical support for prospect theory and mental accounting, and loss aversion and narrow framing, respectively. Leal, Rocha, and Duque (2010) use the presence of the disposition effect in different market conditions to consider the presence of prospect theory. They posit that in bull markets, the realization of gains is 'easier' and realizations of losses appear to be more of a 'wrong decision.'

Testing for loss aversion in an experimental setting is challenging as subjects do not make incentivized decisions with their own money. Providing subjects with an initial endowment which then can then make risk choices in the loss domain about is problematic as studies have shown that subjects view it as a windfall gain and causes an endowment effect which biases their decision making (Clark, 2002; Harrison, 2007; Morrison and Oxoby, 2014).[4] To avoid these issues we refrain from examining decisions over losses in these tasks and only consider the role of loss aversion theoretically in Section 7.

Sophistication:

Dhar and Zu (2006) find that wealthier individuals, investors who trade more often, and individuals employed in professional occupations exhibit lower levels of the disposition effect. Similarly, Feng

[4] To overcome this, researchers have used a primer task where participants earn money, which then can then make decisions over losses on, however it is unclear if subjects integrate these gains or continue to view them as windfall gains. In a recent working paper Morrison and Oxoby (2014) have subjects use earnings from an experimental session a full week prior to the loss sessions, suggesting that participants fully integrate the previous winnings.

and Seascholes (2005) and Calvet, Cambell and Sodini (2008, 2009) show that more sophisticated individuals and households with more trading experience are less prone to the disposition effect. Sophistication may be linked to informational asymmetries, for example Dorn and Strobl (2011) show that the disposition effect weakens after an earnings announcement. Similarly Birru (2015) shows that after a stock split there is an absence of the disposition effect, potentially because inattentive investors fail to incorporate the correct reference point and confuse winning and losing assets. Relatedly, Kuhnen (2015) finds evidence of asymmetric learning following the realization of gains or losses. Experiencing losses (gains) tends to make subjects more pessimistic (optimistic) about alternative investment options (Kuhnen, 2015).

3. Experimental Procedures

Our experimental design implements individual incentivized choice tasks allowing us to systematically investigate the several mechanisms which have been proposed to drive the disposition effect. Each subject faces the following three tasks: a belief elicitation task, a risk aversion task with binary choices over lottery pairs, and an investment game. All experimental sessions took place between in Copenhagen Denmark from April 20th to April 29th, 2015.

We elicited individual subjective beliefs about the answers to 10 specific questions. Appendix F.4 lists the 10 questions that were used in this belief elicitation task. In each case there is a correct answer that can be verified the day of the experiment or some months after the experimental session. In particular, we used a Quadratic Scoring Rule (QSR) developed and tested by Harrison, Martínez-Correa and Swarthout (2013, 2014, 2015) and Hossain and Okui (2013) where subjects can earn points in a belief elicitation tasks that give them a greater chance of winning in a lottery that pays either a high amount or nothing. There is convincing experimental evidence that risk aversion can distort elicited beliefs making inference about subjective probability difficult (see

Harrison, Martínez-Correa and Swarthout (2014) for a more detailed discussion). The advantage of this design is that, theoretically and behaviorally, this belief elicitation procedure induces risk neutrality in subjects since a binary lottery provides incentives to individuals to choose a lottery with maximal expected value. Therefore, the beliefs reported in the QSR are subjective probabilities that are not contaminated by risk aversion and thus raw reports directly represent subjective beliefs.

In this belief elicitation task responses were elicited over a continuous range of possible answers presented in terms of 10 intervals or "bins." Figure 1 shows a screenshot of the interface that implements the QSR. The interface was then used to present the belief elicitation tasks to subjects and record their choices, allowing them to allocate tokens in accordance with their subjective beliefs. Subjects could move the sliders at the bottom of the screen to re-allocate the 100 tokens as they wished, ending up with some distribution. The instructions explained that they could earn up to 100 points, as shown in Figure 1 but only by allocating all 100 tokens to one interval and that interval containing the true answer: if the true answer was just outside the selected interval, they would in that case receive 0 points. Points are translated into probability of winning a binary lottery, so if a subject had a token allocation like the one depicted in Figure 1, depending on the true answer to the question, she could earn up to 75 points that gave her a 75% chance of winning 1000 DKK or nothing with 25% chance.

The belief elicitation task was used to measure investor's expectations of the annual percentage change of the OMX20 from October 2014 to October 2015, elicited during our experimental sessions in April 2015. The task was also used to measure investor sophistication and financial literacy as in Di Girolamo, Harrison, Lau, and Swarthout (2015). Investors were asked to answer numerical questions on compounding, the real interest rate and inflation, lifetime expectancy, and Bayes rule.

Investors in our experiments also completed a risky choice task that consisted of a battery of 60 lotteries pairs in the gain domain. Figure 2 shows a screenshot of the computer display that subjects used to complete this task. The lottery display is based on the Hey Orme (1994) design. The 60 lottery pairs are extremely versatile and were chosen to measure, using non-parametric and parametric statistics, a number of related phenomena. Thirty-six of the lottery pairs were chosen from the battery of lottery pairs in Wilcox (2010) which were originally designed to test for a wide range of risk attitudes. These 36 lottery pairs were chosen from a bigger battery of lotteries designed to identify and parametrically estimate deviations from Expected Utility Theory (EUT) such as Rank Dependent Utility (RDU) with different types of probability weighting (i.e., probability optimism or pessimism, inverted-S function normally assumed in Prospect Theory). We use 24 lottery pairs from the innovative designs from Wakker, Erev and Weber (1994) to carefully test the "comonotonic independence" axiom of Rank Dependent Utility which allows us to measure if individuals make decisions consistent with Expected Utility Theory or Rank Dependent Utility models.[5] Additionally, 45 of the lottery pairs are used to calculate an individual's foregone expected value. The measure quantifies the amount, in DKK, that the subject is leaving on the table by selecting the less risky choice within a lottery pair.

To calculate the foregone expected value of lotteries pairs, we first calculate the expected value and standard deviation of each lottery choice A and B within a lottery pair. The foregone expected value is then the difference in the expected value for choices A and B if choice A is selected by the subject *and* the expected value and standard deviation of B is greater than the expected value and standard deviation of A, specifically:

$$\text{Foregone EV} = (EV_B - EV_A) \quad \text{if } EV_B > EV_A \;\;\&\;\; SD_B > SD_A \;\;\&\;\; \text{Choice A is selected.}$$

Because of the strictly greater than conditional statements of the standard deviation and expected value, the foregone expected value can be derived from 45 of 60 lottery pairs.

Finally, the lottery choices allow us to estimate regret aversion. Regret is defined in the seminal work by Loomes and Sugden (1982) as the distance between the payoff of the chosen act

[5] For brevity, we present a detailed explanation of comonotonic independence in Appendix G.1.

and the maximum payoff that could have been gained if the alternative decision would have been chosen. For each lottery, we therefore define the difference in utility that could have been gained from the actual choice and the outcome of the unchosen lottery choice. The specifics detailing the utility measure and estimation strategy is described in more detail in Appendix C.2.

In addition to the lottery tasks, we use an investment game adapted from Gneezy and Potters (1997) as a raw measure of risk aversion. In this experiment there are 10 independent investment rounds each subject faces. In each round the investor begins with an endowment of 1000 DKK in a safe asset and his or her task is to input the amount, X, of the safe asset to invest in a risky asset. The return of the risky asset varies across the 10 investment rounds with a return of either 2X, 2.5X, 3X, or 4X and a risk of earning 0X with probability 0.25, 0.5, or 0.75. The task is therefore used to measure portfolio decisions at varying risk and return payoffs. This task is depicted in Figure 3 and further documented in Appendix F.2.

In Appendix B.1 we plot simple distributions of subject's responses in our experimental tasks. Panel A plots the modal expected annual return for the OMX20 across our sample of investor participants. We note that most subjects have a positive view of expected market returns however some subjects expect substantial losses in the year following the experimental tasks. Panels B and C plots the distributions of subjects' investments and the average expected value they forgo in lottery choice tasks. These panels suggest that there is substantial heterogeneity in our subject's appetite for financial risk in our incentivized tasks. Finally Panels D and E plot the distributions of the fraction of tokens placed into the correct response for three of our questions geared at financial literacy. These distributions represent all subjects in the sample and suggest that financial sophistication varies significantly across the sample.

4. Data and Sampling

Sources of Data

We access administrative records from Statistics Denmark obtaining data containing economic, financial, and demographic information about all individuals in Denmark. The dataset is constructed based on several different administrative registers made available to researchers from Statistics Denmark, as explained below.

Income, wealth, and portfolio holdings are from the official records at the Danish Tax and Customs Administration (*SKAT*). This dataset contains personal income and wealth information by *CPR* numbers on the Danish population. *SKAT* receives this information directly from the relevant sources; financial institutions supply information to *SKAT* on their customers' deposits and holdings of security investments. Employers similarly supply statements of wages paid to their employees. Through Statistics Denmark, we obtain access to personal income and wealth data from 1990 to 2014. From 2006 to 2012, we additionally have information on individuals' stock and mutual fund holdings by ISIN number at the end of the year. Educational records are from the Danish Ministry of Education. All completed (formal and informal) education levels are registered on a yearly basis and made available through Statistics Denmark. We use these data to measure an individual's education level.

Finally, demographic and family data originate from the official Danish Civil Registration System. These records include the personal identification number (*CPR*), gender, date of birth, and provide individual characteristics, such as age, gender, and marital status.

Defining the Disposition Effect

Our focus is on investors who have exhibited the disposition effect in equity trading behavior observable in annually collected tax reports. Our registry data resembles that of Calvet, Campbell and Sodini (2009) and Cronqvist and Siegel (2014) which we use to calculate a measure of the disposition effect for each individual investor by the same construction as Dhar and Zhu (2006), who follow that of Odean (1998). Using the return of an asset we determine whether an asset makes a gain or a loss to an investor and define:

PGR = Proportion of Gains Realized = # realized gains / (# realized gains + # paper gains)

PLR = Proportion of Losses Realized = # realized losses / (# realized losses + # paper losses)

DE = Disposition Effect = PGR – PLR

An asset has a realized gain if an investor sold an asset which had a positive return. An individual has a realized loss in an asset if it is sold with a negative return. A paper gain is then an asset which had a positive return but the investor continues to hold the asset in her portfolio. Similarly a paper loss is a negative return on an unsold asset in the investor's portfolio.

We first collate annual stock holdings data from 2006-2012 for all stock holding individuals and compute an average coefficient for Disposition Effect for each investor based on annual portfolio changes. As Calvet, Campbell and Sodini (2009) and Cronqvist and Siegel (2014), we do not observe active trades throughout the year, rather year-end portfolio holdings. Therefore, we start by looking at the assets that are specifically purchased during our sample period and the buy and sell decisions associated with each purchased asset held by each investor thereafter. At the end of each period we tally-up an investor's realized and paper gains and losses, where the reference point used to calculate a gain or a loss for each individual asset is defined as the most recent active-trade price.

We make the following assumptions: first we only consider individuals who make an active trade within our sample window. By trade we mean that the investor increased or decreased the number of shares of directly held, individual stocks in her portfolio from one period to the next which is measured at the end of the calendar year (we remove assets which become delisted).[6]

[6] We focus specifically on individual stocks rather than mutual funds or ETFs as we do not observe the share allocation of non-individual stock holdings in our data.

Second, since we do not observe the purchase price, sale price, or the reference point an investor has in mind for any specific assets we follow Calvet, Campbell and Sodini (2009) and assume the following: for stocks which are purchased, the purchase price is the average share price from t-1 and t, measured at the end of the calendar year, where t is the first period in which the stocks purchased appeared in the portfolio. The sale price of an asset is the mean of the share price between the two periods where it is sold, and a hold price is the share price at the end of the calendar year. Therefore an asset's return if sold, is the Sale Price minus the Purchase Price, and if held is equal to the Hold Price minus the Purchase Price.

Third, we only consider the trade behavior associated with the most recent reference point in the case of investors who make multiple purchases of the same asset at different points in time. We do this in order to capture the most recent price the investor could have paid for the asset, and also to focus on trades closer to our sampling and experimental sessions. This level of distinction and assumptions on reference points are important in our case and not in Odean (1998) and Dhar and Zhu (2006) because we do not observe specific purchase points as they do in their active trade data. We calculate the above for each year 2007-2012. We only include investors who have at least one realized gain and at least one realized loss (similar to Dhar and Zhu (2006) and Cronqvist and Siegel (2014)). Finally we compute the average coefficient of DE in the decision years most recent to our experiments, 2010-2012. Further details regarding the construction of the disposition effect can be found in Appendix D.

Sampling Procedures and Subject Pool

To recruit for our experimental tasks, we begin by identifying all family units in Denmark, and sample from eligible households in the greater Copenhagen area.[7] We exclude any family unit with a stock market and mutual fund portfolio of less than 5,000 Danish kroner on average per household

[7] Sampling procedures are documented in detail in Appendix E.

adult in any 3 years from 2006-2012, as measured by tax records. We also exclude 16,277 investors who have average stock holdings that exceed that of the 99th percentile of the distribution. From this sample, we construct our measure of disposition effect, and sample from the top 95 percentile of individuals who have a non-missing DE coefficient. By construction, these investors have a DE coefficient equal to unity, or 2,034 investors from the sample population. Our target was to recruit 70 of these individuals as our sample group of individuals with the disposition effect, and we managed to recruit 66 participants to our experiments.

Our control group therefore consists of active participants who are not designated in our high disposition treatment sample, or 160 subjects. We use a simple matching procedure when comparing individuals from our treated and control samples in order to reduce any bias from observable characteristics which may be correlated with higher disposition effect behavior. Appendix A.2 details the one-to-one nearest neighbor matching estimation used. We match on propensity score from a model including the following covariates: *gender, age, education length, marital status, quartile of net wealth, disposable income, average portfolio turnover*, *risk share*, and the *number of unique equities in the portfolio*. The observables we base the matching on were selected based on common demographic and financial characteristics most often used in studies similar to ours, relying upon constructed financial measures and administrative data most notably Calvet, Cambell and Sodini (2009) and Cronqvist and Siegel (2014).

Table 1 outlines the descriptive statistics of our final sample. We report means and standard deviations for demographic and financial characteristics for all subjects. For each individual, we report the *age, gender, marital status*, *years of education* and whether the individual has a *financial education*. For the *number of children in the household*, *net wealth, disposable income, debt, bank savings,* and *total value of debt* and *equity* of all housing investments we report the value from year-end 2014, approximately 4 months prior to the experimental sessions. Column 4 compares the mean characteristics of disposition effected individuals and a matched control group and test whether these differences are significantly different from zero with an unpaired *t*-test. As expected, differences between the two groups are economically small and insignificant after the matching procedure.[8]

Similarly, in Table 2 we compare the 2010-2012 average of the market value at the end of the year for *total portfolio value*, the *value of directly-held stocks*, and the *value of mutual funds.*[9] We observe *risky asset share* (i.e. fraction of liquid assets allocated to stocks) as well as the share of *investments* (mutual funds and stocks). The *number of assets in the portfolio* is the unique number of stocks and mutual funds held by each investor, *market tenure* is the number of years since 1986 (the first year of total portfolio holdings available in our data) the individual has held a positive balance of stocks. *Portfolio change* and *portfolio turnover* are defined as the year-to-year change in total portfolio value, and the absolute value of year-to-year portfolio sales and purchases divided by the average portfolio value, respectively. Comparing the disposition effected individuals to the control sample in Column 4 suggests that individuals with high levels of disposition effect hold a larger portfolio of risky assets, both in levels as well as in the share of their liquid wealth. This, however, comes without surprise as these investors are less likely to realize losses and, by definition, are holding on to risky assets longer than their non-disposition effected counterparts.

5. Results

Beliefs about Market Returns:

The starting point of our analysis is to characterize the beliefs about market returns for our entire sample. We follow Harrison, Martínez-Correa and Swarthout (2013, 2014, 2015) and analyze subjects' elicited belief distributions using interval regressions. Table 3 presents these interval regressions where the dependent variable represents the weighted midpoint of subject's belief of the annual percentage change from October 2014 to October 2015, elicited during our experimental

[8] Appendices A.3 and A.4 provide demographic and portfolio characteristics for the full sample of subjects.
[9] The distinction between dates is primarily due to data availability. We sampled individuals in 2015 and therefore use their most recent financial and demographic data for our control variables (2014). However, our dataset on trading behavior encompasses 2006-2012, therefore portfolio characteristics and incidence of the disposition effect is based on data during that time range.

sessions in April 2015. In Column 1, the constant term suggests that the average investor in our sample expects a market return of approximately 16.6% in the OMX Copenhagen 20 Index. In Column 2 we add the variable of interest, *disposition effect individuals* which represents investors included in our sample of individuals with high levels of the disposition effect in their real trading behavior. The coefficient indicates that these individuals have a 5.8 percentage points higher expectation of the annual OMX20 return. In Column 3 we add a full set of demographic and financial control variables. Throughout the analysis we find that men are more likely to have higher expectations about market returns. This finding comes as little surprise, as literature has thoroughly discussed the differences in financial behavior between men and women.[10] In addition, Column 3 suggests that investors with higher net wealth and more disposable income have higher expectations about future market returns. This result is interesting as previous literature has suggested that higher wealth individuals are more financially literate (van Rooij, Lusardi, and Alessie (2012); van Rooij, Lusardi, and Alessie (2011)) and take on more financial risk (Vissing-Jorgensen (2002); Guiso and Jappelli (2005); Malmendier and Nagel (2011); Sodini, Van Nieuwerburgh, Vestman, and Von Lilienfeld-Toal (2016)), which contribute to their greater wealth accumulation. Our results suggest that more wealthy individuals also expect to earn a higher return on their investments which could be an alternative, or additional mechanism of wealth accumulation compared to the consensus that higher wealth investors can afford (or are sophisticated enough) to take on higher levels of risk.

In Column 3, once accounting for heterogeneity across observable characteristics, disposition effect individuals anticipate a 5.2 percentage point greater market return than investors who do not suffer from the disposition effect. Figure 4 shows how these two distributions diverge. In Figure 5 we plot the historical market returns for the OMX20 from 1991-2015. We note that our subject's expectations of the market are more or less realistic given the distribution of historical returns.

[10] See Charness and Gneezy (2012) and Croson and Gneezy (2009) for an overview on gender differences in gender on risk taking and investment decisions.

The interval regressions presented in Table 3 assume the underlying data to be normally distributed. The validity of this assumption is tested in Appendix Figure B.2. Panel A plots the average distribution of market beliefs for investors with high disposition effect. The dark grey bars represent the actual beliefs from the elicited task, while the light grey bars represent maximum likelihood estimates fit from a normal distribution, stemming from Appendix Table A.5. The *x*-axis denotes the bin representing the percentage change, while the *y*-axis gives the fraction of 100 tokens allocated to the bin. The confidence intervals of the fitted values along with the *p*-values suggest that the normal distribution provides an accurate representation of the true data. Panel B does the same for the control sample of active investors.

In order to characterize higher order moments of the beliefs investors hold about market returns, we test an alternative distribution in Appendix A.6. The beta distribution allows us to measure differences between treated and control investors in the skewness or kurtosis of their beliefs about market returns. Column 1 of Appendix A.6 provides maximum likelihood estimates of a normally distributed interval regression which coincide with the results presented in Table 3. In Column 2 of Appendix A.6 we show the interval regression coefficients using a beta distribution. Column 2 shows that the beta distribution predicts a slightly higher difference in mean beliefs (5.8%) about market returns, while holding the level the same at an average 13.6% average percentage change in the OMX20. For measures of the variance, skewness, or kurtosis investors with high levels of DE are not statistically significant from a group of control investors when fitting the beta distribution. Panels A and B of Appendix Figure B.3 tests the fit of the beta distribution to the actual distribution of beliefs.

The findings from Tables 3 and Appendix A.6 suggest that in an incentivized belief task, investors with the disposition effect in our sample exhibit higher future expected returns in the market.[11]

Preferences for Risk:

We use several elicitation mechanisms to determine the risk taking behavior of investors in our sample. Many of the determinants of the disposition effect previously described in the literature such as prospect theory and loss aversion are rooted in their relationship to risk. As such, we want to first understand if as expected utility maximizers, investors with and without the disposition effect react differently in incentivized experimental tasks to financial risk taking.

In Table 4, we measure preferences for risk taking via an investment game modeled after Gneezy and Potters (1997) as a raw measure of risk aversion. In Columns 1 and 2, we document these results. The dependent variable is the fraction of a 1,000 DKK endowment the subject can choose to invest. The main finding is that disposition effect investors invest no differently than a control sample of active investors. Turning to Columns 3 and 4, we use data from 45 pairs of lotteries in the gain domain. For each of these lotteries we define the *forgone expected value* as the difference in expected value between the risky and safe option for each lottery choice where the investor chooses the less risky option. Therefore the higher the average forgone expected value for each investor implies that the investor is more risk averse, as she is forgoing additional expected earnings in an attempt to mitigate risk. In Columns 3-4, the foregone expected value is the dependent variable and a higher degree of forgone expected value indicates higher levels of risk aversion. Column 4 suggests that men, on average have a lower forgone expected value, consistent

[11] In a survey question administrated as part of the experimental procedures, investors with the disposition effect also exhibited higher levels of market expectations in a similar, non-incentivized survey question. In the following multiple choice question, *"Concerning publically-traded Danish stocks (OMX 20 Cap Index): How many percentage points will Danish publicly-traded stock prices increase/decrease in the next year?"* Disposition-prone investors answered a modal expected return of "10-20%" while our matched sample of investors answered a modal return of "5-10%" This provides anecdotal evidence of the accuracy of our belief tasks, as well as the differences between the two types of investors.

with other measures of risk taking across a wide literature. In addition, university education and higher wealth individuals behave more risk loving. The main finding from Columns 3 and 4, however is that having a high degree of disposition effect does not determine differences in risky lottery choices in our experiments.

In Appendix Table A.7 we structurally estimate risk measures using choices from 36 lottery pairs as well as data the investment task. Column 1-3 assume EUT while Columns 4-6 focus on RDU. Columns 1 and 4 use the lottery choices over risk, Columns 2 and 5 use the Gneezy and Potters (1997) task, and Columns 3 and 6 pool the two tasks into one analysis. The covariate indicating high disposition effect investors remains statistically and economically insignificant. The combined results of our experiments over risk suggest that disposition effect prone investors do not differ from other active investors in their propensity to take on financial risk.

Regret Aversion:

In Table 5 we structurally estimate regret aversion using incentivized lottery tasks. As briefly described, regret aversion implies that investors anticipate experiencing regret if she chooses a prospect where she would have been better off if she had chosen differently. Conversely, she anticipates experiencing pride if she selects the prospect that gave the best outcome.

In our experimental tasks, subjects make *n* choices between two different lotteries (A or B) with potential outcomes $\{a_1,\ a_2, \ldots, a_n\}$ and $\{b_1,\ b_2, .., b_n\}$. Following Sugden and Loomes (1982) we assume that there exists a regret function, $R(a_i, b_i)$, that captures the regret/pride logic,

$$R(b_i, a_i) = e^{(\varphi*(u(b_i)-u(a_i)))} - 1 \quad and \quad R(a_i, b_i) = e^{(\varphi*(u(a_i)-u(\,b_i)))} - 1$$

The parameter φ captures regret aversion if $\varphi > 0$, regret loving if $\varphi < 0$ and regret neutrality when $\varphi = 0$. The valuation of each lottery is then similar to what an Expected Utility maximizer would do, except that now anticipated regret and pride is taken into account,

$$EU_A = \sum_{i=1}^{n} p_i * (u(b_i) - R(b_i, a_i)) \text{ and } EU_B = \sum_{i=1}^{n} p_i * (u(a_i) - R(a_i, b_i)).$$

We assume simple constant relative risk aversion (CRRA) utility and estimate model parameters using maximum likelihood.[12]

Table 5 presents raw coefficients where *phi* gives us our measure of regret and rejoice. If one wants to model regret aversion, it requires that the function is strictly increasing. In our estimations we allow for the *phi* parameter to be free such that we can also model regret loving behavior. In Column 1 the coefficient of the constant term in the equation for *phi* is positive and statistically significant, which indicates that the average investor in our sample is regret averse in their lottery decisions. The variable of most interest is *disposition effect individuals*, representing the treatment of investors sampled with high levels of disposition effect. The variable is positive and marginally significant at the 10 percent confidence level. In Column 2 we add a full set of controls for demographic and financial characteristics as in previous estimations and find that disposition-prone investors do not appear to have higher aversion to regret compared to similar active investors. The findings from Table 5 show interestingly that the average investor in our sample is relatively regret averse, however this does not appear to be an important distinction between investors with and without the disposition effect.

Prospect Theory and Violations of EUT:

As noted Section 2, we do not experimentally elicit preferences consistent with Prospect Theory (PT) for a number of reasons related to challenges of imposing losses in the laboratory. Instead, we focus on RDU which in the gain domain, behaves similar to PT.

A subset of our lottery tasks based on Wakker, Erev and Weber (1994), tests the "comonotonic independence" axiom of RDU, a stronger version of the independence axiom associated with EUT. The latter implies that choices between two lotteries with common outcomes are not affected by changes in the common outcome. Thus one can vary the common outcome as much as one wants

[12] See Appendix C.1 for more detailed information.

and the choice between the two lotteries would be the same. Comonotonic independence predicts the same implication with additional restrictions on the changes in the common outcome: the choice between two lotteries will be the same as long as changes in the common outcome do not affect the *ranking* of outcomes. Therefore, by testing comonotonic independence one is testing the rank-dependence feature of RDU and PT.[13]

In general we find support for our subjects' choice patterns both with disposition effect and from the control sample to be consistent with RDU.[14] In Table 6 we summarize the results of differences in violations from EUT across disposition-prone and control investors in our sample. The lotteries consist of 6 sets of 4 lottery pairs (24 lotteries). Within each set there are up to three violations of the independence axiom for EUT and RDU a subject can choose (18 total violations). Table 6 tests the differences in the observed total number of violations. Column 4 shows that disposition effected investors make on average slightly more violations than their control counterparts, however these differences are not statistically significant. In Appendix Table A.8 we present additional information on the types of violation. We note however that the average investor in the sample makes a non-negligible number of violations in a manner consistent with RDU, i.e. 6 violations on average of a possible 18.

Sophistication

Investor sophistication and financial literacy have been suggested to be important determinants of the disposition effect. In all of our analysis we control for measures of sophistication, specifically portfolio turnover and the size in value and assets of the portfolio. Because we are using a matched sample based on these characteristics, we in a sense constrain observable measures of sophistication

[13] An example of Comonotonic independence is provided in Appendix G.1.

[14] We test for equality of proportions where the null hypothesis predicts that the proportion of observed violations consistent with rank dependent utility theory is not significantly different from 2/3. If the proportion of observed violations consistent with RDU is significantly less than 2/3 this is evidence in favor of RDU with inverted-S probability weighting function. The test rejects the null hypothesis with the proportion equal to 0.604 ($p<0.001$)

between disposition effected investors and comparable active investors. Using our experimental belief task, we can go one step further and investigate the literacy of investors in our sample.

In Table 7 we report the relationship between financial literacy and the disposition effect for active investors with four questions geared at interpreting the subject's financial literary. Our belief task and literacy questions are based on Di Girolamo, Harrison, Lau, and Swarthout (2015), who pose questions on interest compounding, the real interest rate and inflation, and lifetime expectancy of men and women. The two questions directly extend from Lusardi and Mitchell (2007, 2011) who apply these literacy questions to the Health and Retirement Survey (HRS) in the United States.

The dependent variable in Column 1 represents the subject's answer to the numerical question on compounding interest, while Column 2 is a numerical question on the real interest rate. In each case the dependent variable takes the form as the percentage of tokens placed into the correct answer.[15] Across columns, our analysis suggests that having a university education seems to increase the fraction of tokens an individual places into the correct answer. In addition there seems to be a partial correlation between financial literacy and higher wealth and income individuals, however the significance of these results are not incredibly stable across the two questions.

The main variable of interest in Table 7 is *Disposition effect individuals,* again, representing investors sampled with high levels of disposition effect. Contrary to previous literature hypothesizing a link between the disposition effect and literacy (Dhar and Zhu (2006)) our results suggest that investors with the disposition effect are not significantly different from other active investors in terms of their financial knowledge.[16]

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[15] The full text of the questions are as follows: *Interest Compounding*: "Suppose you had 1,000 kroner in a savings account and the interest rate is 2% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?" The correct answer is 1,104 kroner. *Real Interest Rate:* "Suppose you had 2,000 in a saving account. The interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, what would be the real value of the money on this account?" The correct answer is 1,980 kroner. See Appendix E for additional details.

[16] We also ask a question on Bayes rule to see if investors perceive probabilities different and find no significant differences between disposition effected and control investors. The question is as follows, *Bayes Rule:* "A reporter for a magazine for women is writing an article about tests for breast cancer, and is trying to determine the actual significance of the tests results. He has the following information: 100 of every 10,000 women undergoing a routine exam will actually have breast cancer; of every 100 women with breast cancer that undergo a routine exam, 80 will receive a

6. Additional Specifications:

<u>*Extremal Validity:*</u>

It is important to ask the question, how do our measures of behavior elicited in the laboratory explain differences in observed portfolio choices? We analyze this in Table 8. In Columns 1-4 the dependent variable is the share of a subject's liquid wealth invested in directly held, individual stock investments in 2012. We first consider the effect of market beliefs on investments specifically on individual stock holdings as these investments most accurately reflect our experimental measure of expectations of market returns. Subjects were asked to provide their expectation of the annual return in the OMX20, the top 20 largest equities measured by free floated market capitalization listed on Nasdaq Copenhagen. In Columns 1-2, the sample consists of our full sample of investors in the experimental task. The variable of interest, *Market beliefs*, is the mode of the expected annual return in the CPH OMX20 by decile. A one unit increase in the variable (i.e., a 10 percent increase in expectations) predicts that individuals hold approximately 5.9 percentage points more of their liquid wealth in individual stocks. Column 2 controls for a full set of demographic control variables. The variable *strong beliefs,* indicates whether the subject placed 100 percent of belief allocation into a single bin response. We note that the coefficient of interest remains largely unchanged. This finding is consistent with Puri and Robinson (2007) who find that optimism (measured by self-reported life expectancy) predicts a higher propensity to own individual stocks, and a larger share of equity wealth invested in individual stocks.

