Essays in Empirical Asset Pricing

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Aleksandra Anna Rzeźnik

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HANDELSHØJSKOLEN

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"The Doctoral School of 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".

Foreword

This thesis is the result of my PhD studies at the Department of Finance at Copenhagen Business School. The thesis consists of 3 essays covering different aspects of the intersection of empirical asset pricing and real estate. Each essay is self-contained and can be read independently.

The first essay provides a demand side explanation for the relationship between market volatility and the market price of liquidity. The second essay (co-authored with Mads Gjedsted Nielsen) uses the 2007 municipality reform in Denmark as an exogenous shock to taxes in order to estimate the effect of both income and property taxes on residential house prices. The third essay (co-authored with Chandler Lutz and Ben MacLean Sand) examines the impact of local economic conditions on the portfolio choices of mutual funds for geographically proximate assets and consequent fund performance.

This thesis has benefited greatly from interaction and support from many individuals. I am grateful to my supervisors: Søren Hvidkjær and Jesper Rangvid for their helpful advice. I would like to thank Susan K. Christoffersen, for her time, support, and friendship throughout the last three years of my PhD studies. Her guidance and encouragement benefited me both academically and personally, and I am extremely grateful to have her as a friend and adviser. I would also like to thank Lasse Heje Pedersen for very helpful discussions and exceptional advice. I am indebted for his intellectual contributions and generosity in providing his time. Many friends have also helped along the way. I would like to thank Mads Gjedsted Nielsen and Sven Klingler for many good times, support and encouragement, both personally and academically. I am very grateful to Ben MacLean Sand for his unswerving support, mentoring, and love. I would like to thank my Mom, Dad, and Sister for their patience and unconditional love during PhD studies.

I would also like to acknowledge the support of Finance Department at Copenhagen Business School and the Ministry of Higher Education and Science for funding my PhD studies. Furthermore, I want to thank the assessment committee, the faculty and PhD students at the Department of Finance at Copenhagen Business School for their useful feedback.

The essays in this PhD thesis have benefited tremendously from the feedback of several people, and they are mentioned in the individual essays.

Aleksandra Anna Rzeźnik
Vienna, October 2016

Summary

Summary in English

Essay 1: Mutual fund flight-to-liquidity

The first essay provides a demand-side explanation for the relationship between liquidity premium and market volatility. While existing research investigates the impact of market uncertainty on mutual fund capital flows, a direct link between uncertainty-induced fund behaviour and the market price of liquidity have not been examined. This paper bridges this gap by showing one channel through which market uncertainty impacts the liquidity premium.

In order to examine the relationship between market uncertainty and the price of liquidity, I draw on insight from Vayanos (2004). In his model, investors withdraw their money if a fund performs poorly, which is more likely during times of high market uncertainty. Consequently, redemption obligations increase when markets are volatile and fund managers put the value of flexibility before its cost by adjusting portfolios toward liquid assets. Market uncertainty induces an aggregate shift in mutual fund demand for liquidity, which feeds back into the market price of liquidity and generates time-variation in the liquidity premium. My empirical analysis exploits the structure suggested by Vayanos (2004) to examine this causal chain.

My analysis contributes to the literature along a number of dimensions. My primary contribution is to show that aggregate mutual fund active liquidity management, driven by market volatility, influences the market price of liquidity. Underlying this finding at the aggregate level, I show a strong and robust response of mutual funds to market volatility that uncovers the fundamental mechanisms driving this aggregate response. First, I establish that market uncertainty is associated with lower fund performance and withdrawals. Second, in response to the threat of withdrawals, funds actively rebalance their portfolios toward more liquid assets. This finding is stronger when (1) funds are in an initially weak liquidity position, and (2) when funds have greater exposure to uncertainty, as captured by the

fund-specific volatility measure that I develop. I establish that these findings are robust to incorporation of cash to analyse the joint decisions regarding cash and equity asset liquidity, and to using variation driven by market volatility that is not forcastable.

Essay 2: House Prices and Taxes (co-authored with Mads Gjedsted Nielsen)

The second essay focuses on the response of residential house prices to the change in municipal income and property tax rates. In order to identify the causal relationship between taxes and house prices, we exploit exogenous variation in municipal income and property tax rates stemming from a 2007 municipality reform.

The 2007 municipality reform was introduced for the purpose of enhancing economies of scale at the municipal level by merging smaller municipalities into larger ones. With the exemption of only four small islands, all municipalities below 20,000 inhabitants had to merge with one or more nearby municipalities in order to create a new municipalities of at least 30,000 inhabitants. After the reform, the merged municipalities had to set a new and common tax rate. If the merging municipalities did not have equal tax rates prior to the reform, the common rate would induce a change in taxes for at least one of the merging municipalities. Merging municipalities had to set the new tax rates equal to or lower than an average of the previous tax rates, plus an adjustment for changes in the public service task handled by the municipalities. Our identification strategy uses a two-stage least squares approach in order to address potential endogeneity issues. In particular, we instrument the post-reform tax rates with the average of the pre-reform tax rates in the merging municipalities. As we show, the pre-reform average is closely related to the chosen tax rate, and is independent of any factors that might influence house prices, such as contemporaneous economic conditions in the municipality.

We find that a 1%-point increase in the income tax rate lead to a drop in house prices of 7.9% and a 1‰-point increase in the property tax rate lead to a 1.1% drop in house prices. The simple present value of a 1%-point perpetual income tax increase and of a 1‰-point property tax increase, relative to the median house price correspond to 7% and 3.3%, respectively. Our findings are thus in line with predicted values. This indicates that the housing market efficiently incorporates taxes into house prices.

Essay 3: Local Economic Conditions and Local Equity Preferences: Evidence from Mutual Funds during the U.S. Housing Boom and Bust (co-authored with Chandler Lutz and Ben MacLean Sand)

The third essay examines how variation in local economic conditions affect mutual fund manager's portfolio allocation decisions and subsequent fund performance. While previous research documents a strong relationship between market-wide conditions (e.g. business cycle) and fund returns, there is relatively little known about the impact of local economic conditions (proxied here by house price growth). In particular, time-varying local conditions may fuel fund manager's intrinsic biases and affect a fund's performance.

In our analysis, we find that mutual funds respond to changes in local housing prices by shifting the degree of home bias in their equity portfolios; negative house price shocks cause funds to tilt their portfolio in favour of nearby equity holdings. However, we do not find that housing price shocks are related to what we call 'fund tangibles' (net-flows, liquidity position, etc.). Thus, the relationship between the home bias and house price shocks that we document is not being driven by fund investors' reaction to a change in local economic conditions. We argue that asset information advantage or familiarity are unrelated to local housing price shocks. Thus, our findings suggest a bias in fund manager behaviour that is unrelated to information or familiarity. This previously undocumented behavioural bias is of first-order importance, as the shift in mutual fund preferences towards local stocks induced by deterioration in local economic conditions is associated with mutual fund underperformance.

Our key finding is that deterioration in local economic conditions is associated with a shift in fund manager's preferences towards geographically proximate assets. A one percentage point drop in local house prices is related to a decrease in mean distance between a fund and its holdings by 36 km and increase in a fraction of portfolio held locally by 0.73 percentage point. We also investigate the consequences of house price driven portfolio shifts in terms of fund performance. By relating future fund performance directly with local house price shocks, we find that a one percentage point reduction in local house prices is associated with a 25 bsp and 51 bsp decrease in future 3- and 6-month characteristic-adjusted returns, respectively. We then split fund portfolios into local and distant stocks, and calculate the future performance of each sub-portfolio. We find that underperformance is concentrated in the portfolio of local stocks. Finally, we directly relate a manager's degree of home bias to fund future performance. Our two-stage least squares estimates suggest that home bias causes underperformance. A one percent increase in the fraction of local stocks in a portfolio decreases 6-month characteristic-adjusted returns by 69.9 basis points. Overall, our findings suggest that fund reaction to house price shocks reflects a response to perceived risk and fund managers view local assets as being safer, and this behavioural bias leads to poorer fund performance.

Summary in Danish

Essay 1: Investeringsforeningers flugt-til-likviditet

Det første essay giver en forklaring på forholdet imellem likviditetspræmien og markedsvolatiliteten. Mens den eksisterende litteratur undersøger effekten af markedsusikkerhed på investeringsforeningers kapitalbevægelser, har et direkte link imellem investeringsforeningers adfærd induceret af usikkerhed og markedsprisen for likviditet ikke været undersøgt. Dette essay udfylder netop dette hul ved at vise en kanal i hvilken markedsusikkerhed påvirker likviditetspræmien.

For at kunne undersøge dette forhold mellem markedsusikkerhed og likviditetspræmien, trækker jeg på resultater fra Vayanos (2004). I denne model trækker investorer deres penge fra dårligt præsterende investeringsforeninger, hvilket er mere sandsynligt i tider med høj markedsusikkerhed. Som en konsekvens vil indløsningsforpligtelserne stige når markederne er volatile og fondsforvaltere foretrækker værdien af fleksibilitet frem for omkostningerne ved at justere porteføljer mod likvide aktiver. Markedsusikkerhed inducerer et samlet skift i investeringsforeningers efterspørgsel efter likviditet, hvilket føder tilbage ind i markedsprisen for likviditet og genererer tidsvariation i likviditetspræmien. Min empiriske analyse udnytter denne struktur foreslået af Vayanos (2004) til at undersøge denne årsagsforbindelse.

Min analyse bidrager til den eksisterende litteratur langs en række dimensioner. Mit primære bidrag er at vise at investeringsforeningers samlede aktive likviditetsstyring, drevet af markedsvolatiltet, påvirker markedsprisen for likviditet. Underliggende denne konklusion på det aggregerede niveau, finder jeg en stærk og robust reaktion af investeringsforeninger på markedsusikkerhed, som afslører den fundamentale mekanisme, der driver denne aggregerede reaktion. Først etablerer jeg, at markedsusikkerhed er associeret med lavere performance og indløsninger. Dernæst, som svar på truslen om indløsninger, rebalancerer investeringsforeningerne deres porteføljer mod mere likvide aktiver. Dette resultat er stærkere når (1) investeringsforeninger er i en oprindeligt svag likviditetsposition, og (2) når foreninger har større eksponering mod usikkerhed, målt ved det foreningsspecifikke volatilitetsmål, som jeg udvikler. Jeg viser, at disse resultater er robuste over for inkorporeringen af kontanter til at analysere de samlede beslutninger omkring kontanter og aktie-aktiv volatilitet, og over for at bruge variation drevet af markedsvolatilitet, der ikke er forudsigelig.

Essay 2: Boligpriser og Skatter (medforfattet af Mads Gjedsted Nielsen)

Det andet essay fokuserer på reaktionen af boligpriserne på ændringer i kommune indkomst- og ejendomskattesatser. For at kunne identificere den kausale sammenhæng imellem skatter og huspriser, udnytter vi eksogen variation i de kommunale indkomst- og ejendomsskatter introduceret af en kommunal reform i 2007.

Kommunalreformen i 2007 var introduceret for bedre at udnytte skalaøkonomier i kommunerne ved at sammenlægge mindre kommuner og derved danner større kommuner. Med undtagelse af kun fire små øer, skulle alle kommuner med færre end 20,000 sammenlægges med en eller flere kommuner for at danne en ny kommune med mindst 30,000 indbyggere. Efter reformen skulle de sammenlagte kommuner sætte fælles udskrivningsprocent og grundskyldspromille. Hvis kommuner ikke havde samme skattesatser før reformen, vil de fælles skattesatser inducere ændringer i skattebetalingen for mindst en af de sammenlagte kommuner. Sammenlagte kommuner skulle sætte en skattesats som var lig med eller under gennemsnittet for de sammenlagte kommuner, plus en justering for ændringer i de velfærdsopgaver som kommunerne varetager. Vores identifikationsstrategi benytter en "two-stage-least-squares" tilgang for at adressere mulige endogenitetsproblemer. Specifikt, instrumenterer vi post-reform skattesatserne med gennemsnittet af præ-reform skattersatserne i de sammenlagte kommuner. Vi viser, at præ-reform gennemsnittet er tæt relateret til den valgte skattesats og er uafhængig af enhver faktor som kunne tænkes at influere huspriserne, så som de økonomiske forhold i de enkelte kommuner.

Vi finder, at et 1%points stigning i indkomstskatten medfører et 7,9% fald i huspriserne og et 1‰-points stigning i ejendomsskatten medfører et 1.1% fald i huspriserne. Den simple nutidsværdi af en permanent 1%-points stigning i indkomstskatten og en 1‰-points stigning i ejendomsskatten, relativt til medianhusprisen svarer til henholdsvis 7% og 3.3%. Vores resultater er således på linie med de forudsagte værdier. Dette indikerer at boligmarkedet forholdsvis efficient inkorporer skatter i priserne.

Essay 3: Lokale Økonomiske Forhold og Lokale Aktiepræferencer: Evidens fra Investeringsforeninger under det Amerikanske Boligmarkeds Optur og Nedgang (medforfattet af Chandler Lutz og Ben MacLean Sand)

Det tredje essay undersøger hvordan variationen i lokale økonomiske forhold påvirker fondsforvalteres porteføljeallokeringsbeslutninger og efterfølgende performance. Mens tidligere forskning dokumenterer en stærk sammenhæng mellem forhold gældende for hele markedet (eksempelvis konjunkturcyklus) og fondsafkast, er der relativt lidt viden omkring effekten af lokale økonomiske forhold (her approksimeret af boligsprisstigninger). I særdeleshed kan tidsvarierende lokale forhold forøge fondsforvalteres iboende fordomme og påvirke investeringsforeningers performance.

Vores analyse viser at investeringsforeninger reagere på ændringer i de lokale boligpriser ved at justere graden af home-bias i deres aktieporteføljer; negative boligprischok forårsager investeringsforeninger til at justere deres portefølje mod nærliggende aktieinvesteringer. Imidlertid finder vi ikke, at boligprischok er relateret til hvad vi kalder 'fonds materielle aktiver' (net-flows, likviditetspositioner, etc.). Således er forholdet imellem home-bias og boligprischok, som vi dokumentere, ikke drevet af investorernes reaktion på ændringer i de lokale økonomiske forhold. Vi argumenterer for at aktivinformationsfordelen/genkendelighed ikke er relateret til lokale boligprischok. Således tyder vores resultater på en bias i fondsforvalteres opførsel, der ikke er relateret til information eller genkendelighed. Denne tidligere udokumenterede adfærdsmæssige bias er af førsteordens vigtighed, eftersom ændringen i investeringsforeningers præferencer mod lokale aktier induceret af en forværring i lokale økonomiske forhold er associeret med fondsunderperformance.

Vores primære resultat er forringelsen af lokale økonomiske forhold er associeret med et skift i fondsforvalteres præferencer for geografiske nærtliggende aktiver. Et et-procentpoints fald i de lokale boligpriser medfører et fald i den gennemsnitlige afstand imellem en investeringsforening og dens investeringer med 36 km og øger andelen af lokale aktiver med 0.73 procentpoint. Vi undersøge også konsekvensen af boligpris pris betingede porteføljeændringer i form af fondsperfomance. Ved at sammenfører fondsperformance direkte med boligprischok finder vi, at et et procentpoints fald i boligpriserne medfører et 25 bps og 51 bps fald i fremtidige henholdsvis 3 og 6 måneders karakteristik-justeret afkast. Vi splitter derpå porteføljerne op i lokale og fjerne aktier og beregner det fremtidige afkast for hver underportefølje. Vi finder at underperformance er koncenteret om porteføljerne med lokale aktier. Til sidst relatere vi fondsforvalteres home-bias til fremtidig fondsperformance. Vores "two-stage-least-squares" estimater antyder, at home-bias forårsager underperformance. En et-procentpoints stigning i andelen af lokale aktier mindsker det 6 måneders karakteristik-justerede afkast med 69.9 basis points. Alt i alt viser vores resultater, at investeringsforeningers reaktion på boligprischok afspejler en respons på opfattet risiko og fondsforvaltere ser lokale aktier som værende sikrere, og denne adfærdsmæssige bias medfører dårligere fondsperformance.

Contents

Introduction

This thesis consists of three essays investigating financial and real estate markets and identifying a relationship between them. A 2008 financial crises provides a perfect example of sizeable interactions between US housing market and equity prices, where a negative shock to house prices triggered a word-wide recession. Therefore, understanding forces driving investors behaviour and preferences, which in turn affect asset prices in both equity and housing market are of great interest.

Previous research document, that investors prefer liquid stocks and require an extra compensation for investing in illiquid assets (Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Amihud (2002)). Liquidity premium, which is the extra return required for holding illiquid assets varies over time (Acharya and Pedersen (2005), Pastor and Stambaugh (2003), Hagströmer et al. 2013) and is correlated to measures of market volatility (Nagel (2012)). In my first essay, I contribute to the existing literature by providing a demand side explanation for the relationship between market price of liquidity and market uncertainty. Specifically, I argue that times of high uncertainty coincide with large market declines. Consequently, investors have greater demands for liquidity and this places upward price pressure on the liquidity premium.

In order to examine this causal chain, I exploit the structure suggested by Vayanos (2004). I investigate an investor's response to uncertainty with US open-end mutual funds data from Morningstar. To analyse the effect of mutual fund demand for liquidity, I construct a fund's active liquidity management measure, which isolates a change in a fund's portfolio liquidity directly under the fund manager's control. Consistent with Vayanos (2004) theoretical predictions, I show that uncertainty is associated with greater outflows from mutual funds. Mutual funds respond to the greater threat of redemptions during times of uncertainty, by shifting the composition of their portfolios towards more liquid assets - the so called 'flight-to-liquidity'. As funds respond to an aggregate market conditions, the coordination of their behaviour places downward price pressure on illiquid assets.

While existing research investigates the impact of market uncertainty on mutual fund capital flows (Ferson and Kim (2012) and Ederington and Golubeva (2011)), a direct link between uncertainty-induced fund behaviour and the market price of liquidity have not be examined. My first essay bridges this gap by showing one channel through which market uncertainty impacts the liquidity premium. Furthermore, consistent with theoretical predictions of Ang et al. (2014), my paper contributes to the empirical asset pricing literature by documenting liquidity targeting among US equity mutual funds. The novelty of my empirical approach allows me to incorporate cash into active liquidity management measure and analyse the joint decision regarding cash and equity asset liquidity.

Empirical investigation of forces and drivers in housing market have been partly constrained by a lack of available data, because most of real estate is privately traded. A proper identification of a causal relationship requires a controlled experiment in order to address any endogeneity concern inherent in the analysis of the prices on quantities. The 2007 municipal reform in Denmark provides a unique laboratory to asses the impact of income and property taxes on residential house prices. In my second essay (co-authored with Mads Gjedsted Nielsen), we eploit the exogenous variation in municipal income and property tax rates to identify causal relationship between taxes and house prices.

The main purpose of the 2007 municipality reform in Denmark was to increase economies of scale at the municipal level by merging smaller municipalities. With the exemption of only four small islands, all municipalities below 20,000 inhabitants had to merge with one or more nearby municipalities in order to create a new municipality of at least 30,000 inhabitants. The merged municipalities were required to jointly set a new tax rate. The new tax rates equal to or lower than an average of the previous tax rates plus an adjustment for changes in the public service task handled by the municipalities. Our identification strategy uses two-stage least square approach in order to address potential endogeneity issues. We instrument the tax rates after the reform with the average of previous tax rates in the merging municipalities, since this average is closely related to the chosen tax rate, and is independent of any factors that might influence house prices, like the economic situation in the municipality.

We find that a 1%-point increase in the income tax rate lead to a drop in house prices of 7.9% and a 1‰-point increase in the property tax rate lead to a 1.1% drop in house prices. The simple present value of a 1%-point perpetual income tax increase and of a 1‰-point property tax increase, relative to the median house price correspond to 7% and 3.3%, respectively. Our findings are thus in line with predicted values. Our analysis provide a support to the findings of Palmon and Smith (1998) about efficient incorporation of taxes into house prices.

In the third essay (co-authored with Chandler Lutz and Ben MacLean Sand), we study how local house market shocks affect a mutual fund asset allocation decision. We contribute to the empirical asset pricing literature by investigating a potential source of investor's home bias. While existing research remains divided on the origin of home bias, we argue that funds' time-varying preferences towards local stocks cannot be explained by informational advantages or manager's familiarity.

In our analysis, we find that mutual funds respond to local house market shocks by shifting the degree of home bias in their equity portfolios; negative house price shocks cause funds to tilt their portfolio in favour of nearby equity holdings. However, we do not find that housing price shocks are related to what we call 'fund tangibles' (net-flows, liquidity position, etc.). Thus, the relationship between the home bias and house price shocks that we document is not being driven by fund investors' reaction to a change in local economic conditions. We argue that asset information advantage or familiarity are unrelated to local housing price shocks. Thus, our findings suggest a bias in fund manager behaviour that is unrelated to information or familiarity. This previously undocumented behavioural bias is of first-order importance, as the shift in mutual fund preferences towards local stocks induced by deterioration in local economic conditions is associated with mutual fund underperformance.

This paper contributes to the literature along a number of dimensions. Our primary contribution is to show that a variation in local economic conditions affect mutual fund managers' preferences towards geographically proximate assets. We also document a strong shift towards safer and higher quality stocks in face of locally decreasing house prices. Last but not least, we argue that our analysis provides evidence of previously undocumented behavioural bias. We find that deterioration in local economic condition induced shift in preferences towards local assets is associated with a significant decrease in a fund's performance. Symmetry of our results suggest that fund manager react to positive shocks to local house market by investing in what they are not familiar with. These results undermine informational advantage and manager's familiarity as potential explanations for time-varying home bias among mutual funds. Overall, our evidence highlights the importance of local economic conditions in fund managers' asset allocation decision making.

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Essay 1

Mutual fund flight-to-liquidity[1]

[1] I thank Susan Christoffersen, Wayne Ferson, Søren Hvidkjær, Markku Kaustia, Sven Klingler, Lasse Heje Pedersen, Jesper Rangvid, Ben Sand, Mike Simutin, Morten Sørensen for helpful comments and suggestions. I am also grateful to participants at the PhD Nordic Finance Workshop in Helsinki, 3rd Annual USC Marshall Ph.D. Conference in Finance, brown bag seminar at Aarhus University, University of Copenhagen and Copenhagen Business School.