In Column 3 and 4 we specifically focus on the disposition effect investor sample, and a control sample of investors, respectively. Investors with the disposition effect, as shown, have more optimistic beliefs and (mechanically) hold a larger share of their wealth in risky assets. Given this, it

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positive test result; of every 9,900 who do not have breast cancer that undergo a routine exam, 950 will also receive a positive test result. You have received a representative sample of women who underwent routine exams and tested positive for breast cancer. What percent of this sample do you expect to actually have breast cancer?" The correct answer is 80 / (80+950) = 7.8.

is natural that the effect of market beliefs does not explain additional risk taking in Column 3. Column 4 suggests that investors without the disposition effect, who take higher risk in their real portfolios, hold more optimistic beliefs in the returns of the stock market.

In Columns 5-6 the dependent variable is the share of an investor's liquid wealth invested in total risky assets (i.e., individual stock investments and mutual funds) in 2012. We note that the correlation between market beliefs and total risky asset investments is not significantly different from zero. In Columns 7-8 this measure is created with our most recent data from 2014 and remains fundamentally unchanged. Again, this finding supports existing results by Puri and Robinson (2007) who find that optimists invest more in individual stocks, but do not necessarily place a larger fraction of their wealth into risky investments. The results from Table 8 suggest that beliefs in the OMX20 seem to be strongly correlated to portfolio investment in direct stock holdings, as expected. Columns 5-8 suggest that this is less apparent for mutual funds and total market investment decisions. Unfortunately data limitations only allow us to investigate the underlying assets and the tilt toward individual stocks over mutual funds and exchange traded funds for the years prior to 2013.

Table 8 in total suggests that investors with more optimistic beliefs in the OMX20 are more likely to hold directly-held equity investments in the stock market and are less likely to delegate their risky assets by holding mutual fund assets. This result is related to a literature on delegation and the disposition effect. Most notably Change, Solomon, and Westerfield (2016) who find that delegation reverses the regret or disutility associated with realizing losses. Our results reinforce this idea and add to the literature that delegation may have direct implications on belief and expectation formation.

In Table 9, we focus on our detailed portfolio data from 2012 and investigate the correlation between expectations in the returns of the OMX20 and real-world investments in specific OMX20 assets. In Columns 1-2 the dependent variable is an indicator variable for investment in stocks contained in the OMX20 index. Since our data reflect portfolios at year-end we include assets which were indexed on the OMX20 at any time throughout the year. There were however, relatively few changes to the composition of the index. One asset is dropped in June of 2012 while another is added.[17] We include both of these in our measure. Two stocks are added to the portfolio on December 27th, 2012, however we do not include these in our measure of the assets indexed on the OMX20 as the addition takes place at the very end of the year. We also include investments in OMX20 specific ETFs or mutual funds into our measure of these assets; however these indirect investments make up a rather small fraction of total investments across the sample. Columns 1 and 2 show that for a 10 percent increase in investor's expectations of OMX returns, they were approximately 9 percentage points more likely to have held these assets in the past.

In Columns 3-4 the dependent variable is the market value at the end of 2012 of an investor's portfolio holdings of equities contained in the OMX20 index. After controlling for demographic and financial controls, we find that a 10 percent increase in expectations is correlated with an approximate 20,400 DKK ($3,700 USD) larger previous investment in OMX indexed equities. In Columns 5-8 the dependent variable is the share of a subject's liquid wealth invested in direct stock investments of equities in the OMX20 index in 2012. Similarly, in Columns 5-6 we find that higher expectations about the OMX20 are directly correlated with higher previous investment as a share of total financial wealth. The coefficient is approximately 5 percentage points higher and statistically significant at the 5 percent confidence level. Columns 7 and 8 present these results across the samples of types of investors. Contrasting Table 9 from Table 8 suggests that increase in risk taking observed by optimistic investors is strongly driven by their investment in equities indexed in the OMX20.

Sample Selection:

[17] The assets included in the OMX20 index and the minimal changes to the index are detailed in Appendix A.1.

An initial critique of the results presented thus far is that experimental protocols could be biased by the quality of the subject pool and the results could be an outcome of sample selection. In Appendix Table A.9, we present a Heckman sample selection regression where the dependent variable represents the weighted midpoint of subject's belief of the annual percentage change from October 2014 to October 2015, elicited in April 2015. The variable of interest is *disposition effect individuals*, representing investors sampled with high levels of disposition effect. Column 2 shows the effect of the main coefficients while controlling for sample selection, applying the sample selection equation presented in Column 1. The model is estimated using full maximum likelihood estimation. We use the following exogenous sampling variables, *percentage win* is the chance of receiving a show up fee (either 10 or 20%), the *show up amount* (either 1000 or 2000 kroner) as well as the *travel distance* from individual's home to experimental site. The variable is measured in the kilometer distance and is computed and provided by Statistics Denmark.

The logic behind the instruments is simple. The probability of receiving a financial incentive and the size of the incentive should be positively correlated with participation in the experiment. The distance between an individual's home and the experimental site should be negatively correlated with selection into the experiment, however uncorrelated with previous measures of the disposition effect. Column 1 shows that the travel distance is a strong predictor of participation into the experiment. For each kilometer further that a subject lives from the experimental site is correlated with a -0.8 percentage points decrease that he or she will participate in the experiments. This instrument is significant at the 1% level. Column 2 shows that after accounting for this selection, *disposition effect individuals* have on average a 9 percentage points higher expected mean belief in market returns. This result, after accounting for selection, is close to our main results from Table 3 showing a mean difference of 5.2 percentage points between active investors and active investors with the disposition effect.

Macroeconomic Expectations:

Another cause for concern would be if individuals with the disposition effect also held higher expectations or beliefs about *other* unrelated phenomena and we are attributing differences in market returns to differences in *overall* expectations. To address this concern, in Figure 6 we plot the belief distributions of disposition effect individuals and our control sample of active investors for expectations of the unemployment rate in 6 months and the annual percentage change in GDP growth in Denmark. Panels A and B show that the distributions between the two groups are very similar and disposition effect individuals do not have statistically different beliefs about other macroeconomic fundamentals.

7. A Theoretical Relationship between Beliefs and the Disposition Effect

Our goal is to match our empirical findings thus far with a theoretical application of the disposition effect. As our main result shows that disposition effected investors hold more optimistic beliefs about market returns, however do not depart from other measures such as risk taking, we focus next on a model consistent with these results.

Optimism requires a belief that the good state is the best possible outcome, and this state will be realized with a higher probability. We therefore study optimism by considering the incidence of the disposition effect when the probability of a good state increases. One could also model optimism by taking as point of reference the true objective probability distribution or the beliefs of a given individual. However, optimism will be modeled anyway as an increase of the subjective probability above this reference "objective" probability. Therefore we choose to model the effect of optimism on the disposition effect by studying what happens when we increase the subjective probability of the good state.

We have previously discussed two plausible ways in which expectations about the stock market can be connected to the disposition effect, which we describe in the following ways: 1) an *ex-post* rationalization effect and 2) an *ex-ante* optimism effect.

The *ex-post* rationalization effect is a natural explanation since an individual that exhibits the disposition effect might be tempted to rationalize the choice of keeping losing stocks. Although limited in the context of the disposition effect, this psychological channel has been analyzed empirically and theoretically by studying how individuals bias subjective probabilities in a way that reduces psychological discomfort. Individuals put more probability weight on good outcomes with little evidence to support this updating or by selectively picking information which rationalizes their biased beliefs. For instance, Brunnermeier and Parker (2005) develop a model in which subjects optimally choose to be optimists (i.e., putting more probability weight on the good outcomes) against the cost of worse decision-making since they are biasing beliefs away from true probabilities. Malmendier and Nagel (2011) suggest that low market participation *"could be the result of individuals' attempts to learn from their experiences, albeit not by using all 'available' historical data, as in standard rational or even bounded rational learning models, but by focusing on their lifetime experiences. Consistent with this view, Malmendier and Nagel (2009) show that inflation expectations are influenced by individuals' inflation experiences in similar ways as risk taking and stock return expectations are influenced by individuals' return experiences."* Relatedly, Kuhnen (2016) finds experimental evidence supporting this while Andersen, Hanspal and Nielsen (2016) show that when experiences are made directly compared to common or cohort-experiences, the effect on future, active risk taking is amplified.

The *ex-ante* optimism effect is a less intuitive channel and implies that individuals with more optimistic beliefs/expectations are more prone to exhibit disposition effect. As stated, optimism is defined as subjective probability distributions that put more weight on better outcomes. In our experiment we claim that our recruited subjects that exhibited disposition effect put more probability weight on higher stock returns than individuals in the control group, and therefore we consider the former group more optimistic that the latter group. Below we describe a simple model that allows one to study and understand this counterintuitive channel in which beliefs can affect the disposition effect behavior.

We use the theoretical framework in Barberis and Xiong (2009) to study the effect of expectations and beliefs on disposition effect behavior. We focus on the model described in Section III of Barberis and Xiong (2009) as a plausible way to model disposition effect behavior using Prospect-Theory-like preferences. The important aspect of the model is that the decision-maker derives utility from *realized* gains and losses. In Barberis and Xiong's (2009, p. 772) words: "*In this case* [of realized gains and losses], *if the investor buys shares of a stock at the start of the year and then, a few months later, sells some of the shares, he receives a jolt of prospect theory utility right then, at the moment of the sale, where the argument of the prospect theory value function is the size of the realized gain and loss.*"

Assume a prospect theory maximizer with the utility function proposed by Tversky and Kahneman (1992) and that describes preferences for risk-taking:

$$v(y) = \begin{cases} y^{\alpha}, & \text{if } y \geq 0 \\ -\lambda(-y)^{\alpha}, & \text{if } y < 0 \end{cases}$$

with $0 < \alpha < 1$ and $\lambda > 1$.[18] The latter condition is an important ingredient of prospect theory because it allows us to model loss aversion originally described by Kahneman and Tversky (1979) by the idea that "losses loom greater than gains." One of the main implications of this utility function is that individuals are risk averse in the gain domain (i.e., $y \geq 0$) and risk lovers in the loss domain (i.e., $y < 0$, where gains and losses are defined according to a reference point.

The individual can invest in an asset with a distribution of gross return between any two periods *t* and *t*+1 according to the following subjective probability distribution

$$R_{t,t+1} = \begin{cases} R_u > R_f \text{ with probability } \pi \\ R_d < R_f \text{ with probability 1- } \pi \end{cases}$$

[18] Tversky and Kahneman (1992) actually suggested a more general version of this utility function that allows for a utility risk aversion parameter for the gain domain and another for the loss domain. Tversky and Kahneman (1992) concluded that experimental evidence suggested the same utility risk aversion parameter for both the gain and the loss domain. Barberis and Xiong (2009) follow this approach as well in this study.

The stock is i.i.d. distributed across periods, R_u represents the gross return in the good state, R_d represents the return in the bad state and R_f is the gross return of the risk free asset. The individual believes that the good states is realized with probability π and the bad state with probability (1- π). An important aspect of prospect theory is probability weighting but we follow for now Barberis and Xiong (2009) and assume probability weighting is absent.[19] Similarly we assume a two-period model such that there are three stock holding events: t = 0, 1 and 2, where the first two are trading periods and x_0, x_{1u} and x_{1d} are the individual's asset demands, respectively, in period t = 0, in period t = 1 when the good state is realized, and in period t = 1 when the bad state is realized. The individual has wealth W_t in period t and the price of the risky asset at any given period is P_t.

The investor solves the following maximization problem at t = 0:

$$\max_{x_0, x_{1u}, x_{1d},} E_0\left[v\big((x_0 - x_1)(P_1 - P_0)\big)\mathbf{1}_{[x_1 < x_0]} + v\big(x_1(P_2 - P_b)\big)\mathbf{1}_{[x_1 > 0]}\right],$$

where

$$P_b = \begin{cases} P_0 & \text{if } x_1 \leq x_0 \\ \dfrac{x_0 P_0 + (x_1 - x_0)P_1}{x_1}, & \text{if } x_1 > x_0 \end{cases}$$

subject to

$$W_2 = W_0 + x_0 P_0\big(R_{0,1} - 1\big) + x_1 P_1\big(R_{1,2} - 1\big) \geq 0.$$

The indicator function $\mathbf{1}_{[x_1 < x_0]}$ is equal to 1 when the condition $x_1 < x_0$ is satisfied and 0 otherwise, and the indicator function $\mathbf{1}_{[x_1 > 0]}$ is similarly defined.[20]

Let's carefully explain each of the factors in the objective function of the maximization problem to understand the psychological mechanisms. The second factor $v\big(x_1(P_2 - P_b)\big)\mathbf{1}_{[x_1 > 0]}$ is the utility in the final period t = 2. The individual derives utility in the final period if she holds

[19] We have conducted a similar analysis following Hens and Vleck (2011) who allow for probability weighting. The results are very similar to the ones we describe below and in line with the results from Hens and Vleck (2011) where probability weighting has little power to explain the incidence of disposition effect. This analysis is detailed in Appendix J.

[20] For simplicity and exposition purposes we assume that the individual can only take non-negative positions in the risky asset.

shares of the risky asset (i.e., $x_1 > 0$). Notice that the reference point to the individual here is P_b, which implies that she perceives a gain from her investment if the price in period t = 2 (i.e., P_2) is greater than the cost basis of the portfolio and therefore makes a financial gain.[21] The first factor $v\big((x_0 - x_1)(P_1 - P_0)\big)\mathbf{1}_{[x_1<x_0]}$ is the utility derived from selling shares of the risky asset (i.e., $x_1 < x_0$) in the interim trading period t = 1. The subject's reference point in this instance is the price in the first period (i.e., P_0) since this is the cost basis of the portfolio she holds in the second period t = 1. The investor derives utility at t = 1 from a gain if she sells shares of the risky asset at a price higher than she bought at t = 0. Conversely, she feels a loss in utility from a loss in t = 1 if the prices at which she sells shares of the assets is below the price at which she bought the asset in the in the first period.

The disposition effect in this model arises when $x_{1u} < x_0 \leq x_{1d}$. The intuition behind this is simple; an investor shows disposition in her investment allocations if the allocation she devotes to risky assets in the bad-state is greater than the allocation she invests in the good-state. In this context the investor is more prone to hold the risky asset in the bad state while realizing her position in the good state.

Following Hens and Vleck (2011), we plot the incidence of the disposition effect while varying the parameters of the model. We set $\alpha = 0.88$ and $\lambda = 2.25$, both values taken directly from Tverskey and Kahneman (1992) as measures of risk and loss aversion. We allow R_u and R_d to take values, using steps of 0.1, in the intervals (1, 2) and (0.1,1), respectively, and set $R_f = 1, W_0 = 40$ and $P_0 = 40$. We solve the model numerically using software coded in *Mathematica 10.2* by Wolfram Research (2015) and a grid to span the possible values of R_u and R_d. This implies that we solve the model for each of the possible combination of these parameters.

[21] Notice that the cost basis in the final period P_b can be either the price of the asset in the first period if the investor only bought shares in the first period, or a weighted average of the price of the asset in the first and second period if she bought shares in both periods.

Figure 7 shows the incidence rate of the disposition effect when the probability of the good state is 50% as was assumed in the analysis of Barberis and Xiong (2009). The space in lighter color indicated in the figure shows which combinations of R_u and R_d under which rates of return will result in the investor exhibiting disposition effect. The darker color in the figure represents the areas where no disposition effect is observed. In the case of Figure 7, disposition effect is observed in 15% of the cases considered in the grid used to create the figure.

Since we are interested in understanding how beliefs can affect the incidence of the disposition effect we have solve the model assuming different levels of probability π. We want to study what happens to the disposition effect when the individual becomes more optimistic about the good state of the risky asset which in our case is modeled as π being increased. Therefore we repeat the exercise while varying the levels of the probability π. Figure 8 shows the summary of the results of this analysis.[22]

In Figure 8 the solid line shows a positive relationship between π and the incidence of the disposition effect while maintaining the same parameters used in Figure 7. The incidence of the disposition effect peaks at 25% when the probability of the good state is close to 70%, then decreases to close to 0% when the probability is near 100%. This non-linear relationship occurs because at very low and very high probabilities of the good state the disposition effect is not present, and therefore the incidence rate at these probability levels is near zero. The intuition is simple, at very low probabilities, subjects have little incentive to hold the asset even if the good state is realized, and the disposition effect is not present by construction. At very high probabilities subjects have strong incentives to hold the asset even if the bad state is realized, individuals will hold the asset no matter the realized state and the disposition effect will not be present, implying that the disposition effect is present for the cases of intermediate probabilities.

[22] Figure B.4 in Appendix B shows a figure similar to Figure 6 for different probability levels.

One interesting finding with the particular set of parameters that we chose is that the incidence of the disposition effect increases as the probability increases in the interval (0, 0.7). This is counterintuitive at first glance since one would expect that more optimistic beliefs are accompanied by a higher demand of the risky asset. However, one has to keep in mind that what matters for the disposition effect is how an increase in probability affect the incentives to keep the asset when the bad state is realized compared against how that increase affects the incentives to keep the asset when the good state is realized.

Why would we observe an increase in the incidence of the disposition effect when we increase the probability in the interval (0, 0.7)? The answer is related to the loss aversion feature of the prospect theory model. One feature of this model is that due to loss aversion, subjects are risk averse in the gain domain and risk loving in the loss domain. The fact that we observe an increase in the incidence of the disposition effect when the probability is increased is related to the fact that a prospect theory individual is more likely to keep the asset when the bad state is realized since he behaves in a risk loving manner when the bad state is realized, while the same investor is less likely to keep the asset when the good state is realized as he would behave in a risk averse manner in that case. Increasing the probability makes the risky asset more attractive than the sure loss derived from liquidating the position in the asset that performed poorly in the risk loving case. Increasing the probability also makes the risky asset more attractive in the risk-averse case for this investor but the probability must be high enough such that no disposition effect is present (i.e., $x_{1u} > x_{1d}$).

To corroborate this intuition we change the utility parameter α from 0.88 to 0.65. This will have the effect that the individual will be more risk averse in the gain domain and more risk loving in the loss domain. This implies that we should observe more a higher incidence of the disposition effect since it exacerbates the incentive to sell the asset when it is performing well as the investor is now more risk averse in the gain domain, as well as the incentive to keep the asset when it performs poorly due to higher risk loving in the loss domain. The dashed-line in Figure 8 exemplifies this intuition as we can see that the incidence of the Disposition Effect is greater when the parameter α is reduced to 0.6, at essentially all levels of probability.

To summarize, increasing the probability of the good state across a wide range of the probability interval increases the incidence of the disposition effect. This is a counterintuitive finding as one would expect a higher probability of the good state to increase the incentive to keep a risky asset. However, it is important to consider how increasing probabilities affect the incentive to keep the asset when the bad state is realized relative to how incentives are affected when the good state are realized. If these incentives are stronger in the bad state relative to the good state, then the disposition effect is present. In the simple example we show above, higher probability increases the incidence of the disposition effect. This is driven by the loss aversion feature of prospect theory because it implies that investors behave in a risk loving manner when the bad state is realized and in a risk averse manner when the good state is realized. Increasing the probability of a good state creates a stronger incentive to keep the asset in the risk loving case for the investor than the incentives it creates in the risk-averse case for the investor to keep the asset, across a wide range of probabilities.

8. Conclusion

In this paper we take a first step at testing some of the mechanisms behind the disposition effect in an incentivized laboratory setting. Using administrative tax data on asset holdings from Denmark we measure the degree of the disposition effect held by each individual investor. We then recruit laboratory experiment participants from these two samples and test a battery of individual, incentivized, tasks which allows us to examine preference measures as correlates to the disposition effect. Our experimental design elicits subjective beliefs via a Quadratic Scoring Rule (QSR) from each individual, allowing us to precisely measure beliefs and expectations about financial markets and the economy, and investor sophistication and literacy. In addition, using a battery of lottery tasks with varying risky outcomes, we identify regret aversion, violations of expected utility theory, and several different measurements of risk aversion.

Disposition-prone investors expect a market return on a balanced portfolio of assets to be approximately 5 percentage points greater than the expectations of other active investors; this is an economically significant result relative to a mean expected return of 14%. Furthermore, we find no differences in the risk taking behavior between these two groups of investors across three different measurements of risk taking. These differences in expectations cannot be explained by differences in financial literacy or beliefs about other macroeconomic fundamentals such as aggregate unemployment or GDP growth. Our results help disentangle the interrelated nature of preferences for risk and subjective beliefs over uncertain returns and provide an important contribution to the literature on the mechanisms behind the disposition effect. In future work, it will be interesting to uncover which direction the causality runs between expectations and the disposition effect, focus on incentivized measures of loss aversion and probability weighting, and finally, to explore beliefs over more detailed and specific equities and asset classes for various groups of investors.

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Table 1: Summary Statistics

We report the mean and standard deviation for demographic and financial characteristics for all subjects in our sample. For each individual, we report the *age, gender, marital status, years of education* and whether the individual has a *financial education* obtained in 2014. For *net wealth, disposable income, total debt, bank savings,* and *total value of debt and equity of all housing investments* we report the year-end market value in 2014. We compare the mean characteristics of the Disposition Effect (DE) individuals and a matched control group and test whether these differences are significantly different from zero. Matching is one-to-one nearest neighbor matching based on propensity score from a model including *gender, age, education length, marital status, quartile of net wealth, disposable income, average portfolio turnover*, *risk share*, and the *number of unique equities in the portfolio.* Corresponding *t*-statistics are reported in square brackets. All amounts are in thousands year-2010 DKK. Standard deviations are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	All **(1)**	**DE individuals** **(2)**	**Control** **(3)**	**Difference** **(2)-(3)**
Age	49.6	49.0	50.2	-1.21
	(11.8)	(11.8)	(11.9)	[-0.59]
Male	0.68	0.68	0.68	0.00
	(0.47)	(0.47)	(0.47)	[0.00]
Married	0.61	0.62	0.59	0.030
	(0.49)	(0.49)	(0.50)	[0.35]
Length of education	14.7	14.9	14.5	0.42
	(2.82)	(2.84)	(2.82)	[0.86]
Financial education	0.24	0.20	0.29	-0.091
	(0.43)	(0.40)	(0.46)	[-1.22]
Net wealth	1232.3	1288.6	1176.0	112.6
	(2012.4)	(1837.3)	(2186.1)	[0.32]
Disposable income	396.3	436.8	355.8	81.1
	(417.9)	(560.9)	(184.4)	[1.12]
Value of debt	979.9	937.1	1022.7	-85.6
	(1232.5)	(927.7)	(1482.2)	[-0.40]
Value of bank deposits	232.3	219.1	245.5	-26.4
	(387.3)	(387.1)	(390.0)	[-0.39]
Total value of property	1536.9	1469.3	1604.5	-135.2
	(2015.8)	(1246.8)	(2574.0)	[-0.38]
Subjects	132	66	66	-

Table 2: Portfolio Characteristics

We report the mean and standard deviation for portfolio characteristics for all subjects in our selected sample. For each individual, we report the 2010-2012 average for all values including the market value at the end of the year for *total portfolio value*, the *value of directly-held stocks*, and the *value of mutual funds*. We observe *risky asset share* (i.e. fraction of liquid assets allocated to stocks) as well as the share of *investments* (mutual funds and stocks). The *number of assets in the portfolio* is the unique number of stocks and mutual funds held by each investor, *market tenure* is the number of years since 1986 the individual has held a positive balance of stocks. The *average year-to-year portfolio change* is year-to-year change in value of all portfolio holdings from 2012-2014 while *the average portfolio turnover* is the absolute value of portfolio sales and purchases divided by the average portfolio value from 2010-2012. We compare the mean characteristics of Disposition Effect (DE) individuals and a control group and test whether these differences are significantly different from zero. Corresponding *t*-statistics are reported in square brackets. All amounts are in thousands year-2010 DKK. Standard deviations are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	All	**DE individuals**	**Control**	**Difference**
	(1)	**(2)**	**(3)**	**(2)-(3)**
Value of mutual funds and stocks	262.7	365.9	159.5	206.3*
	(685.1)	(874.1)	(400.2)	[1.74]
Value of directly-held stocks	133.4	215.8	51.0	164.8***
	(306.2)	(407.4)	(96.3)	[3.20]
Value of mutual funds	129.3	150.0	108.5	41.5
	(614.7)	(775.8)	(398.5)	[0.39]
Risk share of stocks/wealth	0.32	0.43	0.21	0.22***
	(0.31)	(0.34)	(0.24)	[4.38]
Risk share of investments/wealth	0.40	0.49	0.31	0.18***
	(0.29)	(0.31)	(0.25)	[3.73]
Number of assets in portfolio	3.78	3.82	3.74	0.076
	(3.24)	(2.92)	(3.55)	[0.13]
Market tenure	14.5	14.8	14.3	0.47
	(7.18)	(6.80)	(7.59)	[0.37]
Average Disposition Effect	0.81	1.00	0.04	0.96***
	(0.41)	(0.00)	(0.36)	[10.5]
Average year-to-year portfolio change	0.19	0.14	0.27	-0.14**
	(0.29)	(0.32)	(0.24)	[-2.62]
Average portfolio turnover	0.52	0.56	0.48	0.080
	(0.40)	(0.37)	(0.42)	[1.15]
Subjects	132	66	66	-

Table 3: Subjective Beliefs of Market Returns

We present interval regressions where the dependent variable represents the subject's belief of the annual percentage change from October 2014 to October 2015, elicited in April 2015. The variable of interest is *Disposition effect individuals,* representing investors sampled with high levels of disposition effect. The sample consists of Disposition effect individuals and a matched sample of control investors. Matching is one-to-one nearest neighbor matching based on propensity score from a model including *gender, age, education length, marital status, quartile of net wealth, disposable income, average portfolio turnover*, *risk share*, and the *number of unique equities in the portfolio*. Column 2 adds the *disposition effect* covariate to Column 1 which identifies half of the investors in our sample with high levels of the disposition effect. Column 3 adds a full set of control variables to the raw specification on Column 1. In Column 3 we control for demographic and financial characteristics for both the model and *ln(sigma)* parameter (not displayed). All amounts are in thousands year-2010 DKK. Standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	What will be the annual percentage change of the OMX Copenhagen 20 index?		
	(1)	**(2)**	**(3)**
Disposition effect individuals		0.058**	0.052**
		(0.023)	(0.021)
Male			0.063***
			(0.022)
Age			-0.003
			(0.007)
Age squared			0.000
			(0.000)
College education			0.004
			(0.026)
Married			-0.052**
			(0.024)
Second quartile of net wealth			-0.022
			(0.029)
Third quartile of net wealth			-0.018
			(0.031)
Fourth quartile of net wealth			-0.009
			(0.037)
Log disposable income			0.032
			(0.021)
Value of directly-held stocks			0.021
			(0.015)
Value of mutual funds			-0.012
			(0.015)
Constant	0.166***	0.137***	-0.008
	(0.012)	(0.017)	(0.171)
Subjects	132	132	132
Observations	13,200	13,200	13,200

Table 4: Risk Taking and the Disposition Effect

In the following table we consider how experimental measures of risk taking vary with the Disposition Effect. In Columns 1-2 the dependent variable is the average size of a subject's investment (i.e., the fraction of 1,000 DKK that the individual chose to invest.) in an investment task. In Columns 3-4 the dependent variable is the average foregone expected value of choices in risky lottery tasks. The variable of interest is *Disposition effect individuals* representing the treatment of investors sampled with high levels of disposition effect. We control for demographic and financial characteristics as outlined below. Estimates represent the coefficients after an OLS regression. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	**Investment size**		**Foregone expected value**	
	(1)	**(2)**	**(3)**	**(4)**
Disposition effect individuals	0.033	0.019	3.458	5.446
	(0.033)	(0.033)	(15.679)	(14.763)
Male		-0.004		-55.944***
		(0.034)		(15.112)
Age		0.004		3.400
		(0.012)		(4.976)
Age squared		-0.000		-0.008
		(0.000)		(0.053)
College education		-0.026		-38.096**
		(0.037)		(15.967)
Married		-0.009		-5.446
		(0.038)		(17.278)
Second quartile of net wealth		-0.105**		32.185*
		(0.043)		(19.027)
Third quartile of net wealth		0.009		-2.909
		(0.049)		(20.393)
Fourth quartile of net wealth		0.026		-28.931
		(0.054)		(22.711)
Log disposable income		0.036		-11.820
		(0.027)		(10.205)
Value of directly-held stocks		-0.001		49.907
		(0.043)		(32.338)
Value of mutual funds		0.056**		3.931
		(0.024)		(10.400)
Constant	0.473***	0.321	117.428***	96.371
	(0.023)	(0.276)	(11.143)	(93.567)
Subjects	132	132	132	132
Observations	1,320	1,320	5,940	5,940

Table 5: Regret Aversion

In the following table we structurally estimate regret aversion using data from incentivized tasks on risk taking. We present raw coefficients estimated by maximum likelihood. The variable of interest *Disposition effect individuals,* representing the treatment of investors sampled with high levels of disposition effect. *Phi* represents the model parameter which describes investors' preferences for regret. In Column 2 we add a full set of controls for demographic and financial characteristics as outlined in previous tables. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Regret Aversion	
	(1)	**(2)**
r		
Disposition effect individuals	0.103	0.105
	(0.087)	(0.065)
Constant	0.475***	0.258
	(0.074)	(0.382)
phi		
Disposition effect individuals	0.128*	-0.008
	(0.076)	(0.074)
Constant	0.497***	0.413
	(0.132)	(0.544)
mu		
Constant	0.811***	0.572***
	(0.146)	(0.115)
Controls	No	Yes
Subjects	132	132
Observations	7,920	7,920

Table 6: Comonotonic Independence Violation Tests

Using a battery of lotteries from Wakker, Erev and Weber (1994), we test the "comonotonic independence" axiom of Rank Dependent Utility theory. The table below presents the average number of individual violations of comonotonic independence per choice set across 6 choice sets. In Columns 1-4 we compare the total number of violations of individuals with the disposition effect and a control group and test whether these differences are significantly different from zero. The maximum number of violations possible is 18. Additional and more specific tests of violations are contained in Appendix A.8. Corresponding *t*-statistics are reported in square brackets. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	All **(1)**	**DE individuals** **(2)**	**Control** **(3)**	**Differences** **(2)-(3)**
Total violations	6.09	6.42	5.76	0.67
	(2.75)	(2.63)	(2.85)	[1.40]
Subjects	132	66	66	-
Observations	132	66	66	-

Table 7: Sophistication and Financial Literacy

In the following table we report results for four questions geared at interpreting the subject's financial literary and sophistication. The dependent variable in Column 1 represents the subject's answer to a numerical question on compounding interest, while Column 2 is a numerical question on the real interest rate. In each case the dependent variable takes the form as the percentage of tokens placed into the correct answer. The full text of these questions and the corresponding answers are detailed in Appendix F. All questions were elicited in April 2015. The variable of interest is *Disposition effect individuals* representing the investors sampled with high levels of disposition effect. We control for demographic and financial characteristics as outlined below. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Compounding interest	**Real interest rate and inflation**
	(1)	**(2)**
Disposition effect individuals	-0.100	-0.051
	(0.076)	(0.080)
Male	0.132	0.007
	(0.086)	(0.087)
Age	0.012	-0.004
	(0.030)	(0.029)
Age squared	-0.000	-0.000
	(0.000)	(0.000)
College education	0.038	0.080
	(0.095)	(0.089)
Married	0.009	-0.071
	(0.086)	(0.088)
Second quartile of net wealth	0.142	0.039
	(0.120)	(0.114)
Third quartile of net wealth	0.218*	0.185
	(0.114)	(0.127)
Fourth quartile of net wealth	0.259*	0.112
	(0.132)	(0.126)
Log disposable income	0.006	0.245***
	(0.097)	(0.071)
Value of mutual funds and stocks	0.037	0.060
	(0.033)	(0.044)
Constant	0.451	-0.741
	(0.679)	(0.618)
Subjects	132	132
Observations	132	132

Table 8: External Validity: Does Behavior in the Lab Explain Observed Portfolio Choices?

In the following table we consider how portfolio measures of risk taking vary with incentivized subjective beliefs about returns of the OMX20. In Columns 1-4 the dependent variable is the share of a subject's liquid wealth invested in direct stock investments in 2012. In Columns 5-6 the dependent variable is the share of a subject's liquid wealth invested in total risky assets (i.e., stock investments and mutual funds). In Columns 7-8 this measure is created with data from 2014. Columns 1-2 include the full sample of investors in our experimental tasks, Columns 3, 5, and 7 include only investors which were sampled with the disposition effect and Columns 4, 6, and 8 include only the control group of investors. The variable of interest is *Market beliefs*, which is the mode of expected annual return in the CPH OMX20 grouped into deciles. The variable *Strong beliefs* indicates whether the subject placed 100 percent of the allocation into a single belief bin. The table states the coefficients after an OLS regression. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	**Equity risk share**				**Total risk share**			
	Full sample		**DE**	**Control**	**DE**	**Control**	**DE**	**Control**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Market beliefs	0.059***	0.058***	0.026	0.055**	-0.010	0.029	-0.027	0.026
	(0.018)	(0.017)	(0.033)	(0.021)	(0.029)	(0.026)	(0.035)	(0.031)
Strong beliefs indicator		0.038	-0.001	0.092	0.056	0.215**	0.017	0.144
		(0.071)	(0.107)	(0.084)	(0.096)	(0.088)	(0.106)	(0.117)
Male		-0.009	-0.056	0.013	-0.032	-0.080	0.094	-0.181*
		(0.060)	(0.100)	(0.059)	(0.088)	(0.070)	(0.105)	(0.092)
Age		-0.020	-0.009	-0.039*	-0.003	-0.051**	0.005	-0.073**
		(0.019)	(0.033)	(0.021)	(0.030)	(0.024)	(0.036)	(0.033)
Age squared		0.000	0.000	0.000	0.000	0.000*	-0.000	0.001*
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
College education		-0.021	0.110	-0.192***	0.173*	-0.143*	0.140	-0.137
		(0.065)	(0.114)	(0.070)	(0.101)	(0.079)	(0.115)	(0.102)
Married		0.149**	0.169	0.056	0.114	0.001	-0.026	-0.135
		(0.058)	(0.104)	(0.064)	(0.096)	(0.069)	(0.103)	(0.087)
Second quartile of net wealth		0.022	-0.004	0.079	0.013	0.016	0.152	0.071
		(0.075)	(0.131)	(0.082)	(0.127)	(0.101)	(0.149)	(0.114)
Third quartile of net wealth		0.048	0.051	0.055	0.050	-0.039	-0.009	0.142
		(0.078)	(0.137)	(0.076)	(0.138)	(0.088)	(0.158)	(0.107)
Fourth quartile of net wealth		0.001	-0.070	0.084	-0.037	0.130	0.179	0.309**
		(0.089)	(0.144)	(0.076)	(0.138)	(0.097)	(0.160)	(0.129)
Log disposable income		0.066	0.014	0.051	0.018	0.098	0.183***	0.118
		(0.054)	(0.105)	(0.046)	(0.088)	(0.061)	(0.066)	(0.084)
Constant	-0.106	-0.071	0.135	0.537	0.268	0.930	-0.680	1.440*
	(0.128)	(0.435)	(0.735)	(0.492)	(0.669)	(0.634)	(0.826)	(0.782)

R^2	0.069	0.141	0.143	0.302	0.143	0.195	0.206	0.229
Subjects	132	132	66	66	66	66	132	132
Observations	132	132	66	66	66	66	132	132

Table 9: External Validity: Does Behavior in the Lab Explain OMX Investment?

In the following table we consider how portfolio measures of risk taking vary with incentivized subjective beliefs about returns of the OMX20. In Columns 1-2 the dependent variable is an indicator variable for investment in stocks contained in the OMX20 index in 2012. In Columns 3-4 the dependent variable is the market value at the end of 2012 of an investor's portfolio holdings of equities contained in the OMX20 index. In Columns 5-8 the dependent variable is the share of a subject's liquid wealth invested in direct stock investments of equities in the OMX20 index in 2012. Columns 1-6 include the full sample of investors in our experimental tasks, Column 7 includes only investors which were sampled with the disposition effect, and Column 8 includes only the control group of investors. The variable of interest is *Market beliefs*, which is the mode of expected annual return in the CPH OMX20 grouped into deciles. The variable *Strong beliefs* indicates whether the subject placed 100 percent of the allocation into a single belief bin. The table states the coefficients after an OLS regression. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variable	**OMX20 investor**		**Value of OMX20 equities**		**OMX20 risk share**			
			Full sample				**DE**	**Control**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Market beliefs	0.088***	0.092***	26.409**	20.386*	0.050***	0.054***	0.018	0.064***
	(0.029)	(0.030)	(11.053)	(10.463)	(0.018)	(0.019)	(0.033)	(0.021)
Strong beliefs indicator		-0.033		49.287		0.044	-0.022	0.161*
		(0.105)		(63.765)		(0.075)	(0.115)	(0.082)
Male		-0.080		-11.532		-0.054	-0.070	-0.082
		(0.086)		(38.277)		(0.062)	(0.105)	(0.060)
Age		0.033		6.539		0.024	0.045	-0.004
		(0.034)		(11.678)		(0.018)	(0.032)	(0.016)
Age squared		-0.000		-0.073		-0.000	-0.000	-0.000
		(0.000)		(0.123)		(0.000)	(0.000)	(0.000)
College education		0.113		63.615**		0.035	0.166	-0.151**
		(0.096)		(32.130)		(0.062)	(0.106)	(0.065)
Married		0.028		87.835**		0.129**	0.175	0.023
		(0.097)		(37.319)		(0.059)	(0.108)	(0.065)
Second quartile of net wealth		0.029		-17.442		0.047	-0.017	0.122
		(0.127)		(27.859)		(0.081)	(0.145)	(0.076)
Third quartile of net wealth		-0.019		-24.981		-0.008	-0.063	0.062
		(0.135)		(39.070)		(0.084)	(0.158)	(0.070)
Fourth quartile of net wealth		0.104		97.276*		0.054	-0.022	0.180**
		(0.139)		(50.966)		(0.097)	(0.165)	(0.078)
Log disposable income		-0.074		31.679		0.010	-0.065	0.035
		(0.093)		(32.426)		(0.048)	(0.079)	(0.043)
Constant	0.011	-0.397	-95.988	-485.524**	-0.134	-0.784*	-0.636	-0.163

	(0.213)	(0.747)	(73.321)	(212.564)	(0.128)	(0.411)	(0.735)	(0.356)
R^2	0.064	0.101	0.027	0.175	0.049	0.117	0.147	0.341
Subjects	132	132	132	132	132	132	66	66
Observations	132	132	132	132	132	132	66	66

Figure 1: Subjective Beliefs Elicitation Mechanism

The below figure shows a sample interface used to implement a Quadratic Scoring Mechanism (QSR) in order to elicit subject beliefs over 10 questions. The maximum earnings in each decision task is 1,000 kroner for individuals. Please see Appendix F.4 and H for more information.

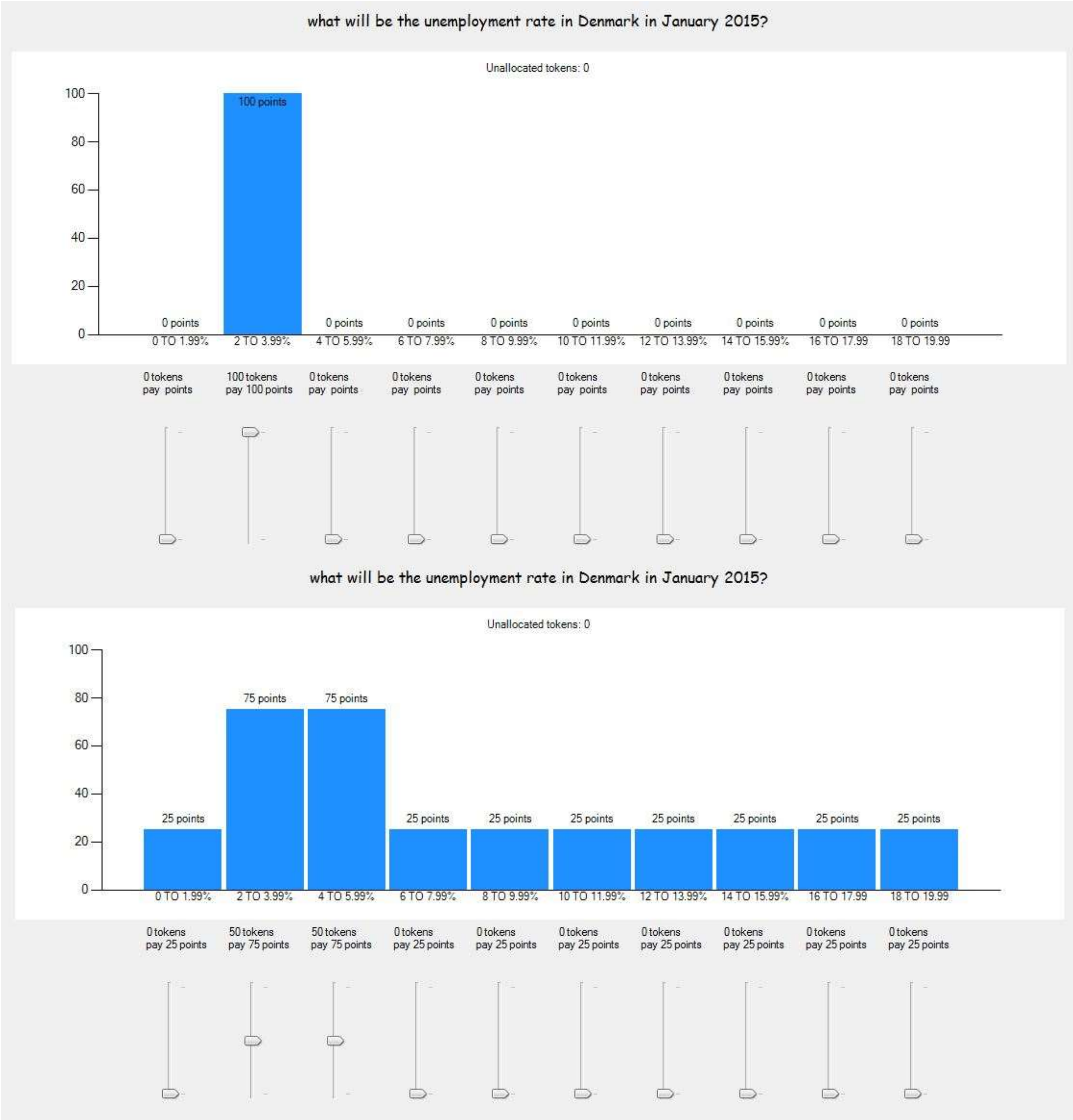


Figure 2: Lottery Elicitation Mechanism

The below figure shows a sample interface used to implement 60 lottery choice questions with varying payoffs and probabilities. Please see Appendix F.3 for more information.

Figure 3: Investment Game Mechanism

The below figure shows a sample interface used to implement 10 investment choice questions modeled after Gneezy and Potters (1997). Please see Appendix F.2 for more information.

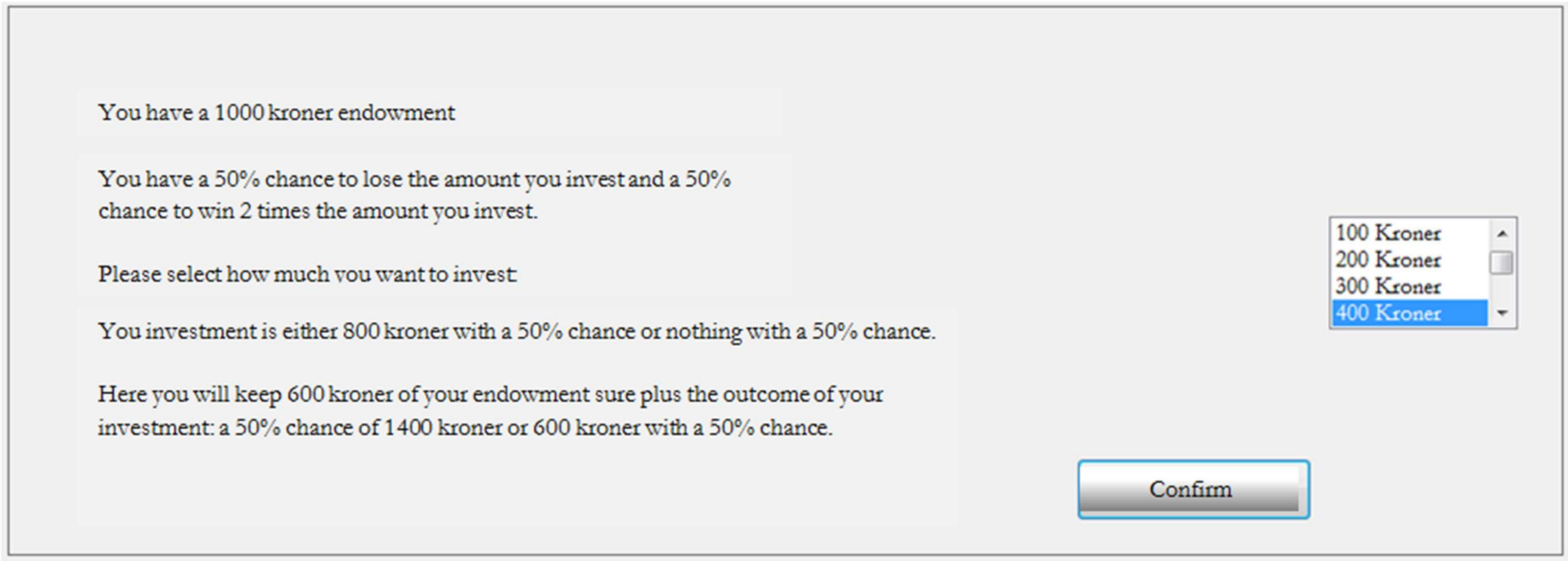


Figure 4: Subjective Beliefs of Market Returns

Figure 1 below shows the individual's subjective beliefs of the expected return from October 2014 to October 2015 of the OMX CPH20, elicited in April 2015. The *x-axis* denotes the bin representing the percentage change, while the *y*-axis gives the fraction of 100 tokens allocated to the bin. The light grey bars represent our sample of interest, Deposition effect individuals, while the dark grey bars are a control sample. The figure is a visualization of Column 1 from Table 3.

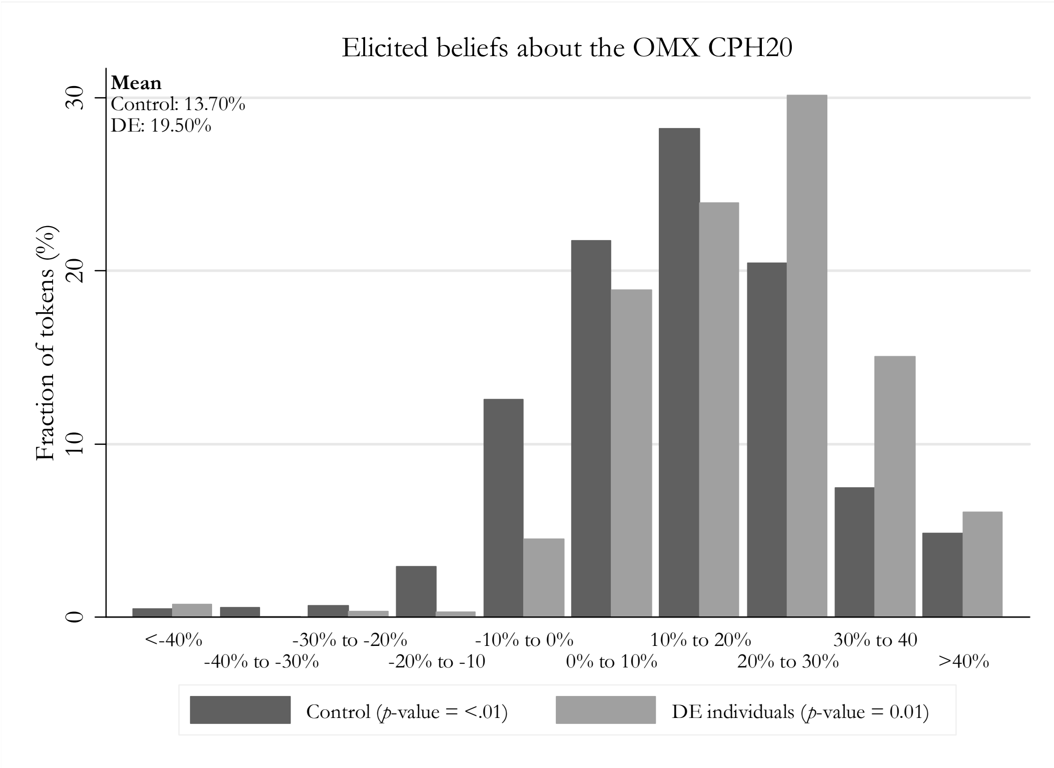


Figure 5: Historical Market Returns

We graph the distribution of the annual returns in the OMX CPH20 from 1991 to 2015. The *x-axis* denotes annual the percentage change, while the *y*-axis gives the count. Data is from Statistics Denmark.

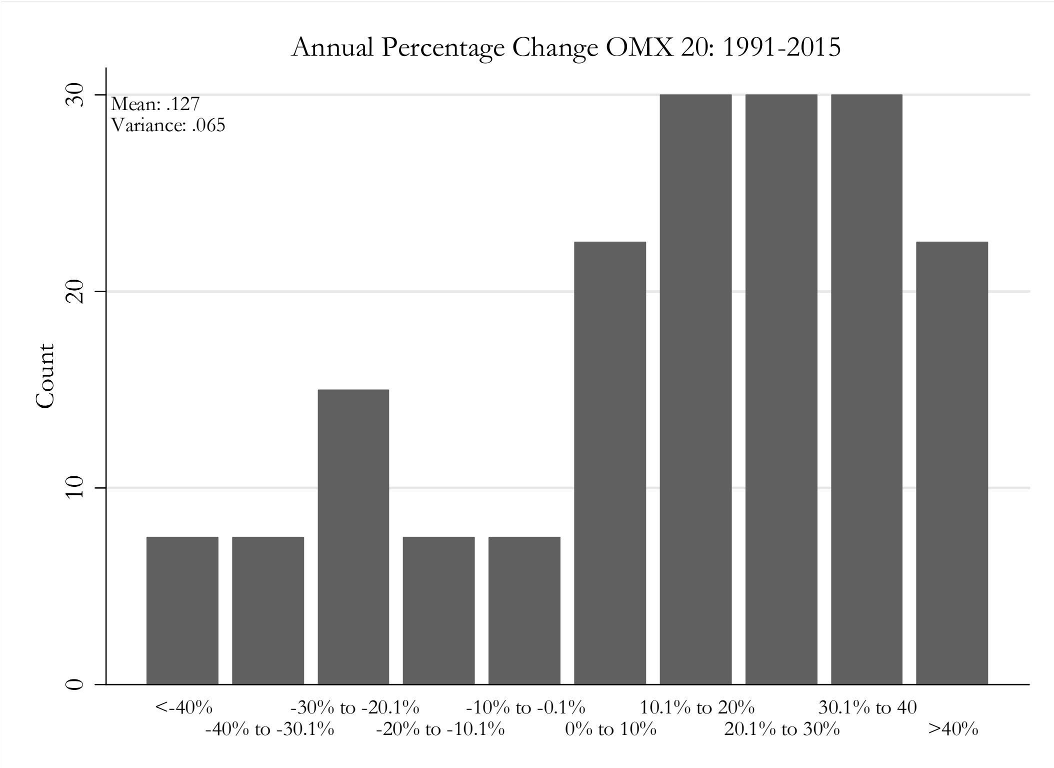
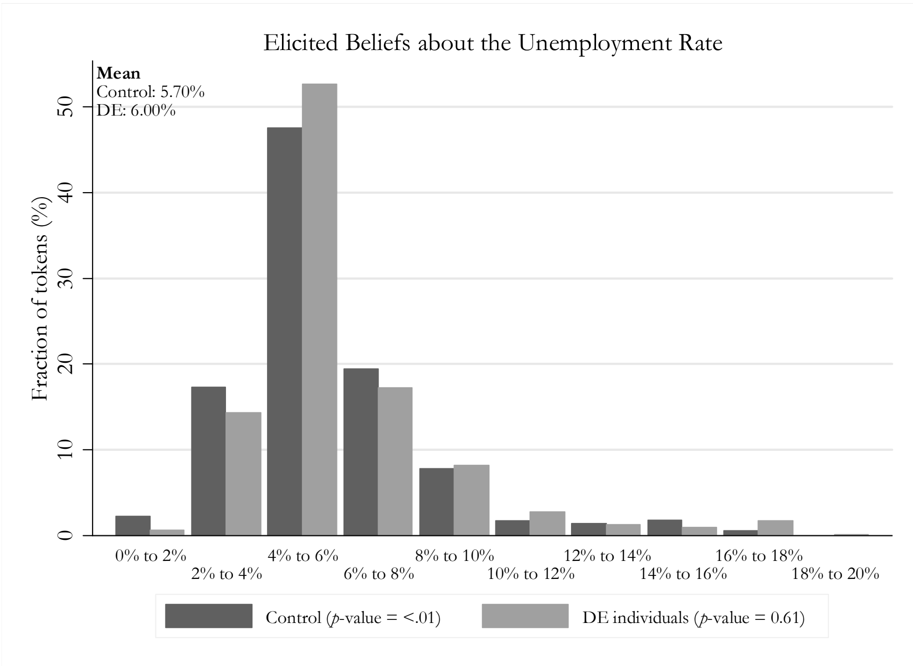


Figure 6: Subjective Beliefs of General Economic Indicators

In Panel A we show the individual's subjective beliefs on the question "What will be the unemployment in Denmark in September 2015?" In Panel B we similarly ask the question "What will be the yearly percentage change in the GDP in Denmark for the second quarter of 2015?" Both questions were elicited in April 2015. The *x-axis* denotes the bin representing the percentage change, while the *y*-axis gives the fraction of 100 tokens allocated to the bin. The light grey bars represent Disposition effect individuals, while the dark grey bars are a control sample. The figures follow a similar econometric specification as Column 1 from Table 3 (not reported).

Panel A:



Panel B:

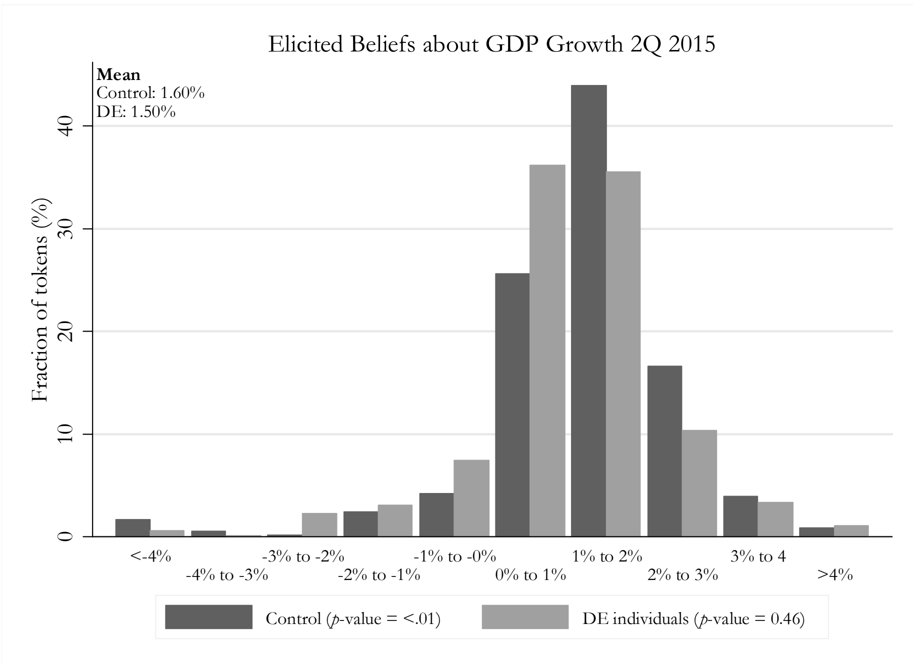


Figure 7: Incidence Rate of the Disposition Effect

The figure below shows the incidence of the disposition effect when $\boldsymbol{\pi = 0.5}$. The space in lighter color depicts the incidence of the disposition effect while regions depicted in darker color shows under which combination of R_U and R_D the disposition effect does not arise. The x-axis plots R_U, the gross returns of an equity in the good state, while the y-axis plots R_D, the gross returns of an equity in the bad state. The figure below assumes an investor with loss aversion. Specifically, W_0=40; α=0.88; β = 2.25; R_F=1.0; R_U=1.0-2.0, and R_D=0.1-1.0. The incidence rate of the disposition effect is 15%, since the region depicted in the lighter color represents 15% of the total area of the graph.