Abstract

This paper examines the liquidity choices of mutual funds during times of market uncertainty. I find that when markets are uncertain, mutual funds actively increase the liquidity of their portfolio – often referred to as a 'flight-to-liquidity.' In aggregate, mutual fund behaviour has implications for the market; the market driven flight-to-liquidity places upward pressure on the liquidity premium. I examine the underlying mechanisms driving fund behaviour. I show that market volatility is associated with lower fund performance and withdrawals, which causes funds to adjust the composition of their portfolio towards more liquid assets in order to meet potential redemptions. This causal chain is consistent with Vayanos (2004), who argues that fund managers are investors with time-varying liquidity preferences due to threat of withdrawal. Aggregated over funds, the effect is substantial: a one standard deviation increase in my measure of flight-to-liquidity yields a 0.63 standard deviation increase in the excess return required for holding illiquid securities.

1.1 Introduction

A stock's liquidity and how its liquidity evolves over time are a primary concern to investors. Recent studies show that investors prefer more liquid stocks and expect an extra compensation for holding an illiquid asset (Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Amihud (2002)). Similarly, market makers need compensation for providing liquidity to investors and they charge a higher price if a traded asset is less liquid. This excess return required by both investors and market makers for bearing liquidity risk, which is called the liquidity premium, not only varies over time (Acharya and Pedersen (2005), Pastor and Stambaugh (2003), or Hagströmer et al. 2013), but it is also correlated to measures of market uncertainty. However, the mechanism driving this association is not well understood:

> *The fact that expected returns from liquidity provision are strongly related to the VIX index does not necessarily imply that the VIX index itself is the state variable driving expected returns from liquidity provision. More likely, the VIX proxies for the underlying state variables that drive the willingness of market makers to provide liquidity and the public's demand for liquidity.* (Nagel (2012), p.2008)

In this paper, I investigate one channel through which market uncertainty affects the liquidity premium. Whereas Nagel (2012) relates the price of liquidity to its supply, I explore a demand-side explanation. In particular, I argue that times of high uncertainty coincide with large market declines. Consequently, retail investors have greater demands for liquidity and this places upward pressure on the liquidity premium.[2] While I cannot directly observe an investor's demand for liquidity, it can be partly inferred from mutual funds' net flows. This is due to the fact that mutual funds provide liquidity to their shareholders . Consistent with this idea, I show that uncertainty is associated with greater outflows from mutual funds. Mutual funds, responding to the greater threat of redemptions during times of uncertainty, shift the composition of their portfolios toward more liquid assets – the so called 'flight-to-liquidity.'[3] As funds respond to an aggregate market condition, the coordination of their behaviour places downward price pressure on illiquid assets. The effect is substantial: a one standard deviation in my measure of flight-to-liquidity causes a 0.63 standard deviation increase in the market price of liquidity.

[2]See e.g. Bernardo and Welch (2004) and Morris and Shin (2004).

[3]A related and recent paper by Huang (2014) provides empirical evidence of an association between expected market volatility and the liquidity of mutual fund holdings. My paper builds on this evidence by exploring the underlying mechanism driving this association and relating mutual fund liquidity management to the market level price of liquidity.

In order to examine the link between market uncertainty and the price of liquidity, I draw on insight from Vayanos (2004). In his model, investors withdraw their money if a fund performs poorly, which is more likely during times of high market uncertainty. Consequently, redemption obligations increase when markets are volatile and fund managers put the value of flexibility before its cost by adjusting portfolios toward liquid assets. Market uncertainty induces an aggregate shift in mutual fund demand for liquidity, which feedbacks into the market price for liquidity and generates time-variation in the liquidity premium. My empirical analysis exploits the structure suggested by Vayanos (2004) to examine this causal chain.

I investigate a mutual fund's response to uncertainty with US open-ended mutual funds data from Morningstar. In these data mutual funds actively invest in US equity between January 1998 and December 2013. A key variable in my analysis, which I refer to as 'active liquidity management,' is a measure of how funds actively manage the liquidity of their portfolios by adjusting the composition of their assets. I construct this variable by first computing a fund's monthly portfolio liquidity as a weighted average of the holdings Amihud's (2002) liquidity measure, where the weights are a fraction of the portfolio invested in each stock. The change in a fund's portfolio liquidity between two months can be decomposed via a common shift-share analysis.[4] This decomposition represents a shift in portfolio liquidity from two distinct sources: (1) shifts due to a change in the liquidity of the holdings (the Amihud measure), and (2) shifts due to active modification of a portfolio's composition in terms of holdings. This second component is my measure of a fund's active liquidity management, since it isolates the change in a portfolio's liquidity directly under the fund manager's control.

In Vayanos's (2004) model, a key factor impacting a fund's liquidity preference is the threat of withdrawal, which is increasing in market volatility. Thus, a key relationship in my analysis is how a fund's active liquidity management responds to net flows, which I examine in a regression framework. In doing so, I attempt to control for possible confounding factors, such as variables that capture overall market performance and the availability of liquidity, seasonality and year fixed-effects, and also for a complete, unrestricted set of fund-level fixed effects. These latter variables are meant to capture possible time-invariant fund characteristics. Using this set of controls, I identify the effect of net flows on liquidity management by focusing on within-fund and within-year, over-time variation. The OLS estimates of this relationship suggest that funds are unresponsive to net flows. However, while fund fixed effects mitigate the problem of possible correlation between net flows and

[4] Shift-share allows to decompose the change in a weighted mean into one part that is due to a change in the weights and another part that is due to the change in the underlying variable (Dunn, 1960).

fund time-invariant factors, there is still a potential endogeneity concern arising from omitted time-varying variables that are correlated with fund flows, such as time-varying skills (Kacperczyk et al. (2014)). To overcome this potential identification issue, and to focus on variation in net flows stemming from market uncertainty, I exploit the structure of Vayanos's model which suggests a natural instrumental variable – market volatility.

A two-stage estimation procedure arises naturally from the structure of the model, which predicts that net flows are negatively impacted by market uncertainty, causing funds to adjust portfolio liquidity. The first-stage relates net flows to market uncertainty, which is measured in my baseline empirical work by a realized market volatility estimator, and controls for the same variables as above. I find that realized volatility strongly predicts outflows from equity mutual funds, a necessary requirement for the instrumental variables estimation procedure. This result is both consistent with the model and with existing literature.[5] In the first-stage regression, a one standard deviation shock to market volatility decreases aggregate fund flows by 0.4%. Following Vayanos's (2004) framework, I show that this effect is partly explained by a deterioration in a fund's performance when markets are more volatile.

The second-stage relates a fund's active liquidity management to variation in net flows induced by market uncertainty. In contrast to the OLS estimates, I find that by isolating the variation in fund net flows stemming only from market volatility, mutual funds strongly respond to redemption obligations by actively managing the liquidity of their portfolio. A one standard deviation decrease in fund's net flows causes a 1.9 standard deviation increase in actively managed portfolio's liquidity. This estimate is robust to market-wide returns and liquidity, and focuses on within-year variation. Thus, the identifying variation comes from shifts in realized market volatility holding market-wide performance and liquidity constant. In order for the instrumental variables procedure to yield causal estimates of mutual fund responses to uncertainty, my maintained assumption is that these shifts in realized volatility, above and beyond a rigorous set of controls for market performance, are exogenous to mutual funds. While this assumption is plausible, since individual funds are small relative to the market as a whole, I also show that the results are robust to using variation in realized volatility that is *not forcastable* by US CBOE Volatility Index (VIX), which I call a 'volatility shock.' This robustness check ensures that my results are not driven by anticipatory behaviour.

These results demonstrate that mutual funds respond to negative shocks to their flows induced by market uncertainty by increasing the liquidity of their portfolios. In aggregate,

[5]For example, Ederington and Golubeva (2011) and Ferson and Kim (2012) show a negative relationship between future expected volatility and net aggregate equity fund flows.

the time-varying liquidity preferences of mutual funds can contribute to the time-varying nature of the market price of liquidity (Vayanos (2004)). To examine this link, I measure the market liquidity premium as the additive inverse of the difference between illiquid and liquid portfolio returns, following Jensen and Moorman (2010). I relate this to mutual fund demand for liquidity, which I calculate by aggregating my measure of active liquidity management over funds in each period. The association between these two variables is strong and is consistent with the model's predictions. In order to address any endogeneity concern inherent in the analysis of the prices on quantities, I use market volatility in an instrumental variable approach. By only using the variation in aggregate active liquidity management stemming from market uncertainty, I show that a volatility-induced shift in preferences towards more liquid assets exerts downward price pressure on illiquid stocks, which is reflected in the narrowing of the measured return spread. A one standard deviation increase in actively managed portfolio's liquidity decreases the return spread by 2.13%. Thus, a major contribution of my paper is that it provides a partial explanation for the observed relationship between the liquidity premium and market uncertainty found in the literature.

In my baseline analysis I use only equity holdings information to study a mutual fund's response to the threat of withdrawal. In reality, cash is an important component of a fund active liquidity management. Thus, I incorporate information on cash holdings into my analysis. First, I treat a cash holdings decision separately from liquidity management of equity holdings. I show that fund managers increase the percentage of the portfolio held in cash when they face the threat of redemptions, consistent with Huang (2014). However, treating cash and equity decisions separately is incorrect if there is strategic interaction between those two decisions. I respond to this difficulty by incorporating both cash and equity into a fund's portfolio by treating cash as any other equity position when measuring active liquidity management. The novelty of my approach is that it allows for the analysis of the *joint* decisions regarding cash and equity asset liquidity. I assign the Amihud measure of zero to cash and use weights equal to the fraction of a portfolio held in the form of cash. After incorporating cash into a fund's active liquidity management, I show that the response to uncertainty remains unchanged.

One potential weakness of my analysis is that it relies on over-time variation that is common to all funds. However, funds differ from one another in terms of the composition of their holdings. This difference will translate into differences in exposure to market volatility, which is measured as the volatility of the S&P 500. In order to assess the importance of this, I create a fund-specific volatility measure that is based on the composition of assets the funds actually hold. For each mutual fund, I measure the fraction of the portfolio invested in one of the ten GICS sectors, and construct a fund-specific uncertainty measure by estimating the value-weighted average of Garman and Klass's (1980) sector realized volatility. This method allows both over-time and between-fund variation to be exploited in my analysis. I find that mutual funds react stronger to my fund-specific volatility measure compared to the market one. This implies that my results based on market volatility are conservative, since fund reaction depends on their portfolio exposure. This result is new to the literature.

A possible source of heterogeneity of a fund's response to market uncertainty comes from the differences in its initial liquidity position. Funds that happen to be more illiquid when market volatility increases are expected to have stronger reactions since it is more difficult for them to meet redemptions. To investigate this, I develop a measure of 'illiquidity shock' for each fund. This variable is defined as a percentage change in a portfolio's liquidity due to a change in the market-wide Amihud measure of the assets, holding investment shares fixed. The idea behind this variable is that it captures shocks to a fund's liquidity position that are exogenous to management decisions at a specific date. In fact, this measure arises naturally in my shift-share decomposition of a fund's average Amihud changes. I show that mutual funds actively manage the liquidity of their portfolio not only in times of high market uncertainty, but also when they face an illiquidity shock. This finding suggests that managers target the liquidity of their portfolio. While this result is consistent with the theoretical predictions of Ang et al. (2014), empirically establishing evidence of a liquidity targeting in the case of mutual funds is a new contribution to the literature. I also show that mutual funds experiencing an illiquidity shock respond stronger to market uncertainty, meaning that they more aggressively tilt their portfolio towards liquid stocks.

My paper contributes to the literature along a number of dimensions. My primary contribution is to show that aggregate mutual fund active liquidity management, driven by market volatility, influences the market price of liquidity. Underlying this finding at the aggregate level, I show a strong and robust response of mutual funds to market volatility that uncovers the fundamental mechanisms driving this aggregate response. First, I establish that market uncertainty is associated with lower fund performance and withdrawals. Second, in response to the threat of withdrawals, funds actively rebalance their portfolios toward more liquid assets. This finding is stronger when (1) funds are in an initially weak liquidity position, and (2) when funds have greater exposure to uncertainty, as captured by the fund-specific volatility measure that I develop. I establish that these findings are robust to incorporation of cash to analyse the *joint* decisions regarding cash and equity asset liquidity, and to using variation driven by market volatility that is not forcastable.

A number of studies are related to this work. First, as noted above, my empirical work is guided by the theoretical model of Vayanos (2004). The empirical focus of my work is related to Huang (2014) and Ben-Rephael (2014). However, in contrast to these papers, which estimate reduced form relationships, I provide a mechanism explaining mutual fund flight-to-liquidity by more formally investigating Vayanos (2004), and relate fund responses to the market price of liquidity. Ben-Rephael (2014)'s identification comes from times of crisis, whereas my paper's identification is general, and comes from within-year shifts in market volatility. Thus, I show that flow-induced changes in mutual fund liquidity preferences are reflected in the time-varying market price of liquidity more generally, and are not just isolated to times of crisis. I use market uncertainty as the main driver of mutual fund flight-to-liquidity. Beber et al. (2009) also condition their analysis on market uncertainty and they show a shift in liquidity preferences of sovereign bond investors when market volatility is high. I show that market volatility affects mutual fund demand for liquidity, which is in line with the prediction of Brunnermeier and Pedersen (2009) that increases in market volatility coincide with liquidity dry-ups. Whereas my study investigates the impact of the threat of withdrawals on mutual fund active liquidity management, Liu and Mello (2011) analyse optimal asset allocation for hedge funds in the face of possible coordinated redemptions. There is also a series of papers examining the effect of mutual fund flows on concurrent stock returns. However, none of these explain the time-varying nature of liquidity premium with flow-induced trading. Lou (2012) shows that flow-induced trading can explain stock price momentum. Greenwood and Thesmar (2011) relates price volatility and the co-movement in stock returns to the trades of distressed mutual fund and their spill-over effects. Coval and Stafford (2007) demonstrate that flow-induced transactions of funds experiencing substantial in- and outflows exert price pressure on their traded holdings, thus providing liquidity to those constrained funds can be very profitable.

The paper is organized as follows. In the next section, I relate my analysis to the existing literature. In section 3.2, I describe the data and the variable construction in detail. In Section 3.4, I explain estimation approach and report the empirical results. In Section 1.5, I show the robustness of my results. Section 3.5 concludes.

1.2 Related Literature

This paper is related to, and builds on, three distinct lines of literature. First, my paper contributes to a large and growing literature that focuses on liquidity dry-ups with evidence of a causal mechanism related to investor behaviour. The second contribution of the paper lies in an examining investor's portfolio liquidity choices, which is related to a literature that began with the seminal paper of Constantinides (1986). Finally, my paper adds to the literature discussing the asset pricing implications of investor behaviour.

1.2.1 Liquidity Dry-Ups

My study relates to the growing literature on times of liquidity dry-ups. Much of the literature discusses the mechanism leading to periods of evaporating liquidity. For example, Bernardo and Welch (2004) model liquidity runs, where investors fear future liquidity shocks and prefer to sell today in order to receive an average price. Brunnermeier and Pedersen (2009) provide a model with a feedback relationship between assets' market liquidity and investors' funding liquidity. They predict that increases in market volatility coincide with drops in market liquidity, because of market-makers' limited liquidity provision. Malherbe (2014) proposes an adverse selection liquidity model, where holding cash imposes a negative externality, reducing future market liquidity and causing liquidity dry-ups.[6]

There is little empirical evidence on investors' behaviour in times of liquidity crises. Beber et al. (2009) focus on the importance of the quality and the liquidity for the determination of sovereign yield spreads. They show changes in a credit quality can explain sovereign yield spreads to a large extent. However, in times of market uncertainty liquidity of sovereign bonds is the main driver of the yield spreads.[7] My study builds on this existing literature by analysing liquidity preferences of equity mutual funds in times of high market volatility, which in turn coincide with liquidity dry-up periods.

1.2.2 Portfolio Choices with Trading Costs

Several theoretical studies investigate investors' portfolio choices in the presence of trading costs. Ang et al. (2014) propose a model of an optimal allocation between liquid and illiquid assets. The liquidity risk comes from periods of an uncertain duration, where illiquid assets cannot be traded and consumption can only be funded by a liquid part of the portfolio. They show, among others, that investors have an optimal portfolio composition of liquid and illiquid assets (ξ^*), to which they rebalance whenever it is possible. The portfolio management in times of crisis constitutes the main focus of a growing number of empirical studies. Manconi et al. (2012) look at institutional bond holders in 2007. They find that liquidity-constrained mutual funds contribute to the transmission of the crises from securitized bonds to corporate bonds. Huang (2014) shows in a reduced form that mutual funds have liquidity preferences in times of market uncertainty and their liquidity management is reflected in fund performance. Ben-Rephael (2014) analyses ten episodes of volatility shocks. He shows that mutual funds on average sell more illiquid than liquid stocks and illiquid assets experience a greater price discount than liquid ones during crisis periods.

[6] See also Gennotte and Leland (1990), Huang and Wang (2009), and Krishnamurthy (2010).
[7] See also Longstaff (2004).

My empirical study is closely related to the model of Vayanos (2004). In the theoretical framework, he proposes a link between volatility-induced performance and net flows that, in turn, affect a fund's behaviour. The probability of fund performance falling below a benchmark increases with volatility. Fund investors monitor the performance and they withdraw their money when the performance drops below the threshold. Since mutual fund managers fear the redemptions, they require higher risk premium per unit of volatility and are less willing to keep illiquid stocks in their portfolio. In consequence, illiquid stocks experience greater price discount what is reflected in an increase in market liquidity premium. The threat of the redemptions is also a main driver of an institutional investor portfolio allocation in the study of Liu and Mello (2011). They propose a model on portfolio choices of hedge funds up against the risk of coordinated withdrawals. There is a trade-off between higher returns and greater liquidation costs that determines an optimal level of cash holdings. However, hedge fund managers choose a suboptimal (too high) level of cash as a result of their fear of coordinated redemptions.[8] My empirical analysis focuses on equity mutual fund portfolio composition in face of a threat of withdrawal. Consistent with the existing literature, I show that mutual fund managers target the liquidity of their portfolio and in face of threat of withdrawals they shift towards more liquid assets.

1.2.3 Asset Pricing Implications of Funds' Behaviour

This paper shows a relationship between volatility induced fund active asset allocation and market liquidity premium. Thus, my analysis also relates to the literature that focuses on an explanation of market predictabilities with mutual fund trading which is induced by investors' flows and managers correlated behaviour. Coval and Stafford (2007) provides a rational explanation for the deviation of stock prices from its fundamental value. They show that mutual fund transactions triggered by both large out- and inflows can push prices away from their intrinsic value. Investors trading against those distress funds can generate a high return from providing liquidity. Lou (2012) explains the return momentum and reversal by means of expected flow-induced trading.[9] Finally, Gârleanu and Pedersen (2007) develop a theoretical framework, where they link market liquidity and risk-management practices of institutional investors. They show that in case of high market volatility, or reduced risk-bearing capacity a feedback relationship between risk-management and market liquidity can arise. As a result of tighter risk-management the prices of illiquid stocks decrease and

[8] Chernenko and Sunderam (2015) show that cash holdings play a significant role in accommodation of mutual fund in- and outflows.

[9] See for return comovement - Antón and Polk (2014) and Greenwood and Thesmar (2011), liquidity comovement - Koch et al. (2010).

the market price of liquidity increases. My empirical analysis provides evidence that stock prices can deviate from their intrinsic value because of investor demand unrelated to the fundamentals. In line with the existing literature, I show that mutual fund transactions induced by the threat of withdrawal put upward price pressure on the liquidity premium.

1.3 Data and Variable Construction

In this section, I introduce my data source and processing procedures. I also explain the construction of the variables used for my analysis and I discuss descriptive statistics.

1.3.1 Mutual fund and stock data

I use monthly mutual fund holdings obtained from Morningstar database for the period of 1998-2013. The data is complied from both mandatory SEC filings and voluntary disclosures. Elton et al. (2010) provide a comparison of the Morningstar holdings data with the more frequently used data from Thomson Reuters. They conclude that Morningstar is without survivorship bias and it captures 18.5% more trades than Thomson Reuters database does. Since this paper focuses on the impact of mutual fund active asset allocation on the US equity market, I include domestic mutual funds actively investing in US equity.

Mutual funds' total net assets (TNA), net returns, net flows, cash holdings and other fund characteristics are also obtained from Morningstar database. For mutual funds with multiple share classes, I calculate the TNA-weighted average of net returns (cash holdings) across all share classes to derive the net return (cash holdings) of the fund. Mutual fund net flows are already available at the fund level.

The stock data (daily returns, prices, trading volumes and shares outstanding) for common shares (share code 10 and 11) are obtained from the Center for Research in Security Prices (CRSP). I require each stock to have at least 15 days of return and dollar volume data in a month. I use CUSIP identification number to merge mutual fund holdings information with CRSP stock database. I include only those mutual funds with 70% of their holdings value identified as a common US equity and successfully merged with CRSP dataset. In order to measure market uncertainty, I obtain daily information on open, close, high, and low price for S&P 500 index from Finance Yahoo website, and daily VIX observation from Chicago Board Options Exchange (CBOE).[10]

After applying these screening procedures, I obtain a sample of 85,560 fund-month observations on 1,601 different mutual funds. Table 1.1 shows summary statistics of the mutual

[10] https://ca.finance.yahoo.com/q/hp?s=^GSPC and http://www.cboe.com/micro/vix/historical.aspx.

funds' main characteristics for each year. The number of mutual funds in the sample increases from 169 in 1998 to 1,006 in 2013. The median *TNA* varies over time between 252.05 million in 2003 and 765.16 million in 1998. The number of different stocks held across all mutual funds in my sample increases from 2,285 in 1998 to 3,908 in 2007. There is some skewness in the number of stocks held by mutual funds, meaning that there are few mutual funds with numerous stocks in their portfolio. The median number of stocks per fund is between 64 and 90. The last column in Table 1.1 shows the percentage of the holdings value that has been successfully merged with common stocks from CRSP dataset.