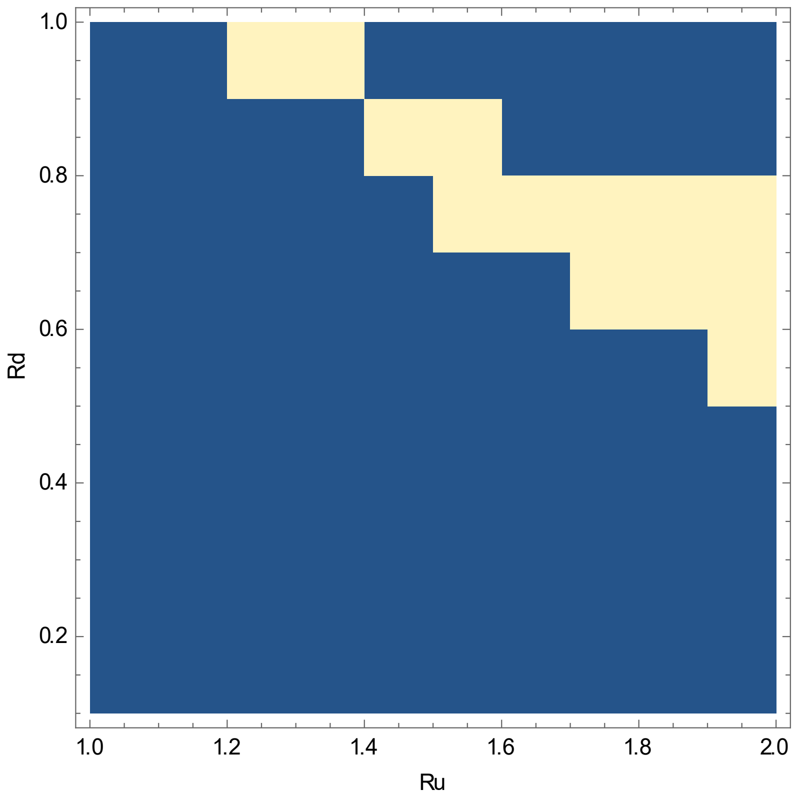
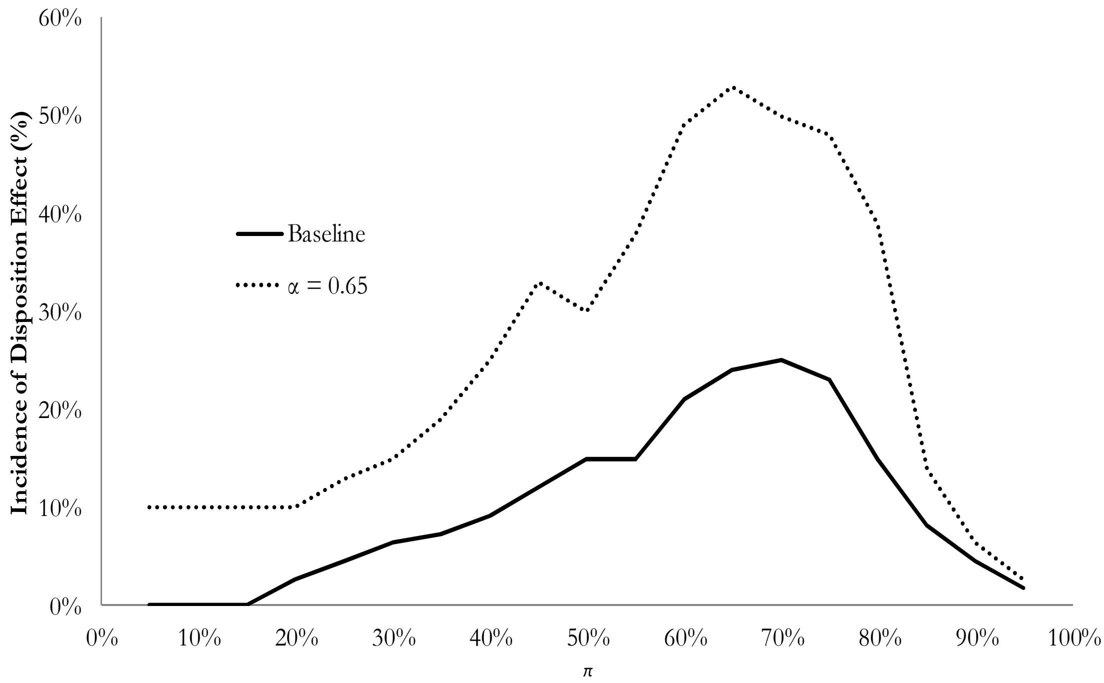


Figure 8: Incidence of the Disposition Effect

The figure below plots the relationship between π and the incidence of the disposition effect. The *x-axis* denotes value of π, or the probability of the good state occurring. The *y*-axis gives the incidence of the disposition effect. The solid-line labeled "Baseline" corresponds to parameters α = 0.88 and λ = 2.25. The dashed-line corresponds to parameters α = 0.65 and λ = 2.25.



Online Appendix for Believe or Not: Expectations Matter for the Disposition Effect
By

Steffen Andersen, Tobin Hanspal, Jimmy Martinez-Correa, and Kasper Meisner Nielsen

The following tables and figures are included in this appendix:

Appendix A: Additional Tables and Estimations

Appendix A.1: Composition and Changes to the OMX20 Index

The table below states the individual equites included in the OMX20 index at closest time to the experimental sessions and sampling (2015) as well as the dates closest to our detailed data on individual stock holdings (2012). Additions to the index are in bold. The OMX20 indexes the top 20 largest equities measured by free floated market capitalization listed on the Copenhagen Stock Exchange by Nasdaq Copenhagen.

The OMX Copenhagen 20 Indexes constituents effective: : December 22, 2014 - December 21, 2015)

A.P. Møller - Mærsk A A/S	**ISS A/S**
A.P. Møller - Mærsk B A/S	Jyske Bank A/S
Carlsberg B A/S	Nordea Bank AB
Chr. Hansen Holding A/S	Novo Nordisk B A/S
Coloplast B A/S	Novozymes B A/S
Danske Bank A/S	Pandora A/S
DSV A/S	TDC A/S
FLSmidth & Co. A/S	Tryg A/S
Genmab A/S	Vestas Wind Systems A/S
GN Store Nord A/S	William Demant Holding A/S

The OMX Copenhagen 20 Indexes constituents effective Dec 27, 2012:

A.P. Møller - Mærsk A A/S	Lundbeck
A.P. Møller - Mærsk B A/S	Nordea Bank AB
Carlsberg B A/S	Novo Nordisk B A/S
Chr. Hansen Holding A/S	Novozymes B A/S
Coloplast B A/S	Pandora A/S
Danske Bank A/S	TDC A/S
DSV A/S	Topdanmark
FLSmidth & Co. A/S	Tryg A/S
GN Store Nord A/S	Vestas Wind Systems A/S
Jyske Bank A/S	William Demant Holding A/S

The OMX Copenhagen 20 Indexes constituents effective June 18, 2012:

A.P. Møller - Mærsk A A/S	NKT Holding
A.P. Møller - Mærsk B A/S	Nordea Bank AB
Carlsberg B A/S	Novo Nordisk B A/S
Chr. Hansen Holding A/S	Novozymes B A/S
Coloplast B A/S	Pandora A/S
Danske Bank A/S	TDC A/S
DSV A/S	Topdanmark
FLSmidth & Co. A/S	Tryg A/S
GN Store Nord A/S	Vestas Wind Systems A/S
Lundbeck	William Demant Holding A/S

Table A.2: Matching Model

The following table presents marginal effects after a logistic regression model used to predict propensity scores for being a Disposition effect individual, serving as the first-stage matching model. The dependent variable takes the value of one if the subject is part of the *disposition effect individual* sample. Propensity scores are then used to match one-to-one nearest neighbors in Columns1. Column 1 matches on all covariates displayed to develop a one-to-one match with control individuals. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	1-1 Matching
	(1)
Male	0.098*
	(0.053)
Age	0.003
	(0.019)
Age squared	-0.000
	(0.000)
College education	0.043
	(0.057)
Married	0.215***
	(0.057)
Second quartile of net wealth	-0.047
	(0.073)
Third quartile of net wealth	-0.001
	(0.079)
Fourth quartile of net wealth	0.112
	(0.101)
Log disposable income	0.040
	(0.056)
Average portfolio turnover	0.435***
	(0.055)
Number of assets in portfolio	-0.010
	(0.009)
Value of mutual funds and stocks	0.105**
	(0.052)
Pseudo R^2	0.241
Subjects	226
Observations	226

Table A.3: Summary Statistics Full Sample

We report the mean and standard deviation for demographic and financial characteristics for all subjects in our sample. For each individual, we report the *age, gender, marital status, years of education* and whether the individual has a *financial education* obtained in 2014. For *net wealth, disposable income, total debt, bank savings,* and *total value of debt and equity of all housing investments* we report the year-end market value in 2014. We compare the mean characteristics of the Disposition Effect (DE) individuals all other participants and test whether these differences are significantly different from zero. Corresponding *t*-statistics are reported in square brackets. All amounts are in thousands year-2010 DKK. Standard deviations are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	All	**DE individuals**	**Control**	**Difference**
	(1)	**(2)**	**(3)**	**(2)-(3)**
Age	48.0	49.0	47.5	1.44
	(12.0)	(11.8)	(12.1)	[0.83]
Male	0.57	0.68	0.52	0.16**
	(0.50)	(0.47)	(0.50)	[2.33]
Married	0.48	0.62	0.42	0.20***
	(0.50)	(0.49)	(0.49)	[2.82]
Length of Education	14.5	14.9	14.4	0.56
	(2.84)	(2.84)	(2.83)	[1.34]
Financial education	0.21	0.20	0.21	-0.016
	(0.41)	(0.40)	(0.41)	[-0.26]
Net wealth	947.6	1288.6	807.0	481.6*
	(1701.8)	(1837.3)	(1627.8)	[1.85]
Disposable income	349.2	436.8	313.1	123.8*
	(334.2)	(560.9)	(158.0)	[1.76]
Value of debt	837.8	937.1	796.8	140.3
	(1065.9)	(927.7)	(1118.0)	[0.97]
Value of bank deposits	213.9	219.1	211.8	7.34
	(337.0)	(387.1)	(315.3)	[0.14]
Total value of property	1235.2	1469.3	1138.6	330.7
	(1730.5)	(1246.8)	(1889.5)	[1.54]
Subjects	226	66	160	-

Table A.4: Portfolio Characteristics Full Sample

We report the mean and standard deviation for portfolio characteristics for all subjects in our selected sample. For each individual, we report the 2010-2012 average for all values including the market value at the end of the year for *total portfolio value*, the *value of directly-held stocks*, and the *value of mutual funds*. We observe *risky asset share* (i.e. fraction of liquid assets allocated to stocks) as well as the share of *investments* (mutual funds and stocks). The *number of assets in the portfolio* is the unique number of stocks and mutual funds held by each investor, *market tenure* is the number of years since 1986 the individual has held a positive balance of stocks. The *average year-to-year portfolio change* is year-to-year change in value of all portfolio holdings from 2012-2014 while *the average portfolio turnover* is the absolute value of portfolio sales and purchases divided by the average portfolio value from 2010-2012. We compare the mean characteristics of the Disposition Effect (DE) individuals and all other subjects and test whether these differences are significantly different from zero. Corresponding *t*-statistics are reported in square brackets. All amounts are in thousands year-2010 DKK. Standard deviations are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	All	**DE individuals**	**Control**	**Difference**
	(1)	**(2)**	**(3)**	**(2)-(3)**
Value of mutual funds and stocks	190.8	365.9	118.6	247.3**
	(538.1)	(874.1)	(281.9)	[2.25]
Value of directly-held stocks	90.9	215.8	39.4	176.4***
	(242.1)	(407.4)	(77.3)	[3.49]
Value of mutual funds	99.9	150.0	79.2	70.9
	(477.7)	(775.8)	(274.5)	[0.72]
Risk share of stocks/wealth	0.26	0.43	0.18	0.25***
	(0.30)	(0.34)	(0.25)	[5.37]
Risk share of investments/wealth	0.36	0.49	0.30	0.20***
	(0.29)	(0.31)	(0.27)	[4.51]
Number of assets in portfolio	3.70	3.82	3.65	0.17
	(4.69)	(2.92)	(5.25)	[0.31]
Market tenure	13.9	14.8	13.5	1.23
	(7.04)	(6.80)	(7.13)	[1.22]
Average Disposition Effect	0.71	1.00	0.039	0.96***
	(0.47)	(0.00)	(0.28)	[18.2]
Average year-to-year portfolio change	0.21	0.14	0.26	-0.12***
	(0.28)	(0.32)	(0.24)	[-2.63]
Average portfolio turnover	0.33	0.56	0.24	0.32***
	(0.39)	(0.37)	(0.36)	[5.94]
	190.8	365.9	118.6	247.3**
Subjects	226	66	160	-

Table A.5: Subjective Beliefs of Market Returns

In the following table we structurally estimate the subjective beliefs of market returns using normal (Columns 1-2) and beta-delta (Columns 3-4) distributions and estimated by maximum likelihood. We present raw coefficients and the variable of interest *Disposition effect individuals,* representing the treatment of investors sampled with high levels of disposition effect, in Columns 1-4. In Columns 2 and 4 we add controls for demographic and financial characteristics as outlined in previous tables. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Distribution		**Normal**			**Beta**	
		(1)	**(2)**		**(3)**	**(4)**
	mu			*alpha*		
Disposition effect individuals		0.058**	0.052***		-0.252**	-0.231***
		(0.023)	(0.021)		(0.106)	(0.084)
Constant		0.137***	-0.008		-0.556***	0.198
		(0.017)	(0.171)		(0.071)	(0.725)
	ln(sigma)			*beta*		
Disposition effect individuals		-0.079	-0.002		0.100	-0.074
		(0.136)	(0.113)		(0.280)	(0.232)
Constant		-1.877***	-1.548		2.158***	1.668
		(0.081)	(1.128)		(0.169)	(2.099)
Controls		No	Yes		No	Yes
Subjects		132	132		132	132
Observations		1,320	1,320		1,320	1,320

Table A.6: Computed Coefficients of Subjective Beliefs of Market Returns

We present the computed coefficients from the structural estimates of subjective beliefs of market returns using normal and beta distributions estimated by maximum likelihood from Appendix A.5. All computations are based on the estimation found in Columns 2 and 4 of Appendix A.5 including all control variables. We compare the *mean*, *mode*, *variance*, *skewness*, and *kurtosis* of the subjective beliefs of the Disposition Effect (DE) individuals and a control group and test whether these differences are significantly different from zero. The values represent the differences between disposition effect individuals and the control group. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Distribution	**Normal distribution**	**Beta distribution**
Average level	0.137***	0.136***
	(0.016)	(0.017)
Differences in	**(DE individuals) – (Control)**	**(DE individuals) – (Control)**
Mean	0.052***	0.058***
	(0.021)	(0.021)
Variance	0.003**	0.008
	(0.001)	(0.016)
Skewness	-	-0.079
		(0.061)
Kurtosis	-	-580.98
		(2360.66)
Subjects	132	132
Observations	1,320	1,320

Appendix A.7: Parametric Analysis of Risk Preferences

In the following table we structurally estimate risk measures using incentivized tasks. Columns 1-3 assume Expected Utility Theory (EUT) while Columns 4-6 focus on Rank Dependent Utility Theory (RDU). Columns 1 and 4 use X lottery choices over risk, Columns 2 and 5 use the Gneezy and Potters (1997) task, and Columns 3 and 6 pool the two tasks into one analysis. We present raw coefficients estimated by maximum likelihood. The variable of interest *Disposition effect individuals,* representing the treatment of investors sampled with high levels of disposition effect, in Columns 1-4. In Columns 2 and 4 we add controls for demographic and financial characteristics as outlined in previous tables. All amounts are in thousands year-2010 DKK. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

		EUT			**RDU**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
r						
Disposition effect individuals	0.089	-0.013	-0.017	0.079	-0.041	-0.020
	(0.137)	(0.026)	(0.044)	(0.135)	(0.057)	(0.029)
Constant	0.455***	0.249***	0.013	0.456***	0.269**	0.007
	(0.097)	(0.048)	(0.030)	(0.103)	(0.107)	(0.021)
mu						
Constant	0.154***	0.020***	0.197***	0.154***	0.013	0.152***
	(0.008)	(0.007)	(0.014)	(0.008)	(0.010)	(0.007)
gamma						
Disposition effect individuals				0.010	0.921	0.089
				(0.127)	(1.455)	(0.165)
Constant				1.000***	2.781***	1.364***
				(0.099)	(0.506)	(0.117)
Controls	No	No	No	No	No	No
Subjects	132	132	132	132	132	132
Observations	7920	1330	9250	7920	1330	9250

Table A.8: Comonotonic Independence Violation Tests

Using a battery of lotteries from Wakker, Erev and Weber (1994), we test the "comonotonic independence" axiom of Rank Dependent Utility theory. The table below presents the average number of individual violations of comonotonic independence per choice set across 6 choice sets. In Columns 1-4 we compare the total number of violations, pessimism violations, optimism violations, and rank dependent utility of individuals with the disposition effect and a control group and test whether these differences are significantly different from zero. In each case, the maximum number of violations possible is 18. Additional and more specific tests of violations are contained in Appendix 7. Corresponding *t*-statistics are reported in square brackets. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	All	**DE individuals**	**Control**	**Differences**
	(1)	**(2)**	**(3)**	**(2)-(3)**
Total violations (A + B + C)	6.09	6.42	5.76	-0.67
	(2.75)	(2.63)	(2.85)	[-1.40]
A. Pessimism violations	1.63	1.76	1.50	-0.26
	(1.44)	(1.52)	(1.36)	[-1.03]
B. Optimism violations	2.63	2.77	2.48	-0.29
	(1.82)	(1.80)	(1.84)	[-0.91]
C. Rank dependent utility violations	1.86	1.97	1.74	-0.23
	(1.15)	(1.21)	(1.09)	[-1.13]
Subjects	132	66	66	-

Table A.9: Sample Selection Estimation Beliefs on Market Returns

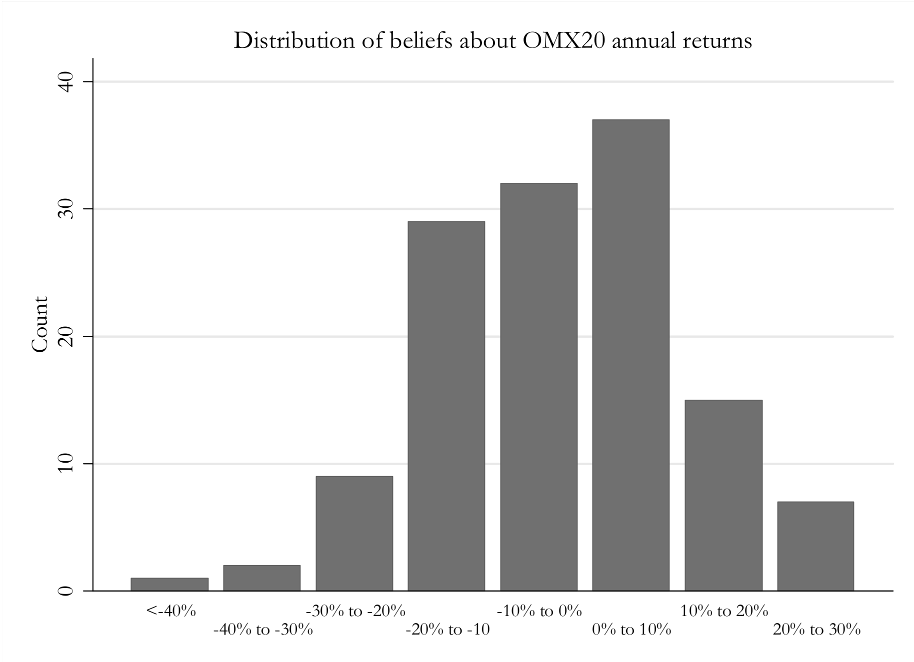
We present a Heckman sample selection regression where the dependent variable represents the weighted midpoint of subject's belief of the annual percentage change from October 2014 to October 2015, elicited in April 2015. The variable of interest is *Disposition effect individuals,* representing investors sampled with high levels of disposition effect. Column 2 shows the effect of the main coefficients while controlling for sample selection, applying the sample selection equation presented in Column 1. The model is estimated using full maximum likelihood estimation. We use exogenous sampling variable as *percentage win* as the chance of receiving a show up fee (either 10 or 20%) and potential *show up amount* (either 1000 or 2000 kroner) as well as the *travel distance* in kilometers from individuals home to experimental site. All amounts are in thousands year-2010 DKK. Standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1) Selection (First stage)	(2) Beliefs (Second stage)
Disposition effect individuals		0.090***
		(0.018)
Percentage win	-0.008	
	(0.005)	
Show up amount	0.000	
	(0.000)	
Travel distance (km)	-0.008***	
	(0.002)	
Controls	No	No
Subjects	8277	8277

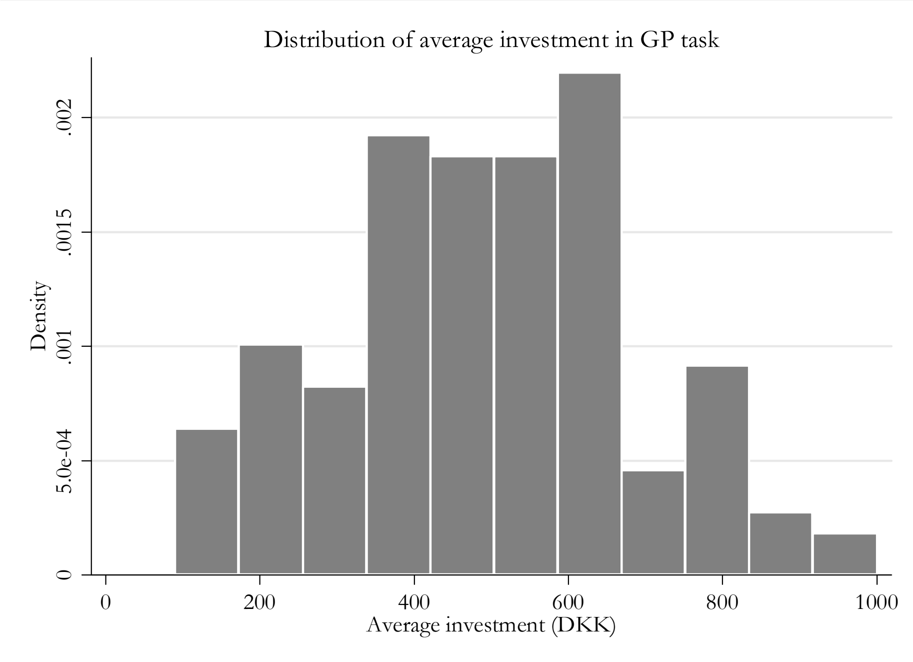
Figure B.1: Raw Experimental Task Results

The figures below depict individual's raw responses to our experimental tasks. Panel A plots a distribution of the modal belief of the annual return of the OMX20 across all subjects. Panel B plots the distribution of individuals' average investment in the Gneezy and Potters (1997) investment task. Panel C plots the distribution of individuals' average forgone expected value. Finally, Panel D plots the distributions of responses for our belief tasks on financial literacy (Di Girolamo, Harrison, Lau, and Swarthout (2015)).

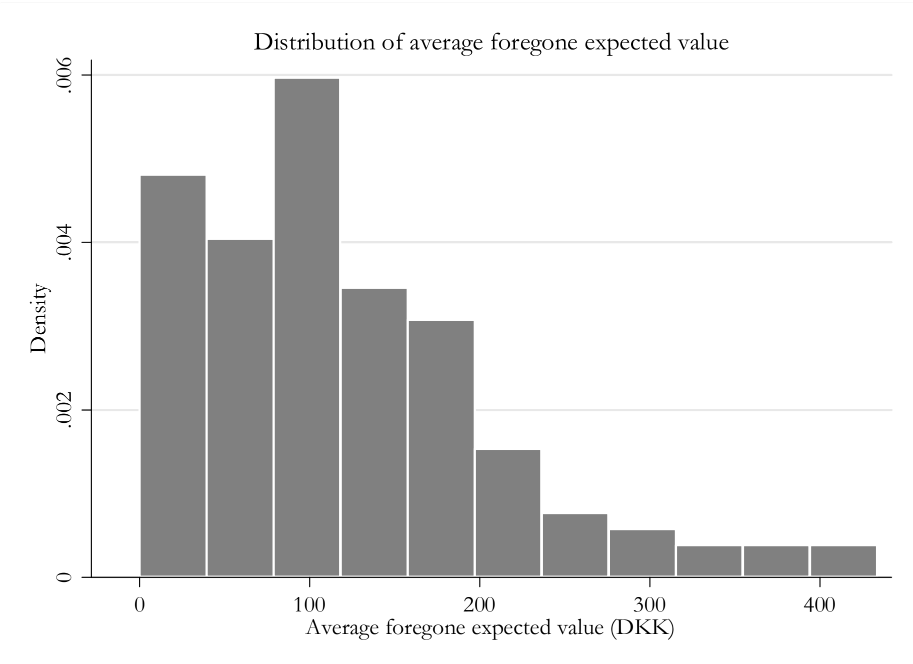
Panel A:



Panel B:



Panel C:



Panel D:

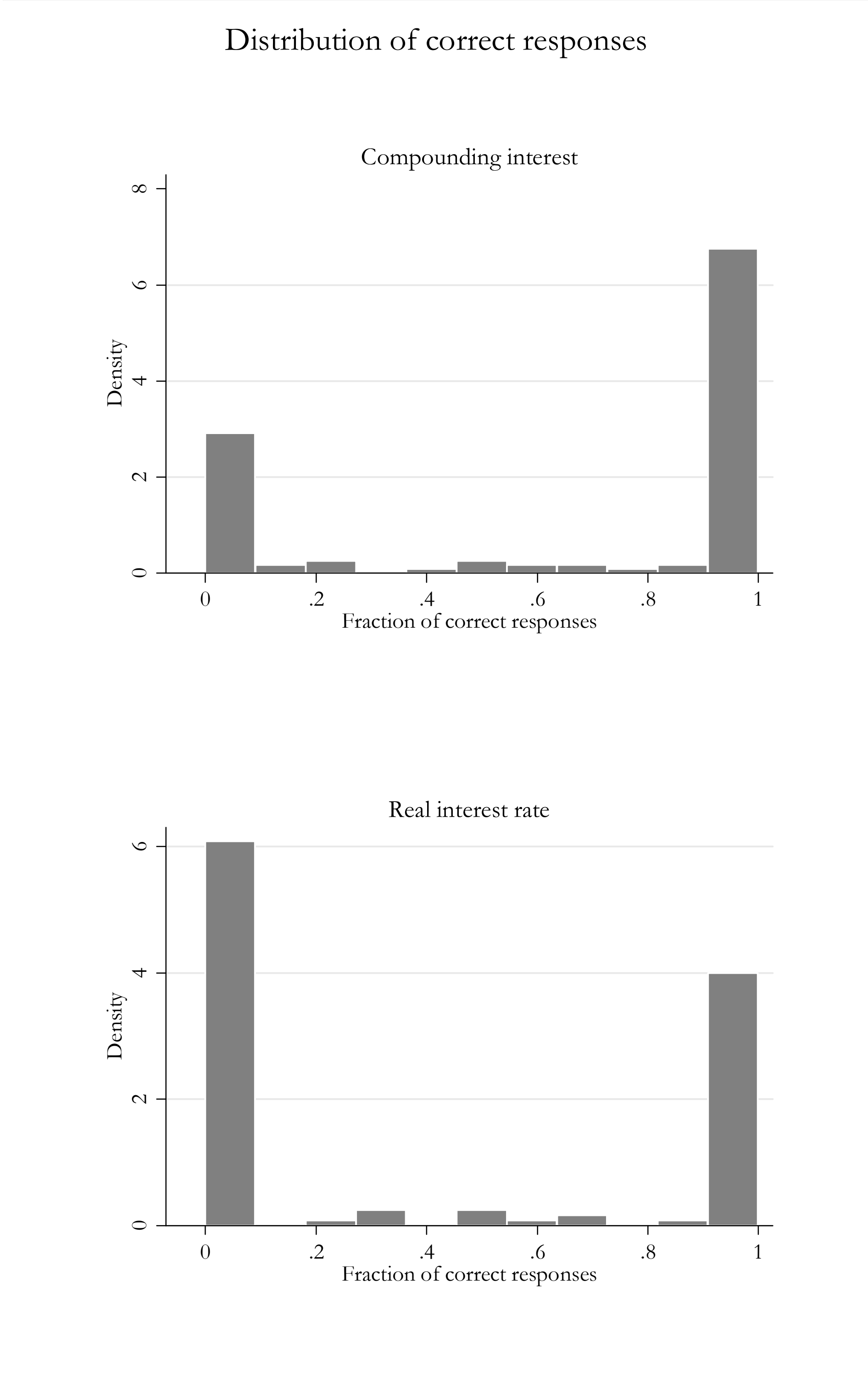
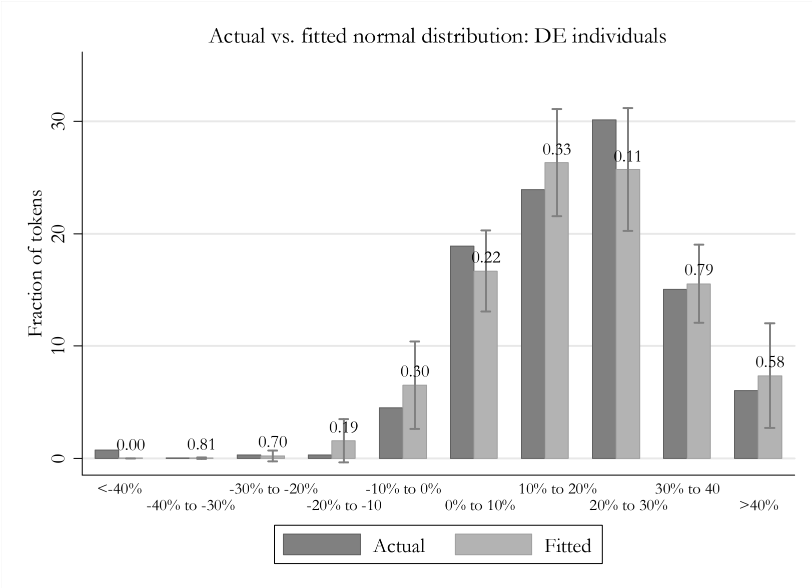

Distribution of correct responses
Compounding interest
Density
0
2
4
6
8
0
.2
.4
.6
.8
1
Fraction of correct responses
Real interest rate
Density
0
2
4
6
0
.2
.4
.6
.8
1
Fraction of correct responses

Figure B.2: Subjective Beliefs of Market Returns: Actual vs. Fitted Values: Normal Distribution

The figure below depicts the individual's subjective beliefs of the annual percentage change from October 2014 to October 2015 of the OMX CPH20, elicited in April 2015. The dark grey bars represent the actual beliefs from the elicited task, while the light grey bars represent maximum likelihood estimates fit from a normal distribution, stemming from Appendix Table 4. The *x-axis* denotes the bin representing the percentage change, while the *y*-axis gives the fraction of 100 tokens allocated to the bin. 95% confidence intervals are overlaid on the fitted estimates and *p*-values shown about the bars represent the significant differences between the actual and fitted values. The figure is a visualization of Column 2 from Appendix Table A.5.

Disposition effect individuals:



Control individuals:

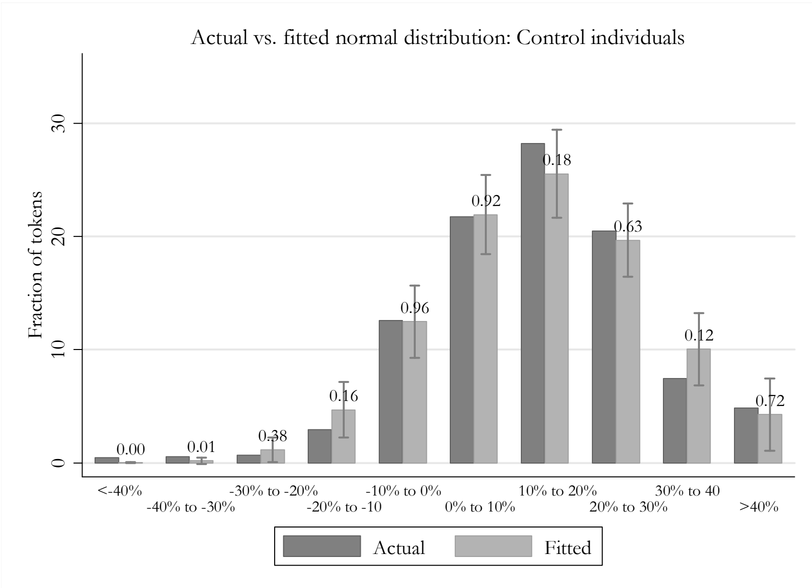
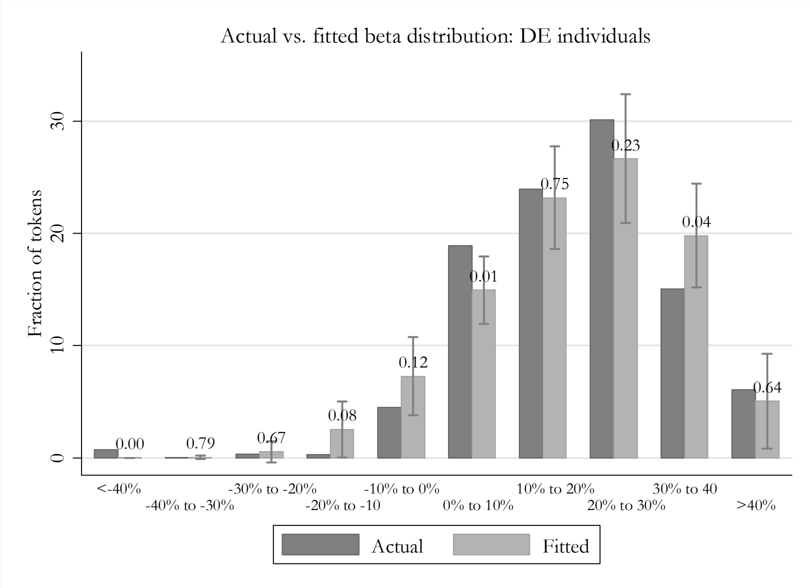


Figure B.3: Subjective Beliefs of Market Returns: Actual vs. Fitted Values: Beta Distribution

The figure below depicts the individual's subjective beliefs of the annual percentage change from October 2014 to October 2015 of the OMX CPH20, elicited in April 2015. The dark grey bars represent the actual beliefs from the elicited task, while the light grey bars represent maximum likelihood estimates fit from a beta distribution, stemming from Appendix Table 4. The *x-axis* denotes the bin representing the percentage change, while the *y*-axis gives the fraction of 100 tokens allocated to the bin. 95% confidence intervals are overlaid on the fitted estimates and *p*-values shown about the bars represent the significant differences between the actual and fitted values. The figure is a visualization of Column 4 from Appendix Table A.5.

Disposition effect individuals:



Control individuals:

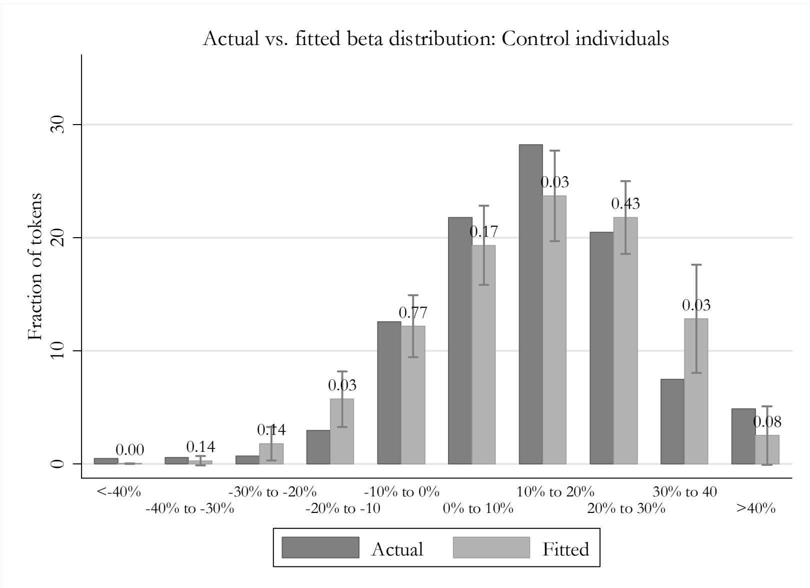
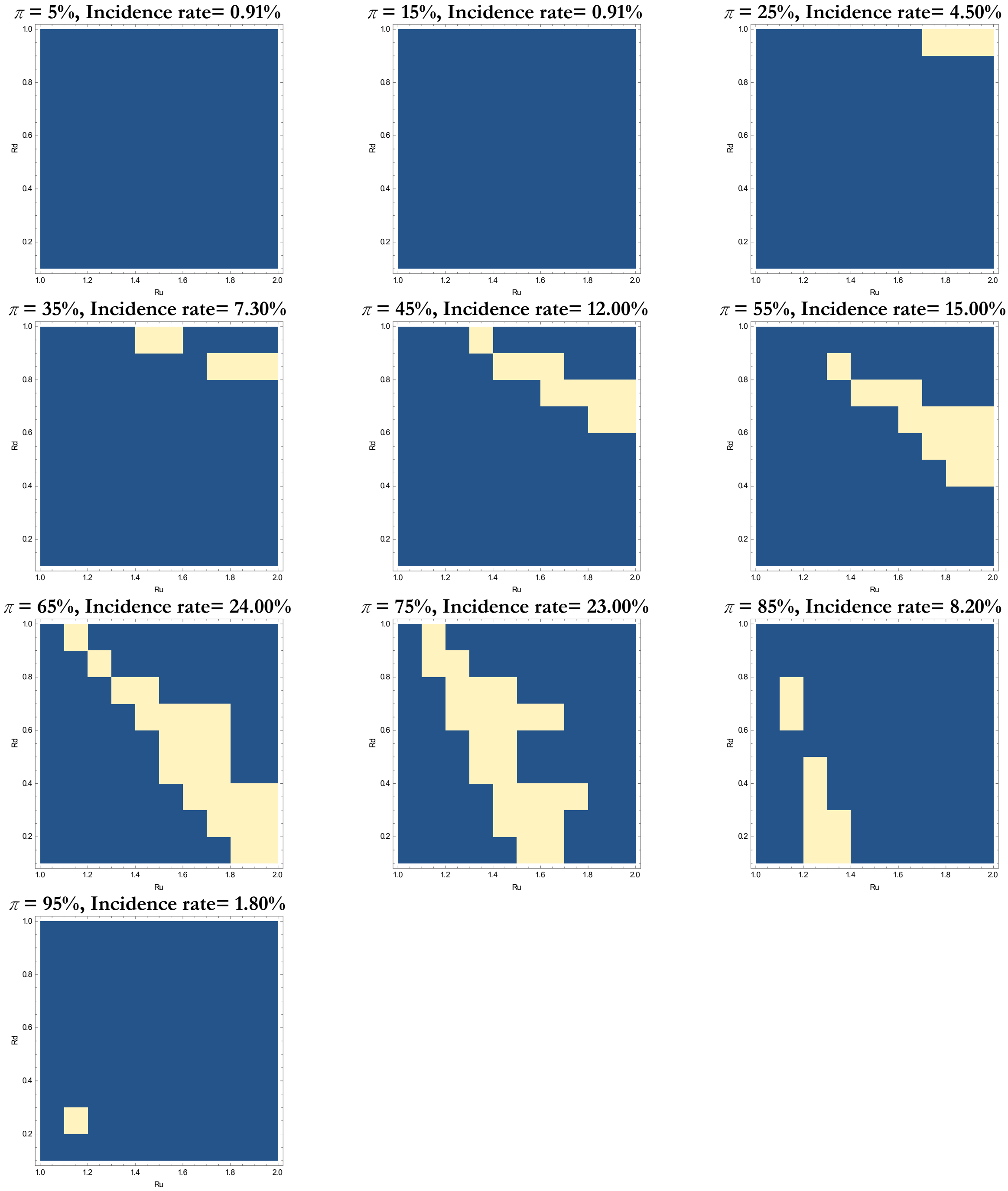


Figure B.4: Incidence of the Disposition Effect when $\pi \in (5\%, 95\%)$

The figures below shows the incidence of the disposition effect when $\pi \in (5\%, 95\%)$. We use increments of 5 percentage points in the probability interval. The space in lighter color depicts the incidence of the disposition effect while regions depicted in darker color shows under which combination of R_U and R_D the disposition effect does not arise. The x-axis plots R_U, the gross returns of an equity in the good state, while the y-axis plots R_D, the gross returns of an equity in the bad state. The figures below assumes an investor with loss aversion. Specifically, W_0=40; α=0.88; λ = 2.25; R_F=1.0; R_U=1.0-2.0, and R_D=0.1-1.0.



Appendix C: Additional Methodology

Appendix C.1: Regret Aversion

Regret aversion is one of the original explanations given for the Disposition Effect, initially suggested by Shefrin and Statman (1985). The intuition is that an individual will experience regret if she has to sell losing stocks in the market and feel pride when she sells winners. In our laboratory setting, regret aversion implies that the subject's anticipate experiencing regret if she chooses a prospect where she would have been better off if she had chosen differently. Conversely, she anticipates experiencing pride if she selects the prospect that gave the best outcome.

In our binary lottery tasks there are *n* states of the prospect and the probability distribution $\{p_1, p_2, .., p_n\}$ describes the likelihood of each state. Subjects have the option of choosing between two different lotteries (A or B) with potential outcomes $\{a_1, a_2, ..., a_n\}$ and $\{b_1, b_2, .., b_n\}$. Following Sugden and Loomes (1982) we assume that there exists a regret function, $R(a_i, b_i)$, that captures the regret/pride logic. We also assume that the regret function is non-decreasing in the difference of valuations of lottery outcomes per state ($u(a_i) - u(b_i)$) and $R(a_i, b_i) = 0$ if $a_i, = b_i$. Therefore, we choose to assume the following simple parametric form when the individual is valuing lottery A;[23]

$$R(b_i, a_i) = e^{(\varphi * (u(b_i) - u(a_i)))} - 1$$

The parameter φ is capturing regret aversion if $\varphi > 0$, regret loving if $\varphi < 0$ and regret neutrality when $\varphi = 0$. Symmetrically when the individual is evaluating lottery B the regret function is given by;

$$R(a_i, b_i) = e^{(\varphi * (u(a_i) - u(b_i)))} - 1$$

The individual valuation of lottery A has a structure very similar to what an Expected Utility maximizer would do, except that now anticipated regret and pride is taken into account such that the valuation is:

$$EU_A = \sum_{i=1}^{n} p_i * (u(b_i) - R(b_i, a_i)) \text{ and } EU_B = \sum_{i=1}^{n} p_i * (u(a_i) - R(a_i, b_i)),$$

where $u(.)$ is a simple utility function and $u'(.) > 0$ and $u''(.) < 0$.
We assume a simple CRRA function where,

$$u(a_i) = {(1 - a_i)^{1-\alpha}} \Big/ {(1 - \alpha)}$$

and α measures preferences for risk and $\alpha > 0$ denotes risk aversion, $\alpha = 0$ risk neutrality and $\alpha < 0$ risk loving.

Consider a general model of prospect choice, in which the likelihood of observing an individual j choosing prospect A in choice k, ($y_{j,k} = A$), is determined by the differences in valuation of the prospects, $\Delta EU = (EU_A - EU_B)$, and a stochastic Fechner error $\varepsilon \sim N(0, \sigma_\varepsilon)$. In each choice the probability of observing subjects choosing prospect A is given by:

$$p_{j,k}(y_{j,k} = A | \varphi_j, \alpha_j) = p_{j,k}((EU_A - EU_B + \varepsilon) > 0.$$

---

[23] Notice that this regret function under the assumption that u'(.)>0 and u''.()<0 satisfies the two conditions as $\frac{\partial R(a_i, b_i)}{\partial (u(a_i) - u(b_i))} > 0$ and $R(a_i, b_i) = 0$ if $a_i, = b_i$.

With the normally distributed stochastic choice error, and the observed variable y, the likelihood contribution of each prospect choice for subject k is then defined as:

$$L_{j,k}(\varphi_j, \alpha_j) = \Phi\left((2y-1)\left[\frac{\Delta EU}{\sigma_\varepsilon}\right]\right),$$

where $\Phi(\quad)$ is the cumulative normal distribution. We additionally control for utility scale across choices, by applying normalization within each choice, as proposed by Wilcox (2015).

The model easily extent to allow for estimation over the entire sample as we will do, by allowing for covariates in the sample $x_{\mathrm{j,k}}$. Allowing φ_j and α_j to be a function of $x_{\mathrm{j,k}}$ we obtain the joint log likelihood:

$$L_{j,k}(\varphi, \alpha) = \sum_k \sum_j log(L_{j,k})$$

To find the total effect of DE we only allow our regret and risk aversion coefficients to be measures of our DE variable and to allow for correlated error terms we cluster errors at the individual level.[24]

[24] One could have followed several alternative approaches if concerned with underlying unobserved heterogeneity, not caused by the differences in samples. Alternatively we could have estimated the model at the individual, and compared the distribution of estimated coefficients across the two samples, or estimated a random coefficient model and compared the differences in estimated means between the two samples. As we are only interested in the total effect of the two samples, and not the underlying distributions, we choose to find the effect by control on observables.

Appendix D: Data identification of Disposition Effect

We define exhibition of the Disposition Effect as the literature has, originally termed in Shefrin and Statman (1985), as the tendency to hold onto losing assets and sell winners. Odean (1998) uses data from active traders and constructs the aggregated Disposition Effect (DE) for all investors in his sample. Similarly, Dhar and Zhu (2006) use daily individual investor portfolio data to compute a measure of DE at the individual level. Calvet, Campbell and Sodini (2009) use a slightly different approach since they do not have daily active trade records by considering the effect of 'winning' and 'loosing' portfolios (positive and negative asset returns) on the propensity to unload assets and fully exit the stock market. Owners of winning stock market portfolios who suffer from the disposition effect are more likely to sell and exit the market, thus investors with losing portfolios are more likely to hold onto these assets.

We characterize the DE within our sample of investors using a similar approach. Our data resembles that of Calvet, Campbell and Sodini (2009) which we use to calculate a measure of the disposition effect for each individual investor by the same construction as Dhar and Zhu (2006), who in turn follow that of Odean (1999). Using the return of an asset they determine whether an asset makes a gain or a loss to an investor and define:[25]

PGR = Proportion of Gains Realized = # realized gains / (realized gains + # paper gains)
PLR = Proportion of Losses Realized = # realized losses / (# realized losses + # paper losses)
DE = Disposition Effect = PGR – PLR

If DE>0 the individual is less likely to realize losses compared to gains and is characterized by trading with a disposition effect, that is to say, that the individual has a disposition to sell winning stocks and to hold on to losing stocks.

An asset has a realized gain if an investor sold the asset which had a positive return. An individual has a realized loss in an asset if it is sold with a negative return. A paper gain is then an asset which had a positive return however the investor continues to hold the asset in her portfolio, and therefore the gain is not realized, it is only a paper gain. Similarly a paper loss is a negative return on an unsold asset in the investor's portfolio.

We use our sample of investors from 2006-2012 and compute an average coefficient for Disposition Effect for each investor based on trades in 2010-2012. We start by looking at the assets that are specifically purchased during our sample period and the buy and sell decisions associated with each asset held by each investor over our time frame. At the end of each period we tally-up an investor's realized and paper gains/losses, where the reference point used to calculate what is a gain or a loss for each individual asset is defined as the most recent active-trade price. We make the following assumptions: First we only consider individuals who make an active trade within our sample window. By trade we mean that the investor increased or decreased the *number* of shares in her portfolio from one period to the next which is measured at the end of the calendar year (we remove assets which become delisted, e.g, banks that default). Second, since we do not observe the purchase price, sale price, or the reference point an investor has in mind for any specific assets we follow Cavlet, Cambell and Sodini (2009) and assume the following: for stocks which are purchased, the purchase price is the average share price from t-1 and t, measured at the end of the calendar year, where t is the first period in which the stocks purchased appeared. The sale price of an asset is

[2525] We define below in more detail each of the components of our measure of the disposition effect.

the mean of the share price between the two periods where it is sold, and a hold price is the share price at the end of the calendar year. Therefore an asset's return if sold, is the Sale Price minus the Purchase Price, and if held is equal to the Hold Price minus the Purchase Price.

For example, if an investor buys an asset during 2006 and sells some shares during 2007 the reference point is the average purchase price in 2006 and the sell price is the average price in 2007. Suppose the price in 2006 was 100 DKK per share and the price in 2007 was 110. This would imply that the return of this sale is a gain per share of 10 DKK (110 DKK – 100 DKK). Now suppose that he buys additional shares during 2008 and sells all of his holdings during 2010, the reference point for this asset updates to the purchase price from 2008, and therefore the return calculation of the asset is based on the sell price in 2010 and the reference purchase price in 2008. For a numerical example assume that the price of the stock in 2008 was 120 DKK per share and the price of the stock in 2010 was 90 DKK per share. This would imply that the return in 2010 of selling all the shares in this year is a loss of 30 DKK (120 DKK-90 DKK) per share.

In fact, we only consider the trade behavior associated with the most recent reference point in the case of investors who make multiple purchases of the same asset at different points in time. We do this in order to capture the most recent price the investor could have paid for the asset, and also to focus on trades closer to our sampling and experimental sessions. This level of distinction and assumptions on reference points are important in our case and not in Odean (1999) and Dhar and Zhu (2006) because we do not observe specific purchase points as they do in their active trade data, so we have to make assumptions about the purchase price and the reference point investors place on their assets. We calculate all of the above for our entire sample 2007-2012 however only sample from investors who have at least one realized gain and at least one realized loss (as does Dhar and Zhu in order to calculate an individual DE) in the decision years 2010-2012.

The financial literature has typically found a coefficient of DE of approximately 3-8% when aggregated with trades across the sample and Dhar and Zhu (2006) find a coefficient of 21% when looking at individuals. We find similar results on average in Denmark. Most investors are completely passive, but the distribution of investors reveals strong heterogeneity and many are more likely to realize gains compared to losses.

Appendix E: Sample Construction

We use the administrative registers from Statistics Denmark to sample different households relevant to a series of experiments. The initial stage of our sampling procedures is to select eligible households, then determine groups within the population that serve as treatment and control households. The selected households are then invited for official experimental sessions from Statistics Denmark.

1. Sample Construction

A. Defining a Eligible Household

We use the family identification number (familie_id) to identify all family units in Denmark. In this context, a *family unit* is understood as a single or a couple,[26] living with or without children.[27] In 2013, this is a universe of 2,891,119 family units that we can sample from. We explain below the restrictions we put in this universe to arrive at the subset of family units that we will consider for the household experiments.

1. We only take into account family units with at most 10 members; therefore we exclude 345 household units that were part of family units with more than 10 members.
2. Next, we exclude 1,374,676 children defined as persons living with their legal parents from the sample since we only want to recruit adults making the economic decisions in the family unit.
3. To recruit active investors we recruit the relevant age group of 35-55 year olds. We choose this age range to have households which are actively saving for retirement but have not yet started dissaving.
    a. We exclude 849,038 family units in which the youngest person is either below 18 years of age (a minor), or the youngest is older than 65 years of age (close to retirement).
    b. We then exclude 336,973 family units in which the oldest person is below 35 years of age.
4. We exclude 84,389 family units that have one adult but that adult is married (probably people that are married but living separate from their spouse for different reasons).
5. From the remaining population, we also exclude household not living in greater Copenhagen; there were 846,521 individuals living in greater Copenhagen in 573,218 households. [28]
6. Finally we exclude any family unit with a stock market and mutual fund portfolio of less than 5,000 Danish kroner on average per household adult in the any 3 years between 2006-

[26] A couple is defined as two people who live together and form a couple of one of the following four types: i) married couples; ii) registered partnership (introduced on 1 October 1989); iii) cohabiting couples (two people that are not married or in a registered partnership with each other, but they have at least one child in common registered with a social security number; and iv) cohabiting couples (two adult persons of the opposite sex who have at most 15 years of age difference and that have no children registered with a social security number, and as far as social security number can say, they are not closely related to each other (sibling or parent - child).

[27] Children living at home are counted as part of their parents' families if they : i) live at the same address as at least one parent; ii) are under 25 years old; iii) have never been married; iv) do not have a child or children registered with a social security number; and iv) are not family related to the couple living together.

[28] We include municipalities from Greater Copenhagen (KOM 0-200) with inclusion of municipalities surrounding Roskilde (KOM 240, 253, 259, 265, 269, 350).

2012 as measured by the tax records. We also exclude 16,277 investors who have an average stock holdings that exceed that of the 99th percentile. The file of portfolio eligible individuals are supplied as FG0 (n = 217,283).

This leaves us with 131,635 eligible households consisting of 219,599 individuals. After making these exclusions we are left with the following two types of family units that we will use for the experiments (i) Family units with one adult that is not married (ii) Family units with two adults (married or co-habiting). We define single individuals as family units of type 1 and households as family units of type 2.

i. Investors which Experienced a Bank Default

As in Andersen, Hanspal, and Nielsen (2014) we obtain the information on individuals' stock and mutual fund holdings by ISIN number at the end of the year from the tax authorities. From this dataset we obtain the bank registration number of each individual's primary brokerage account. This bank registration number is the brokerage account associated with the third-party reporting by financial institutions. We are able to match an individual's brokerage bank with his or her portfolio investments. We refer to such overlaps between bank accounts and investments in the same bank as individuals with investments in their own banks, and identify which banks defaulted by ISIN numbers during the period between 2008-2012. In the sample of eligible households we denote the individuals with defaulting experience as focus sample FG1 (n = 9,021).

ii. Investors Exhibiting Disposition Effect Behavior

We define exhibition of the Disposition Effect as the literature has, originally termed in Shefrin and Statman (1985), as the tendency to hold onto losing assets and sell winners. We characterize the DE within our sample of investors using a similar approach. Using the return of an asset they determine whether an asset makes a gain or a loss to an investor and define:

PGR = Proportion of Gains Realized = # realized gains / (#realized gains + # paper gains)
PLR = Proportion of Losses Realized = # realized losses / (# realized losses + # paper losses)
DE = Disposition Effect = PGR – PLR

We will sample from the top 95 percentile to the 99 percentile. These are by construction 4% of the eligible sample and we call this focus group FG2 (n = 2,034).

iii. Health Risk

<u>*Estimating Health Risk*</u>

We estimate a model of health risk based on health records of nuclear family in the period from 1994 to 2011 for the entire Danish population. The goal is to identify the individuals with a predicted high level of health risk, of which they have not yet experienced. We define the dependent variable, y, as a stay in a hospital of more than 5 days in one year, irrespective of diagnosis, where the individual did not have any hospitalization in the previous year.[29] In this sense the dependent variable captures changes in health.

[29] We exclude any hospitalizations due to pregnancies or child births since we want to avoid confounding factors of underlying health problems and health risks related to complications of child births.

For the estimation we use the age relevant sample of the Danish population. We define the relevant age as all individuals of the age between 10 and 55 in year 2000. We then observe from administrative data the health risk on a series of observed background characteristics; age, income, wealth, geographic location, education, and the health records of siblings and parents, e.g. we estimate the following random effects panel probit model where the probability of having a health shock *y* is defined by

$$\Pr[y=1 \mid X, \beta, \alpha] = \Phi(\alpha + x'\beta)$$

Where X is a set of characteristics for individual *i* at time *t*. α is assumed to be randomly normally distributed error for individual *i* with $\alpha_i \sim N[0, \sigma^2_\alpha]$. In our estimation X consist of the following explanatory variables;

Age	defined as years of age
Age^2	defined as years of age to the power of 2
Age^3	defined as years of age to the power of 3
Male	gender
Interaction of age variables and Male	
Married	
Income group	defined as the vigintile of income within each year
Wealth group	defined as the vigintile of wealth within each year
Industry Group	defined as the top level NACE code of employment
Prior health	experienced health shocks by parents and siblings
Obtained a High School Degree	
Obtained a University Degree	

Predicting Health Risk Propensities

We use the estimated coefficients of β to predict propensities to health shocks based on individual's characteristics in 2011, HR, the latest year for which we have data on family health outcomes. That is for each person we calculate the probability of being shocked as HR = Pr(y=1) = $\Phi(x'\beta)$ where β is the estimated coefficient of the above regression.

We sample from the top 95 percentile to the 99 percentile of the HR measure and we call this focus group FG3 (n = 6,606).

2. Drawing the Sample for Recruitment and Design

A. Allocating of Group fraction to sample

We define the following 5 groups

Group 1: Households with two adults
Group 2: Individuals with one adult in household (FG0)
Group 3: Individuals with Default Experience (FG1)
Group 4: Individuals with High DE Behavior (FG2)
(the 95% to the 99% percentile of DE)
Group 5: Individuals with High Health Risk (FG3)
(the 95% to the 99% percentile)

The target is to have 80 households (160 subjects), and 70 subjects in each group for a total of 440 subjects. The show-up lottery per person for each session will be either 25% chance of 800 per person, or 25% of 1000 or 25% of 1500kr. The 5 groups will be evenly present in the grand sample, but only the households will be separated out for specific sessions. We do 20 subjects at a time in each session, each session taking up 2 hours. We do 2 sessions a day, that is 40 subjects per day. In essence we then have 11 session days; 7 days of individuals (14 sessions) and 4 days with household decision (7 sessions). The following table summarizes the design.

Table E.1: Sampling Design

	Day	Show-up fee	# of Subjects Session 1	# of Subjects Session 2
280 Individuals (70 FG0 + 70 FG1 + 70 FG2 + 70 FG3)	1	1000 with 10%	20	20
	2	1000 with 20%	20	20
	3	2000 with 10%	20	20
	4	2000 with 20%	20	20
	5	1000 with 20%	20	20
	6	1000 with 10%	20	20
	7	2000 with 10%	20	20
80 Households (160 subjects)	8	1000 with 10%	20	20
	9	1000 with 20%	20	20
	10	2000 with 10%	20	20
	11	2000 with 20%	20	20

Appendix F: Experimental Design

F.1. Experimental Design

There are four tasks in the experimental design that are presented in the following order to all subjects: (1) individual risk aversion choice tasks through an Investment Game, (2) individual risk aversion choice tasks through binary lottery choices (3) individual subjective belief questions, and (4) survey questions. For tasks (1)-(3), the order of each question they were presented with in each task was totally randomized. In each task subject had a 10% of getting the opportunity to win something in that task. If subjects got this chance then one of the choices in the task was chosen at random to pay subjects depending on their choices.

ii. Investment game

We use the investment game in Gneezy and Potters (1997) as our raw measure of risk preferences. We have 9 independent rounds of investment choices. In each round the participants receive an endowment of 1000 DKK and they can decide how much they want to invest in a risky investment and how much they want to keep. The probability of losing the invested amount can be 0.25, 0.5 or 0.75. With probability .75, 0.5 or 0.25 subjects win 2, 3 or 4 the invested amount. This means that each of the 9 rounds offer a particular combination of winning the invested amount with the number that multiplies the invested amount if the subject wins. We also added a tenth combination of probability and multiplier (i.e., 0.5 and 2.5) to match the design in Gneezy and Potters (1997). Each round is independent and no gain or loss is accumulated.

iii. Binary Lottery

We have a battery of 60 lottery pairs, presented to subjects in random order.

Wakker, Erev and Weber (1994) constructed lotteries to carefully test the "comonotonic independence" axiom of RDU. Their main lottery pairs consist of 6 sets of 4 pairs of lotteries. The logic of their design can be seen by considering the first set, from Wakker, Erev and Weber (1994; Figure 3.1). The second and third prizes in each pair stay the same within the set of 4 choice pairs. The only thing that varies from pair to pair is the monetary value of the first prize, and that is common to the "safe" and "risky" lottery within each pair.[1] Since the first listed prize is a common consequence in both lotteries within a pair, it should not affect choices under EUT. In the 1st pair the first prize is only \$0.50, and is the lowest ranked prize for both lotteries. The first prize increases to \$3.50 for the 2nd pair, and is again the lowest ranked prize for both lotteries: so rank-dependence should have no effect on choice patterns as the subject moves from the 1st to the 2nd pair. But when we come to the 3rd pair the first prize is \$6.50, which makes it the second highest ranked prize for both lotteries; this is where RDU could have a different prediction than EUT, depending on the extent and nature of probability weighting. Finally, in the 4th pair the common consequence is the highest ranked prize for both lotteries, again allowing RDU to predict something different from EUT (and from the choices in the 3rd pair). Note that this design does not formally require an RDU decision-maker to choose differently than an EUT decision-maker; it simply encourages it for a priori reasonable levels of probability weighting. We employ all 24 of their main lottery pairs, and scale the prizes considerably.

[1] What is "safe" and what is "risky" is not so obvious when one allows for probability weighting, but this is how the lotteries are labeled.