1.3.2 Variable construction

Illiquidity measure

A stock's liquidity is unobservable. Out of many liquidity proxies I choose Amihud's (2002) measure.[11] Following Amihud (2002), I define the illiquidity of a stock s on the day d as:

$$Illiq_{s,d} = \frac{|R_{s,d}|}{V_{s,d}}, \tag{1.1}$$

where $R_{s,d}$ is stock s return on day d and $V_{s,d}$ is its dollar volume. I use monthly frequency of mutual fund holdings, thus I estimate monthly stock liquidity by averaging Amihud's (2002) daily measure in month t:

$$Illiq_{s,t} = \sqrt{\frac{1}{D_{s,t}} \sum_{d=1}^{D_{s,t}} Illiq_{s,d}}, \tag{1.2}$$

where $D_{s,t}$ is the number of observation for stock s in month t. To reduce the influence of extreme observations, I choose a square-root transformation.[12] I use a stock-level liquidity measure to compute a monthly value-weighted illiquidity measure at the mutual fund level:

$$Illiq_{f,t} = \sum_{s=1}^{S_{f,t}} \omega^s_{f,t} \cdot Illiq_{s,t}, \tag{1.3}$$

where $S_{f,t}$ is the number of stocks held by mutual fund f in the month t, and $\omega^s_{f,t}$ is a fraction of the portfolio of fund f in month t held in stock s.

[11] Hasbrouck (2009) shows that out of liquidity measures, which he tested, square-root transformation of Amihud measure is the most strongly correlated liquidity proxy with TAQ-based price impact coefficient.

[12] I use the square-root transformation, because it enables me to include cash holdings into the behaviour measure in the later part of my analysis. My results are robust to other Amihud measure transformations. Chordia et al. (2009), Hasbrouck (2009), and Chen et al. (2010), among others, use the square-root transformation of Amihud measure as well.

Existing studies show that market volatility affects a stock's liquidity (e.g. Chung and Chuwonganant (2014), Brunnermeier and Pedersen (2009)).[13] Furthermore, the liquidity of a fund's portfolio can change between two months for two reason: its holdings become more or less liquid, and a fund manager actively manages liquidity of the portfolio by trading securities. In order to separate these two effects I perform a shift-share analysis by decomposing the change in portfolio's liquidity into two components. The first component captures shifts due to a change in the liquidity of the holdings (Amihud measure), and the second corresponds to shifts in the active modification of a portfolio's composition in terms of holdings. I decompose the change in a fund's portfolio liquidity in the following way:

$$\begin{aligned} \Delta Illiq_{f,t} &= \sum_{s=1}^{S_{f,t}} \omega^s_{f,t} \cdot Illiq_{s,t} - \sum_{s=1}^{S_{f,t-1}} \omega^s_{f,t-1} \cdot Illiq_{s,t-1} \\ &= \sum_{s=1}^{S_{f,t-1}} \omega^s_{f,t-1} \left(Illiq_{s,t} - Illiq_{s,t-1}\right) + \sum_{s=1}^{S_{f,t}} Illiq_{s,t} \left(\omega^s_{f,t} - \omega^s_{f,t-1}\right). \end{aligned} \tag{1.4}$$

The first term denotes the change in a portfolio's liquidity due to a market-wide change in individual stock's Amihud measure. The second term is my measure of a fund's active liquidity management B^f_t, which is obtained by isolating the component of the change in a portfolio's liquidity directly under the fund manager's control. It reflects the change in the value of holdings composition as a consequence of asset purchases and sales actively performed by fund's manager.

One challenge with the data is to disentangle an investor's demand for liquidity from her demand for quality. Beber et al. (2009) show that investors' demand for safety and liquidity at the bond market changes over time. In times of market distress investors chase liquidity rather than credit quality. I use a stock's quality measure constructed by Asness et al. (2013) to control for a portfolio's quality.[14] The quality measure captures four dimensions of quality: profitability, growth, safety, and pay. For each mutual fund every month, I calculate a value-weighted quality rank $Quality^f_t$ (eq. 1.3) and use it as a fund level control variable.

[13]Chung and Chuwonganant (2014) shows that the liquidity of a single stock is strongly related both to its own risk and to the level of uncertainty in the market as a whole. In their theoretical model, Brunnermeier and Pedersen (2009) also predict that increases in VIX coincide with drops in market liquidity, because market-maker's liquidity provision is limited when the market volatility is high.

[14]I am grateful to Lasse Heje Pedersen for sharing with me their quality measure.

Fund performance and investors flows

In Vayanos's (2004) model, an investor withdrawals from a mutual fund, when a fund's performance falls below a given threshold. As the threshold is not precisely defined, I use the S&P 500 index as the benchmark. The S&P 500 index seems to be a natural choice, as even daily newspapers deliver information about its performance on a regular basis. I define mutual fund f performance in month t as:

$$Perf_{f,t} = R_{f,t} - R_{M,t}, \tag{1.5}$$

where $R_{f,t}$ is mutual fund monthly return net of management, administrative, and 12b-1 fees and $R_{M,t}$ is the return on S&P500 index in month t.

Morningstar provides estimated fund-level net flows ($MFlow_t^f$) at the monthly frequency.[15] I compute the relative net flows in order to capture the percentage of money flowing into and out of a mutual fund relative to its total assets:

$$Flow_{f,t} = \frac{MFlow_{f,t}}{TNA_{f,t-1}}, \tag{1.6}$$

where $TNA_{f,t-1}$ is a total net asset of the fund f in the previous month.

Market level variables

I use historical market volatility as a proxy for uncertainty measure. Following prior literature (e.g. Longstaff et al. (2011)), I choose a standard way of estimating realized market volatility proposed by Garman and Klass (1980). The Garman-Klass volatility estimator can be calculated based on open-high-low-close prices (OHLC) of the S&P 500 index:

$$RVol_t = \sqrt{\frac{Z}{D_t} \cdot \sum_{d=1}^{D_t} \frac{1}{2} \cdot \left(\log \frac{h_d}{l_d}\right)^2 - (2 \cdot \log(2) - 1) \cdot \left(\log \frac{c_d}{o_d}\right)^2}, \tag{1.7}$$

where h_d, l_d, o_d, and c_d are high, low, open, and close prices of stock S&P 500 index on day d. Z is the number of closing prices in a year, and D_t is the number of historical prices used for the market volatility estimate in month t.

In the robust analysis, I use a non-forcastable part of market realized volatility. I obtain it by regressing realized market volatility measure $RVol_t$ on its forecast for the current month. I save the residuals $Res(Vol)_t$ from this regression and use them as the shock component

[15] An estimated fund-level net flows are computed from aggregated share-class-based flows if available, otherwise estimated from surveyed fund size.

of market volatility. I choose a monthly average of the CBOE Volatility Index (VIX) daily observations as my market volatility forecast because of its beneficial characteristic of being forward looking.[16] VIX is also a well known measure for market risk and is sometimes called an 'investor fear gauge'.

Existing research shows that times of high market volatility are associated with periods of liquidity dry-ups. According to Nagel (2012), a reduction in market-wide liquidity increases the cost of providing liquidity and the risk of holding illiquid stocks. Vayanos (2004) predicts that fund managers' risk aversion increases with market uncertainty, thus they become less willing to hold illiquid securities and require a higher return for bearing the costs and risks. Consequently, illiquid stocks are especially affected by the deterioration in market liquidity and they experience sizeable price discounts. To capture time-varying liquidity premium, I use the return differential between illiquid and liquid stocks that incorporate the price movement of these securities. I construct the return spread by sorting all stocks every month into five portfolios based on their mean liquidity over past 3 months, and calculate the monthly value-weighted return for each portfolio. I create a zero-cost portfolio that is long in the least liquid quintile and short in the most liquid one. A decrease in the return on this portfolio indicates a drop in the price of illiquid securities, higher required return for holding illiquid stocks, and an increase in the market price of liquidity.[17]

Summary statistics

Table 1.2 panel A with summary statistics for the constructed variables gives some insights into mutual funds liquidity preferences. The mean (median) fund illiquidity is 31.015 (25.574), meaning that mutual funds invest in the top 12% of most liquid stocks.[18] They also prefer stocks of better quality in their portfolio with the mean (median) quality rank of 0.656 (0.657). They keep on average 3.2% of their holdings in the form of cash. An average fund experiences monthly net cash flows of 0.8% of TNA and generates an average return of 0.08% above the return on the S&P500 index.

Panel B in table 1.2 shows the correlations between the main variables. The market uncertainty measured by realized volatility is negatively correlated with fund relative performance (-0.22), flows (-0.32), and active liquidity management measure (-0.42), whereas

[16] CBOE Volatility Index was introduced by the Chicago Board Options Exchange in 1993. It was designed to measure the market's expectation of 30-day volatility implied by at-the-money S&P100 (VXO) option prices. In 2003, a new VIX measure was launched, which is based on the S&P500 Index and is estimated as a weighted average of call and put prices for a wide range of strike prices (*source:* `http://www.cboe.com/micro/vix/vixwhite.pdf`).

[17] The return spread is an additive inverse of the proxied market liquidity premium.

[18] I obtain the value of 12% from assigning illiquidity ranks between zero and one for all stocks every month and estimate a fund-level illiquidity rank.

it is positively correlated with portfolio's illiquidity (0.48). Performance is also negatively correlated with the change in market-wide liquidity $\Delta Noise_t$ (-0.19), whilst fund flows co-vary positively with market return $R_{M,t}$. This strong negative relationship between realized volatility and fund performance is also pronounced in Figure 1.1. The shaded areas depict periods of high market volatility. This figure shows that mutual funds underperform the market in times of high market uncertainty. The negative relationship between market volatility and fund flows is illustrated in Figure 1.2. Not surprisingly, the plot shows that on average mutual funds experience inflows when market volatility is low, however when market uncertainty increases investors withdraw their money from equity mutual funds.[19]

1.4 Estimation and Results

Following Vayanos (2004), I estimate a system of three equations. He shows that high market uncertainty increases the probability of a fund's performance falling below a given threshold, which in turn, is associated with an increase in a fund's redemption obligations. Managers fear withdrawals, therefore they increase the liquidity of their portfolio and, at the same time, they exert an upward price pressure on the market liquidity premium.

1.4.1 Estimation Setup

The first step of the analysis examines whether there is a relationship between current fund performance and its flows. In Vayanos (2004), investors withdraw their money from the mutual fund if its performance falls below a given benchmark. I estimate the impact of a fund's relative performance on flows by running a regression of net flows on current performance, and a set of fund-specific and market-wide variables. I also control for fund time-invariant characteristics, seasonality in the flows, and across-year variation.[20]

Step 1:

$$Flow_{f,t} = \beta_0 + \beta_1 Perf_{f,t} + \beta_2 Q_{f,t} + X_t'\Omega + b_f + b_q + b_y + \epsilon_{f,t}, \tag{1.8}$$

where $Q_{f,t}$ is a measure of a quality of funds' holdings, X_t is a vector of market-wide control variables such as return on market portfolio, market-wide liquidity, equity market liquidity, funding liquidity and NBER recession period dummies, b_f is a full set of unrestricted fund fixed effects, b_q are quarter of year specific intercepts to capture seasonal effects, and b_y

[19] Ederington and Golubeva (2011) also find a negative correlation between equity fund flows and stock market volatility. Ferson and Kim (2012) find a negative correlation between market volatility and equity fund flows, but a positive relation between volatility and flows to bond funds and money market funds.

[20] See Kamstra et al. (2014) for the evidence on the seasonality in mutual fund flows.

corresponds to year fixed effects.[21]

When analysing the impact of concurrent fund performance on its flows, a possible endogeneity problem arises. I address this with an instrumental variable approach. I use exogeneous variation in realized market volatility as an instrument. This choice of the instrument stems directly from the structure in Vayanos (2004).[22] In the first stage regression I estimate the impact of market uncertainty on funds' relative performance.
First stage:

$$Perf_{f,t} = \alpha_0 + \alpha_1 RVol_t + \alpha_2 Q_{f,t} + X_t'\Lambda + a_f + a_q + a_y + \varepsilon_{f,t}. \tag{1.9}$$

I expect that increases in market uncertainty are associated with a deterioration in a fund's performance and outflows from equity mutual funds. My supposition is in line with existing studies of French et al. (1987) and Campbell and Hentschel (1992) who show that periods of high volatility are associated with downward market movements.

After showing that my first conjecture is supported by the data, I investigate whether there is a link between a fund's active liquidity management and the threat of withdrawal. I define the active liquidity management as the part of the decomposed change in the fund's illiquidity from equation (1.4), that is fully determined by the manager's portfolio allocation decision, $B_{f,t}$.
Step 2:

$$B_{f,t} = \gamma_0 + \gamma_1 Flow_{f,t} + \gamma_2 Q_{f,t} + X_t'\Gamma + g_f + g_q + g_y + \xi_{f,t}. \tag{1.10}$$

In the last step, I examine whether a mutual fund's aggregate liquidity preferences induced by market uncertainty feedback into market level of liquidity pricing and contributes to the time-varying nature of the liquidity premium. I expect that mutual funds' shift toward more liquid assets in times of high market volatility exert a downward price pressure on illiquid asset. Consequently, the measured return differential between liquid and illiquid stocks decreases and the market price of liquidity increases. To test my conjecture, I regress the return on the zero cost portfolio on the aggregate mutual fund's active liquidity man-

[21] I use S&P 500 return as a proxy for market portfolio return. Hu et al. (2013) suggest a noise measure, which captures daily deviations of coupon-bearing Treasury securities' market yields from the model yields. They show that their measure is informative about liquidity conditions of different (market) origins. The noise data is available at: `http://www.mit.edu/~junpan/Noise_Measure.xlsx`. I use Pastor and Stambaugh (2003) measure for equity market liquidity from: `http://faculty.chicagobooth.edu/lubos.pastor/research/liq_data_1962_2014.txt` and TED spread (the difference between 3-Month LIBOR based on US dollars and 3-Month Treasury Bill) as a measure for funding liquidity from: `https://research.stlouisfed.org/fred2/series/TEDRATE/downloaddata`. The recession periods are taken from the NBER website: `http://www.nber.org/cycles.html`.

[22] Section 1.4.2 discusses the endogeneity issue more detailed.

agement measure and other control variables.[23]

Step 3:

$$LP_t = \delta_0 + \delta_1 B_t + \delta_3 Q_t + X_t'\Theta + d_q + d_y + \upsilon_t, \tag{1.11}$$

where LP_t is a return on a zero cost portfolio, which is long in illiquid stocks and short in liquid ones, B_t denotes the aggregate measure of mutual fund's active liquidity management, computed by combining individual fund holdings information.

1.4.2 Endogeneity and Instrumental Variable

Estimation of the OLS system of equations, described in the previous sub-section, raises a potential endogeneity issue. In the first step in equation 1.8, simultaneity bias (reverse causation) might arise between fund performance and its flows, resulting in the correlation between fund performance and the error term $\varepsilon_{f,t}$. Thus, one of the major concerns is to consistently identify the α_1 coefficient from equation 1.8. Most studies ignore the endogeneity issue because of the difficulty in finding plausible instruments, but exceptions include Reuter and Zitzewitz (2010) and Phillips et al. (2013) who use an exogenous shock to overcome the endogeneity bias between a fund performance and flows. Following Christoffersen et al. (2014), who review academic papers studying flows to asset managers, I consider several potential sources of bias. Investors come to a decision about their (dis)investment based on a fund's performance. A well performing fund attracts more capital, whereas investors withdraw their money from a bad performing one. The impact of the performance on investors flows have been studied by Ippolito (1992) and Sirri and Tufano (1998), among others. They analyse the relationship from a perspective of performance determining the flows. On the other hand, Gruber (1996) and Zheng (1999) focus on smart money effect, where fund flows can predict future performance. Christoffersen et al. (2014) also consider two other channels, through which flows influence the performance: diseconomies of scale (fund performance decreases with the fund size) and direct cost of flows (e.g. the front running costs - Coval and Stafford (2007) and incurred transaction costs reducing the average fund's performance - Edelen (1999)).

In order to estimate a fund's response to the redemption obligations, I regress a fund's active liquidity management measure on its net flows, a set of control variables and quarter of a year dummy variable to capture seasonality. By including fund fixed effects, I control for a fund's unobserved time-invariant characteristics (e.g. a fund manager talent). In order to pick up omitted shocks that affect both fund flows and liquidity management of all mutual

[23] I sort the stocks based on their mean Amihud measure over previous three months into five portfolios. I calculate a monthly value-weighted return on each of the portfolios. The return spread LP_t is defined as the difference between return on the least liquid portfolio and the most liquid one.

funds (e.g. financial crises in 2008) I add a full set of unrestricted year fixed effects to the regression. However, there may still be time-varying, unobservable joint determinants of active liquidity management and net flows that are not captured by fund fixed effects. Kacperczyk et al. (2014) argue that manager's skill is not constant, but varies over time. A manager's skill come with the experience. It also depends on the focus of different tasks performed in different times. Therefore, the correlation between fund's flows and active liquidity management may wrongly indicate the causal relationship, while it is the unobservable time-varying managerial skill that determines for both fund flows and their liquidity preferences.

An unobservable time-varying fund's strategy can also be a potential source of endogeneity bias in equation 1.10.[24] Different economic conditions require different strategies of a portfolio allocation. Suppose, that a change in the strategy (towards more stock-picking one) takes place in bear times and a fund manager decreases the liquidity of the portfolio. Then, investors might demonstrate their dissatisfaction with the negative change in the strategy and withdraw their money from the fund. Thus a negative effect of fund flows on the liquidity preferences would be erroneously identified.

In the final step, I identify a response of the market liquidity premium to a shift in mutual fund liquidity preferences. Since prices and quantities are endogenously determined by demand and supply factors, the error term υ_t in equation 1.11 may be correlated with the measure of funds' aggregate liquidity preferences. Thus, I have to separate exogenous demand shifters in active liquidity management measure from supply ones. By isolating exogenous variation in mutual fund liquidity preferences, I can identify the impact of mutual fund demand on the market price of liquidity.

In order to address the simultaneity bias and omitted variable problem, I apply an instrumental variable approach. The choice of market uncertainty as the instrument comes naturally from the framework of Vayanos (2004) model, where he uses market volatility as a main driver of fund's performance, flows, and liquidity preferences. I exploit the fact that the realized market volatility is random from the perspective of a single mutual fund, and thus uncorrelated with the residuals in equations 1.8 and 1.10. While controlling for other variables such as market-wide liquidity measure $\Delta Noise_t$ and funding liquidity $TEDSpread_t$, which reflect supply-side of liquidity, I use market uncertainty as an instrument for funds' aggregate active liquidity management to identify the effect of mutual fund liquidity demand on the market price of equity in equation 1.11.

I estimate this system of three equations and most of subsequent specifications using

[24]Lynch and Musto (2003) propose a model, where they show that investor flows respond to a new fund strategy.

panel regression model, calculating standard errors by clustering at the fund and year-month dimensions. This approach addresses the concern that the errors, conditional on independent variables, might be correlated within fund and time. Clustering only at the fund level imposes a very strong assumption that there is no cross-sectional correlation. Thus, ignoring the time effect in my panel data is incorrect and bias downwards standard errors, producing too small confidence intervals and too large t-statistics.[25]

1.4.3 Empirical Results

I start my empirical analysis with examining the relationship between fund flows and performance. I estimate equation 1.8 and report the results in Table 3, columns 4 to 6. In each of the specifications, I include fund, quarter of year and year fixed effects. Column 4 reports results of equation 1.8 in a bivariate specification with fixed effects. The performance coefficient is positive and statistically significant. In column 5, I estimate the same equation and include return on the market portfolio $R_{M,t}$, Hu et al. (2013) measure of market-wide liquidity $\Delta Noise_t$ and Pastor and Stambaugh (2003) measure of aggregated equity market liquidity PS_t. The coefficient on fund performance remains positive and significant. Finally in column 6, I add three more control variables: a measure of funding liquidity $TEDSpread_t$, quality of fund's holdings $Quality_{f,t}$ and a dummy variable *Recession* equal to one for those months that belong to NBER recession periods, otherwise zero.

The estimates of fund performance might be biased because of the reverse causality problem discussed in the previous subsection. Thus, I use the instrumental variable approach, which require a crucial assumption that the instrument is uncorrelated with the omitted variables. If this is the case, then the instrument can be used to isolate the variation in the variable of interest that is uncorrelated with the error term. I use market realized volatility as the instrument. It seems plausible, that the variation in the market volatility is non-manipulative from the perspective of a single fund. Table 3 columns 1 through 3 show the coefficients from the first stage regressions in equation 1.9. The coefficient on market uncertainty remains negative and highly statistically significant in all three specification. This means that fund relative performance decreases with market uncertainty. This result is supported by the existing literature documenting a negative relationship between stock returns and market volatility (see e.g.: French et al. (1987) and Campbell and Hentschel (1992)). The magnitude of the estimated effect is economically significant. The estimated coefficient from column 1 implies that one standard deviation increase in stock market volatility decreases fund relative performance by 0.3% ($0.21 \cdot 1.386$). The size of the coefficient is

[25]See Petersen (2009).

unaffected by the inclusion of other control variables.

In table 3 columns 7 to 9, I substitute the endogenous variable (performance) with the exogenous one (realized market volatility) and perform ordinary least square regressions, where the regression coefficients are both consistent and unbiased. The reduced form regressions show a strong negative and significant correlation between fund flows and market uncertainty, while I control for other market-wide and fund-specific variables. The estimates from 2SLS second stage can be understood as re-scaled coefficient from the reduced form. Thus, I expect a positive and significant coefficient of fund performance in the flow regression.[26] As predicted, IV specification reports positive and statistically significant coefficients on $Perf_{f,t}$ in table 3 columns 10 to 12. It seems that OLS underestimates the size of the coefficient. In the IV specification, a one standard deviation decrease in performance reduces the percentage net flows by 0.2%. This applies that fund's average flow falls by \$2,259,180 from \$8,515,500 to \$6,256,320.[27]

According to Vayanos (2004) when markets are uncertain, it is more likely that a fund performance falls below a benchmark. However OLS regressions show only the average effect of market volatility on fund performance. In order to investigate the impact of market uncertainty on the distribution of fund performance, I use a quantile regression approach, which estimate the effect of market uncertainty at different points of fund performance conditional distribution. Figure 1.3 shows quintile regression estimated coefficients of realized market volatility from the model in equation 1.9 for the 10th, 25th, 50th, 75th, and 90th percentile. The regression coefficient at a given quantile indicates the effect of a one standard deviation increase in market uncertainty on fund performance, assuming that the other variables are fixed, with 95% confidence interval bands. The figure shows that a fund's performance response to market uncertainty is heterogeneous. The dispersion of fund performance increases with market volatility. Specifically, the upper quartile performance remains unaffected by high market volatility, whereas bad performance deteriorates even further.