The remaining 36 lottery pairs were chosen from the battery of lottery pairs in Wilcox (2010) which were originally designed to test for a wide range of risk attitudes. This 36 lottery pairs were chosen from a bigger battery of lotteries designed to identify and parametrically estimate deviations from EUT such as RDU with different types of probability weighting (i.e., probability optimism or pessimism, inverted-S function normally assumed in Prospect Theory).

iv. *Subjective Belief Questions*

We ask 10 questions, in random order. We reference them here as Q1 through Q10 for convenience. The maximum earnings in each decision task is 1,000 kroner. In each question there is a correct answer that can be verified the day of the experiment or some months after the experimental session. In particular, we used a Quadratic Scoring Rule (QSR) developed and tested by Harrison, Martínez-Correa and Swarthout (2013, 2014, 2015) and Hossain and Okui (2013) where subjects can earn points in a belief elicitation tasks that give them greater chance of winning in a lottery that pays either a high amount or nothing. The advantage of this design is that, theoretically and behaviorally, this belief elicitation procedure induces risk neutrality in subjects since a binary lottery provides incentives to individuals to choose a lottery with maximal expected value. Therefore, the beliefs reported in the QSR are subjective probabilities that are not contaminated by risk aversion and thus raw reports represent directly subjective beliefs. There is convincing experimental evidence that risk aversion can distort elicited beliefs making inference about subjective probability difficult (see Harrison, Martínez-Correa and Swarthout (2014) for a more detailed discussion). Questions Q8, Q9 and Q10 used to measure investor sophistication and financial and statistical literacy were taken from Di Girolamo, Harrison, Lau and Swarthout (2015).

Q1. **Stock Market**. What will be the annual percentage change of the OMX Copenhagen 20 index between October 2014 and October 2015?

Q2. **Unemployment Rate**. What will be the unemployment in Denmark in September 2015?

Statistics Demark will release this figure on 2015-10-29.

Q3. **GDP growth in Denmark**. What will be the yearly percentage change in the GDP in Denmark for the second quarter of 2015?

Statistics Denmark has scheduled the release on 2015-09-30 (National accounts (quarterly - revised) 2 quarter 2015)

Q4. **Days in hospital bed**. What fraction of the population in Denmark spent 5 or more bed days in a hospital during 2014?

Statistics Denmark has scheduled the release on 2015-10-20 (Hospitalizations 2014).

Q5. **Days in hospital bed by gender**. What fraction of the population in Denmark that spent 5 or more bed days in a hospital during 2014 were women?

Statistics Denmark has scheduled the release on 2015-10-20 (Hospitalizations 2014).

Q6. **Expected Lifetime for Men**. "Based on 2013-14 statistics, if a man lived to be 65 in Denmark, how many more years would he expect to live? Note that this is not the age he would die at, but how many more years he would expect to live."

Statistics Denmark has scheduled the release on 2015-02-13 (Life expectancy 2013/2014)
The correct answer is 78.5-65 = 13.5

Q7. **Expected Lifetime for Women**. "Based on 2013-14 statistics, if a woman lived to be 65 in Denmark, how many more years would she expect to live? Note that this is not he age she would die at, but how many more years she would expect to live."

Statistics Denmark has scheduled the release on 2015-02-13 (Life expectancy 2013/2014)
The correct answer is 82.7-65 = 17.7

Q8. **Bayes Rule in Frequencies, Breast Cancer**.
"A reporter for a magazine for women is writing an article about tests for breast cancer, and is trying to determine the actual significance of the tests results. He has the following information:

- 100 of every 10,000 women undergoing a routine exam will actually have breast cancer;
- of every 100 women with breast cancer that undergo a routine exam, 80 will receive a positive test result;
- of every 9,900 who do not have breast cancer that undergo a routine exam, 950 will also receive a positive test result.

You have received a representative sample of women who underwent routine exams and tested positive for breast cancer. What percent of this sample do you expect to actually have breast cancer?"

The correct answer is 80 / (80+950) = 7.8, and we elicit responses in deciles (0% to 9.9%, 10% to 19.9%,... , 90% to 99.9%).

Q9. **Interest Compounding**.
"Suppose you had 1,000 kroner in a savings account and the interest rate is 2% per year and you never withdraw money or interest payments. After 5 years, how much would you have on this account in total?"

The correct answer is 1,104 kroner. Elicit responses between 1,050 kroner and 1,150 kroner in intervals of 10 kroner.

Q10. **Real Interest Rate**.
"Suppose you had 2,000 in a saving account. The interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, what would be the real value of the money on this account?"

The correct answer is 1,980 kroner. Elicit responses between 1,950 kroner and 2,050 kroner in intervals of 10 kroner.

v. *Survey Questions*

Each participant was asked to provide responses to a survey questionnaire. The survey questions were taken from the related existing literature and asked questions on investment behavior, health, trust, economic expectations, and questions about how decisions are made within the household.

Sources of questions are added below:

Investment Questions

From Hoffmann and Shefrin, 2014:

1) What type of investor do you consider yourself to be? If you do not have an investment portfolio, choose 'Not applicable'.
   a) Very careful
   b) Careful
   c) Speculative
   d) Very speculative
   e) Disinterested
   f) Not applicable

2) Which strategies do you use as a basis for your investment decisions? Multiple answers are allowed. If you do not have an investment portfolio, choose 'Not applicable'.
   a) I base my investment decisions on technical analysis
   b) I base my investment decisions on fundamental analysis
   c) I base my investment decisions on the professional advice of an investment analyst
   d) I base my investment decisions on my personal intuition
   e) Other
   f) Not applicable

3) What is the most important objective regarding your investment portfolio? If you do not have an investment portfolio, choose 'Not applicable'.
   a) Saving for retirement: being able to stop working at an earlier age and/or have a higher retirement income
   b) Hobby: interest in the stock market
   c) Building financial buffer: building financial buffer for future unexpected expenses
   d) Speculation: trying to profit from short term developments in the stock market
   e) Capital growth: achieve a higher expected return than a savings account
   f) Other
   g) Not applicable

The following questions are originals

4) How often do you **look at/monitor** (even if you do not make changes or adjustments) your portfolio allocation and performance? If you do not have an investment portfolio, choose 'Not applicable'.
   a) At least once a day
   b) A few times per week
   c) A few times per month
   d) Once a month

e) A few times per year
f) Never
g) Not applicable

5) How often do you **actively change or make adjustments** to your portfolio allocation? If you haven't made any investments, choose 'Not applicable'.
a) At least once a day
b) A few times per week
c) A few times per month
d) Once a month
e) A few times per year
f) Never
g) Not applicable

6) If one of your investments products is **doing well**, would you say you are more likely to hold on to it for a longer time and hope it continues to do well, or sell it and realize the capital gains? If you haven't made any investments, choose 'Not applicable'.
a) I am more likely to hold on to it
b) I am more likely to sell it
c) Not applicable

7) If one of your investment products is **doing poorly**, would you say you are more likely to hold on to it for a longer time and hope it 'rebounds', or sell it and minimize the loss on your investment? If you haven't made any investments, choose 'Not applicable'.
a) More likely to hold on to it
b) More likely to sell it
c) Not applicable

Health Questions

From DNB Household Survey 2013

8) How would you in general describe your health?
a) Excellent
b) Good
c) Fair
d) Not so good
e) Poor

9) Do you suffer from a chronic illness, disorder, handicap, or serious consequences from an accident?
a) Yes
b) No

10) How likely is it that you will attain at least the age of 65?
a) 0 - 10%
b) 11 - 20%
c) 21 - 30%
d) 31 - 40%
e) 41 - 50%

f) 51 - 60%
g) 61- 70%
h) 71 - 80%
i) 81 - 90%
j) 91 - 100%

11) How likely is it that you will attain at least the age of 70?
    a) 0 - 10%
    b) 11 - 20%
    c) 21 - 30%
    d) 31 - 40%
    e) 41 - 50%
    f) 51 - 60%
    g) 61- 70%
    h) 71 - 80%
    i) 81 - 90%
    j) 91 - 100%

12) How likely is it that you will attain at least the age of 80?
    a) 0 - 10%
    b) 11 - 20%
    c) 21 - 30%
    d) 31 - 40%
    e) 41 - 50%
    f) 51 - 60%
    g) 61- 70%
    h) 71 - 80%
    i) 81 - 90%
    j) 91 - 100%

13) How likely is it that you will attain at least the age of 90?
    a) 0 - 10%
    b) 11 - 20%
    c) 21 - 30%
    d) 31 - 40%
    e) 41 - 50%
    f) 51 - 60%
    g) 61- 70%
    h) 71 - 80%
    i) 81 - 90%
    j) 91 - 100%

Trust

From: Guiso, L., Sapienza, P. & Zingales, L. 2008

14) Generally speaking, would you say that most people can be trusted or that you have to be very careful when dealing with people?
    a) Most people can be trusted
    b) One has to be very careful with other people

c) Don't know

15) How much do you trust your bank official or broker as financial advisor for your investment decisions? If you haven't made any investments, choose 'Not applicable'.
   a) A lot
   b) Enough
   c) More or less
   d) Not much
   e) Not at all
   f) Not applicable

Economic Expectations Questions

From Starr-McCluer, 1999:

Unemployment

16) Now turning to unemployment in Denmark: In **1 year** from now, do you think there will be __ unemployment compared to now?
   a) Much more
   b) Somewhat more
   c) About the same
   d) Somewhat less
   e) Much less

17) Regarding unemployment in Denmark: In **5 years** from now, do you think there will be __ unemployment compared to now?
   a) Much more
   b) Somewhat more
   c) About the same
   d) Somewhat less
   Much less

General Economy

18) Now turning to business conditions in Denmark as a whole: In **1 year** from now, do you think Denmark will be in___ financial conditions, compared to now?
   a) Much better
   b) Somewhat better
   c) About the same
   d) Somewhat worse
   e) Much worse

19) As for the **long term** business conditions in Denmark as a whole: In **5 years** from now do you think Denmark will have ___ financial conditions, compared to now?
   a) Much better
   b) Somewhat better
   c) About the same
   d) Somewhat worse
   e) Much worse

20) What about business conditions in Europe as a whole: In **1 year** from now do you think Europe will have ___ financial conditions, compared to now?
   a) Much better
   b) Somewhat better
   c) About the same
   d) Somewhat worse
   e) Much worse

21) As for the **long term** business conditions in Europe as a whole: In **5 years** from now do you think Europe will have ___ financial conditions, compared to now?
   a) Much better
   b) Somewhat better
   c) About the same
   d) Somewhat worse
   e) Much worse

Household Situation

22) Now turning to the economic situation of you and your family: In **1 year** from now, do you think you and your family will be ___ , compared to now?
   a) Much better off
   b) Somewhat better
   c) About the same
   d) Somewhat worse off
   e) Much worse off

23) As for the **long term** economic situation of you and your family: In **5 years** from now, do you think you and your family will be ___ , compared to now?
   a) Much better off
   b) Somewhat better
   c) About the same
   d) Somewhat worse off
   e) Much worse off

Stock Market

24) Concerning the global stock market, in **1 year** from now, do you expect average stock prices to be ___ compared to now?
   a) Much higher
   b) Somewhat higher
   c) About the same
   d) Somewhat lower
   e) Much lower

25) As for the global stock market in the **long term**, in **5 years** from now, do you expect average stock prices to be ___ compared to now?
   a) Much higher
   b) Somewhat higher
   c) About the same
   d) Somewhat lower
   e) Much lower

26) Concerning publically-traded Danish stocks (OMX 20 Cap Index): How many percentage points will Danish publicly-traded stock prices increase/decrease in the **next year**?

a) More than -50%
b) -50 to -40%
c) -40 to -30%
d) -30 to -20%
e) -20 to -10%
f) -10 to -5%
g) -5 to -3%
h) -3 to -1%
i) -1 to 0%
j) 0%
k) 0 to 1%
l) 1 to 3%
m) 5%
n) 5 to 10%
o) 10 to 20%
p) 20 to 30%
q) 30 to 40%
r) 40 to 50%
s) More than 50%

27) Concerning the **longer term** for publically-traded Danish stocks (OMX 20 Cap Index): How many percentage points a year will Danish publicly-traded stock prices increase/decrease on average over the **next 5 years**?

a) More than -50%
b) -50 to -40%
c) -40 to -30%
d) -30 to -20%
e) -20 to -10%
f) -10 to -5%
g) -5 to -3%
h) -3 to -1%
i) -1 to 0%
j) 0%
k) 0 to 1%
l) 1 to 3%
m) 5%
n) 5 to 10%
o) 10 to 20%
p) 20 to 30%
q) 30 to 40%
r) 40 to 50%
s) More than 50%

House Prices

From DNB Household Survey, 2013:

28) Do you own or rent the property of your primary home?

a) Rent
b) Own (Ejerbolig or Andelsbolig)

29) How many percentage points do you expect housing prices to increase/decrease in the **next year**?

a) More than -50%
b) -50 to -40%
c) -40 to -30%
d) -30 to -20%
e) -20 to -10%
f) -10 to -5%
g) -5 to -3%
h) -3 to -1%
i) -1 to 0%
j) 0%
k) 0 to 1%
l) 1 to 3%
m) 5%
n) 5 to 10%
o) 10 to 20%
p) 20 to 30%
q) 30 to 40%
r) 40 to 50%
s) More than 50%

30) How many percentage points a year do you expect housing prices to increase/decrease on average over the **next 5 years**?

a) More than -50%
b) -50 to -40%
c) -40 to -30%
d) -30 to -20%
e) -20 to -10%
f) -10 to -5%
g) -5 to -3%
h) -3 to -1%
i) -1 to 0%
j) 0%
k) 0 to 1%
l) 1 to 3%
m) 5%
n) 5 to 10%
o) 10 to 20%
p) 20 to 30%
q) 30 to 40%
r) 40 to 50%
s) More than 50%

31) How many percentage points do you expect house renting prices to increase/decrease over the **next year**?

a) More than -50%
b) -50 to -40%
c) -40 to -30%
d) -30 to -20%
e) -20 to -10%
f) -10 to -5%
g) -5 to -3%
h) -3 to -1%
i) -1 to 0%
j) 0%
k) 0 to 1%
l) 1 to 3%
m) 5%
n) 5 to 10%
o) 10 to 20%
p) 20 to 30%
q) 30 to 40%
r) 40 to 50%
s) More than 50%

32) How many percentage points a year do you think house renting prices will increase/decrease on average over the **next 5 years**?

a) More than -50%
b) -50 to -40%
c) -40 to -30%
d) -30 to -20%
e) -20 to -10%
f) -10 to -5%
g) -5 to -3%
h) -3 to -1%
i) -1 to 0%
j) 0%
k) 0 to 1%
l) 1 to 3%
m) 5%
n) 5 to 10%
o) 10 to 20%
p) 20 to 30%
q) 30 to 40%
r) 40 to 50%
s) More than 50%

Household Questions

From De Palma, Picard and Ziegelmeyer, 2011:

33) Are you married or living with a partner?

a) No
b) Yes

IF 'YES', CONTINUE WITH THE SURVEY. IF 'NO', FINISH THE SURVEY HERE.

34) Which of the following categories describe your relationship with your partner best?
   a) We are married with prenuptial agreement
   b) We are married without prenuptial agreement
   c) We live together

35) How many persons - apart from yourself and your partner - is your couple financially responsible for?
   a) 1
   b) 2
   c) 3
   d) 4
   e) More than 5

36) How many persons — apart from yourself, your partner, and the previously mentioned persons— are you yourself financially responsible for?
   a) 1
   b) 2
   c) 3
   d) 4
   e) More than 5

37) Do you and your partner own **joint** real estate?
   a) No
   b) Yes

38) Do you own **personal** real estate?
   a) No
   b) Yes

39) Please type in the approximate value of the **joint property** of your couple. Property includes, for example, financial investments, savings, and works of art. Estate property is excluded!
   a) 0 DKK
   b) 1 to 100,000 DKK
   c) 100,000 to 250,000 DKK
   d) 250,000 to 500,000 DKK
   e) 500,000 to 1,000,000 DKK
   f) 1,000,000 to 1,500,000 DKK
   g) 1,500,000 to 5,000,000 DKK
   h) 5,000,000 to 10,000,000 DKK
   i) More than 10,000,000 DKK

40) Please type in the approximate value of your **personal property**. Property includes, for example, financial investments, savings, and works of art. Estate property is excluded!
   a) 0 DKK
   b) 1 to 100,000 DKK
   c) 100,000 to 250,000 DKK
   d) 250,000 to 500,000 DKK

e) 500,000 to 1,000,000 DKK
f) 1,000,000 to 1,500,000 DKK
g) 1,500,000 to 5,000,000 DKK
h) 5,000,000 to 10,000,000 DKK
i) More than 10,000,000 DKK

From DNB Household Survey, 2013:

41) We would like to ask you how your household is organized. Which of the following statements represent the situation in your household most?
   a) All our money belongs to both of us; there is no distinction between his/hers and mine
   b) Part of the money is considered to be someone's own, the other part is mutual money
   c) The money we earn individually is one's own
   d) Other

42) Now we would like to ask you how financial decisions are taken in your household. Which of the following statements represent the situation in your household best?
   a) My partner has full control of finances and household money
   b) My partner has more control over finances and household money
   c) Each of us have equal say regarding finances and household money
   d) I have more control over finances and household money
   e) I have full control of finances and household money
   f) Another settlement

From De Palma, Picard and Ziegelmeyer, 2011:

43) Concerning your **joint holiday destination**, please indicate your role and the respective role of your partner in the decision making process:
   a) My partner makes this decision alone
   b) It is a joint decision, but my partner is decisive in case of disagreement
   c) It is a joint decision and we are on equal footing
   d) It is a joint decision, but I am decisive in case of disagreement
   e) I make this decision alone
   f) Other

44) Concerning your **joint place of residence**, please indicate your role and the respective role of your partner in the decision making process:
   a) My partner makes this decision alone
   b) It is a joint decision, but my partner is decisive in case of
   c) It is a joint decision and we are on equal footing
   d) It is a joint decision, but I am decisive in case of disagreement
   e) I make this decision alone
   f) Other

45) Concerning the **number of joint children and their education**, please indicate your role and the respective role of your partner in the decision making process:
   a) My partner makes this decision alone
   b) It is a joint decision, but my partner is decisive in case of disagreement
   c) It is a joint decision and we are on equal footing
   d) It is a joint decision, but I am decisive in case of disagreement

e) I make this decision alone
f) Other

46) Concerning the purchase of **valuable goods** (furniture, TVs, computers etc.), please indicate your role and the respective role of your partner in the decision making process:
a) My partner makes this decision alone
b) It is a joint decision, but my partner is decisive in case of disagreement
c) It is a joint decision and we are on equal footing
d) It is a joint decision, but I am decisive in case of disagreement
e) I make this decision alone
f) Other

47) Concerning **saving/borrowing of money** decisions, please indicate your role and the respective role of your partner in the decision making process:
a) My partner makes this decision alone
b) It is a joint decision, but my partner is decisive in case of disagreement
c) It is a joint decision and we are on equal footing
d) It is a joint decision, but I am decisive in case of disagreement
e) I make this decision alone
f) Other

48) Concerning **financial investment** decisions of the household (investing money in alternatives with higher risk but higher return than safe saving products), please indicate your role and the respective role of your partner in the decision making process:
a) My partner makes this decision alone
b) It is a joint decision, but my partner is decisive in case of disagreement
c) It is a joint decision and we are on equal footing
d) It is a joint decision, but I am decisive in case of disagreement
e) I make this decision alone
f) Other

49) Concerning **insurance** decisions of the household, please indicate your role and the respective role of your partner in the decision making process:
a) My partner makes this decision alone
b) It is a joint decision, but my partner is decisive in case of disagreement
c) It is a joint decision and we are on equal footing
d) It is a joint decision, but I am decisive in case of disagreement
e) I make this decision alone
f) Other

50) If you have purchased a **family car**, please indicate your role and the respective role of your partner in the decision making process:
a) My partner makes this decision alone
b) It is a joint decision, but my partner is decisive in case of disagreement
c) It is a joint decision and we are on equal footing
d) It is a joint decision, but I am decisive in case of disagreement
e) I make this decision alone
f) Other
g) We do not have a family car

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Appendix G: Comonotonic Independence

Appendix G.1: Identification of Violations Example

Consider the following real lottery examples:

Lottery pair rWEW1 (order lot 1, lottery set 1):

	Payoff	Probability
Lottery A:		
	180	**0.55**
	2160	0.25
	2520	0.20
Lottery B:		
	180	**0.55**
	1620	0.25
	3240	0.20

Lottery pair rWEW2 (order lot 2, lottery set 1):

	Payoff	Probability
Choice C:		
	1260	**0.55**
	2160	0.25
	2520	0.20
Choice D:		
	1260	**0.55**
	1620	0.25
	3240	0.20

We use the battery of lotteries in Wakker, Erev and Weber (1994) to test violations of the independence axiom, a key assumption of Expected Utility. This axiom implies that common consequences among options do not matter for choice, in other words, choices should be independent of irrelevant alternatives. In the context of out experiment this means that if two lotteries share a common outcome, this should not affect choice, and one should be able to increase or decrease that outcome and individuals should make the same choice.
Assume the subject is offered to choose between Lottery A and B and Lottery C and D. Assume that the individual is an expected utility maximizer with utility function u(.). Then the individual will value each lottery according to expected utility as follows:

$$EU_A = 0.55 * u(180) + 0.25 * u(2160) + 0.20 * u(2520)$$
$$EU_B = 0.55 * u(180) + 0.25 * u(1620) + 0.20 * u(3240).$$

Depending on the utility function u(.) subjects either choose Lottery A or B. For the sake of the argument assume subjects choose A. Also notice that the outcome common to both choices (180) does not matter for the choice since it cancels out in the comparison between the two lotteries.

Now assume the same individual is given the option to choose between Lottery C or D. Notice that these two lotteries are very similar to Lotteries A and B. In fact, the only thing that has changed is that the common outcome 180 has been changed to 1260. Under expected utility, by the independence axiom, the common outcomes between lotteries cancel out and do not matter for choice. If we spell out the expected utility for Lottery C and D as follows

$$EU_C = 0.55 * u(1260) + 0.25 * u(2160) + 0.20 * u(2520)$$

$$EU_D = 0.55 * u(1260) + 0.25 * u(1620) + 0.20 * u(3240),$$

we realized that the choice between these two lotteries is essentially the same as the choice between Lottery A and B *once* the common outcomes between the lotteries (180 and 1260) are not taken into account. Therefore, if the individual chooses lottery A in the first choice, then expected utility implies that the same person should choose lottery C in the second choice. Wakker, Erev and Weber (1994), constructed their battery of 24 lottery pairs using this logic, and developed 18 tests of expected utility. They varied the probability of the common outcome, the stakes of the common outcome as well as the ranking of the common outcome within the lotteries, for instance, the common outcome could be the worst possibly prize in a given pair of lotteries, and they increase the common outcome such that it became the best possible outcome. All these variations allow them to construct a powerful test of expected utility.

Appendix G.2: Detailed Violations

We use the battery of lotteries from Wakker, Erev and Weber [1994] and scaled their prizes by a factor of 60. They constructed lotteries to carefully test the "comonotonic independence" axiom of RDU, a stronger version of the independence axiom. The latter implies that choices between two lotteries with common outcomes are not affected by changes in the common outcome. Thus one can vary the common outcome as much as one wants and the choice between the two lotteries would be the same. Comonotonic independence predicts the same implication but putting some restrictions on the changes in the common outcome: the choice between two lotteries will be the same as long as changes in the common outcome do not affect the ranking of outcomes. Therefore, by testing comonotonic independence one is testing the rank-dependence feature of RDU.

The battery of lotteries consists of 6 sets of 4 lottery pairs. Within each set there are several tests that can be jointly used to identify EUT maximizers and RDU maximizers with different types of probability weighting by testing the *comonotonic independence axiom*. Let's exemplify the logic using their first set of 4 lotteries which is presented below:

Table G.1: First set of four lottery pairs in Wakker, Erev and Weber [1994].

		"Safe" Lottery			"Risky" Lottery		
		Low	**Middle**	**High**	**Low**	**Middle**	**High**
Pair 1	**Stakes**	**0.5**	6.0	7.0	**0.5**	4.5	9.0
	Probability	.55	.25	.2	.5	.25	.2
Pair 2	**Stakes**	**3.5**	6.0	7.0	**3.5**	4.5	9.0
	Probability	.5	.25	.2	.5	.25	.2
Pair 3	**Stakes**	6.0	**6.5**	7.0	4.5	**6.5**	9.0
	Probability	.25	.55	.20	.25	.55	.20
Pair 4	**Stakes**	6.0	7.0	**9.5**	4.5	9.0	**9.5**
	Probability	.25	.2	.55	.25	.2	.55

The analysis that follows applies equivalently to other 5 sets of lotteries.

In each of the four pairs of a particular set, subjects need to choose either the "Safe" lottery (S) or the "Risky" lottery (R). We denote a string of choices over the four lottery pairs with a vector of the following type $\{S_1, R_2, S_3, R_4\}$. This vector denotes an individual that chose S in the first pair, R in the second pair, S in the third pair and R in the fourth pair, where the indices indicates the pair within each set. To generalize choices in the four pairs are generally described as $\{C_1, C_2, C_3, C_4\}$ where each $C_i = S_i, R_i$ □ $i = 1,2,3,4$. Now we describe first the predictions and choice patterns that are consistent with EUT and RDU and then we explain the intuition.

The main null hypothesis (H0) in Wakker, Erev and Weber [1994] dictates that violations of the independence axiom will occur equally likely in all pairwise comparisons of choices.

Prediction 1: EUT predicts that the independence axiom holds for all comparisons. This implies that choices are consistent with EUT if choices in each of the 4 lottery pairs in all 6 sets are such that:

1. $\{S_1, S_2, S_3, S_4\}$ or
2. $\{R_1, R_2, R_3, R_4\}$

Each set of four lottery pairs provides one test of comonotonic independence and two tests of noncomonotonic independence. Therefore, H0 predicts that the proportion of violations of comonotonic independence will be equal to the proportion of noncomonotonic independence. RDU predicts that violations of noncomonotonic independence will be greater. For these tests of EUT and the ones that follow for RDU, Wakker, Erev and Weber [1994] have assumed that subjects do not make "behavioral errors" that lead them to make choices that do not reflect their true preferences. In their original design each of the 24 pairs of lottery was presented twice to assess the level of consistency in choices. We did not follow this strategy since we design the experiment such that we could conduct both choice pattern analysis as well as parametric estimations where we correct for behavioral errors.

Prediction 2: RDU predicts that choices should be the same in comonotonic pairs. In the case of the set of lotteries in Table A1, this means that increasing the common low payoff of 0.5 to 3.5 should not affect the choices so we should observe:

1. $\{S_1, S_2\}$ or
2. $\{R_1, R_2\}$

Prediction 3: Moving from Pair 2 to Pair 3 the common consequence increases from 3.5 to 6.5 but the ranking of outcomes changes, it went from being the lowest outcome in Pair 2 to be the middle outcome in Pair 3.This implies that RDU no longer predicts the same choices in Pair 3 as in Pair 1 and 2. The nature of the deviation depends on the type of probability weighting of the subject.

Prediction 3.1 (Probability Pessimism): Probability pessimism increases the attractiveness of the safe choice. Therefore we can expect any of the following patterns

1. $\{R_1, R_2\ S_3\}$ or
2. $\{S_1, S_2, S_3\}$
3. But $\{S_1, S_2, R_3\}$ is excluded

Prediction 3.2 (Probability Optimism): Probability optimism increases the attractiveness of the risky choice. Therefore we can expect any of the following patterns

1. $\{S_1, S_2, R_3\}$ or
2. $\{R_1, R_2, R_3\}$
3. But $\{R_1, R_2\ S_3\}$ is excluded

Prediction 4: Moving from Pair 3 to Pair 4 the common consequence increases from 6.5 to 9.5 but the ranking of outcomes changes, it went from being the middle outcome in Pair 3 to be the highest outcome in Pair 4.This implies that RDU no longer predicts the same choices in Pair 3 as in Pair 1 and 2. The nature of the deviation depends on the type of probability weighting of the subject.

Prediction 4.1 (Probability Pessimism): Probability pessimism increase the attractiveness of the risky choice. Therefore we can expect any of the following patterns

1. {S_3, R_4} or
2. {R_3, R_4}
3. But {R_3, S_4} is excluded

Prediction 4.2 (Probability Optimism): Probability optimism increases the attractiveness of the safe choice. Therefore we can expect any of the following patterns

1. {R_3, S_4} or
2. {S_1, S_2}
3. But {S_3, R_4} is excluded

Prediction 5 (S-shape Probability weighting, overweighting of small probabilities and underweighting if higher probabilities): We refer to this as the Cumulative Prospect Theory (CPT) model since RDU coincides with CPT in the gain domain. Moving from Pair 2 to Pair 3 the common consequence increases from 3.5 to 6.5 but the ranking of outcomes changes, it went from being the lowest outcome in Pair 2 to be the middle outcome in Pair 3. Overweighting of small probabilities implies that CPT no longer predicts the same choices in Pair 3 as in Pair 1 and 2. The probability pessimism at higher probabilities increases the attractiveness of the risky choice. Therefore we can expect any of the following patterns (exactly the same as Prediction 4.1)

1. {S_3, R_4} or
2. But {R_3, S_4} is excluded as it is a violation of CPT

Conversely, probability optimism at low levels increases the attractiveness of the safe choice. Therefore we can expect any of the following patterns

1. {R_3, S_4} or
2. But {S_3, R_4} is excluded as it is a violation of CPT

We summarize below the predicted changes for each of the six lottery sets.