The estimates of the second step from equation 1.10 are reported in table 4. The first three columns present OLS regression estimates of fund active liquidity management on its net flows. The $Flow_{f,t}$ coefficient is negative and insignificant in each specification, meaning that mutual fund liquidity preferences are unresponsive to redemption obligations. However, the γ_1 coefficient from equation 1.10 might be biased because of omitted variable problem (e.g. unobservable time-varying manager's skill) discussed in section 1.4.2. Thus, I use

[26]The coefficient on performance in 2SLS second stage is equal to the ratio of realized volatility coefficient in the first stage to realized volatility coefficient in the reduced form regression.

[27]The fund average TNA (unreported) is 1,050 millions. The average monthly flow is: $0.811\% \cdot \$1,050$ Mio. $=$ 8.5155 Mio. One standard deviation increase in realized volatility reduces the percentage net flows approximately by $0.2\% = 0.811\% - 0.22 \cdot 0.987\%$. This means that the fund's average netflow is reduces by \$2,259,180 to \$6,256,320.

instrumental variable approach and instrument endogenous fund flows with market realized volatility. Columns 4 to 6 show the reduced form regressions. The coefficient on market uncertainty is negative and statistically significant. Therefore, I expect coefficient on instrumented flows in the active liquidity management regression to be positive and significant.[28] When I isolate the part of the variation in fund flows that is induced by market uncertainty (by instrumenting fund's flows with market realized volatility), the $Flow_{f,t}$ coefficient changes its sign to a positive one (compared with a negative sign in OLS regressions) and remains strongly significant - columns 7 to 9. This implies, that market uncertainty induced outflows are associated with funds actively increasing liquidity of their portfolio. The effect is substantial: a one standard deviation decrease in fund flows is related to a 1.9 standard deviation increase in a fund's flight-to-liquidity.

To examine the impact of funds' active liquidity management on market liquidity premium, I re-estimate equations 1.8 to 1.10 in case of one large equity fund consisting of all the funds in my sample. I compute funds' aggregate performance, flows, and active liquidity management measure by calculating monthly averages weighted by market capitalization of funds' holdings. I expect that in times of market uncertainty funds' aggregate liquidity preferences create a price pressure in the equity market. Specifically, while the redemption obligations increase with market uncertainty, mutual funds prepare themselves for possible withdrawals by increasing liquidity of their portfolio. They demand more liquid stocks pushing their prices up. On the other hand, illiquid stocks become less attractive because they entail high costs when they have to be liquidated (e.g. in order to meet redemptions). The prices of illiquid stocks are expected to decrease because mutual funds require higher return as a compensation for greater liquidation risk. Consequently, the realized return on a zero-cost portfolio (long in the quintile with the most illiquid stocks and short in the quintile with most liquid one) declines as well. Table 5 reports the aggregate time series regression estimates from equations 1.8 – 1.11. Columns 1 and 2 show reduced form regressions of aggregate fund performance and flows on the realized market volatility. Similar to the estimates from panel regressions, the aggregate regressions report a negative impact of market uncertainty on fund performance and net flows. OLS regression estimates of equation 1.11 are reported in columns 6 through 9 in Table 5. The estimated OLS coefficients show a positive and statistically significant effect of funds' aggregate liquidity preferences on the measured return spread between illiquid and liquid portfolio. This means that an increase in mutual fund aggregate demand for liquid stocks create a downward price pressure on illiquid stocks, and thus the return spread decreases as well.

However, the δ_1 from equation 1.11 might be biased because of the simultaneity prob-

[28] The 2SLS first stage of fund behaviour regression is in table 3 in columns 7–9.

lem rooted in the analysis of the prices on quantities that I described in subsection 1.4.2. Therefore, I use instrumental variable approach to mitigate the endogeneity issue. Columns 3 to 5 report coefficient estimates from the 2SLS first stage regression, where I regress the aggregate funds' active liquidity management measure (which increases with illiquidity) on the realized market volatility. Analogous to the panel regressions (in table 4), the aggregate time-series regressions show a negative relationship between market uncertainty and a measure of fund liquidity preferences. An increase in market volatility results in mutual funds tilting their portfolio towards more liquid assets. Columns 9 to 11 report the reduced form regressions, where I substitute the endogenous active liquidity management with exogenous realized market volatility. When the market volatility increases, the return spread between illiquid and liquid portfolios narrow. The market uncertainty coefficient from the reduced form regression is negative and highly significant, implying a positive and significant effect of fund behaviour on the return differential.

In the last three columns of table 5, I report the coefficient estimates from instrumental variable approach. I use the exogenous variation of realized market volatility as the instrument for funds' aggregate liquidity preferences and regress the return on a zero-cost portfolio on the instrumented liquidity management and other control variables that are supposed to capture the effect of liquidity supply (e.g. market-wide liquidity measure $Noise_t$ and funding liquidity measure $TEDSpread_t$). In all specifications the B_t coefficient is positive and significant, providing similar results to the OLS regressions. However, OLS seems to underestimate the impact of funds' active liquidity management. A one standard deviation increase in aggregate fund liquidity preferences (one standard deviation decrease in the measure), decreases the return spread by 2.13% from 0.012% to -2.118% ($0.63 \cdot 3.381\%$).[29]

1.4.4 Heterogeneity

Up to this point I only use market volatility over-time variation that is common to all funds. However, a fund's exposure to market uncertainty depends on the exposure of its holdings. Because of differences across funds' holdings compositions, mutual funds' exposure to market uncertainty differ as well. In order to capture the diversity of funds' responses to market uncertainty arising from the exposure of the individual holdings, I construct a fund specific realized volatility measure. I use daily (high, low, open, close) prices for ten S&P 500 Sector Indices that I obtained from Bloomberg, and compute the realized volatilities for each sector following Garman and Klass (1980). Then I match fund holdings to the ten GICS

[29] 0.011%, 3.381% are the unreported mean and standard deviation of value-weighted liquidity premium.

sectors.[30] I calculate a fund specific realized volatility by taking a weighted average of sector realized volatilities with weights equal to the percentage of the portfolio invested in each of the sectors. I expect that mutual funds respond stronger to their fund specific realized volatilities, which reflect more precisely the exposure of the holdings to market uncertainty. I call my analysis of assessing the heterogeneity in a fund's active liquidity management to market uncertainty, measured with a fund specific realized volatility, a 'direct approach.'

Table 6 reports the results of the direct approach. In the first column I regress funds' liquidity preferences on overall market realized volatility (as in the previous analysis), thus it serves as a reference point.[31] In the second column, I estimate the impact of a fund-specific realized volatility on the active liquidity management of a fund. The size of the coefficient on the fund-specific realized volatility is indeed larger (by around 16%) than the coefficient on market-wide realized volatility.[32] However, fund-specific realized volatility relies on fund-specific sector weights, that are simultaneously determined with the active liquidity management decision $B_{t,f}$. In order to mitigate the endogeneity problem, I construct an exogenous fund-specific realized volatility measure $RVol^{EX}_{f,t}$ that uses sector weights different from actual ones. In column 3, I use weights that correspond to the average of fund-specific sector weights over previous three months. In column 4, instead of value-weighting I use equal weights for sector realized volatilities. 2SLS second stage regressions are presented in columns 5 to 6. The size of the instrumented coefficient on the fund-specific realized volatility (0.074) remains larger than overall market realized volatility coefficient (0.061) in column 1. This implies that market-wide realized volatility captures funds' exposure to uncertainty in a noisy manner and funds' responses depend on uncertainty that is embedded in their holdings. Once the exposure of the holdings to market uncertainty is more precisely identified, a fund's response becomes stronger.

Existing literature (e.g. Chordia (1996)) suggests that in equilibrium investors with high liquidation risk choose to invest in those mutual funds that charge lower load fees and hold more liquid assets. This implies that mutual funds differ from each other in terms of their initial liquidity positions. Redemptions are costly for a mutual fund for two reasons: unnecessary trading expenses, and cash holdings compromising fund performance. When market uncertainty increases, illiquid mutual funds face potentially higher costs of meeting withdrawals, and thus they are expected to respond stronger to the increases in market volatility.[33] In order to examine the relationship between a fund's initial liquidity position

[30] S&P 500 sector and industry indices use Global Industry Classification Standards (GICS) as well.

[31] The time period of the analysis is limited to 144 months from January 2002 to December 2013, because of the sector indices data availability.

[32] $(\frac{0.071}{0.061} - 1) \cdot 100\% = 16.4\%$

[33] See also Manconi et al. (2012), who show that among funds holding 'toxic' securitized bonds, those with high turnover and high volatility of their flows react stronger to liquidity dry-ups by liquidating more of

and its response to market uncertainty, I develop a measure of an 'illiquidity shock' for each fund. This measure is supposed to capture shocks to a portfolio's liquidity that are independent of a manager's decision. More precisely, I use the component of the change in a portfolio's liquidity stemming from the shift due to a change in the market-wide liquidity of the holdings (their Amihud measure). A fund-specific liquidity shock is defined as a percentage change in the liquidity of a portfolio keeping a fund's investment decision constant:[34]

$$IlliqShock_{f,t} = \frac{\sum_{s=1}^{S_{f,t-1}} \omega^s_{f,t-1}(Illiq_{s,t} - Illiq_{s,t-1})}{\sum_{s=1}^{S_{f,t-1}} \omega^s_{f,t-1} Illiq_{s,t}},$$

where $\omega^s_{f,t-1}$ and $Illiq_{s,t}$ are defined in section 1.3.2. In my analysis, to which I refer as the 'indirect approach', the main variable of interest is the interaction term between a fund-specific illiquidity shock and market realized volatility. I expect funds experiencing an exogenous shock to the liquidity of their portfolio (they become more illiquid) respond stronger to uncertainty in the market, and thus tilt their portfolio towards liquid assets more aggressively.

Table 6 columns 7 and 8 show estimated coefficients from the regression of a mutual fund active liquidity management measure on market realized volatility, a fund-specific liquidity shock and other control variables. The $IlliqShock_{f,t}$ coefficient in column 7 is negative and statistically significant, as is the effect of market uncertainty. This may imply that mutual funds target the liquidity of their portfolios. When they experience exogenous illiquidity shock, they actively trade stocks in order to mitigate the effect of the shock. This result supports the theoretical model of Ang et al. (2014), who predict that investors have an optimal composition of liquid and illiquid assets, and whenever it is possible they rebalance their portfolios to the optimal ratio. Column 8 shows the interaction term between a fund-specific illiquidity shock and market realized volatility. The interaction coefficient is negative and significant, meaning that those mutual funds that are subject to the illiquidity shock in times of high market uncertainty more aggressively change their portfolio towards more liquid stocks. The main effects of realized market volatility and illiquidity shock remain negative, yet insignificant.

1.5 Robustness Test

To check the robustness of my findings, I re-estimate equation 1.10, but use alternative measures of stock liquidity - the bid-ask spread and a log transformation of Amihud measure.

corporate bonds to meet redemptions.

[34] The illiquidity shock is obtained from the shift-share analysis of a change in a portfolio's liquidity in equation 1.4.

I also incorporate the cash holdings, which constitute a considerable part (on average 3.2%) of a portfolio, to the active liquidity management measure. Finally, I use only the non-forcastable component of market volatility and I re-estimate the set of equation 1.8 – 1.11.

1.5.1 Cash Holdings

Stock holdings constitute only one part of mutual fund's portfolio. A skilful cash management can contribute to a fund's flexibility. Managers with available cash can react quickly to new information by purchasing an attractive stock or avoid costly fire sales by meeting redemptions with their cash buffer.[35] Cash is infinitely liquid, therefore it is important to include it into my analysis. When a mutual fund faces a threat of withdrawal, it can enhance the liquidity of the portfolio either by increasing cash holdings or by increasing a fraction of liquid equities. Consequently, cash and equity decisions are interrelated and treating them separately can provide an erroneous result. In order to capture the interaction between cash and equity decisions, I include cash in my active liquidity management measure. The square-root transformation of Amihud measure allows me to incorporate cash holdings without any difficulties. Thus, I assign the lowest value (zero) of Amihud measure to cash. In columns 1 to 2, 5 to 6, and 9 to 10 in table 7, I use the active liquidity management measure computed with the square-root transformation of Amihud measure incorporating cash and repeat the same analysis from table 4. The results are similar: volatility-induced outflows are strongly associated with managers increasing liquidity of their portfolio. Columns 1 and 2 report OLS regression estimates, and columns 9 and 10 show IV coefficients from the regressions of the active liquidity management with cash on fund's net flows. In case of OLS regression the coefficient on $Flow_{f,t}$ is negative and significant. However, when I isolate the variation in fund flows that stems from market uncertainty, the fund flow coefficient changes its sign and remains highly significant. By incorporating cash into funds' liquidity preferences, the effect of volatility-induced net flows on the active liquidity management measure remain almost unaltered.

Some of the existing studies (Chordia (1996) and Huang (2014)) treat cash decision separately. Consequently, I replace the active liquidity management measure $B_{f,t}$ in equation 1.10 with the percentage of holdings held in the form of cash and report the estimates in table 7.[36] $Flow_{f,t}$ coefficient estimates from OLS cash holdings regressions in columns 3 and 4 is positive and significant. This suggests that cash holdings decrease with funds' outflows. The reduced form regressions in columns 7 to 8 report a positive and significant effect of realized market volatility on the level of cash holdings. Columns 11 and 12 show

[35] See e.g. Edelen (1999), Coval and Stafford (2007), Simutin (2013).

[36] The first stage regressions have been already reported in table 3 columns 4 through 6.

the IV results. The coefficient on $Flow_{f,t}$ changes it sign to a negative one and remains significant (as it does in active liquidity management regression in table 4), when I only use the variation in funds' flows that is induced by market volatility. This means that fund managers increase the level of percentage cash holdings when they face uncertainty induced withdrawals. A one standard deviation decrease in fund flows increases on average cash holdings by 0.8% from 3.2% to 4.00% ($0.92 \cdot 0.959\%$).[37]

1.5.2 Alternative Liquidity Measures

Throughout my analysis, I use the square-root transformation of Amihud measure because it enables me to incorporate cash holdings into a fund's active liquidity management measure. However, some of the existing studies on stock liquidity choose a log transformation of Amihud measure to reduce the influence of the extreme outliers.[38] I also use the bid-ask spread as a measure of stock liquidity by averaging the daily proportional bid-ask spread over a month.[39] The results with alternative liquidity measures are reported in table 8. Both the reduced form and 2SLS second stage regression estimates confirm the previous results. Volatility induced outflows are strongly associated with fund managers actively shifting their portfolio towards more liquid assets. This result is robust irrespective of the stock liquidity measure I use.

1.5.3 Market Volatility Shock

I re-estimate the set of equations 1.8 to 1.11 using an alternative measure of market uncertainty. I use the volatility shock, that is a non-forecastable component of realized market volatility. I regress current Garman and Klass (1980) realized market volatility on this month forecast VIX, and use the residual from this regression as the measure of the shock part of market volatility - $Res(Vol)_t$. I report the estimates from reduced form and second stage panel regressions of funds' performance, flows, active liquidity management and time-series regressions of the measured return spread in table 9. Each row of the table reports the estimated coefficient and t-statistics for the variable of interest and other control variables. In each of the eight reduced form regressions, the estimated coefficient of volatility shock has the same sign, is similar in the size to the coefficient on realized volatility in tables 3 to 5, and remains highly statistically significant. These results show that the previous

[37] My empirical results are supported by Chordia (1996), who shows that equity mutual funds increase their cash holdings when facing more redemption uncertainty.

[38] See e.g.: Brennan et al. (2013), Hameed et al. (2010), and Karolyi et al. (2012)

[39] I compute the weighted average for each portfolio as in equation 1.3, and then decompose the change in the holdings - equation 1.4.

results are not just an artefact of market volatility predictability, but rather that a fund's performance, flows and liquidity preferences respond to the non-forcastable component of market volatility, which results in the time-varying market price of liquidity.

By using the variation in funds' aggregate active liquidity management induced by market volatility shock, I show that mutual funds' liquidity preferences have a significant impact on the market liquidity premium. As a proxy for the market price of liquidity, I choose the return on the zero-cost portfolio that is long in the quintile of the most illiquid stocks and short in the quintile with the most liquid ones. The reduced form regressions in columns 11 and 12 report a negative relationship between unanticipated market volatility and the return spread. The coefficients on the instrumented funds' aggregate liquidity preferences in columns 13 and 14 are positive, significant and of the comparable size to the coefficient in table 5 column 14. A one standard deviation decrease in the behaviour measure (increase in the liquidity of the aggregate portfolio) decreases the return spread by 2.06% from 0.012% to -2.048%.

1.6 Conclusion

I contribute to the empirical asset pricing literature by providing a potential explanation for the relationship between the market price of liquidity and the uncertainty. While existing research investigates the impact of market uncertainty on mutual fund capital flows, a direct link between uncertainty-induced fund behaviour and the market price of liquidity have not been examined. This paper bridges this gap by showing one channel through which market uncertainty impacts the liquidity premium.

This empirical study builds on Vayanos (2004)'s theoretical framework, where investors withdraw their money when a fund's performance falls below a given threshold, which is more likely during times of high market uncertainty. Consequently, managers facing a threat of increasing redemption obligations tilt their portfolio toward more liquid stocks to minimize future transaction costs. This aggregate shift in a fund's liquidity preference translates into a market level increase in the price of liquidity. To examine the described mechanism, I measure a fund's active liquidity management using data from Morningstar on monthly holdings of US active mutual funds investing in US equity between January 1998 and December 2013. I obtain the measure by isolating the change in a portfolio's liquidity that is due to a manager's decision over a holding's composition.

Using this measure of active liquidity management, I study the response of a fund to uncertainty-induced net flows. OLS estimates suggests that funds do not respond to their flows. However, OLS estimates are potentially biased by unobservable time-variation in the data that is correlated with fund flows. To address this endogeneity concern I use market volatility as an instrument to identify the causal effect of uncertainty on the liquidity of a mutual fund - a procedure that arises naturally from the structure of Vayanos's (2004) model.

I provide empirical evidence of a negative relationship between fund net flows and market uncertainty, which is consistent with existing research (Ederington and Golubeva (2011) and Ferson and Kim (2012)). By isolating the variation in fund flows induced by market volatility, I show that mutual funds actively manage the liquidity of their portfolios in response to their redemption obligations. A one standard deviation decrease in fund's net flows causes a 1.9 standard deviation increase in an actively managed portfolio's liquidity. I also find consistent results when I include cash holdings into the active liquidity management measure or examine fund cash management separately. Mutual fund managers increase the liquidity of their portfolio by tilting their positions towards more liquid stocks and expanding their cash holdings. However, these results do not provide any insight on the heterogeneity of a fund's response to the redemption obligation, because I use over-time variation that is common to all funds. I address this issue by constructing a fund-level uncertainty measure, and I show that a fund's exposure to the volatility depends on the exposure of their holdings. I also find that mutual funds experiencing an adverse shock to the liquidity of their holdings tilt their portfolio towards more liquid stocks and rebalance their positions even more aggressively when market volatility is high.

These results indicate that mutual funds have time-varying liquidity preferences. Applying Vayanos's theoretical framework to my empirical analysis, I show that a volatility-induced aggregate increase in a fund's actively managed portfolio's liquidity will exert a downward price pressure on illiquid stocks. A return on a zero-cost portfolio, which is long in illiquid and short in liquid stocks, decreases in response to mutual funds' aggregate shift towards liquid assets. The effect is substantial: a one standard deviation increase in a fund's liquidity preference, decreases the measured return spread by 2.13 percent.

This paper provides a rational explanation of asset mispricing. Based on my analysis, I show that many mutual funds follow the same strategy by actively increasing liquidity of their portfolios when they expect their redemption obligations to increase. Whereas transactions of a single fund have no significant market impact, an aggregate shift in funds' liquidity preferences could potentially deviate prices from their fundamental values. I show that when market uncertainty increases, many mutual funds contemporaneously face possible withdrawals and thus tilt their portfolio towards more liquid assets at the same time. Consequently, the market-wide price of liquidity increases and illiquid stocks are adversely affected by this non-fundamental shift in funds' demand.

1.7 Appendix

1.7.1 Vayanos (2004) model

The model's set up is in continuous-time, infinite horizon economy. The market consists of N risky assets with dividends being driven by stochastic volatility v_t. The volatility follows a square root process:

$$dv_t = \gamma(\bar{v} - v_t)dt + \sigma\sqrt{v_t}dB_t^v. \tag{1.12}$$

The dividend process δ_{nt} for a single asset n is defined as:

$$d\delta_{nt} = \kappa(\bar{\delta} - \delta_{nt}) + \sqrt{v_t}(\phi_n dB_t + \psi_n \sigma dB_t^v + dB_{nt}), \tag{1.13}$$

where dB_t^v, dB_t, dB_{nt} is a systematic, residual, and idiosyncratic volatility shock.

There is S_n shares supplied to the market of asset n, The asset n can be bought (sold) at $p_{nt} + \epsilon_n$ ($p_{nt} - \epsilon_n$), where ϵ_n is a stock-specific exogenous transactions cost and p_{nt} denotes an average price.

The model focuses on mutual fund, whose redemption obligations depend on fund's performance. A fund manager manages a fund of a size W_t and he has full discretion regarding portfolio's asset allocation. A manager has CARA type preferences:

$$-E\int_0^\infty \exp(-\alpha c_t - \beta t)dt, \tag{1.14}$$

where c_t is a consumption rate.

Withdrawals are extreme. Once individual decide to redeem the money, a fund's size is reduced to zero. Mutual fund investors withdraw their money from random reason, but also if fund's performance falls below a threshold - $\hat{L}$. Investors' monitoring takes place at discrete times $k\Delta t$ with a probability $\hat{\mu}$, where $k \in Z$ and $\Delta t > 0$. Investors' monitoring implies evaluation of the change in a fund's size during the interval $[t - \Delta t, t]$. Consequently, a fund is liquidated with a probability:

$$\hat{\mu}\text{Prob}\left(W_t - W_{t-\delta t}) \leq -\hat{L}\right). \tag{1.15}$$

By assuming that Δt is very small, $\hat{\mu} = \mu\Delta T$ and $\hat{L} = L\sqrt{\Delta t}$. Consequently, a fund's liquidation takes place at a rate $\mu\pi_t$, where π_t is:

$$\pi_t = \lim_{\Delta t \to 0} \text{Prob}\left(W_t - W_{t-\delta t}) \leq -L\sqrt{\Delta t}\right). \tag{1.16}$$

So far this liquidation rate captures only liquidations due to poor fund's performance, therefore an arbitrary small constant λ is added to reflect a rate at which a fund may be liquidated for random reasons.

A manager faces two budget constraints in his optimization problem:

1. Evolution of a fund's size:

$$dW_t = f\left(W_t - \sum_{n=1}^{N} x_{nt}p_{nt}\right)dt + \sum_{n=1}^{N} x_{nt}(\delta_{nt}dt + dp_{nt}) - rW_t dt - \sum_{n=1}^{N} \epsilon_n \left|\frac{dx_{nt}}{dt}\right|, \quad (1.17)$$

   where x_{nt} is number of shares invested in stock n. The evolution of the fund size depends on liquidation event as well. After a liquidation occurrence fund size decreases by:

$$\Delta W_t = -\sum_{n=1}^{N} \epsilon_n \left(|x_{nt}^-| + |x_{nt}^+|\right), \quad (1.18)$$

   where x_{nt}^+ and x_{nt}^- denote the number of shares invested in asset n in a new and old fund, respectively.

2. Evolution of a fund manager's wealth:

$$dw_t = (rw_t + aW_t - c_t)dt, \quad (1.19)$$

   where aW_t is a manager's fee charged for providing services to his investors.

The paper analysis two scenarios:

- non-performance based liquidation[40],
- performance based liquidation,

that provide distinctive solutions. By maximizing manager's utility function with respect to budget constraints in case of non-performance based liquidation, the models implies that:

- volatility and liquidity premium do not affect the liquidation rate (proposition 1),
- there is no effect of transaction costs on an asset price and its risk premium (proposition 1).

In case of performance-based liquidation, the liquidation rate is $\lambda + \mu\pi_t$ with $\mu > 0$. There is a significant difference between first order conditions in no performance- versus performance-

[40] The monitoring rate μ is assigned a value of zero.

based scenario[41]:

$$\begin{aligned} E_t(dR_{nt}) &= A\text{Cov}_t(dR_{nt}, dR_{Mt}) + AZ'(v_t)\text{Cov}_t(dR_{nt}, dv_t) \\ &\quad + \boldsymbol{\mu\pi_{x_n}(v_t, x_t)|_{x_t=S}\frac{\exp(2A\epsilon - 1)}{A}dt} \\ &\quad + \left[r + 2\left[\lambda + \boldsymbol{\mu\pi(v_t)}\right]\exp(2A\epsilon)\right]\epsilon_n dt. \end{aligned} \tag{1.20}$$

First, liquidity premium depends not only on λ (as it is the case in no performance-based scenario), but also on the performance monitoring rate μ and the probability rate that a fund performance falls below a given threshold π_t. It is more likely that a fund underperformances, when volatility is high. Consequently, market risk premium per unit of volatility increase with volatility[42]. The second term is new and represents (liquidation) risk premium. Increasing a fraction of a portfolio invested in asset n affects the riskiness of a portfolio and consequently the probability of a fund's performance falling below a given benchmark. This is why, fund's managers asset allocation decision become more risk-averse when volatility increases and a liquidations becomes more likely.

The solution of the performance-based scenario (proposition 5) provides different predictions than no performance-based case. First, there is a direct effect of volatility on asset's risk premium, because of liquidation risk premium's sensitivity to the volatility. Second, illiquid assets are subject to greater price discount in face of volatility increase. As a consequence of fund's underperformance in face of market volatility, a liquidation is more likely, and thus a fund manager prefers more liquid assets (i.e. low transaction costs).

[41]Terms that are only relevant for the performance based scenario are in bold.

[42]Vayanos (2004) discusses this implication in footnote 35.

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Figures

Figure 1.1: Fund Aggregate Performance and Realized Market Volatility.

This figure shows time series of Garman and Klass (1980) monthly realized market volatility (black) and aggregate performance of US active equity mutual funds investing in US equity (grey) from January 1998 to December 2013. Both fund performance and market volatility are z-scored. The shaded gray areas depict periods of the highest market volatility.

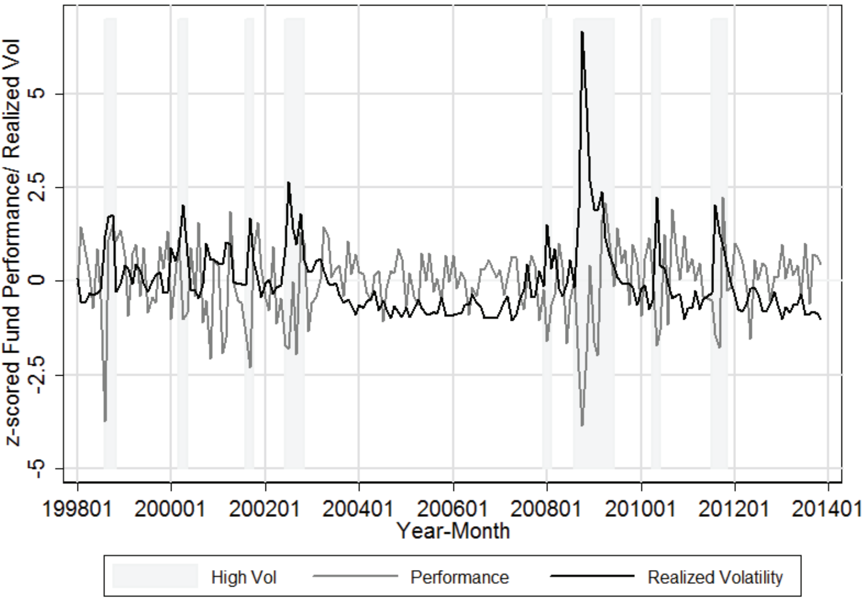

Figure 1.2: Fund Aggregate Flows and Realized Market Volatility.

This figure shows time series of Garman and Klass (1980) monthly realized market volatility (black) and aggregate net flows of US active equity mutual funds investing in US equity (grey) from January 1998 to December 2013. Both fund net flows and market volatility are z-scored. The shaded gray areas depict periods of the highest market volatility.

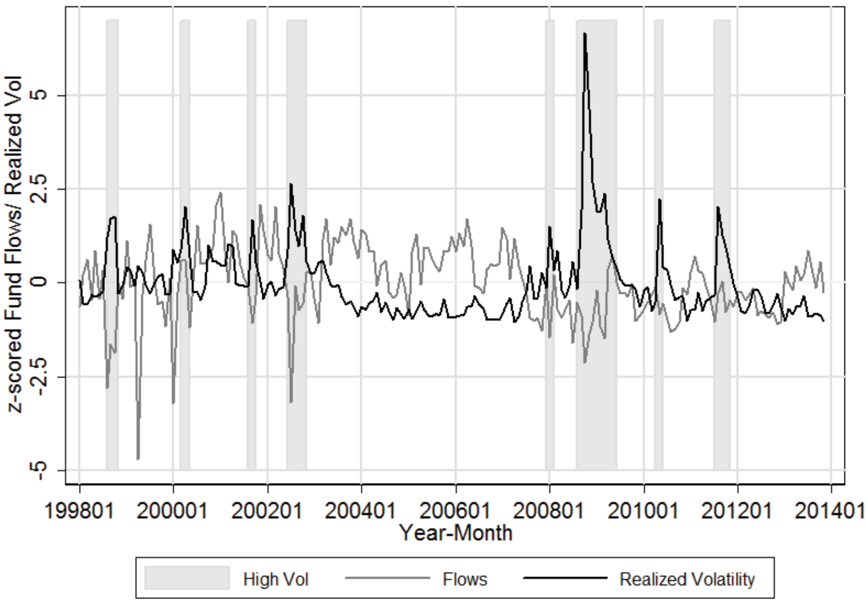

Figure 1.3: Quintile Regression of Fund Performance on Market Realized Volatility.

This figure graphically depicts realized volatility estimated coefficients from quintile regressions (for 10th, 25th, 50th, 75th, and 90th percentiles) of fund performance on market volatility, fixed effects and other control variables. The respective values are connected by the maroon solid line with accompanying estimated 95% confidence intervals shaded in grey.

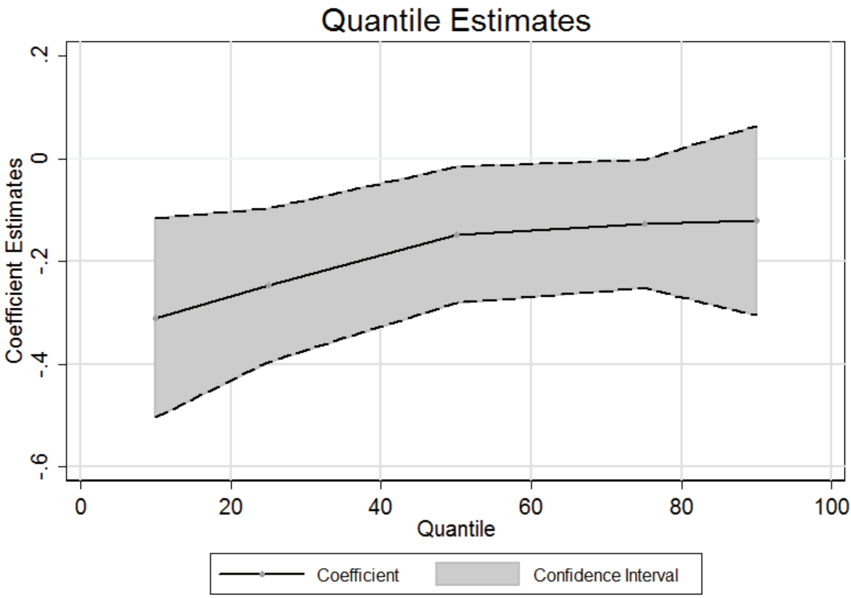

Table 1.1: Mutual Fund Summary Statistics.

This table shows summary statistics on the mutual fund sample obtained from the Morningstar database. The sample includes US active equity mutual funds investing in US equity that existed at any time during January 1998 through December 2013 for which monthly holdings information is available, overall 85,560 fund-month observations. *No. Funds* is the number of distinct funds each year in my sample. *TNA* is a total net assets. *No. Stocks per Fund* is a number of stocks held by a fund on average; *No. Stocks* is an average number of distinct stocks held by all mutual funds in the sample; *Matching Rate* is the percentage of the holdings value that has been successfully merged with CRSP stock data (mutual funds with matching rate lower than 70% are discarded from the sample).

Year	No. Funds	TNA ($ Million)		No. Stocks per Fund		No. Stocks	Matching Rate
		Mean	Median	Mean	Median		
1998	169	1881.32	765.16	103	64	2285	0.81
1999	234	1203.71	551.64	96	62	2365	0.82
2000	296	1217.10	658.12	121	71	3193	0.83
2001	374	1053.51	364.40	101	68	2469	0.86
2002	525	1016.71	375.54	121	76	3053	0.89
2003	689	878.33	252.05	121	77	3162	0.89
2004	685	883.19	274.16	123	82	3203	0.87
2005	584	1080.80	380.15	131	82	3252	0.88
2006	535	961.79	316.34	124	82	3534	0.90
2007	636	1430.40	665.75	162	85	3908	0.91
2008	677	1406.80	541.72	184	89	3816	0.90
2009	787	1191.11	457.29	195	95	3620	0.90
2010	868	1475.04	560.56	201	93	3652	0.90
2011	995	1743.75	579.85	189	90	3509	0.89
2012	1004	1962.01	616.62	186	85	3417	0.89
2013	1006	3468.98	743.83	191	88	3391	0.89

Table 1.2: Summary Statistics: Funds' Performance, Flows, Behaviour Measures, and Other Control Variables.

Panel A shows summary statistics on the main variables used in this paper. $Perf_{f,t}$ is fund's relative performance in percentage and it is calculated as fund's monthly net return minus the return on S&P500. $Flow_{f,t}$ is fund net flow relative to its lagged TNA. $\sqrt{Illiq_{f,t}}$ is a value-weighted sqaure-root of Amihud measure for a mutual fund estimated from its holdings. $B_{f,t}$ is a measure of fund's active liquidity management. $Cash_{f,t}$ is the percentage of the holdings kept in cash. $Quality_{f,t}$ is a measure of the quality of fund's holdings. $RVol_t$ reflects market uncertainty and is calculated by Garman and Klass (1980) measure of realized volatility. $R_{M,t}$ is the return on S&P500. $\Delta Noise_t$ is a market-wide liquidity measure constructed by Hu et al. (2013). $PSLiq_t$ is Pastor and Stambaugh (2003) equity market liquidity measure. $TEDSpread$ reflects funding liquidity and is defined as the difference between 3-Month LIBOR based on US dollars and 3-Month Treasury Bill. For each item, I compute the cross-sectional averages in each month from January 1998 to December 2013 (I only have the data for fund's quality until December 2012). The reported statistics are computed from the time-series of the 192 monthly cross-sectional averages for each item. Panel B shows correlation computed from the time-series of the 192 monthly cross-sectional averages for each item.

PANEL A:

	$Perf_{f,t}$ (%)	$Flow_{f,t}$ (%)	$\sqrt{Illiq_{f,t}}$ $(\cdot 10^6)$	$B_{f,t}$ $(\cdot 10^6)$	$Cash_{f,t}$ (%)	$Quality_{f,t}$	$RVol_t$	$R_{M,t}$ (%)	$\Delta Noise_t$	$PSLiq_t$ $(\cdot 1000)$	$TEDSpread_t$ $(\cdot 1000)$
Mean	0.082	0.811	31.015	-0.076	3.201	0.656	14.175	0.596	-0.002	-0.032	0.494
Std. Dev.	1.386	0.978	12.624	0.670	0.959	0.018	7.563	4.600	0.796	0.078	0.416
Min	-4.526	-1.013	16.714	-2.876	2.045	0.618	6.426	-16.795	-3.338	-0.334	0.020
5th	-2.075	-0.559	18.478	-1.180	2.180	0.627	7.105	-7.985	-0.802	-0.171	0.160
25th	-0.733	0.095	21.784	-0.283	2.466	0.642	9.388	-1.852	-0.244	-0.064	0.220
50th	0.063	0.633	25.574	0.037	2.805	0.657	12.167	1.112	-0.017	-0.026	0.365
75th	0.880	1.475	38.984	0.220	3.993	0.669	16.796	3.725	0.182	0.017	0.635
95th	2.251	2.510	51.228	0.740	5.148	0.686	28.688	7.671	0.883	0.078	1.300
Max	6.954	4.750	87.078	2.540	6.556	0.699	64.701	10.929	5.010	0.201	3.350

PANEL B:

	$Perf_{f,t}$ (%)	$Flow_{f,t}$ (%)	$\sqrt{Illiq_{f,t}}$ ($\cdot 10^6$)	$B_{f,t}$ ($\cdot 10^6$)	$Cash_{f,t}$ (%)	$Quality_{f,t}$	$RVol_t$	$R_{M,t}$ (%)	$\Delta Noise_t$	$PSLiq_t$ ($\cdot 1000$)	$TEDSpread_t$ ($\cdot 1000$)
$Perf_t$	1										
$Flow_{f,t}$	0.12	1									
$\sqrt{Illiq_{f,t}}$	-0.12	0.0078	1								
$B_{f,t}$	0.18	0.28	-0.41	1							
$Cash_{f,t}$	-0.12	0.21	0.85	-0.27	1						
$Quality_t$	-0.034	-0.40	-0.44	0.014	-0.44	1					
$RVol_t$	-0.22	-0.32	0.48	-0.42	0.27	0.024	1				
$R_{M,t}$	0.11	0.14	-0.067	0.073	-0.038	-0.067	-0.40	1			
$\Delta Noise_t$	-0.16	-0.014	-0.0031	-0.18	0.036	0.029	0.17	-0.29	1		
$PSLiq_t$	0.069	0.12	-0.26	0.20	-0.16	0.065	-0.40	0.18	-0.095	1	
$TEDSpread_t$	-0.12	-0.12	0.25	-0.28	0.22	0.19	0.48	-0.24	0.39	-0.26	1

Table 3: First Stage, OLS and Instrumental Variable Panel Regressions of Fund's Flows on Fund's Performance and Other Control Variables.

This table uses monthly data from Morningstar from January 1998 through December 2013 (85,560 fund-month observations) to examine the relationship between fund's flows and its relative performance. All the variables (excluding *Recession*) are z-scored. Columns 1–3 show the coefficients from the 2SLS first stage regression of fund performance $Perf_{f,t}$ on realized market volatility. Columns 4–6 show the coefficients from OLS regression of flows $Flow_{f,t}$ on funds' performance $Perf_{f,t}$. Columns 7–9 report the reduced for regressions, where fund flows are regressed on realized market volatility. Columns 10–12 show instrumental variable regression coefficients. I use Garman and Klass (1980) realized market volatility $RVol_t$ as the instrument for the performance in the columns 10–12. I include control variables as: return on S&P500 index $R_{M,t}$, Hu et al. (2013) measure of the market-wide liquidity $\Delta Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, fund's value-weighted quality measure of its holdings $Quality_{f,t}$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for fund, year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors that are clustered both at year-month and a fund level.

	First Stage			OLS			Reduced Form			IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Perf_{f,t}$				0.021	0.018	0.018				0.21	0.17	0.14
				(3.10)	(2.66)	(2.55)				(3.53)	(2.25)	(2.24)
$RVol_t$	-0.21	-0.17	-0.19				-0.043	-0.029	-0.027			
	(-4.74)	(-2.72)	(-2.92)				(-5.28)	(-3.32)	(-2.88)			
$R_{M,t}$		0.054	0.057		0.027	0.026		0.020	0.021		0.011	0.013
		(0.80)	(0.84)		(3.89)	(3.70)		(2.79)	(2.92)		(0.63)	(0.81)
$\Delta Noise_t$		-0.058	-0.055		0.0066	0.0093		0.0068	0.0083		0.017	0.016
		(-1.21)	(-0.96)		(1.04)	(1.24)		(0.92)	(0.94)		(1.97)	(1.95)
$PSLiq_t$		-0.0078	0.0085		0.019	0.018		0.013	0.014		0.014	0.013
		(-0.15)	(0.16)		(2.89)	(2.72)		(2.02)	(2.12)		(1.42)	(1.37)
$TEDSpread_t$			0.037			-0.0091			0.00026			-0.0050
			(0.83)			(-1.05)			(0.03)			(-0.58)
$Quality_{f,t}$			0.055			-0.014			-0.013			-0.021
			(1.78)			(-0.84)			(-0.80)			(-1.22)
$Recession$			198.2			-8.25			9.54			-18.8
			(0.79)			(-0.28)			(0.30)			(-0.43)
Qtr, Year, Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85560	85560	74609	85560	85560	74609	85560	85560	74609	85560	85560	74609
R^2	0.066	0.072	0.081	0.16	0.16	0.17	0.16	0.16	0.17			

t statistics in parentheses

Table 4: First Stage, OLS and Instrumental Variable Panel Regressions of Fund's Behaviour on Fund's Flows and Other Control Variables.

This table uses monthly data from Morningstar from January 1998 through December 2013 (85,560 fund-month observations) to examine the relationship between fund's behaviour and its net flows. All the variables (excluding *Recession*) are z-scored. Columns 1–3 show the coefficients from the first stage regression of fund flows $Flow_{f,t}$ on realized market volatility. Columns 4–6 show the coefficients from OLS regression of fund active liquidity management $B_{f,t}$ on fund's net flows $Flow_{f,t}$. Columns 7–9 show instrumental variable regression coefficients. I use Garman and Klass (1980) realized market volatility $RVol_t$ as the instrument for the fund net flows in the columns 7–9. I include control variables as: return on S&P500 index $R_{M,t}$, Hu et al. (2013) measure of the market-wide liquidity $\Delta Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, fund's value-weighted quality measure of its holdings $Quality_{f,t}$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for fund, year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors that are clustered both at year-month and a fund level.

	OLS			Reduced Form			IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Flow_{f,t}$	-0.0031	-0.0037	-0.0036				1.30	1.92	2.24
	(-1.18)	(-1.41)	(-1.31)				(3.73)	(3.00)	(2.94)
$RVol_t$				-0.057	-0.058	-0.062			
				(-4.60)	(-3.66)	(-3.70)			
$R_{M,t}$		0.019	0.017		-0.00027	0.000098		-0.039	-0.049
		(1.73)	(1.68)		(-0.03)	(0.01)		(-1.56)	(-1.64)
$\Delta Noise_t$		-0.014	-0.011		-0.011	-0.011		-0.026	-0.034
		(-1.15)	(-0.75)		(-0.92)	(-0.79)		(-2.06)	(-2.05)
$PSLiq_t$		0.0040	0.0014		-0.0095	-0.0098		-0.031	-0.038
		(0.31)	(0.10)		(-0.81)	(-0.79)		(-1.71)	(-1.81)
$TEDSpread_t$			-0.016			0.0065			0.010
			(-0.87)			(0.61)			(0.49)
$Quality_{f,t}$			0.0051			0.0048			0.029
			(0.75)			(0.72)			(1.18)
Recession			-14.5			22.1			-6.45
			(-0.44)			(0.64)			(-0.09)
Qtr, Year, Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85560	85560	74609	85560	85560	74609	85560	85560	74609
R^2	0.0016	0.0022	0.0023	0.0034	0.0036	0.0037			

t statistics in parentheses

Table 5: First Stage, OLS, Reduced Form, and Instrumental Variable Time-Series Regressions of the Return on a Zero-Cost Portfolio, Aggregate Fund's Behaviour, and Other Control Variables.

This table uses monthly data from Morningstar from January 1998 through December 2013 (192 observations) to examine the relationship between market liquidity premium and mutual fund active liquidity management. All the variables (excluding *Recession*) are z-scored. Column 1 and 2 show reduced form regression of aggregate fund performance and flows on realized market volatility. Columns 3–5 show the coefficients from the 2SLS first stage regression of aggregate fund active liquidity management $B_{f,t}$ on market uncertainty. Columns 6–8 show the coefficients from OLS regression of return spread between illiquid and liquid stocks on funds' aggregate behaviour $B_{f,t}$. Columns 9–11 report the reduced for regressions, where the return spread is regressed on realized market volatility. Columns 12–14 show instrumental variable regression coefficients. I use Garman and Klass (1980) realized market volatility $RVol_t$ as the instrument for the aggregate fund behaviour in the columns 12–14. I include control variables as: return on S&P500 index $R_{M,t}$, measure of the market-wide liquidity $\Delta\ Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, funds' aggregated quality measure of their holdings $Quality_t$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors.