Table G.2: Predictions for Lottery Set #1

1st Pair			2nd Pair			3rd Pair			4th Pair			
1-55	56-80	81-	**1-55**	56-80	81-	56-80	**1-55**	81-	56-80	81-	**1-55**	Cards #
0.5	6.0	7.0	**3.5**	6.0	7.0	6.0	**6.5**	7.0	6.0	7.0	**9.5**	**Prizes of Safe Lottery**
0.5	4.5	9.0	**3.5**	4.5	9.0	4.5	**6.5**	9.0	4.5	9.0	**9.5**	**Prizes of Risky Lottery**

0.5	⇨	**3.5**	⇨	**6.5**	⇨	**9.5**	**Common Outcome (CO)**
	×		×		×		EUT
	×		+		+		RDU
	×		~~S→R~~		~~R→S~~		RDU, pessimism
	×		~~R→S~~		~~S→R~~		RDU, optimism
	×		~~S→R~~		~~S→R~~		CPT

Note: Table directly taken from Wakker, Erev and Weber [1994]. EUT excludes any preference change if the CO is changed (×); thus one should observed {S_1, S_2, S_3, S_4} or {R_1, R_2, R_3, R_4}. RDU excludes no preference changes if the CO is changed from 3.5 to 6.5 or if it is changed from 6.5 to 9.5 (+) but excludes any preference change when the CO increases from 0.5 to 3.5. RDU with pessimism excludes a change from S to R if CO is changed from 3.5 to 6.5 (but permits a change from R to S).

Table G.3: Predictions for Lottery Set #2

1st Pair			2nd Pair			3rd Pair			4th Pair			
1-65	66-85	86-	**1-65**	66-85	86-	66-85	**1-65**	86-	66-85	86-	**1-65**	Cards #
0.5	3.5	5.5	**2.5**	3.5	5.5	3.5	**4.5**	5.5	3.5	5.5	**6.5**	**Prizes of Safe Lottery**
0.5	3.0	6.0	**2.5**	3.0	6.0	3.0	**4.5**	6.0	3.0	6.0	**6.5**	**Prizes of Risky Lottery**

0.5	⇨	**2.5**	⇨	**4.5**	⇨	**6.5**	**Common Outcome (CO)**
	×		×		×		EUT
	×		+		+		RDU
	×		~~S→R~~		~~R→S~~		RDU, pessimism
	×		~~R→S~~		~~S→R~~		RDU, optimism
	×		~~S→R~~		~~S→R~~		CPT

Note: Table directly taken from Wakker, Erev and Weber [1994]. EUT excludes any preference change if the CO is changed (×); thus one should observed $\{S_1, S_2, S_3, S_4\}$ or $\{R_1, R_2, R_3, R_4\}$. RDU excludes no preference changes if the CO is changed from 2.5 to 4.5 or if it is changed from 4.5 to 6.5 (+) but excludes any preference change when the CO increases from 0.5 t3 3.5. RDU with pessimism excludes a change from S to R if CO is changed from 2.5 to 4.5 (but permits a change from R to S).

Table G.4: Predictions for Lottery Set #3

1st Pair			2nd Pair			3rd Pair			4th Pair			
1-40	41-80	81-	41-80	**1-40**	81-	41-80	**1-40**	81-	41-80	81-	**1-40**	Cards #
0.5	2.5	6.0	2.5	**3.0**	6.0	2.5	**5.5**	6.0	2.5	6.0	**8.0**	**Prizes of Safe Lottery**
0.5	1.5	7.5	1.5	**3.0**	7.5	1.5	**5.5**	7.5	1.5	7.5	**8.0**	**Prizes of Risky Lottery**

0.5	⇨	**3.0**	⇨	**5.5**	⇨	**8.0**	**Common Outcome (CO)**
	×		×		×		EUT
	+		×		+		RDU
	~~S→R~~		×		~~R→S~~		RDU, pessimism
	~~R→S~~		×		~~S→R~~		RDU, optimism
	~~S→R~~		×		~~S→R~~		CPT

Note: Table directly taken from Wakker, Erev and Weber [1994]. EUT excludes any preference change if the CO is changed (×); thus one should observed {S_1, S_2, S_3, S_4} or {R_1, R_2, R_3, R_4}. RDU excludes no preference changes if the CO is changed from 2.5 to 4.5 or if it is changed from 5.5 to 8.0 (+) but excludes any preference change when the CO increases from 0.5 t3 3.0. RDU with pessimism excludes a change from S to R if CO is changed from 0.5 to 3.0 (but permits a change from R to S).

Table G.5: Predictions for Lottery Set #3

1st Pair			2nd Pair			3rd Pair			4th Pair			
1-70	71-80	81-	71-80	**1-70**	81-	71-80	**1-70**	81-	71-80	81-	**1-70**	Cards #
2.5	5.5	10.5	5.5	**6.0**	10.5	5.5	**9.5**	10.5	5.5	10.5	**13.0**	**Prizes of Safe Lottery**
2.5	3.5	12.5	3.5	**6.0**	12.5	3.5	**9.5**	12.5	3.5	12.5	**13.0**	**Prizes of Risky Lottery**

2.5	⇨	**6.0**	⇨	**9.5**	⇨	**13.0**	**Common Outcome (CO)**
	×		×		×		EUT
	+		×		+		RDU
	~~S→R~~		×		~~R→S~~		RDU, pessimism
	~~R→S~~		×		~~S→R~~		RDU, optimism
	~~S→R~~		×		~~S→R~~		CPT

Note: Table directly taken from Wakker, Erev and Weber [1994]. EUT excludes any preference change if the CO is changed (×); thus one should observed {S_1, S_2, S_3, S_4} or {R_1, R_2, R_3, R_4}. RDU excludes no preference changes if the CO is changed from 2.5 to 6.0 or if it is changed from 9.5 to 13.0 (+) but excludes any preference change when the CO increases from 9.5 to 13.0. RDU with pessimism excludes a change from S to R if CO is changed from 2.5 to 6.0 (but permits a change from R to S).

Table G.6: Predictions for Lottery Set #5

	1st Pair			2nd Pair			3rd Pair			4th Pair		
Cards #	**1-50**	51-60	61-	51-60	**1-50**	61-	51-60	61-	**1-50**	51-60	61-	**1-50**
Prizes of Safe Lottery	**0.0**	2.0	2.0	2.0	**2.0**	2.0	2.0	2.0	**4.0**	2.0	2.0	**6.0**
Prizes of Risky Lottery	**0.0**	0.0	3.0	0.0	**2.0**	3.0	0.0	3.0	**4.0**	0.0	3.0	**6.0**

Common Outcome (CO)	**0.0**	⇨	**2.0**	⇨	**4.0**	⇨	**6.0**
EUT		×		×		×	
RDU		+		+		×	
RDU, pessimism		~~S→R~~		~~R→S~~		×	
RDU, optimism		~~R→S~~		~~S→R~~		×	
CPT		~~S→R~~		~~S→R~~		×	

Note: Table directly taken from Wakker, Erev and Weber [1994]. EUT excludes any preference change if the CO is changed (×); thus one should observed {S_1, S_2, S_3, S_4} or {R_1, R_2, R_3, R_4}. RDU excludes no preference changes if the CO is changed from 0.0 to 2.0 or if it is changed from 2.0 to 4.0 (+) but excludes any preference change when the CO increases from 4.0 to6.0. RDU with pessimism excludes a change from S to R if CO is changed from 0.0 to 2.0 (but permits a change from R to S).

Table G.7: Predictions for Lottery Set #6

	1st Pair			2nd Pair			3rd Pair			4th Pair		
Cards #	**1-50**	51-60	61-	51-60	**1-50**	61-	51-60	61-	**1-50**	51-60	61-	**1-50**
Prizes of Safe Lottery	**2.0**	4.0	4.0	4.0	**4.0**	4.0	4.0	4.0	**6.0**	4.0	4.0	**8.0**
Prizes of Risky Lottery	**2.0**	2.0	5.0	2.0	**4.0**	5.0	2.0	5.0	**6.0**	2.0	5.0	**8.0**

Common Outcome (CO)	**2.0**	⇨	**4.0**	⇨	**6.0**	⇨	**8.0**
EUT		×		×		×	
RDU		+		+		×	
RDU, pessimism		~~S→R~~		~~R→S~~		×	
RDU, optimism		~~R→S~~		~~S→R~~		×	
CPT		~~S→R~~		~~S→R~~		×	

Note: Table directly taken from Wakker, Erev and Weber [1994]. EUT excludes any preference change if the CO is changed (×); thus one should observed {S_1, S_2, S_3, S_4} or {R_1, R_2, R_3, R_4}. RDU excludes no preference changes if the CO is changed from 2.0 to 4.0 or if it is changed from 4.0 to 6.0 (+) but excludes any preference change when the CO increases from 6.0 to8.0. RDU with pessimism excludes a change from S to R if CO is changed from 2.0 to 4.0 (but permits a change from R to S).

Appendix H: Manuscript

Welcome announcement

Thank you for agreeing to participate in this survey. Statistics Denmark is conducting the survey on behalf of a group of researchers at Copenhagen Business School. The survey is funded by the Social Science Research Council and concerns the economics of decision making.

The survey consists of 4 parts and one questionnaire. You will have a 10% probability of receiving a payment for one of your decisions in each part of the survey, and you will receive a lottery for your participation which gives you a 10% [20%] chance of receiving 1000 [2000] kroner. You will play this lottery at the end of the survey after you have finished all parts of the survey.

Before we begin the survey, we will distribute a consent form to all participants. The form explains what the survey is about, your rights as a participant in the survey, and how we make payments to you. All records and published results will be linked to anonymous codes only, and not to your name.

[Distribute consent forms.]

We will now continue with the survey. You will be given written instructions during the survey, but make all decisions on the computer in front of you. The instructions you are about to read are self-explanatory. We will answer any questions you might have during this experiment. We kindly ask that you do not talk to each other for the individual tasks during the experiment.

We will now distribute the first set of instructions.

[Distribute instructions for Part 1.]

Part 1

In this task you will be asked to make joint decisions with your assigned partner. Each of you will be endowed with some amount of money which you can keep or use to buy insurance and secure some of earnings. We will present you with 20 of these choices. An example of your task is shown on the next page.

The left half of the screen shows the information directly relevant for Person A, and the right half of the screen shows the information relevant for Person B. Both of you can either choose to buy insurance or not, but both of you have to make the same choice.

Example:

The screenshot shows an example in which each of you are endowed with 1200 kroner shown at the top of the screen. You need to discuss and decide between the following alternatives:

1. Each of you have a 50% chance to win 2000 kroner and a 50% chance to get nothing. Here you keep the full 500 kroner so you either get 3200 kroner with 50% chance or 1200 kroner with a 50% chance. This is shown in the upper half of the screen.
2. Each of you can buy insurance for 1000 kroner each for sure price of 2000 kroner each. Here you keep 200 kroner of your endowment. This is shown in the lower half of the screen.

When you both have agreed, you need to click on the option you both prefer the most: either 'insurance' or 'no insurance'. If you cannot agree you can choose "Choose for us," and the computer will randomly pick one of the options. Notice that you cannot change your choice once you have clicked on an option.

Payment:

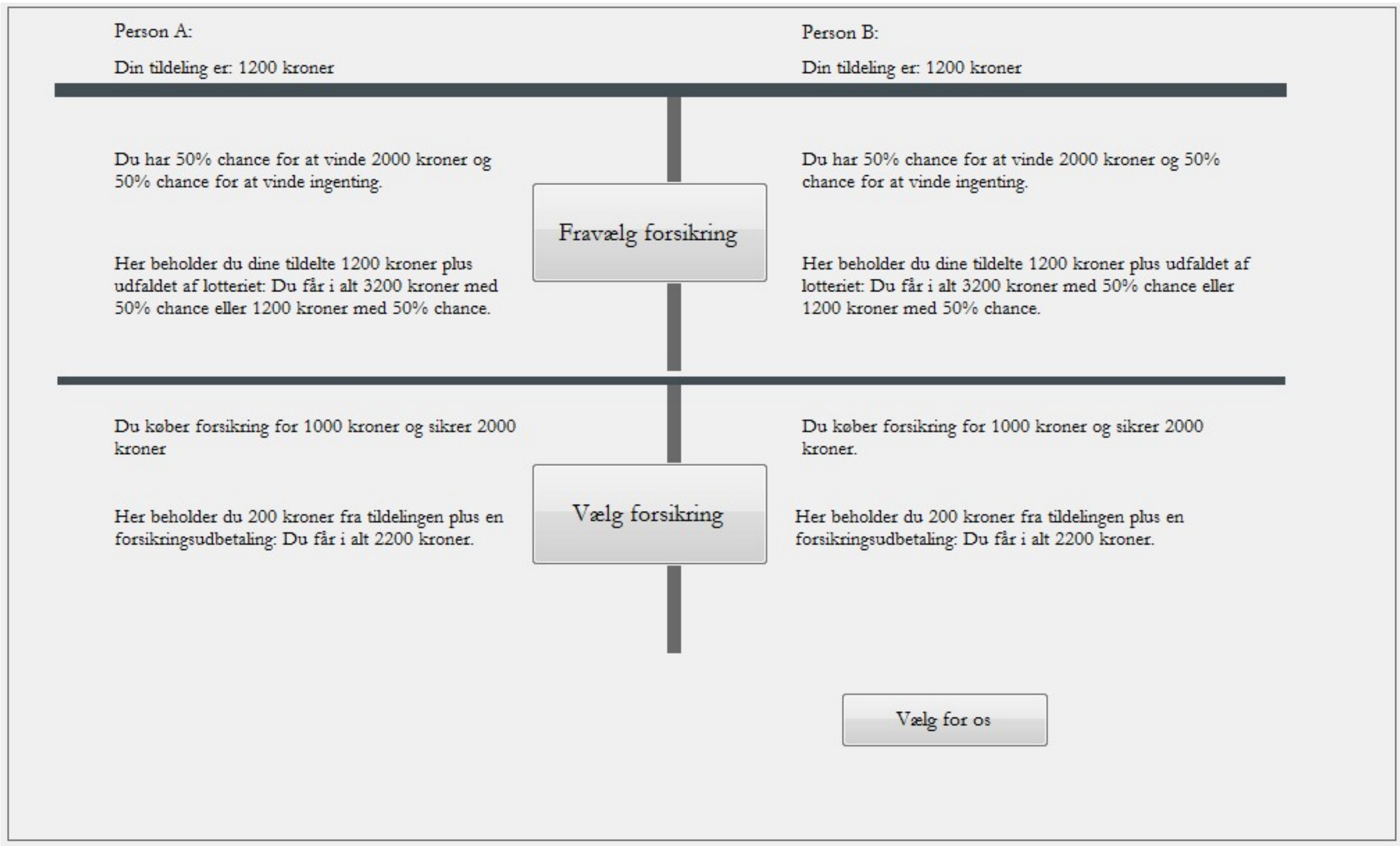
You have a 1-in-10 chance of receiving a payment in one of your decisions. The random draw is made with a 10-sided die. You choose which of you will roll the die. If the outcome is the number 1 then you will receive a payment in one of the decisions. You will not receive a payment if the outcome is any other number.

If you are receiving a payment in one of the 20 decisions, then we will select one of the decisions by rolling a 20-sided die.

The outcome of each investment choice will be determined by the draw of a random number between 1 and 100. Each number is equally likely to occur, and you will draw the number yourself using two 10-sided dice. You will each of you will receive two 10-sided and you will determine the payment in your agreed choice by individually rolling the dice, therefore you may each have different outcomes in earnings for a task.

When you make your choices you will not know which decision is selected for payment. You should therefore treat each decision as if it is actually paid out.

If you are selected to receive a payment, then the money will be transferred Denmark to each of your personal bank account by Statistics.



Part 2

In this task you will make 10 investment choices. In each round you will start with an endowment shown at the top of the screen. You must decide how much of this amount you prefer to invest in each investment round. An example of your task is shown on the next page.

Example:

In this example you can earn twice the amount you chose to invest with a 50% chance or lose your investment with a 50% chance. You can choose the amount of money you want to invest by clicking on the drop-down menu and selecting the amount you wish to invest.

The outcome of each investment choice will be determined by the draw of a random number between 1 and 100. Each number is equally likely to occur, and you will draw the number yourself using two 10-sided dice.

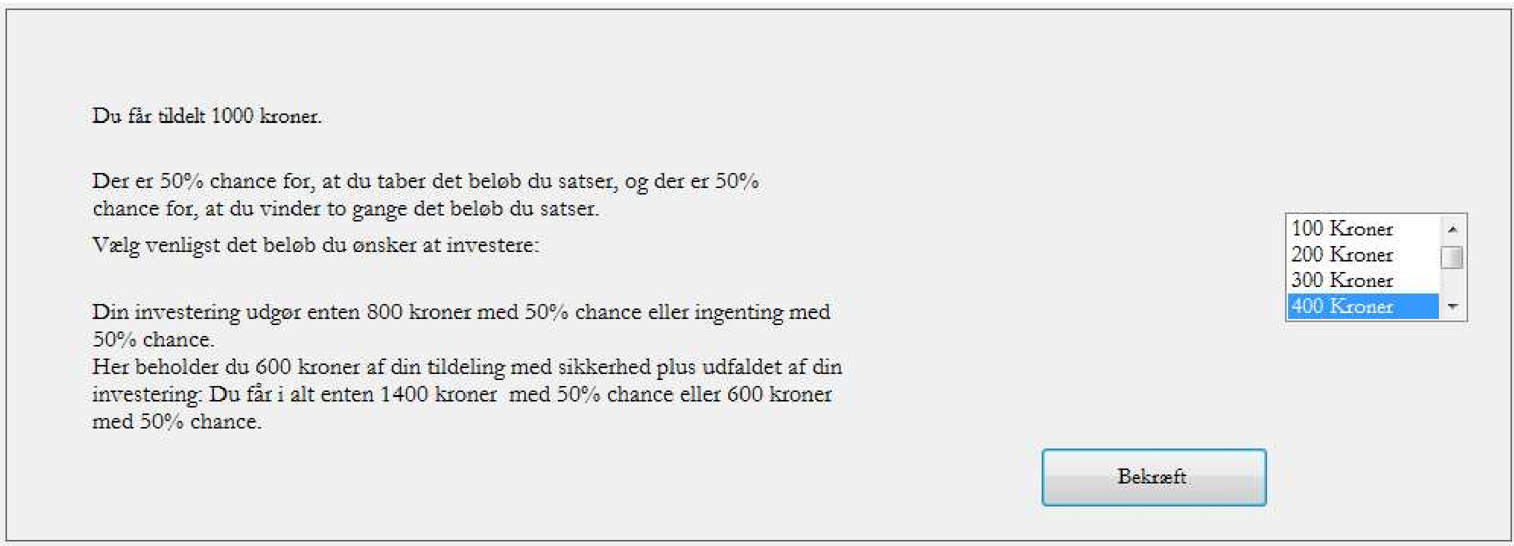
Suppose you choose to invest 400 kroner of your 1000 kroner endowment as shown in the example. This means that you would earn 600 kroner for sure from your initial endowment plus the outcome of your investment, which yields either 1400 kroner with a 50% chance (dice 1 to 50) or nothing with a 50% chance (dice 51-100).

Payment:

After you have made all of your choices you will have a 1-in-10 chance of receiving a payment in one of your decisions. The random draw is made with a 10-sided die. If the outcome is the number 1 then you will receive a payment in one of the decisions.

If you are receiving a payment for one of the 10 decisions, then you will select one of the decisions by rolling a 10-sided die. When you make your choices you will not know which decision may be selected for payment. You should therefore treat each decision as if it is actually paid out.

If you are selected to receive a payment, then the money will be transferred to your personal bank account tomorrow by Statistics Denmark.


Du får tildelt 1000 kroner.
Der er 50% chance for, at du taber det beløb du satser, og der er 50% chance for, at du vinder to gange det beløb du satser.
Vælg venligst det beløb du ønsker at investere:
Din investering udgør enten 800 kroner med 50% chance eller ingenting med 50% chance.
Her beholder du 600 kroner af din tildeling med sikkerhed plus udfaldet af din investering: Du får i alt enten 1400 kroner med 50% chance eller 600 kroner med 50% chance.
100 Kroner
200 Kroner
300 Kroner
400 Kroner
Bekræft

Part 3

In this task you will make a number of choices between two options labeled "Left" and "Right." We will present you with 60 of these tasks. For each task you should choose the option you prefer. An example of your task is shown on the next page

Example:

The outcome of each option will be determined by the draw of a random number between 1 and 100. Each number is equally likely to occur, and you will draw the number yourself using two 10-sided dice.

In the example the Left option pays 300 kroner if the random number is between 1 and 40, and it pays 900 kroner if the number is between 41 and 100.

The Right option pays 300 kroner if the random number is between 1 and 50; it pays 700 kroner if the number drawn is between 51 and 100. When you play your preferred lottery, the computer will display which numbers on the two 10-sided dice that are linked to the different prizes.

Payment:

You have a 1-in-10 chance of receiving a payment in one of your decisions. The random draw is made with a 10-sided die. If the outcome is the number 1 then you will receive a payment in one of the decisions. You will not receive a payment if the outcome is any other number.

If you are receiving a payment in one of the 60 decisions, then you will select one of the decisions by rolling a 6-sided and a 10-sided die. A third draw with two 10-sided dice determines the payment in your choice of the Left or Right option.

When you make your choices you will not know which decision may be selected for payment. You should therefore treat each decision as if it is actually paid out.

If you are selected to receive a payment, then the money will be transferred to your personal bank account tomorrow by Statistics Denmark.


Venstre
Højre
kr. 900
kr. 300
kr. 700
kr. 300
Chancen for at vinde kr. 300 er 40%
Chancen for at vinde kr. 900 er 60%
Chancen for at vinde kr. 300 er 50%
Chancen for at vinde kr. 700 er 50%
Vælg venstre
Vælg højre

Part 4

In this task you will state your beliefs about certain things. An example of your task is shown on the next page. We will present you with 10 of these tasks.

You earn points in this task. Every point that you earn gives you a greater chance of winning 1000 kroner.

Example:

In the example you are asked to state your belief about the unemployment rate in Denmark in January 2014. The first figure shows what the computer screen looks like. You have 100 tokens that must be allocated across 10 possible answers, and you can use the sliders at the bottom of the screen to allocate the 100 tokens.

The first figure shows an example where you allocate the 100 tokens to a single answer, which in this example is an unemployment rate between 2% and 3.99%. In this case you are allocating all 100 tokens to a single answer, which means that you can earn a maximum 100 points if this answer is correct. If your answer is correct then you will receive a payment of 1000 kroner for sure. If your answer is incorrect then you will receive nothing.

The second figure shows an example where you allocate the 100 tokens evenly between two answers. In this example 50 tokens are allocated to an unemployment rate between 2% and 3.99%, and 50 tokens are allocated to an unemployment rate of 4% and 5.99%. You can earn 75 points if the true answer falls into either of the two intervals, giving a 75% chance of winning 1000 kroner, and a 25% chance of winning nothing. If the true answer falls outside of the two intervals, you will have a 75% chance of winning nothing, and a 25% chance of winning 1000 kroner.

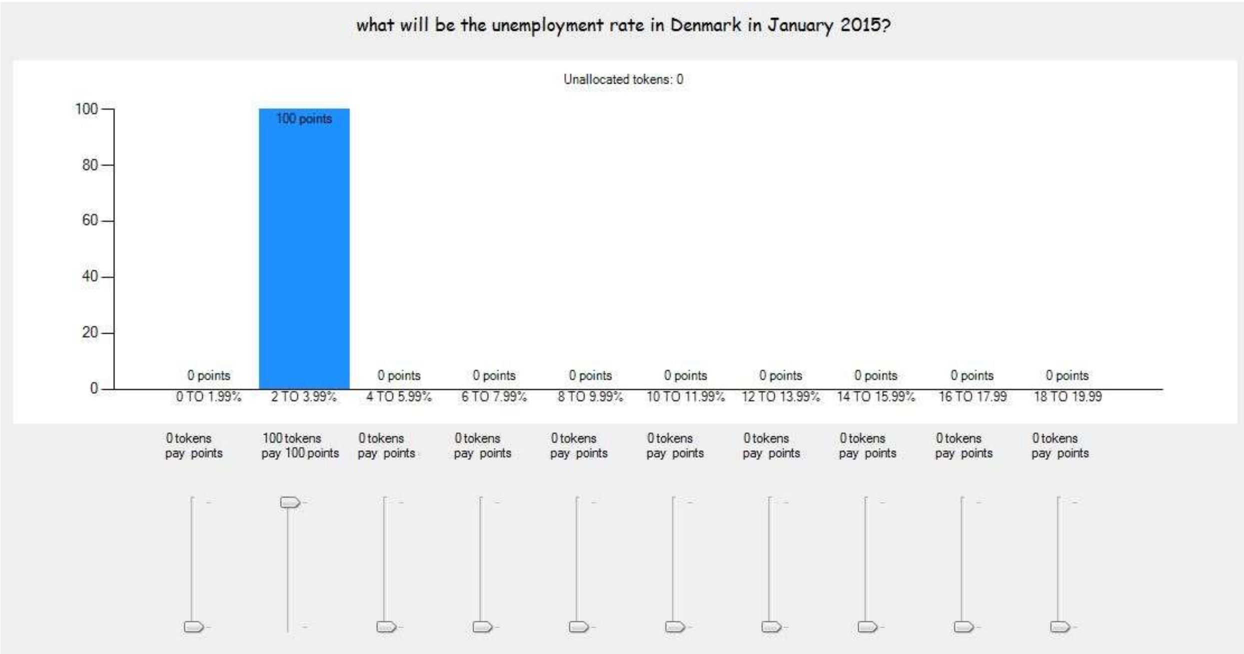
Payment:

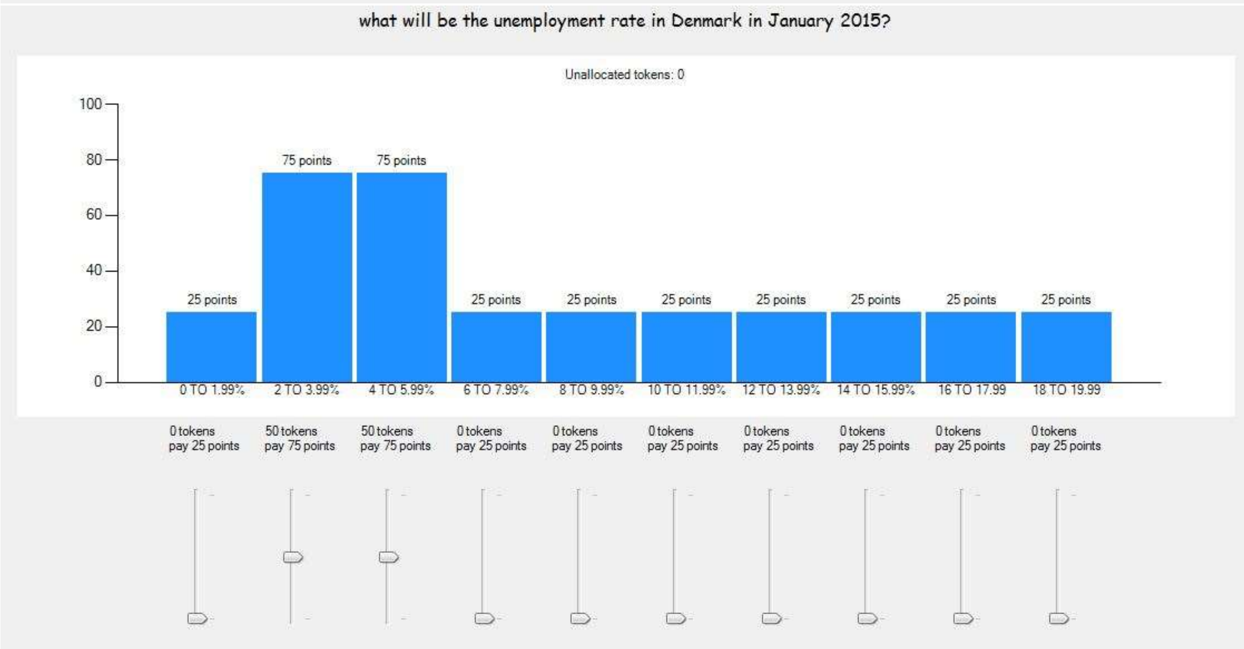
To win in this task you will roll two 10-sided dice, with every outcome between 1 and 100 equally likely. If you roll a number that is less than or equal to your earned points, you earn 1000 kroner.

You have a 1-in-10 chance of receiving a payment in one of your decisions. The random draw is made with a 10-sided die. If the outcome is the number 1 then you will receive a payment in one of the decisions. You will not receive a payment if the outcome is any other number.

If you are receiving a payment in one of the 10 decisions, then we will randomly select one of the decisions by rolling a 10-sided dice. When you make your choices you will not know which decision is selected for payment. You should therefore treat each decision as if it is actually paid out.

If you are selected to receive a payment, then the money will either be transferred tomorrow or on the first of November if the event happens in the future. All amounts are transferred to your personal bank account by Statistics Denmark.


what will be the unemployment rate in Denmark in January 2015?
Unallocated tokens: 0
100 points
0 points
0 TO 1.99%
2 TO 3.99%
4 TO 5.99%
6 TO 7.99%
8 TO 9.99%
10 TO 11.99%
12 TO 13.99%
14 TO 15.99%
16 TO 17.99
18 TO 19.99
0 tokens pay points
100 tokens pay 100 points


what will be the unemployment rate in Denmark in January 2015?
Unallocated tokens: 0
25 points
75 points
0 TO 1.99%
2 TO 3.99%
4 TO 5.99%
6 TO 7.99%
8 TO 9.99%
10 TO 11.99%
12 TO 13.99%
14 TO 15.99%
16 TO 17.99
18 TO 19.99
0 tokens pay 25 points
50 tokens pay 75 points

Appendix I: Overview and Code for Theoretical Section

I.1.Theoretical Framework Following Barberis and Xiong (2009)

[Currently detailed in paper]

I.2. Theoretical Framework following Hens and Vleck (2011)

Here we follow Hens and Vleck (2011) and model a simple financial market where individuals can invest in a risk-free and a risk-bearing assets (e.g., bonds and stocks denoted by Rf and R). The time horizon of investment decisions consists of two periods where each period resolves into either a good state (S=u) or a bad state (S=d). The investor's portfolio decision is to maximize utility by allocating his wealth, W, between the risky and risk-free assets. The share of wealth invested in stocks is given by λS, while investments in risk-free bonds are 1- λS. We assume that the investor is initially endowed with wealth W0 at time t = 0 and in times t = 1,2 state S=u (S=d) is realized with probability p (1-p) and the investor allocates λu (λd) accordingly.