	$Perf_t$	$Flow_t$	First Stage			OLS			Reduced Form			IV		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
B_t						0.55	0.58	0.58				0.53	0.63	0.66
						(6.47)	(6.15)	(6.25)				(3.64)	(4.42)	(4.37)
$RVol_t$	-0.056	-0.40	-0.56	-0.60	-0.62				-0.30	-0.38	-0.40			
	(-2.15)	(-3.38)	(-4.63)	(-4.15)	(-3.99)				(-3.21)	(-3.34)	(-3.34)			
$R_{M,t}$	0.96	0.074		-0.097	-0.096		-0.14	-0.14		-0.21	-0.21		-0.15	-0.14
	(35.56)	(0.93)		(-0.87)	(-0.85)		(-1.52)	(-1.47)		(-2.04)	(-1.95)		(-1.63)	(-1.58)
$\Delta Noise_t$	-0.027	0.18		-0.12	-0.14		0.082	0.064		0.014	-0.015		0.091	0.076
	(-1.31)	(2.62)		(-1.03)	(-1.10)		(1.24)	(0.93)		(0.13)	(-0.14)		(1.43)	(1.12)
$PSLiq_t$	0.000088	0.020		-0.059	-0.073		0.075	0.084		0.034	0.033		0.071	0.081
	(0.00)	(0.22)		(-0.57)	(-0.68)		(0.97)	(1.03)		(0.38)	(0.35)		(0.95)	(1.04)
$TEDSpread_t$	-0.0056	0.016			0.070			0.067			0.13			0.080
	(-0.23)	(0.17)			(0.63)			(0.93)			(1.16)			(1.22)
$Quality_t$	0.026	0.19			-0.30			0.13			-0.047			0.15
	(0.86)	(0.98)			(-1.55)			(0.95)			(-0.35)			(1.05)
$Recession$	68.3	183.3			-28.1			-205.9			-193.4			-174.9
	(0.80)	(0.53)			(-0.08)			(-0.67)			(-0.46)			(-0.62)
Qtr, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	179	179	192	192	179	192	192	179	192	192	179	192	192	179
R^2	0.97	0.38	0.34	0.35	0.38	0.40	0.43	0.45	0.20	0.23	0.24			

t statistics in parentheses

Table 6: First Stage, Reduced Form, and Instrumental Variable Panel Regressions of Fund's Active Liquidity Management on Fund Specific Uncertainty and Illiquidity Shock.

This table uses monthly data from Morningstar from January 2002 through December 2013 (79,424 fund-month observations) - columns 1 to 6 and from January 1998 through December 2013 (85,560 fund-month observations) - columns 7 and 8, to examine the heterogeneous responses of mutual fund to market uncertainty. All the variables (excluding *Recession*) are z-scored. Columns 1 to 6 show the results of a direct analysis of mutual fund heterogeneous responses to market uncertainty. Columns 7 and 8 report estimates from indirect approach. Columns 1 and 2 show OLS regression of fund active liquidity management on market-wide and fund-specific uncertainty measure, respectively. I construct fund-specific uncertainty by value weighting S&P500 sector realized volatilities, where weights are equal to fraction of the portfolio invested in a given sector. In columns 3 and 4, I regress fund active liquidity management on alternative measures of fund-specific uncertainty, which does not require actual portfolio weights. In column 3, I use weights that correspond to the average of fund-specific sector weights over previous three months. In column 4, I calculate a simple average of the sector-specific realized volatilities. Columns 5–6 report IV regression estimates of fund active liquidity management on the instrumented fund-specific uncertainty measure, where alternative measures from column 3 and 4 are used as instruments. Columns 7–8 show the coefficients from OLS regression of fund behaviour on market-wide uncertainty and fund-specific liquidity shock. The liquidity shock at the fund level is defined in equation 1.12. I use Garman and Klass (1980) realized volatility estimator as a measure of market and sector uncertainty. I include control variables as: return on S&P500 index $R_{M,t}$, Hu et al. (2013) measure of the market-wide liquidity $\Delta Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for fund, year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors that are clustered both at year-month and a fund level.

	DIRECT						INDIRECT	
	$RVol_t$	$RVol_{f,t}$	Reduced Form		IV		Liquidity Shock	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$RVol_t$	-0.061						-0.045	-0.030
	(-3.57)						(-2.49)	(-1.31)
$RVol_{f,t}$		-0.071			-0.071	-0.074		
		(-3.38)			(-3.48)	(-3.61)		
$RVol_{f,t}^{EX}$			-0.071	-0.072				
			(-3.47)	(-3.59)				
$IlliqShock_{f,t}$							-0.029	-0.015
							(-2.84)	(-1.44)
$IlliqShock_{f,t} \times RVol_t$								-0.0072
								(-2.22)
$R_{M,t}$	0.0038	0.0049	0.0043	0.0044	0.0049	0.0043	-0.0045	-0.0029
	(0.38)	(0.49)	(0.43)	(0.43)	(0.48)	(0.43)	(-0.45)	(-0.28)
$\Delta Noise_t$	-0.0080	-0.0068	-0.0070	-0.0060	-0.0068	-0.0067	-0.0038	0.0051
	(-0.58)	(-0.48)	(-0.50)	(-0.42)	(-0.48)	(-0.48)	(-0.30)	(0.37)
$PSLiq_t$	-0.013	-0.014	-0.014	-0.014	-0.014	-0.015	-0.012	-0.012
	(-1.03)	(-1.06)	(-1.06)	(-1.07)	(-1.07)	(-1.11)	(-1.01)	(-0.92)

$TEDSpread_t$	0.0037	0.0021	0.0023	0.0022	0.0022	0.0028	-0.0015	-0.0027
	(0.35)	(0.19)	(0.20)	(0.21)	(0.19)	(0.25)	(-0.24)	(-0.24)
Recession	46.3	67.6	67.5	67.6	67.8	69.7	3.59	4.07
	(1.14)	(1.56)	(1.57)	(1.57)	(1.59)	(1.63)	(0.11)	(0.12)
Qtr, Year, Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	79424	79424	79424	79424	79424	79424	85560	85560
R^2	0.012	0.012	0.012	0.012			0.015	0.015

t statistics in parentheses

Table 7: OLS, Reduced Form, and Instrumental Variable Panel Regressions of Cash Holdings on Fund Flows and Other Control Variables.

This table uses monthly data from Morningstar from January 1998 through December 2013 (85,560 fund-month observations) to examine the relationship between fund's cash holdings and its net flows. Cash holdings $Cash_{f,t}$ is defined as percentage of TNA held in the for of cash. $BC_{f,t}$ is the active liquidity management measure that incorporates cash holdings and assign the lowest value (zero) of square-root Amihud measure. All the variables (excluding *Recession*) are z-scored. Columns 1–2 and 3–4 show the OLS coefficients of cash holdings $Cash_{f,t}$ and active liquidity management measure incorporating cash $BC_{f,t}$ on fund's net flows. Columns 5–8 show the coefficients from the reduced form regression of fund's cash holdings $Cash_{f,t}$ and behaviour including cash $BC_{f,t}$ on realized market volatility $RVol_t$. Columns 9–12 show instrumental variable regression coefficients, where I instrument fund's net flows with market uncertainty measure. I use Garman and Klass (1980) realized market volatility $RVol_t$ as the instrument for the performance in the columns (7)-(9). I include control variables as: return on S&P500 index $R_{M,t}$, Hu et al. (2013) measure of the market-wide liquidity $\Delta Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, fund's value-weighted quality measure of its holdings $Quality_{f,t}$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for fund, year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors that are clustered both at year-month and a fund level.

	OLS				Reduced Form				IV			
	$BC_{f,t}$		$Cash_{f,t}$		$BC_{f,t}$		$Cash_{f,t}$		$BC_{f,t}$		$Cash_{f,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Flow_{f,t}$	-0.016	-0.016	0.13	0.12					1.27	2.16	-0.92	-1.18
	(-4.36)	(-4.23)	(7.75)	(7.35)					(3.73)	(2.88)	(-4.13)	(-2.30)
$RVol_t$					-6.74	-7.33	4.72	3.84				
					(-4.73)	(-3.67)	(5.11)	(4.05)				
$R_{M,t}$		0.017		-0.0088		0.00013		0.0031		-0.045		0.027
		(1.60)		(-1.72)		(0.01)		(0.64)		(-1.61)		(1.61)
$\Delta Noise_t$		-0.011		-0.0061		-0.012		-0.0049		-0.030		0.0048
		(-0.81)		(-0.86)		(-0.87)		(-0.95)		(-1.94)		(0.40)
$PSLiq_t$		0.0023		-0.0076		-0.0085		0.00017		-0.038		0.016
		(0.17)		(-1.23)		(-0.71)		(0.03)		(-1.81)		(1.24)
$TEDSpread_t$		-0.015		0.027		0.0065		0.015		0.0059		0.017
		(-0.85)		(2.40)		(0.62)		(1.32)		(0.29)		(1.19)
$Quality_{f,t}$		-0.011		-0.020		-0.012		-0.021		0.017		-0.037
		(-1.04)		(-0.97)		(-1.14)		(-1.01)		(0.44)		(-1.19)
$Recession$		-17.9		66.1		17.3		46.7		-3.31		54.5
		(-0.55)		(1.65)		(0.51)		(1.26)		(-0.05)		(0.98)
Qtr, Year, Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85560	74609	84634	73691	85560	74609	84634	73691	85560	74609	84634	73691
R^2	0.014	0.014	0.46	0.46	0.015	0.015	0.44	0.45				

t statistics in parentheses

Table 8: Reduced Form, and IV Panel Regressions with Alternative Measures of Liquidity.

This table uses monthly data from Morningstar from January 1998 through December 2013 (85,560 fund-month observations) to examine the relationship between fund's active asset allocation and its net flows. ln(*Amihud*) is a natural logarithm of Amihud measure. *Bid-Ask* is a proportional Bis-Ask spread. All the variables (excluding *Recession*) are z-scored. Columns 1–4 show the reduced form regression coefficient of alternative behaviour measures on fund's net flows. Columns 5–8 show the coefficients from the 2SLS second stage regression of fund's active liquidity management (computed with alternative liquidity measures) on fund flows instrumented with realized market volatility $RVol_t$. I use Garman and Klass (1980) realized market volatility $RVol_t$ as the instrument for the performance in the columns (7)-(9). I include control variables as: return on S&P500 index $R_{M,t}$, Hu et al. (2013) measure of the market-wide liquidity $\Delta Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, fund's value-weighted quality measure of its holdings $Quality_{f,t}$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for fund, year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors that are clustered both at year-month and a fund level.

	Reduced Form				IV			
	ln(*Amihud*)		$Bid-Ask$		ln(*Amihud*)		$Bid-Ask$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Flow_{f,t}$					3.09	4.52	1.45	2.56
					(4.05)	(2.63)	(3.92)	(2.64)
$RVol_t$	-16.4	-15.3	-7.74	-8.70				
	(-5.80)	(-4.24)	(-3.95)	(-2.90)				
$R_{M,t}$		0.018		0.00044		-0.075		-0.053
		(0.73)		(0.03)		(-1.25)		(-1.37)
$\Delta Noise_t$		0.016		-0.0079		-0.021		-0.029
		(0.58)		(-0.48)		(-0.51)		(-1.42)
$PSLiq_t$		-0.0020		-0.0045		-0.064		-0.040
		(-0.13)		(-0.24)		(-1.64)		(-1.34)
$TEDSpread_t$		-0.021		0.036		-0.023		0.035
		(-0.94)		(1.98)		(-0.59)		(1.26)
$Quality_{f,t}$		-0.046		-0.028		0.012		0.0052
		(-2.80)		(-1.93)		(0.16)		(0.11)
Recession		85.6		-93.8		42.4		-118.2
		(0.88)		(-1.28)		(0.28)		(-1.58)
Qtr, Year, Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85560	74609	85560	74609	85560	74609	85560	74609
R^2	0.053	0.055	0.033	0.035				

t statistics in parentheses

Table 9: Reduced Form, and Instrumental Variable Panel and Time-Series Regressions with Non-forecastable Component of Market Volatility.

In this table columns 1–10 use monthly fund-level data from Morningstar from January 1998 through December 2013 (85,560 observations), the columns 11–14 use aggregated fund behaviour (192 observations) to examine the relationship between market liquidity premium and mutual fund active liquidity management. All the variables (excluding *Recession*) are z-scored. Column 1–2 (3–4) show reduced from panel regression of fund performance (flows) on market volatility shock $Res(Vol)_t$. Columns 5–6 show the coefficients from the 2SLS second stage regression of fund flows on instrumented performance with the non-forecastable component of market uncertainty. Reduced form and instrumental variable regressions of aggregate funds' active liquidity management B_t are in columns 7–8 and 9–10, respectively. Columns 11–12 and 13–14 show the coefficients from reduced form and 2SLS second stage regressions of return spread between illiquid and liquid stocks on market volatility shock and instrumented funds active liquidity management B_t. The non-forecastable component of market volatility is a residual from the regression of realized market volatility $RVol_t$ (constructed as in Garman and Klass (1980)) on the current month VIX forecast. I include control variables as: return on S&P500 index $R_{M,t}$, Hu et al. (2013) measure of the market-wide liquidity $\Delta Noise_t$, Pastor and Stambaugh (2003) measure of equity market liquidity $PSLiq_t$, a measure of funding liquidity $TEDSpread_t$, funds' aggregated quality measure of their holdings $Quality_t$, and a dummy variable *Recession* is a dummy variable equal one if there was a NBER recession in a given month, otherwise zero. I control for year and quarter fixed effects. The t-statistics reported in the tables reflect robust standard errors.

	$Perf_t$		$Flow_t$				B_t				LP_t			
	Reduced		Reduced		IV		Reduced		IV		Reduced		IV	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
$Res(Vol)_t$	-0.20	-0.18	-0.033	-0.023			-0.041	-0.043			-0.17	-0.30		
	(-4.85)	(-3.23)	(-4.23)	(-2.51)			(-5.81)	(-3.66)			(-2.36)	(-2.86)		
$Perf_{f,t}$					0.16	0.13								
					(4.91)	(2.39)								
$Flow_{f,t}$									1.26	1.89				
									(4.55)	(2.41)				
B_t													0.39	0.61
													(2.77)	(3.73)
$R_{M,t}$		0.039		0.019		0.014		-0.000029		-0.037		-0.22		-0.14
		(0.59)		(2.62)		(1.03)		(-0.00)		(-1.27)		(-1.97)		(-1.60)
$\Delta Noise_t$		0.0088		0.016		0.015		0.0045		-0.027		0.069		0.069
		(0.18)		(1.96)		(1.90)		(0.33)		(-1.88)		(0.66)		(0.97)
$PSLiq_t$		0.0041		0.014		0.013		-0.0086		-0.035		0.050		0.083
		(0.07)		(1.92)		(1.50)		(-0.61)		(-1.63)		(0.52)		(1.07)
$TEDSpread_t$		-0.0096		-0.0067		-0.0055		-0.010		0.0027		0.030		0.072
		(-0.21)		(-0.84)		(-0.65)		(-0.65)		(0.14)		(0.26)		(1.08)
$Quality_{f,t}$		0.055		-0.013		-0.020		-0.016		0.0087		-0.061		0.14
		(1.75)		(-0.80)		(-1.18)		(-1.63)		(0.26)		(-0.45)		(0.98)
$Recession$		114.6		-2.92		-17.5		-10.9		-5.37		-380.3		-194.1
		(0.47)		(-0.10)		(-0.43)		(-0.34)		(-0.08)		(-0.92)		(-0.67)
Qtr, Year, Fund FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85560	74609	85560	74609	85560	74609	85560	74609	85560	74609	192	179	192	179
R^2	0.075	0.082	0.16	0.17			0.014	0.014			0.17	0.22		

t statistics in parentheses

Essay 2

House Prices and Taxes[1]

[1]We thank Steffen Andersen, Lasse Heje Pedersen, Jesper Rangvid, Ben Sand and seminar participants at Copenhagen Business School, PenSam Liv A/S, at the 2014 European Econometric Society meeting, and at the 2014 World Finance Conference in Venice for helpful comments. Mads Gjedsted Nielsen gratefully acknowledges the financial support of PenSam Liv A/S.

Abstract

By using the 2007 municipality reform in Denmark as an exogenous shock to municipal tax rates, we find that a 1%-point increase in income tax rates lead to a drop in house prices of 7.9% and a 1‰-point increase in the property tax rates lead to a 1.1% drop in house prices. The simple present values of a 1%-point perpetual income tax increase and a 1‰-point property tax increase, relative to the median house price, are 7% and 3.3%, respectively. Our findings are thus in line with the predicted median tax loss. This indicates that the housing market efficiently incorporates taxes into house prices. The exogeneity of the shock to taxes and the size of the dataset is an improvement over earlier studies.

2.1 Introduction

It is difficult to measure the effect of taxes on house prices. Since the seminal work of Oates (1969) many researchers have tried to estimate the degree of property tax capitalization into house prices. That is, the extent to which higher property taxes, all else equal, lead to lower house prices. Full capitalization is said to occur when the change in house prices exactly corresponds to the present value of a change in taxes. The common approach (as in Palmon and Smith (1998b), Oates (1969), Edel and Sclar (1974), Oates (1973), and Rosen and Fullerton (1977)) in the literature has been to use cross-sectional data on house sales in one or a few counties with varying taxes. Besides the small sample size and the small geographical area, the main problem with this type of analysis is controlling for public service, which varies significantly between counties. This is because it is hard to measure the quality of public service.

Another approach (as in Wicks et al. (1968) and Smith (1970)) would be to use tax changes from one year to another, where differences in the quality of public service are arguably much smaller than in the cross section. However, this approach introduces a potential bias if the change in taxes are not completely exogenous to house prices. For example, if the factors driving the tax changes might also influence house prices directly, the estimates will be biased.

In this paper we use the 2007 municipality reform in Denmark as a natural experiment in which the tax changes are completely exogenous, and thus provide unbiased estimates of the effects of taxes on house prices.

Much of the previous literature on taxes and house prices estimates the degree of tax capitalization. Taxes are fully capitalized into house prices if, all else equal, the change in house prices exactly equals the present value of the change in taxes. That is, when accounting for all other factors, the change in house prices completely equals:

$$\sum_{n}^{N} \frac{\Delta \text{Tax}}{(1+i)^n},$$

where i is the relevant discount factor and N the lifetime of the house. For large N, as is reasonable to assume for houses, the present value of the changes in taxes are well approximated by $\frac{\Delta Tax}{i}$. Thus the degree of housing capitalization deliver insights to the rationality and efficiency of the housing market. If the residential housing market is completely rational and efficient, then only future unexpected tax changes can be transferred to future home owners, and we should have full tax capitalization. The current study uses both cross-sectional differences and time changes in the nominal tax rates to estimate the capitalization of taxes.

We argue that the tax changes in relation to the 2007 municipality reform in Denmark were completely exogenous of any factors plausibly influencing house prices.

Whereas the earlier literature only focuses on property taxes, we also look at the capitalization of municipal income taxes. Since Danes pay municipal income taxes in the municipality where they reside, everything else equal, one should prefer living in a municipality with lower taxes.

The purpose of the 2007 municipality reform was to better exploit economies of scale at the municipal level by merging smaller municipalities. With the exemption of only four small islands, all municipalities below 20,000 inhabitants had to merge with one or more nearby municipalities in order to create a new municipality of at least 30,000 inhabitants. The new municipalities set the new tax rates equal to an average of the tax rates of the municipalities participating in the merger plus an adjustment for changes in the public service task offered by the municipalities[2]. The new municipalities had the option to set the tax rates lower than this average plus an adjustment, but only 9 of the 98 municipalities chose to set the income tax rates below the maximum allowed rate, and only 11 chose to set the property tax rates below the allowed maximum. We instrument the tax rates after the reform with the average of the merging municipalities previous tax rates, since this average is closely related to the chosen tax rate, and is independent of any factors that might influence house prices, like the economic situation in the municipality.

Of course the municipalities were free to change the level of public service provided, and so we control for the level of public service. Because the quality of public service is hard to measure, we instrument our service variable with the total school expenditure and the total education expenditure in the municipality.

We find that a 1%-point increase in the income tax rate lead to a drop in house prices of 7.9% and a 1‰-point increase in the property tax rate lead to a 1.1% drop in house prices. The simple present value of a 1%-point perpetual income tax increase and of a 1‰-point property tax increase, relative to the median house price correspond to 7% and 3.3%, repectively. Our findings are thus in line with predicted. This indicates that the housing market efficiently incorporates taxes into house prices, similar to the findings of Palmon and Smith (1998b).

The rest of the paper is organized as follows. Section 2.2 briefly reviews related literature, section 2.3 explains the municipality reform, section 2.4 discusses the data and summary statistics, section 2.5 lays out the estimation strategy, 2.6 presents the results, and section 2.7 concludes.

[2]In connection with the reform some public service task previously defined as state tasks were taken over by the municipalities.

2.2 Related Literature

Oates (1969) was the first to formally test the extent of property tax capitalization. Where full capitalization is said to occur, when controlling all other factors such as public service and housing characteristics, the present value of tax differences equal the differences in house prices. Oates (1969) used cross-sectional data on US property taxes. The study was criticized by Pollakowski (1973) for not properly accounting for the difference in public service levels. Since then many papers have attempted to estimate the degree of property tax capitalization, with differing findings and limited controls for the quality of public service.

Chinloy (1978) and Gronberg (1979) find limited capitalization effects, whereas Oates (1969), Edel and Sclar (1974), Gustely (1976), and Yinger et al. (1988) report varying degrees of tax capitalization. Oates (1973), Reinhard (1981), and Gallagher et al. (2013) find close to full or even over capitalization.

Palmon and Smith (1998b) and Palmon and Smith (1998a) are the first study to properly control for public service except schooling. They construct a quasi-experiment by subdividing houses into municipal utility districts (MUDs) that have similar service levels (except for school quality), but varying effective property taxes. This is an important improvement compared to earlier identification strategies, but still fails to effectively control for public school quality, which is shown to be priced by home owners in Black (1999).

The current study uses both variation in the cross-section of municipalities and over time to estimate the capitalization of taxes. To our knowledge this is the first study to have completely exogenous variation over time due to the municipality reform. Having both cross-sectional and time-series variation should give us a better estimate of the effect of taxes on house prices.

2.3 The Danish Municipality Reform in 2007

In April 2004 the Danish government laid forth a proposal for a reform of the municipalities and regions ("Amter") in Denmark. The background for the proposal was the report from the Structural Commission in January 2004. The idea was to better exploit economies of scale by reducing the number of municipalities from 271 to 98 and thus increasing the size of the municipalities. Furthermore, the 13 regions ("Amterne") were replaced by 5 bigger regions ("Regionerne"), where the new regions lost the ability to levy taxes, and their main task would be hospital services. The reform took effect from January 1st 2007.