Investors are characterized by having cumulative prospect theory-like preferences. Formally, an investor has a probability weighting function, w(p) and a valuation function, v(x) which characterize the investors' subjective value of possible outcomes. These functions are defined as in Tverskey and Kahneman (1992),

$$w(p) = \quad p^{\varrho}/(p^{\varrho} + (1-p)^{\varrho})^{1/\varrho}$$
$$v(x) = \quad x^{\alpha} \quad \text{if } x \geq 0$$
$$\text{and}$$
$$v(x) = \quad -\beta(-x)^{\alpha} \quad \text{if } x < 0$$

where p is the probability of an event and ϱ is a weighting parameter between 0 and 1. The weighting function is constructed such that individuals overweight events at low probabilities and underweight events with higher probabilities. In the value function, β is a coefficient of loss aversion while α is a coefficient of risk aversion.

Assume that the individual bought the asset in the first period. Therefore, when state S=u or S=d is realized, the investor must solves the following optimization problem conditional on having bought the asset in the previous period:

$$\text{Max} \quad V(\lambda S)$$
$$0 \leq \lambda S \leq 1 \tag{2}$$

where

$$V(\lambda S) = w(p)\, v(WS^*(\lambda S^*RS + (1-\lambda S)^*Rf) - W0) + (1-w(p))\, v(WS^*(\lambda S^*RD + (1-\lambda S)Rf) - W0).$$

WS is the wealth of the individual when state S has been realized. We assume W0 is the initial wealth of the subject and we assume is the reference point of the subject.

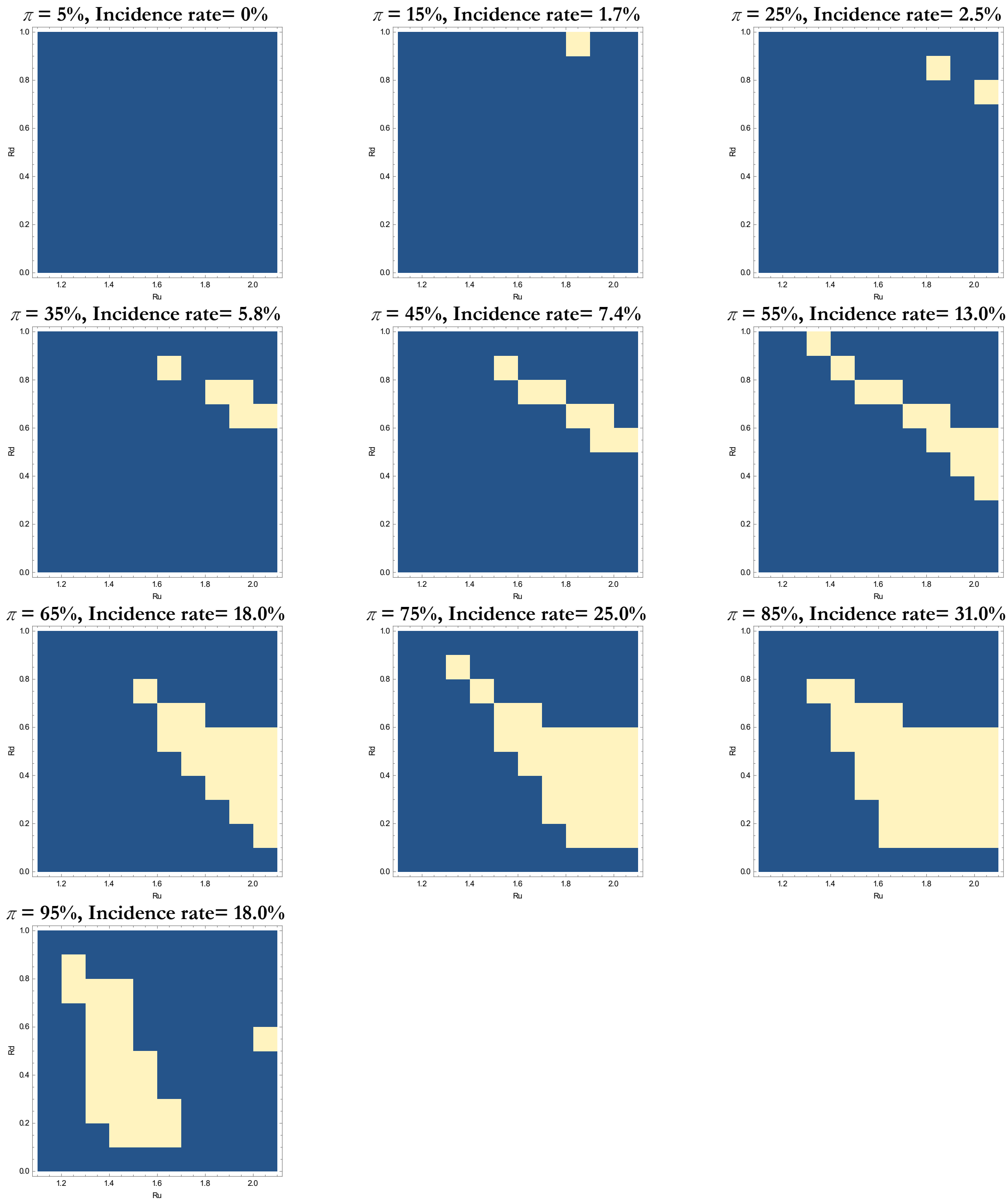
In the context of only one risky asset the disposition effect is understood as the tendency of the individual to sell the asset in the good state S=u and keep the asset in the bad state S=d. Therefore, the disposition effect arises when λd > λu. The intuition behind this is simple; an investor shows disposition in his investment allocations if the allocation he devotes to risky assets in the bad-state is greater than the allocation he invests in the good-state. In this context the investors holds risky assets in the bad state while realizing his positions in the good state.

We are interested in the effect of optimism on the disposition effect. We study this by looking at how often the disposition effect appears when the probability of the good state increases. Notice that we model optimism by looking at what happens to the disposition effect when the subjective probability of the good state increases. One could also model optimism by taking as point of reference the true objective probability distribution or the beliefs of a given "control" individual. However, optimism will be modeled anyway as an increase of the subjective probability above this reference "objective" probability. This is the reason why we choose to model the effect of optimism on the disposition effect by studying what happens when we increase the subjective probability of the good state.

As in Hens and Vleck (2011), we plot the incidence of the disposition effect while varying the parameters of the model. We set $\alpha = 0.88$ and β=2.25 and ϱ=.65, values taken directly from Tverskey and Kahneman (1992). Ru and Rd take values between 1.1-2.1 and 0.0-1.0, respectively. The risk-free rate is set to 1.1. The figures in Appendix XX show the incidence of the disposition effect for probability levels between 0.05 and 0.95. The space in lighter color indicated in these figures shows under which combinations of Ru and Rd the maximization problem results in Disposition Effect behavior. Conversely, the darker area shows the combination of Ru and Rd where the disposition effect is not present.

Figure I.2.1: Incidence of the Disposition Effect in the Hens and Vleck (2011) Framework

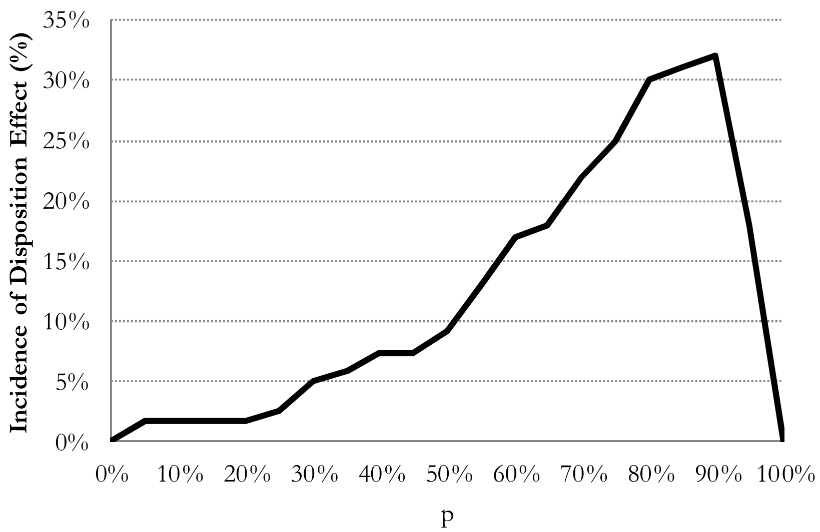
The figures below shows the incidence of the disposition effect when$\boldsymbol{p} \in (5\%, 95\%)$. We use increments of 10 percentage points in the probability interval. The space in lighter color depicts the incidence of the disposition effect while regions depicted in darker color shows under which combination of R_U and R_D the disposition effect does not arise. The x-axis plots R_U, the gross returns of an equity in the good state, while the y-axis plots R_D, the gross returns of an equity in the bad state. The figures below assumes an investor with loss aversion. Specifically, $W_0=1$; $\alpha=0.88$; $\gamma=0.65$; $\beta = 2.25$; $R_F=1.1$; $R_U=1.0\text{-}2.0$, and $R_D=0.1\text{-}1.0$.



We have summarized the results of the analysis in Figure A below where we plot the incidence of the Disposition Effect against the level of probability p used to make the analysis. The figure suggests that for very low and very high probability of the good state the disposition effect is not present (i.e., close to p=0 or p=1). The intuition is simple, for very low probability, subjects will not have incentives to keep the asset even if the good state is realized, so the disposition effect is not present. For very high probability subjects will have strong incentives to keep the asset even if the bad state is realized with very small probabilities, so individuals will keep the asset no matter the realized state and the disposition effect will not be present either. This implies that the disposition effect is present for the cases of intermediate probabilities. In the case above, the disposition effect appears in the interval (0, 0.9).

Figure I.2.2: Incidence of the Disposition Effect at Different Levels of probability p

The figure below plots the relationship between π and the incidence of the disposition effect. The *x-axis* denotes value of p or the probability of the good state occurring. The *y*-axis gives the incidence of the disposition effect.



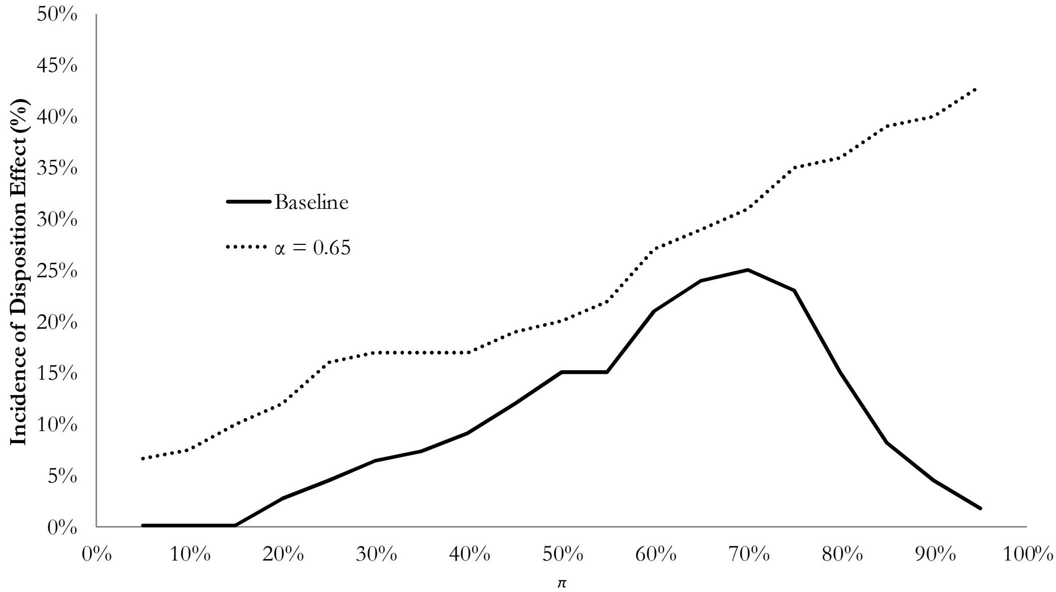
We are interested in the effect of increasing the probability of the good state, which in this simple set up can be understood as increasing optimism, if the probability is the subjective belief about the good state being realized. One interesting finding with the particular set of parameters that we chose is that the incidence of the Disposition Effect increases as the probability increases in the interval (0,0.9). This is counterintuitive at first glance since one would expect that more optimistic beliefs are accompanied by a higher demand of the asset. However, one has to keep in mind that what matters for the disposition effect is how an increase in probability affect the incentives to keep the asset when the bad state is realized compared against how that increase affects the incentives to keep the asset when the good state is realized.

Why would we observe an increase in the incidence of the disposition effect when we increase the probability in the interval (0,0.9)? The answer is related to the loss aversion feature of the Prospect Theory model. One feature of this model is that due to loss aversion, subjects are risk averse in the gain domain and risk loving in the loss domain. The fact that we observe an increase in the incidence of the disposition effect when the probability is increased is related to the fact that a Prospect Theory individual is more likely to keep the asset when the bad state is realized since he behaves in a risk loving manner when this happens, while the same person is less likely to keep the asset when the good state is realized because that same person behaves in a risk averse manner in that case. Increasing the probability makes the risky asset more attractive for the risk-loving version of this person. Although this increased probability also makes the risky asset more attractive for the risk-averse version of this person the probability has to be high enough such $\lambda d < \lambda u$.

To summarize, increasing the probability in the (0,0.9) interval increases the incidence of the Disposition Effect. This is somewhat counterintuitive because one would expect higher probability to increase the incentives to keep the asset, which is actually true. However, one has to analyze how the increase of probabilities affects the incentives to keep the asset when the bad state is realized relative to how incentives are affected when the good state is realized. If these incentives are stronger in the bad state relative to the good state, then the disposition effect is present. In the simple example we show above, higher probability increases the incidence of the Disposition Effect. This is driven by the Loss Aversion feature of Prospect Theory because this implies that the individual behaves in a risk loving manner when the bad state is realized and in a risk-averse manner when the good state is realized. Increasing the probability of the good state creates stronger incentives to keep the asset for the risk-loving version of the individual than the incentives it creates for the risk-averse version of the individual to keep the asset, at least for intermediate probabilities. What constitute "intermediate" probabilities vary with the parameters chosen for the model. For instance, if one increases parameter α (so it indicates higher risk aversion in the gain domain and more risk loving in the loss domain), then one would see that the Disposition Effect is more prevalent and the individual would need very low or very high probabilities to either always sell the asset or always keep the asset no matter what state is realized. This would imply that the positive relation between incidence of the Disposition Effect and probability of the good state will be even stronger in the (0, 1) interval. The intuition is that since the difference between how gain and losses are valued is greater now, the incentives to keep the asset that higher probability creates on the risk-loving version of the individual are now much stronger than the incentives created to keep the asset on the risk-averse version of the individual.

Figure I.2.3: Incidence of the Disposition Effect with α = 0.65

The figure below plots the relationship between π and the incidence of the disposition effect. The *x-axis* denotes value of p, or the probability of the good state occurring. The *y*-axis gives the incidence of the disposition effect. The line labeled "Baseline" corresponds to the data from Figure J.2.2. The line labeled "α = 0.65" uses the same parameters as the Baseline except that the α parameter is reduced from 0.88 to 0.65.



I.2.1. Mathematica 10.2 Code Used to do the Analysis Using the Hens and Vleck(2011) Framework.

```
(* Disposition Effect Simulation
Based on Hens and Vleck (2011)

There is an individual with the choice of investing a proportion λ of his wealth W
into a risky asset and (1-λ) in the safe asset. The risky asset yields Ru if the price
goes up or Rd if the price goes down. The good state is realized with probability p
and the bad state is realized with probability 1-p*)

(*Clear all*)
ClearAll["Global`*"]
(*Generate Wealth Variables for t=1*)

Wu[W0_, λ0_, Ru_, Rf_]:=W0*(λ0*Ru+(1-λ0)*Rf)
Wd[W0_, λ0_, Rd_, Rf_]:=W0*(λ0*Rd+(1-λ0)*Rf)

(*Generate Wealth Variables for t=2*)

(*Conditional on the good state being realized in t=1 and t=2*)

Wuu[W0_,λ0_,λu_, Ru_, Rf_]:=Wu[W0, λ0, Ru, Rf]*(λu*Ru+(1-λu)*Rf)

(*Conditional on the good state being realized in t=1 and the bad state realized in t=2*)

Wud[W0_,λ0_, λu_, Ru_,Rd_, Rf_]:=Wu[W0, λ0, Ru, Rf]*(λu*Rd+(1-λu)*Rf)
(*Conditional on the bad state being realized in t=1 and the good state realized in t=2*)

Wdu[W0_, λ0_,λd_, Ru_,Rd_, Rf_]:=Wd[W0, λ0, Rd, Rf]*(λd*Ru+(1-λd)*Rf)
(*Conditional on the bad state being realized in t=1 and t=2*)

Wdd[W0_, λ0_,λd_, Rd_, Rf_]:=Wd[W0, λ0, Rd, Rf]*(λd*Rd+(1-λd)*Rf)

(*Now Define Probability Weighting*)

w[pi_,γ_]:=(pi^γ)/(pi^γ+(1-pi)^γ)^(1/γ)

wq[pi_,γ_]:=((1-pi)^γ)/(pi^γ+(1-pi)^γ)^(1/γ)
(*Define q*)

q[p_]:=1-p
(*Now Define Prospect Utility*)
v[x_,α_, β_]:=Piecewise[{{x^α,x>=0},{-β*(-x)^α,x<0}}]

(*Now define argument of utility function in t=0 in good state*)

x0u[W0_, λ0_,Ru_, Rf_]:=Wu[W0, λ0, Ru, Rf]-W0

(*Now define argument of utility function in t=0 in bad state*)

x0d[W0_, λ0_,Rd_, Rf_]:=Wd[W0, λ0, Rd, Rf]-W0

(*Now define argument of utility function in t=2 in good state conditional on good state in t=0*)

x1uu[W0_, λ0_,λu_,Ru_, Rf_]:=Wuu[W0,λ0,λu, Ru, Rf]-W0

(*Now define argument of utility function in t=2 in bad state conditional on good state in t=0*)
```

```
x1ud[W0_,λ0_,λu_,Rd_,Ru_, Rf_]:=Wud[W0,λ0, λu, Ru,Rd, Rf]-W0

(*Now define argument of utility function in t=2 in good state conditional on bad state in t=0*)

x1du[W0_, λ0_,λd_,Ru_,Rd_, Rf_]:=Wdu[W0, λ0,λd, Ru,Rd, Rf]-W0

(*Now define argument of utility function in t=2 in bad state conditional on bad state in t=0*)

x1dd[W0_, λ0_,λd_,Rd_, Rf_]:=Wdd[W0, λ0,λd, Rd, Rf]-W0

(*Now Define Utility According to State and Period*)

(*Cummulative Prospect Utility at t=1*)
Vλ0[p_,α_,β_,γ_,W0_,λ0_,Ru_,Rd_, Rf_]:=w[p,γ]* v[x0u[W0, λ0,Ru, Rf],α, β] + (1-w[p,γ])*v[x0d[W0, λ0,Rd, Rf],α, β]

(*Prospect Utility at t=2 conditional on good state realized in period t=1*)

Vλu[p_,α_,β_,γ_,W0_,λ0_,λu_,Ru_,Rd_, Rf_]:=w[p,γ]* v[x1uu[W0, λ0,λu,Ru, Rf],α, β] + (1-
w[p,γ])*v[x1ud[W0,λ0,λu,Rd,Ru, Rf],α, β]

(*Prospect Utility at t=2 conditional on bad state realized in period t=1*)

Vλd[p_,α_,β_,γ_,W0_,λ0_,λd_,Ru_,Rd_, Rf_]:=w[p,γ]* v[x1du[W0, λ0,λd,Ru,Rd, Rf],α, β] + (1-w[p,γ])*v[x1dd[W0,
λ0,λd,Rd, Rf],α, β]

(*Prospect Utility at t=1, Old version from KT (1979)*)
(*
Vλ0[p_,α_,β_,γ_,W0_,λ0_,Ru_, Rd_, Rf_]:=w[p,γ]* v[x0u[W0, λ0,Ru, Rf],α, β] + w[q[p],γ]*v[x0d[W0, λ0,Rd, Rf],α, β]

(*Prospect Utility at t=2 conditional on good state realized in period t=1*)

Vλu[p_,α_,β_,γ_,W0_,λ0_,λu_,Ru_,Rd_, Rf_]:=w[p,γ]* v[x1uu[W0, λ0,λu,Ru, Rf],α, β] +
(w[q[p],γ])*v[x1ud[W0,λ0,λu,Rd,Ru, Rf],α, β]

(*Prospect Utility at t=2 conditional on bad state realized in period t=1*)

Vλd[p_,α_,β_,γ_,W0_,λ0_,λd_,Ru_,Rd_, Rf_]:=w[p,γ]* v[x1du[W0, λ0,λd,Ru,Rd, Rf],α, β] + (w[q[p],γ])*v[x1dd[W0,
λ0,λd,Rd, Rf],α, β]


(*Define the utility when no investment in the asset, only to be used with old PT *)
Vλu0[p_,α_,β_,γ_,W0_,λ0_,λu_,Ru_,Rd_, Rf_]:=(p)* v[x1uu[W0, λ0,λu,Ru, Rf],α, β] + (1-p)*v[x1ud[W0,λ0,λu,Rd,Ru,
Rf],α, β]

(*Prospect Utility at t=2 conditional on bad state realized in period t=1*)

Vλd0[p_,α_,β_,γ_,W0_,λ0_,λd_,Ru_,Rd_, Rf_]:=p* v[x1du[W0, λ0,λd,Ru,Rd, Rf],α, β] + (1-p)*v[x1dd[W0, λ0,λd,Rd,
Rf],α, β]

(*Now Define Disposition Effect Dummy*)
(*DE[λumax_,λ0max_,λdmax_]:=Piecewise[{{1,λumax<λ0max<=λdmax}},0]*)
DE[λumax_,λdmax_]:=Piecewise[{{1,λumax<λdmax}},0]
λuMax[p_,α_,β_,γ_,W0_,λ0_,λuhigh_,λulow_,Ru_,Rd_, Rf_]:=Piecewise[{{1,Vλu[p,α,β,γ,W0,λ0,λuhigh,Ru,Rd,
Rf]>Vλu0[p,α,β,γ,W0,λ0,λulow,Ru,Rd, Rf]}},0]
λdMax[p_,α_,β_,γ_,W0_,λ0_,λdhigh_,λdlow_,Ru_,Rd_, Rf_]:=Piecewise[{{1,Vλd[p,α,β,γ,W0,λ0,λdhigh,Ru,Rd,
Rf]>Vλd0[p,α,β,γ,W0,λ0,λdlow,Ru,Rd, Rf]}},0]
λ0Max[p_,α_,β_,γ_,W0_,λ0high_,λ0low_,Ru_,Rd_, Rf_]:=Piecewise[{{1,Vλ0[p,α,β,γ,W0,λ0high,Ru, Rd,
Rf]>Vλ0[p,α,β,γ,W0,λ0low,Ru, Rd, Rf]}},0]
*)
```

```
(*Now Define Disposition Effect Dummy*)
(*DE[λumax_,λ0max_,λdmax_]:=Piecewise[{{1,λumax<λ0max<=λdmax}},0]*)
DE[λumax_,λdmax_]:=Piecewise[{{1,λumax<λdmax}},0]
λuMax[p_,α_,β_,γ_,W0_,λ0_,λuhigh_,λulow_,Ru_,Rd_, Rf_]:=Piecewise[{{1,Vλu[p,α,β,γ,W0,λ0,λuhigh,Ru,Rd,
Rf]>Vλu[p,α,β,γ,W0,λ0,λulow,Ru,Rd, Rf]}},0]
λdMax[p_,α_,β_,γ_,W0_,λ0_,λdhigh_,λdlow_,Ru_,Rd_, Rf_]:=Piecewise[{{1,Vλd[p,α,β,γ,W0,λ0,λdhigh,Ru,Rd,
Rf]>Vλd[p,α,β,γ,W0,λ0,λdlow,Ru,Rd, Rf]}},0]
λ0Max[p_,α_,β_,γ_,W0_,λ0high_,λ0low_,Ru_,Rd_, Rf_]:=Piecewise[{{1,Vλ0[p,α,β,γ,W0,λ0high,Ru, Rd,
Rf]>Vλ0[p,α,β,γ,W0,λ0low,Ru, Rd, Rf]}},0]

pvec=Range[0,1,0.05];
nlvec =Dimensions[pvec];
nl=nlvec[[1]];

For[l=1,l<=nl,l=l+1,
 (*Define some parameters*)
 W0=1;
 p= pvec[[l]];
 α=.88;
 β = 2.25;
 γ=.65;
 Rf=1.1;
 λ0temp=1;
 k=0;

 (*Define some vectors*)
  Rdvec=Range[0,1,0.1];
    Ruvec = Range[1.1,2.1,0.1];
 nivec =Dimensions[Ruvec];
 njvec=Dimensions[Rdvec];
 ni=nivec[[1]];
 nj=njvec[[1]];
 matemp=Table[-1,nj,ni];
 matλ0max = Table[-1,ni,nj];
 matλumax = Table[-1,ni,nj];
 matλdmax = Table[-1,ni,nj];
 λ0temp = 1;

 For[i=1,i<=ni,i=i+1,
  For [j=1,j<=nj,j=j+1,
   Rui= Ruvec[[i]];
   Rdj=Rdvec[[j]];
   λuvec=NMaximize[{Vλu[p,α,β,γ,W0,λ0temp,λu,Rui,Rdj, Rf],0<=λu<=1},λu,MaxIterations->200];
   λumax=λuvec[[2,1,2]];
   matλumax[[i,j]]=λumax;
   λdvec=NMaximize[{Vλd[p,α,β,γ,W0,λ0temp,λd,Rui,Rdj, Rf],0<=λd<=1},λd,MaxIterations->200];
   λdmax=λdvec[[2,1,2]];
   matλdmax[[i,j]]=λdmax;
   matemp[[j,i]]=DE[λumax,λdmax];
   k=k+DE[λumax,λdmax]
   ]
  ];
 PercentageDE=N[k/(ni*nj)*100,2];
 Print["Disposition Effect Happening in ", PercentageDE,"% of the Cases when p=",p];
 ListContourPlot[matemp,DataRange->{{1.1,2.1},{0,1}},InterpolationOrder->0,FrameLabel-
>{{HoldForm[Rd],None},{HoldForm[Ru],None}},PlotLabel->None,LabelStyle->{GrayLevel[0]}]//Print

 ]
```

(*End of Code*)

Conclusion

This Ph.D. thesis, analyzes the determinants and implications of investment biases, personal experiences in financial markets, and personal financing disruptions on households, individual investors, and entrepreneurs and small business owners. Chapter one, *Once Bitten, Twice Shy: The Role of Inertia and Personal Experiences in Risk Taking,* studies how personal experiences affect individual financial risk taking. To separate the effect of personal experiences from the confounding effect of inertia, we use an identification strategy that relies on a sample of individuals who inherit a portfolio of risky assets. This identification strategy alters the active decision from one of choosing to take risk to one of choosing not to take risk. Our measure of experience derives from investments in retail banks that defaulted following the financial crisis. Chapter one shows that experiences gained personally, aside from inertia or common shocks, explain substantial heterogeneity in individuals' risk taking.

In the second essay of this thesis, *The Effect of Personal Financing Disruptions on Entrepreneurship,* I study how idiosyncratic financing shocks experienced by entrepreneurs during operations affect the survival of their firms. This is of relative importance as the literature to date has shown that credit market disruptions negatively affect large firms, but the majority of financing to small businesses comes from personal debt or the individual assets of the firm owner. I use variation in personal wealth and debt financing from the solvency of retail banking institutions following the financial crisis. The results suggest that changes in access to formal credit and disruptions to banking relationships affect entrepreneurs through their retail bank choice which in turn impedes their personal borrowing abilities. As such, firm owners are significantly more likely to exit from their firm. Losses in personal liquid wealth strongly reduce the rate of entrepreneurial survival, especially for more constrained small business owners. In addition, personal losses have large effects on the intensive margin, as firm owners significantly reduce employed staff. In total, chapter two suggests that personal financing disruptions play an important role in explaining entrepreneurial exit.

The third and final essay, *Believe it or Not: Expectations Matter for the Disposition Effect* attempts to test a number of mechanisms behind the Disposition Effect using economic experiments. The disposition effect is a well documented investment bias where investors are more likely to realize gains over losses in their investment decisions. We use detailed administrative data to identify these investors and recruit them for individual experimental tasks. We find that on average, disposition-prone investors have significantly higher expectations about future market returns. We find no differences in financial sophistication, regret aversion, risk taking behavior, or beliefs about macroeconomic fundamentals. Our results suggest that optimism and expectations may be an important aspect of the disposition effect, but additional analysis is needed to understand precisely which direction the causality runs. We leave this and related avenues open to future research.

Overall, the three chapters of this thesis use highly detailed administrative data on asset allocation and attempts to uncover the causes and repercussions of financial decisions. Each chapter contributes to our understanding of the financial decision making process and shows that experiences, unexpected shocks, and expectations have important consequences on asset allocation and financial biases, and labor market activity. The contribution is important in light of the global financial crisis and subsequent recession, as large macroeconomic events are likely to have triggered individual level experiences with the stock market, financial intermediaries, and about future market returns. In the future it will be interesting to examine the more societal impacts of financial disruptions in greater detail, such as trust and trustworthiness in the financial sector, consumer fraud and white-collar crime, and changes in financial awareness across social circles and peer-groups.

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