In June 2005 the division of the new municipalities was established. Municipalities smaller than 20,000 inhabitants should merge with other municipalities to create a new municipality of at least 30,000 inhabitants. 32 municipalities did not partake in any merger. Figure 2.3 depicts the pre- and post-merger municipality size. Most of the municipalities with less than 20,000 inhabitants (to the left of the vertical line) merge with other municipalities, creating a new larger municipality (mostly with more than 30,000 inhabitants - observations above the horizontal line). The new merged municipalities of course had to set new tax rates.

From 2001 there had been a tax freeze in Denmark. This was still the case during the municipality reform. The tax freeze meant that there could not be municipal tax increases at an aggregate level, so if one municipality decided to raise taxes another had to decrease their taxes by an equal amount. The result was that municipal taxes remained almost completely constant from 2001 to 2007.

Two municipal taxes directly affect households in Denmark; the property tax and the income tax. The municipal income tax is a tax on labor income, and before the reform in 2006, the income tax rates varied from 15.5% to 23.2% as seen from table 2. The municipal property tax is a tax on the assessed value of the lot where a residential property is located. Residential real estate is assessed in odd years. Thus, the only change in property taxes between 2006 and 2007 is due to the reform, since the assessed lot values were not changed. The municipal property tax rates in 2006 ranged from 6‰ to 24‰ as seen from the table 2.

Municipalities could not freely choose the tax rates. Instead they could choose to set the rate equal to or lower than a maximum allowed rate. The maximum allowed tax rates were calculated as an average of the merging municipalities' previous tax rates plus an addition due to the split of the region's public service responsibilities between the state and the municipalities and due to the municipalities taking over some of the state's public service tasks. To avoid the political battles over the new tax rates, and to prevent dramatic changes in any one municipality's tax rate, almost all municipalities chose to set the tax rates equal to the maximum allowed rate. Only 8 of the 98 new municipalities chose to set the income tax rates below the maximum allowed rate, and only 11 chose to set the property tax below the maximum. The old region ("amt") income tax rates were split as 8%-points to the state income taxes, and the rest to the maximum allowed rate for the new municipal income tax. The old region property tax rates were uniformly 10‰, and they were added to the maximum allowed rate of the new municipal property tax rates.

The changes in tax rates were a function of the previous tax rates in the municipalities that happened to merge. The "choice" to merge was determined by the municipal size. It seems reasonable to assume that the change in size of the municipality is independent of factors affecting house prices, since the change of geographical municipal boundary and the change in municipal size should not affect house prices, when properly accounting for changes in municipal factors such as taxes and service.

The selection of which municipalities to partake in a given merger depended on which municipalities that were adjacent to each other. And since all merging municipalities had to agree upon who to merge with, one could imagine that merging municipalities would be similar in terms of tax rates and service levels. This could potentially lead to very small tax changes. However, table 2 shows that both property tax rates and income tax rates changed substantially due to the reform. A few municipalities failed to find candidates to merge with, and in these cases the national parliament decided which municipalities to merge.

Hence, it seems reasonable to assume that the reform instigated a change in tax rates that was exogenous to house prices. Specifically, it seems obvious that the tax changes were independent of the economic situation of the individual municipalities, and thus serves as good experiment to examine how exogenous changes in tax rates affect house prices. Figure 2.1 shows the geographical distribution of the merging and non-merging municipalities. The merging municipalities are located all over Denmark.

2.4 Data

To conduct the study, we have collected a very detailed description of the houses sold including house-specific characteristics and spatial data, the municipal taxes, and the public service levels before and after the municipal reform in Denmark in 2007. In the following sections we describe the data sources and present summary statistics.

2.4.1 House Prices and Spatial Data

All Danish housing sales[3] are recorded by the Danish tax authorities and are available through the Danish public information server through `www.OIS.dk`. It includes sales prices, size, number of rooms etc. for all Danish addresses back to 1992. We use residential house prices from sales in 2006 and 2007. Our regressand is the natural logarithm of the sales price.

We exclude family transactions. Family sales are easily identified in the dataset, because all family sales are registered and marked as such. We also exclude forced sales, and thus only include regular arms length sales in the dataset.

We focus only on the three biggest housing types in Denmark; regular houses, apart-

[3]Except the housing type "Andelsbolig", which is a Danish cooperative housing type, that is governed by very different laws than regular home ownership.

ments, and townhouses[4]. This is done to avoid special house types, that might be priced different than regular owner-occupied housing.

To deal with incorrectly registered sales we trim the data for the top and bottom 1%. We have tried trimming the top and buttom 3, 2, and 0.5% instead, and it did not significantly change the results. Some of the houses in the data are listed as having been remodelled after the sale in either 2006 and 2007, and since the database only records the current house characteristics, we exclude all houses renovated after the sales date to avoid backdated values.

All the addresses of the sold houses are geocoded with latitude and longitude coordinates, and the municipal affiliation before and after the reform of each location is determined through the Danish Geodata Agency's (Geodatastyrelsen) mapping services "GeoVA" and "GeoK7".

The house characteristics are supplemented by the distance to the nearest big city in Denmark. This spatial variable is meant to catch the effects of living close to a big city, like bigger job opportunities, better shopping facilities, closer proximity to schools etc.

2.4.2 Taxes and Public Service

In connection with the Danish municipality reform two tax rates affecting private citizens changed, the municipal property tax rate[5] and the municipal income tax rate. Data on these two taxes before and after the reform are from the Danish Ministry for Economic Affairs and the Interior available at `www.noegletal.dk`.

As part of the reform the previous regions called "Amter" were dismantled and the income taxes previously collected by these regions were split between national taxes and municipal taxes. 8 percentage-points of the regions income tax were converted into an 8% national income tax, and the rest were added to the municipal income tax rate. The added part is not an actual tax increase, since it is exactly offset by the removal of the regional tax. Thus, when comparing pre-reform tax rates to post-reform tax rates, the added part needs to be subtracted the post-reform tax rates to correctly identify real tax changes.

The old regions also had a property tax on the value of each private lot. The tax rate was uniformly 10‰ and this was added to the municipal property tax rate as part of the reform. Again, we subtract 10‰ from the post-reform municipal property tax rate, since this addition was exactly offset by the removal of the regional property taxes.

Table 1 shows a fictitious example of how the tax rates changed because of the reform for households living in two merging municipalities, A and B. The municipalities in the example

[4]Villaer, ejerlejligheder, and rækkehuse in Danish.

[5]The municipal property tax is a tax on the current appraised value of each private property lot.

belonged to different counties ("Amter") before the reform. The new merged municipality, AB, sets the income tax rate equal to the average of the previous tax rates in A and B, plus the part of the county tax rate above 8%, which is the part not transferred to the new state health tax. The new municipal property tax rate is equal to the average of the previous municipal property tax rates plus the county property tax rates (The county property tax rates were uniformly 10‰ before the reform). However, the relevant tax changes exclude the redistribution of the county tax rates. Hence, the relevant tax changes are shown in the last rows in table 1.

The two municipalities, Værløse and Farum, were excluded from the sample, since even though the two municipalities merged, the municipalities upheld differential tax rates even after the reform. This was due to substantial debt and subsequent tax increases in Farum brought on by fraud conducted by then Mayor in Farum, Peter Brixtofte.

To proxy for the quality of public service in a municipality we use a calculated measure from `www.noegletal.dk`. It equals the net expenses used on public service divided by the calculated need of public service taking the demography of the municipality into account. It should, thus be a better measure of public service than simply the total expenditure per capita, since the latter for example would overstate the service level in municipalities with many elderly. A value of 1 indicates that the municipality uses the amount on service justified by the demography and social needs of the municipality. A municipality could thus for example spend a lot on the elderly, without it resulting in a higher service level, if there are many elderly in the municipality. Hence, it should be a better service variable than for example total expenditure per capita. A service value higher than 1 indicates that the municipality uses more than its calculated need, and a value less than 1 would indicate using less than the need. Our service variable will most likely be measured with error. To alleviate this problem we instrument it with the total expenditure spent on schooling per pupil and the total expenditure spent on general education per pupil in the municipality.

2.4.3 Summary Statistics

The dataset includes 64,299 sales in 2006 and 67,500 sales in 2007. Thus significantly expanding the number of observations compared to the earlier studies. As an example, Palmon and Smith (1998b) relies on only 501 sales in the Houston area. The reason why we focus on 2006 and 2007 is that the municipality reform took effect on January 1st 2007. For each sales we have collected the market price of the house, structural characteristics of the house such as the size, the number of rooms, the age, and the distance to the nearest city center. Furthermore, we have collected the municipal property tax, the income tax, and the public service level. The summary statistics are shown in table 2.

2006 and 2007 had similar amounts of sales. And in both years most villas were sold. The structural housing variables are distributed similarly in the two years. The income tax rates in 2006 vary from 15.5% to 23.2% and the property tax rates vary from 6‰ to 24‰, thus providing substantial variation to estimate the tax effect on house prices. The reform led to 256 tax changes geographically located all over Denmark as seen from figure 2.1. 32 municipalities did not partake in a merger, and some municipalities were split, and the split parts merged with different municipalities.

The service variable equals the total expenditure on service in the municipality relative to its calculated need given its demography. In 2007 the dispersion of both property tax rates, the income tax rates, and the service levels were lower than in 2006. This is a direct result of the merging municipalities setting common rates and service levels.

Both the income tax rates and the property tax rates vary substantially due to the reform. From the summary statistics in table 2 it is seen that the changes in the income tax rates ranged from -2.97 percentage points to 3.76 percentage points with a mean of -0.22 percentage points, and the changes in property tax rates ranged from -12.76‰ to 13.86‰. Thus, the reform had substantial impact on the tax rates in some municipalities. The large variation in tax changes will help us in identifying the effect on house prices.

2.5 Estimation Strategy and Identification

To estimate the degree of tax capitalization we use a hedonic regression model (see Rosen (1974)). The idea is that housing, even though being a differentiated product, can be described by a vector of characteristics, over which individuals have preferences. These characteristics can be house specific, location specific, or relate to the local public taxes and services etc. The basic regression model is the following

$$log(Price_{ijt}) = \alpha + \beta x_{ijt} + \gamma_{IT} IT_{jt} + \gamma_{PT} PT_{jt} + \gamma_S S_{jt} + \lambda_k + \rho_t + \varepsilon_{ijt}, \qquad (2.1)$$

where i indexes the individual sales, j indexes the municipalities, and t indexes time. The variables contained in x describe the house specific characteristics relevant for the price. IT_{jt} denotes the municipal income tax, PT_{jt} denotes the municipal property tax, and S_{jt} denotes the public service level in the municipality. λ_k are dummy variables for each of the regional areas in Denmark called "Amter", and ρ_t are monthly dummy variables to capture the general time effect. The ε_{ijt} is the error term for each sale.

The semi-log specification in equation 2.1 is chosen because it provides the best fit of the data. The interpretation of the parameters in the semi-log specification is the relative change in the selling price, $Price$, of a 1 unit of change in the relevant explanatory variable as seen from a simple application of the chain rule on equation 2.1. Shown below for the property tax effect (suppressing subscripts for clarity):

$$
\begin{aligned}
\gamma_{PT} &= \frac{\partial log(Price)}{\partial PT} \\
&= \frac{1}{Price}\frac{\partial Price}{\partial PT} \\
&= \frac{\frac{\partial Price}{Price}}{\partial PT}
\end{aligned}
$$

The number of rooms, the size of the house and the distance to the nearest city are in natural logarithms. This gives a better fit of the model. With the log specification of the explanatory variables the interpretation of the coefficients becomes (suppressing subscripts for clarity):

$$
\begin{aligned}
\beta &= \frac{\partial log(Price)}{\partial log(x)} \\
&= \frac{1}{Price}\frac{\partial Price}{\partial log(x)} = \frac{1}{Price}\left(\frac{\partial log(x)}{\partial Price}\right)^{-1} \\
&= \frac{1}{Price}\left(\frac{1}{x}\frac{\partial x}{\partial Price}\right)^{-1} = \frac{\partial Price}{Price}\bigg/\frac{\partial x}{x}
\end{aligned}
$$

Hence, a coefficients in front of a variable in natural logarithm equal to 0.5 means that a 1% increase in the explanatory variable results in a 0.5% increase in the house price.

After the reform, the merging municipalities were allowed to set the new tax rates lower than or equal to the average of the previous tax rates in the merging municipalities plus an addition due to increased costs because the municipalities took over some public service tasks that were previously handled by the state. This means that some of the non-merging municipalities actually raised their taxes, and that the merging municipalities could set their tax rates higher than the average of previous rates. Furthermore, municipalities could also choose to set the tax rates lower than this calculated maximum. Using the actual tax rates could introduce bias, if for example municipalities in a good economic situation chose to set lower rates.

We therefore choose to instrument the tax rates by the average of the previous rates in the merging municipalities. These instruments are functions of the municipalities being bigger or smaller than 20,000 inhabitants, and the tax rates in the merging/neighboring municipalities. The instrumental variables are thus unrelated to the economic situation in the municipalities, and therefore pose good instruments, if their are related to the actual tax rates. We estimate the model by two stage least squares (2SLS).

The instruments are, however, not unrelated to the level of public service. One could easily imagine that a municipality with high tax rates and high service levels merging with a municipality with low tax rates and service levels, would experience a drop in public service. We will thus need to control for the public service level.

For the 2SLS regression we use median values of sales prices, sizes, number of rooms, etc. for each of the municipalities. This is done to deal with error correlation between sales within the same municipality. The specification hence becomes:

$$log(Price_{jt}) = \alpha + \beta x_{jt} + \gamma_{IT} IT_{jt} + \gamma_{PT} PT_{jt} + \gamma_S S_{jt} + \lambda_j + \rho_t + \varepsilon_{jt}, \qquad (2.2)$$

2.6 Results

The results from estimating equation (2.1) by simple ordinary least squares (OLS) are presented in table 3. In the M1 column the standard errors are clustered on the old municipalities, to deal with residual correlation between sales within the same municipality. We include monthly time dummy variables to pick up any common time series effect. To account for geographical differences in the pricing of houses in Denmark a regional factor is included corresponding the old Danish regions called “Amter”, which were replaced by 5 bigger regions, “Regionerne”, as part of the reform. Ideally the model should include fixed effects for each old municipality to isolate the pure effect of the reform (difference over time), and not allow for any cross-sectional variation driving the results. However, in unreported results include old municipality fixed effects, both the income tax and property tax loose statistical significance. The model including municipal fixed effects only has the time series variation to estimate the tax effects. Unfortunately, we need the cross-sectional variation between municipalities in order to get statistical significance.

It is noticeable that the model with an R^2 of 44% does a reasonably good job explaining the variation in the data, even though the dataset covers sales from all of Denmark. This indicates that the housing characteristics explain most of the house price variation, which is needed to pick up any tax effects.

All the housing characteristic have the expected signs. Not surprisingly, the size of the house and the distance to the nearest city are most important in explaining the sales price. A 1% increase in the distance to the nearest city leads to a 0.097% drop in house prices. A 1% increase in the size leads to an increase in price of 0.748%. The number of rooms also positively influence the house price. The age of the house is negatively related to the price, but the squared age is positively related, indicating that really old houses often are better located and have more charm. Townhouses and villas sell at a discount compared to apartments, but the effect of townhouses disappears in M1, where the standard errors are clustered on old municipalities, and the discount on villas is only barely significant at the 5% level.

In column M2, without standard error clustering, both the income tax rate and the property tax rate are statistically significant and influence house prices negatively. A 1 percentage-point increase in income tax rate leads to a 4.4% drop in house prices. A 1 permille-point increase in the property tax rate, leads to house prices falling by 0.3%. When clustering standard errors on old municipalities (column M1), the property tax is no longer significant.

However, using the actual 2007 post reform tax rates might bias the results, since municipalities were free to set taxes below the average of the previous tax rates plus an addition due to municipalities taking over some public service tasks from the state. This addition do not constitute a tax increase, but merely a redistribution of taxes and tasks between the state and the municipal level. Furthermore, the freedom to set the tax rates below the threshold, might introduce a bias, since municipalities in good economic situations might choose to lower taxes. Becuase the overall economic situation in the municipality also directly affect house prices, this will lead to endogeneity.

The problem can be circumvented by instrumenting the tax rates by a variable that for the 2006 values equal the 2006 tax rates, but for 2007 equals the average of the previous rates in the merging municipalities. For municipalities not participating in a merger, the 2007 values just equal their 2006 values. These two instruments, one for the income tax and one for the property tax, will be independent of the economic situation in each of the municipalities, since it is simply a function of the merger rule (below 20,000 inhabitants), and the tax rates in the neighboring municipalities. Intuitively, the instruments should also be highly correlated with the actual tax rates, since the average previous tax rates were also part of the actual 2007 tax rates.

Table 4 shows the 2SLS estimation instrumenting the income tax and the property tax by the aforementioned variables. All variables are in medians per old municipality, to avoid error correlation between sales in the same municipality. The “First Stage” columns shows that the instruments are indeed highly correlated with the actual tax rates conditional on the exogenous covariates. We, thus, avoid the potential pitfalls in using weak instruments. The “First Stage” regressions are only to show the correlation between the instruments and the actual tax rates. The model is not actually estimated in 2 stages, since this would lead to incorrect standard errors in the second stage.

The "Second Stage" column shows the results from the 2SLS estimation using the two tax rate instruments. The housing characteristics all have the expected signs and are of similar magnitude to the OLS results in table 3. Both the R^2 and the adjusted R^2 are 71%. The increased fit is due to the data being median values per municipality in the 2SLS regressions as opposed to individual sales in the simple OLS estimation. The effects of both tax rates are more significant both economically and statistically compared to the OLS results in table 3. A 1 percentage-point increase in income tax rate lead to a 6.8% drop in house prices. A 1 permille-point increase in the property tax rate, lead to house prices falling by 0.9%.

The results does, however, not control for differences in public service. To address this, we add a service variable to the specification. It equals the net expenses used on public service divided by the calculated need, given the demography of the municipality. Acknowledging that public service is hard to measure, we instrument it by school expenditure per pupil and total educational expenditure per pupil. The results are shown in table 5.

Again the "First Stage" columns show the conditional correlation of the instruments with the respective variables. It is noticeable that the two instruments for service are not as strongly related to our service variable as the tax rate instruments. It is not a major concern for us, as we are not interested in the effect of public service on house prices, but only wish to control for public service differences.

The "Second Stage" column shows the results of the 2SLS estimation. Again, all the housing characteristics have the right signs and similar magnitude as in the previous regressions. The service level is positively related to house prices, but is only significant at the 5% confidence level. The economic magnitude is also quite small. Increasing the service level from 1 to 2, indicating spending twice as much on service as the calculated need, only increases house prices 11.9%. The low estimate is probably partly due to measurement error inducing attenuation bias (estimate is biased towards 0), given that our service instruments are far from perfect.

Controlling for service raises the estimates of both the property tax rate and the income tax rate as expected. A 1%-point increase in income tax rate leads to a 7.9% drop in house prices. A 1‰-point increase in the property tax rate, leads to house prices falling by 1.1%.

One obvious question to consider when using a political reform as a natural experiment, is whether people foresaw the tax changes prior to January 1st 2007. The actual 2007 tax rates were announced on October 15th 2006, however, the tax changes could have been incorporated into property values before this, if people foresaw the changes. This could bias our results towards 0. The number of Google searches related to the reform in figure 2.2) does indicate some peaks in attention prior to January 1st 2007.

To control for this we have tried using 2003 as the pre-event period and 2007 as the post-event period. In 2003 there was no talk about the municipality reform. The estimated coefficients in front of the income and the property tax rates become -5.6% and -0.9%, respectively. These estimates are in the same order of magnitude (and actually a bit closer to 0) as the previous results. The anticipation bias, hence, does seem to be a serious issue.

If people assume tax rates to be constant over time, then it is possible to calculate the present value for a 1% tax difference by assuming a discount rate. We can then compare this theoretical tax benefit/loss to the estimated results in table 5, and find the degree of tax capitalization.

The present value for the median household of a perpetual 1%-point difference in the income tax rate, assuming constant household income, is

$$\frac{\Delta IT * \text{median taxable income}}{r} = \frac{1\% * 315,043}{0.3} = 105,014.$$

We follow Yinger et al. (1988) and Palmon and Smith (1998b) and use a discount rate of 3%. With a median house price in 2007 of 1,500,000, this gives a relative effect of -7,0% for a 1%-point tax increase[6]. This is very close to the estimated -7.9 from table 5, and it corresponds to a capitalization of $-7.9/-7 \approx 110\%$, indicating that the housing market fully incorporates the effect of tax differences and changes into house prices. This result is in line with Oates (1973), Reinhard (1981), and Gallagher et al. (2013) that all find close to a 100% tax capitalization. They, however, focus on property taxes.

Assuming property taxes are paid out of sales prices, or equivalently, that appraisal values equal sales prices, and infinite lifetime for properties, the present value of a 1‰-point difference in property tax rate (assuming constant house values) for the median household equals

$$\frac{\Delta PT * \text{median house value}}{r} = \frac{1‰ * 1,500,000}{0.3} = 50,000$$

The relative effect of a 1‰-point increase in property tax rates thus equals $\frac{0.001}{0.03} = 50,000/1,500,000 \approx 3.3\%$. This is indicates a degree of property tax capitalization of 33%. This assumes that property taxes are paid on property sales prices. In reality, property taxes are paid on the assessed value of the lot, on which the property is placed. The true property tax capitalization will thus probably be higher than 33%.

Another way to get the degree of property tax capitalization is by noting that that the house price is a function of housing characteristics, $f(x)$, ie. size, location etc. less the

[6]The 2007 median taxable income of 315,043 is from Statistics Denmark `www.dst.dk`.

property taxes

$$P = f(x) - \alpha \frac{PT * P}{i} \leftrightarrow P = \frac{f(x)}{1 + \alpha \frac{PT}{i}}$$

where α is the degree of property tax capitalization, i is the relevant discount rate, and PT is the property tax rate. By taking the natural logaritm of both sides, this becomes

$$\ln(P) = \ln(f(x)) - \ln(1 + \alpha \frac{PT}{i}) \approx \ln(f(x)) - \alpha \frac{PT}{i} \tag{2.3}$$

where the approximation works well for small values of $\frac{PT}{i}$. Equation (2.3) corresponds to the estimated equation, and the degree of property tax capitalization can thus be recovered directly from our results as the coefficient in front of the property tax rate divided by $-i$. This assumes that the approximation in equation (2.3) is accurate, and that property taxes are paid on property sales prices. As previously mentioned, property taxes are paid on the assessed value of the lot, on which the property is placed. Using this methodology the degree of tax capitalization becomes

$$\alpha = \frac{-1.1\%}{-3\%} = 36.7\%,$$

which is close the previous result. Since the precise degree of capitalization is highly dependent upon the assumed discount rate, the overall conclusion is that our findings are in line with predicted values, and suggest that the housing market does incorporate taxes into house prices.

2.7 Conclusion

Everything else equal people should prefer lower taxes to higher taxes. So if one municipality has higher tax rates than another municipality with the same level of public service, people can "vote with their feet" and move to the municipality with lower as argued by Tiebout (1956). This mechanism should lead to taxes being capitalized into house prices.

We utilize the 2007 municipality reform in Denmark as a natural experiment to estimate the effect of property tax rates and income tax rates on house prices. We are, hence, able to obtain exogenous cross-sectional and time series variation in tax rates, yielding a dataset of about 600 municipal-year observations.

We find that a 1%-point increase in income tax rate lead to a 7.9% drop in house prices, and 1‰-point increase in the property tax rate, lead to house prices falling by 1.1%. Calculating simple present values of tax changes for the average household yields effects of 7% and 3.3% for the income tax and the property tax, respectively. Our results fall quite close to these, and indicates that the residential housing market does incorporate taxes into house prices.

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2.8 Figures

Figure 2.1: Municipality reform in Denmark. This figure show a map of Denmark with 271 municipalities divided into merging and non-merging municipalities under 2007 municipality reform.

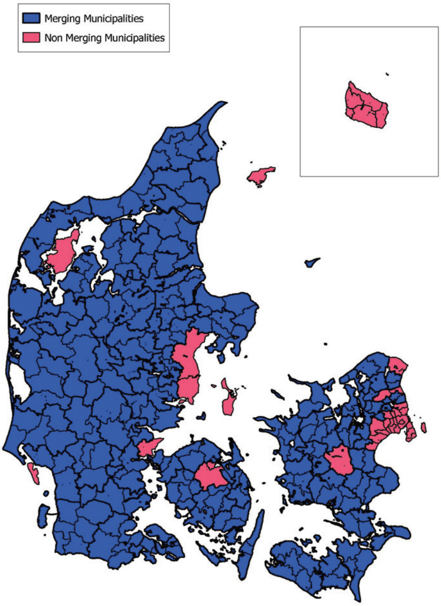


Figure 2.2: Google trend searches. This figure show a time-series of Google searches concerning municipality reform in Denmark. The numbers reflect how frequently a given entry (*Strukturreformen*) was searched relative to the highest frequency point of time. Value of 100 means the greatest popularity, value of 50 suggests that the popularity has been decreasing. If the popularity of *Strukturreformen* was less than 1% compared to the period of greatest popularity we assign a value of 0.

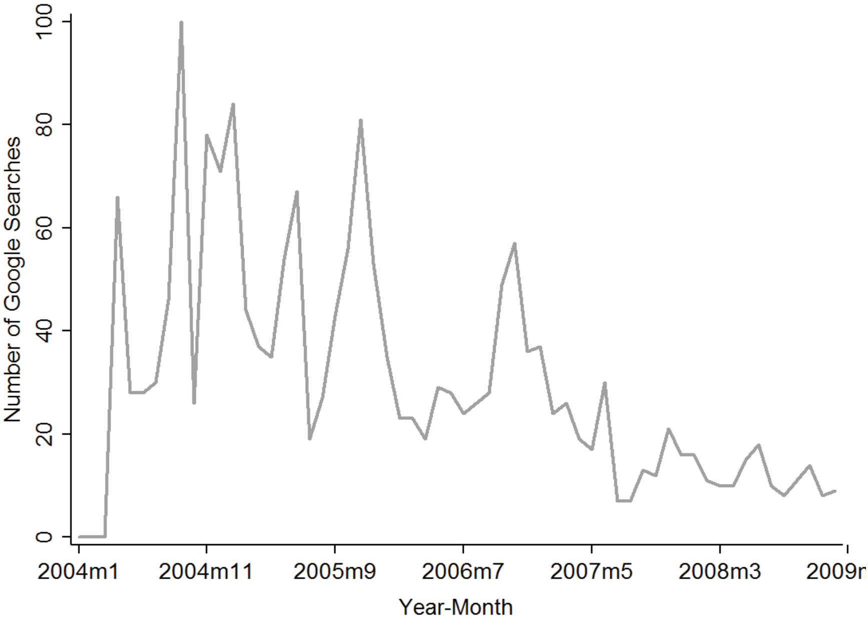
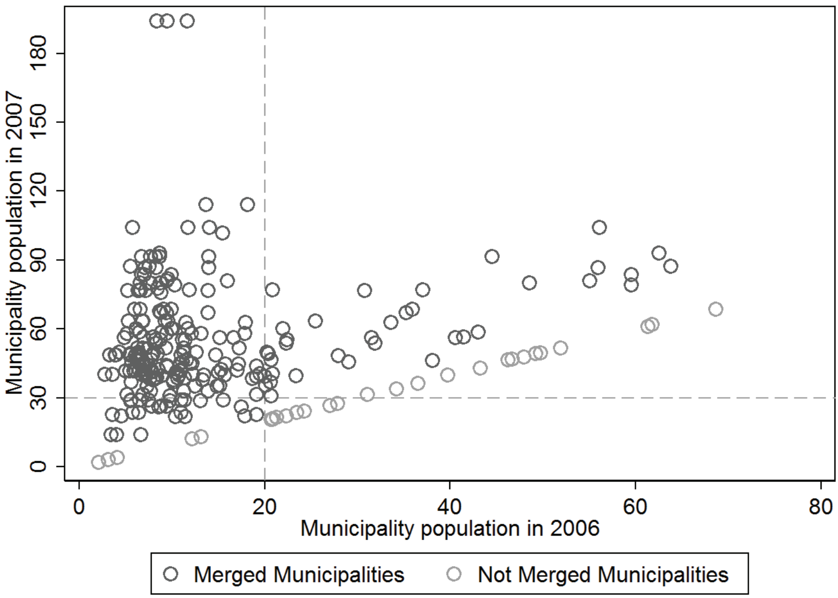


Figure 2.3: Population size in merged and non-merged municipalities. According to municipality reform, municipalities smaller than 20,000 (to the left of the vertical line) were supposed to merge with other municipalities to create a new municipality of at least 30,000 in habitants (above the horizontal line). This figure reports 2007 municipality population sizes in thousands and only for municipalities with less then 80,000 inhabitants in 2006. There were only five municipalities with number of inhabitants larger than 80,000 in 2006: Frederiksberg, Aalborg, Odense, Aarhus, København.



2.9 Tables

Table 1: A tax rate change example. A fictitious example of how the tax rates changed because of the reform for households living in two merging municipalities, A and B. The municipalities in the example belonged to different counties ("Amter") before the reform.

		A	B
Before the reform	Municipal income tax rate	20%	16%
	Municipal property tax rate	8‰	10‰
	County income tax rate	12%	14%
	County property tax rate	10‰	10‰
		AB	
After the reform	Municipal income tax rate	$\frac{20+(12-8)+16+(14-8)}{2} = 23\%$	
	Municipal property tax rate	$\frac{8+10+10+10}{2} = 19‰$	
		A	B
Relevant tax changes	Municipal income tax rate	23-20-(12-8)=-1%	23-16-(14-8)=1%
	Municipal property tax rate	19-8-10=1‰	19-10-10=-1‰

Table 2: Summary statistics for housing and municipal characteristics in 2006 and 2007. This table shows destribution of main variables in our analysis for two periods: 2006 (Panel A) and 2007 (Panel B). This table provides summary statistics for a house sale price, the size and the number of rooms of sold property, its age, distance to the nearest city center, price per square meter, income, property tax and service level in the municipality where a property is located.

PANEL A: 2006

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Price	50000	885000	1350000	1634000	2035000	25000000
Size (m^2)	17	93	121	126	152	1205
Number of rooms	1	3	4	4	5	19
Age in years	1	32	45	58	77	2005
Distance to city center (m)	16	2184	7365	9733	14770	79520
Price/m^2	2059	7644	11510	13660	17770	46830
Income tax (%)	15.50	20.70	21.20	21.13	21.60	23.20
Property tax (‰)	6.00	9.00	12.00	12.99	16.00	24.00
Service Level	0.89	0.98	1.01	1.02	1.05	1.28
Housing types	Townhouse	Apartment	Villa			
No. of sales	11135	7798	45366			

PANEL B: 2007

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Price	50000	995000	1500000	1766000	2246000	30000000
Size (m^2)	11	89	118	123	149	834
Number of rooms	1	3	4	4	5	54
Age in years	1	33	47	58	77	1007
Distance to city center (m)	11	2233	6446	9209	14000	78940

Price/m^2	2059	8667	13330	15340	20860	46850
Income tax (%)	19.26	20.29	20.96	20.91	21.42	22.21
Property tax (‰)	6.56	11.17	12.86	13.89	16.34	24.00
Service Level	0.91	0.97	0.99	1.01	1.03	1.21
Housing types	Townhouse	Apartment	Villa			
No. of sales	15179	7822	44499			

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Income tax rate changes (%)	-2.97	-0.73	-0.21	-0.22	0.23	3.76
Property tax rate changes (‰)	-12.76	-1.45	0.56	0.90	2.93	13.86

Table 3: OLS regression of house prices on tax changes. This table presents OLS panel regressions for period 2006-2007, where log house price is regressed on the municipality income and property tax, and a vector of house characteristics such as log number of rooms, log distance to the city, log size, age, squared age, house type dummy variable (townhouse, villa and apartment). There is month fixed effect included in both of the regressions. In the first model (M1) there is also amt fixed effect and errors are cluster by each old municipality. In the second model (M2) there is amt fixed effect as well, however the errors are not clustered. The t-statistics are provided in the brackets.

Parameter	M1	M2
Intercept	12.382	12.382
	(35.83)	*(214.09)*
Income Tax(%)	-0.044	-0.044
	(-2.69)	*(-19.48)*
Property Tax(‰)	-0.003	-0.003
	(-0.96)	*(-7.67)*
log(No. of rooms)	0.094	0.094
	(8.56)	*(12.76)*
log(Distance to city) (m)	-0.097	-0.097
	(-9.78)	*(-80.54)*
log(Size) (m^2)	0.748	0.748
	(50.68)	*(99.65)*
Age in years	-0.008	-0.008
	(-25.47)	*(-68.07)*
$\text{Age}^2 \cdot 10^3$	0.030	0.030
	(21.13)	*(44.58)*
Housing Type:	-0.031	-0.031
Townhouse	*(-0.71)*	*(-4.28)*
Housing Type:	-0.091	-0.091
Villa	*(-2.02)*	*(-14.85)*
Monthly dummy variable	Yes	Yes
Amt Fixed Effect	Yes	Yes
Municipality Error Clustering	Yes	No
R^2	0.44	0.44
Adj-R^2	0.44	0.44

Table 4: Two stage least square regression of house prices and instrumented tax changes. This table presents two stage least square estimation with two endogenous variable: income tax and property tax. The intended income and property tax are used as instrumental variables for income and property tax, respectively. Amt and month fixed effect are included in each of the regressions. The second and third column show coefficient estimates from the first stage least square estimation, whereas the last column presents the coefficients from the second stage where the median log house price in each old municipality is regressed on income tax and property tax from the first stage and other covariates: median old municipality log number of rooms, log distance to city, log size, age, squared age, house type. The two last raw show the R^2 and adjusted R^2 for each of the regression. The t-statistics are provided in the brackets.

Parameter	First Stage		Second Stage
	Property Tax	Income Tax	log(House Price)
Intercept	0.562	-1.799	13.274
	(0.73)	*(-7.39)*	*(85.68)*
Tax Income (%)			-0.068
			(-14.86)
IV-Intended Income Tax (%)		1.046	
		(142.48)	
Tax Property (%)			-0.009
			(-10.90)
IV-Intended Property Tax (%)	1.007		
	(205.15)		
log(No. of rooms)	-0.244	-0.011	0.063
	(-1.51)	*(-0.27)*	*(2.37)*
log(Distance to city) (m)	0.062	0.012	-0.078
	(2.97)	*(2.28)*	*(-22.95)*
log(Size) (m^2)	0.145	0.124	0.675
	(0.81)	*(2.78)*	*(23.01)*
Age in years	-0.002	0.000	-0.007
	(-0.49)	*(0.39)*	*(-11.96)*
$\text{Age}^2 \cdot 10^3$	-0.005	-0.009	0.024
	(-0.18)	*(-1.43)*	*(5.62)*
Housing Type: Townhouse	-1.220	-0.029	-0.115
	(-4.95)	*(-0.46)*	*(-2.83)*

Housing Type:	-0.894	-0.121	-0.324
Villa	*(-4.49)*	*(-2.41)*	*(-9.84)*
Monthly dummy variable	Yes	Yes	Yes
Amt Fixed Effect	Yes	Yes	Yes
R^2	0.92	0.85	0.71
Adj-R^2	0.92	0.85	0.71

Table 5: Two stage least square regression of house prices on tax and service changes. This table presents two stage least square estimation with multiple endogenous variable: income tax, property tax and service. The intended income and property tax are used as instrumental variables for income and property tax, respectively. Service is instrumented by education expenditures and state school expenditures. *Amt* and month fixed effect are included in each of the regressions. The second, third and fourth column show coefficient estimates from the first stage least square estimation, whereas the last column presents the coefficients from the second stage where the median log house price in each old municipality is regressed on income tax, property tax and service from the first stage and other covariates: median old municipality log number of rooms, log distance to city, log size, age, squared age, house type. The two last raw show the R^2 and adjusted R^2 for each of the regression. The t-statistics are provided in the brackets.

Parameter	First Stage			Second Stage
	Property Tax	Income Tax	Service	log(House Price)
Intercept	0.535 *(0.69)*	-1.794 *(-7.33)*	1690.7 *(3.91)*	13.358 *(76.11)*
Income Tax (%)				-0.079 *(-11.95)*
IV-Intended Income Tax (%)		1.045 *(141.65)*		
Property Tax (‰)				-0.011 *(-7.66)*
IV-Intended Property Tax (‰)	1.007 *(204.62)*			
Service$\cdot 10^3$				0.119 *(2.14)*
Education Expenditure			-0.108 *(-2.26)*	
State School Expenditure			-69.02 *(-5.59)*	
log(No. of rooms)	-0.241 *(-1.49)*	-0.011 *(-0.28)*	84.050 *(0.94)*	0.049 *(1.65)*
log(Distance to city) (m)	0.059 *(2.83)*	0.012 *(2.31)*	-38.96 *(-3.38)*	-0.072 *(-16.19)*
log(Size) (m^2)	0.156	0.125	-152.8	0.696

	(0.87)	*(2.77)*	*(-1.54)*	*(20.88)*
Age in years	-0.002	0.000	4.602	-0.008
	(-0.49)	*(0.39)*	*(2.28)*	*(-10.99)*
$\text{Age}^2 \cdot 10^3$	-0.005	-0.009	-13.681	0.025
	(-0.21)	*(-1.43)*	*(-0.95)*	*(5.23)*
Housing Type:	-1.232	-0.027	502.56	-0.153
Townhouse	*(-4.98)*	*(-0.44)*	*(3.67)*	*(-3.13)*
Housing Type:	-0.909	-0.120	534.616	-0.367
Villa	*(-4.54)*	*(-2.39)*	*(4.84)*	*(-8.81)*
Monthly dummy variable	Yes	Yes	Yes	Yes
Amt Fixed Effect	Yes	Yes	Yes	Yes
R^2	0.92	0.85	0.32	0.67
Adj-R^2	0.92	0.84	0.32	0.67

Essay 3

Local Economic Conditions and Local Equity Preferences: Evidence from Mutual Funds during the U.S. Housing Boom and Bust[1]

[1]We thank Susan Christoffersen and Christian Laux and seminar participants at the Copenhagen Business School.

Abstract

This paper examines the impact of local economic conditions on mutual fund preferences for geographically proximate stocks and consequent fund performance. Specifically, we demonstrate that mutual funds favour firms located within close geographic proximity and that the strength of these preferences vary with local housing price shocks. A decrease in local house prices is strongly associated with an increase in mutual fund home bias and results in a portfolio adjustment towards safer and higher quality holdings. This portfolio adjustment subsequently reduces mutual fund performance: a one percentage point increase in home bias causes a decrease in a fund's 3-month DGTW adjusted future return by 35.3 bsp.

Mutual funds operate in and react to changing economic conditions. Recent empirical and theoretical studies have shown that external conditions affect mutual fund performance and asset allocation decisions.[2] While previous research documents a strong relationship between market-wide conditions (e.g. business cycle) and fund returns, there is relatively little known about how local economic conditions affect a fund's asset management and, consequently, performance. In particular, time-varying local conditions may fuel fund manager's intrinsic biases and affect a fund's performance.

We attempt to fill the gap in the literature by examining how variation in local house prices affects mutual fund preferences towards geographically proximate stocks. To our knowledge, this is the first study directly relating local economic conditions (proxied by local house price growth) to mutual fund portfolio choices and performance.[3] Recent studies document that mutual funds prefer assets with nearby headquarters. However, the mechanism driving local equity preference is subject to ongoing debate. The finance literature offers two main hypothesis explaining investors' home bias: informational advantage and familiarity bias. For example, Coval and Moskowitz (2001) and Ivković and Weisbenner (2005) argue that fund managers have superior information concerning local stocks. On the other hand, Grinblatt and Keloharju (2001), Seasholes and Zhu (2010), and Pool et al. (2012) argue that investors' preferences towards local stocks are driven by familiarity bias.

By examining the relationship between local house price growth and mutual fund portfolio choices, we aim to contribute to the discussion on the mechanisms driving local equity preferences. Previous literature examines the level or degree of mutual fund home bias, and explanations based on information advantage or familiarity relate to fund or asset characteristics. In contrast, we examine how the degree of home bias *changes* in response to *changes* in the fund's external environment. We find that mutual funds respond to changes in local housing prices by shifting the degree of home bias in their equity portfolios; negative house price shocks cause funds to tilt their portfolio in favour of nearby equity holdings. However, we do not find that housing price shocks are related to what we call 'fund tangibles' (net flows, liquidity position, etc.). Thus, the relationship between the home bias and house price shocks that we document is not being driven by fund investors' reaction to a change in local economic conditions. We argue that asset information advantage or familiarity are unrelated

[2]e.g. Ferson and Schadt (1996), Elton et al. (1995), Vayanos (2004), and Korniotis and Kumar (2013).

[3]We believe that house price growth is a good indicator of local economic conditions. For example, Leamer (2007) argues that housing is the most important sector in economic recessions. In a series of papers, Mian and Sufi (2011); Mian et al. (2013), and Mian and Sufi (2014) document that exogenous local house price shocks have strong effects on local demand. Charles et al. (2016) show that the housing demand was a strong predictor of the employment-to-population ratio of US metropolitan areas in the 2000s. Stroebel and Vavra (2014) show that local house price growth is associated with local retail prices, and that the link is driven by demand or local consumer behaviour.

to local housing price shocks. For example, we do not expect local information availability to be systematically related to the magnitude of house price growth during the housing boom. Thus, our findings suggest a bias in fund manager behaviour that is unrelated to information or familiarity. This previously undocumented behavioural bias is of first order importance, as the shift in mutual fund preferences towards local stocks induced by deterioration in local economic conditions is associated with mutual fund underperformance.

Our paper uses data on US open-ended mutual funds from Morningstar. Our sample includes mutual funds that actively invest in US equity between January 2002 and December 2009. We split our sample into two time periods to exploit the dramatic changes in housing prices across the US during the housing boom (2002-2005) and bust (2006-2009). Our data on housing prices are extracted from Zillow and aggregated to the CBSA level, which we refer to as cities. We then match mutual funds to cities using the location of the mutual fund's head office to create a panel of data covering our two time periods. The key relationship we investigate is how local housing price shocks affect mutual fund portfolio choices. To motivate this relationship, consider Figure 3.1, which plots the annual fraction of a fund's portfolio held in local stocks (within 100 km) and mean housing prices across the US. The aggregate data suggests that the degree of mutual fund home bias is inversely related to US housing prices. While this time-series relationship is suggestive, we aim to isolate a causal relationship by exploiting the cross-section dimension of our panel and asking whether portfolio shifts in the fraction of local equity holdings are stronger in cities with larger house price shocks. Our empirical strategy is similar to Mian and Sufi (2011); Mian et al. (2013); Mian and Sufi (2014) who exploit the large variation of house price appreciation and depreciation across cities during the housing boom and bust. We relate house price growth to mutual fund portfolio adjustments at the city-level using a first-differenced regression framework. While this approach controls for time-invariant factors related to city-level house prices and manager behaviour, there is the potential for time-varying omitted factors to confound our estimates. Thus, we use the Saiz (2010) measure of topographical land constraint as an instrument to isolate exogenous variation in house price growth as in Mian and Sufi (2011).

Our investigation begins by analysing whether local economic conditions affect mutual fund net-flows or liquidity decisions. Investor withdrawals in response to local economic downturns, for example, may cause fund managers to rationally alter their portfolio composition. Both OLS and IV results indicate that investors' demand and supply of cash is unresponsive to the variation in local economic conditions. We also find that fund cash, US equity holdings, and active liquidity management do not covary with housing price shocks. Taken together, these results suggest that housing price shocks do not significantly affect investors liquidity demand and, thus, do not create a fundamental need for funds to alter their asset allocation strategies.

We then examine our main relationship of interest by creating several measures of home bias and relating these measures to local housing price growth. Our main measure of home bias is a weighted average of the distance between fund headquarters and the firm headquarters of each asset in their portfolio, where the weights are the share of the asset within the portfolio. We calculate this measure at the beginning and the end of our two sub-periods for each fund, and we document that the average city-level change in home bias is strongly related to house price growth. We show that this relationship is not being driven by any particular city and is robust to alternative measures of home bias. Moreover, this relationship is present in each sub-period: During the boom, cities that experienced larger positive house price growth reduced their home bias the most, while during the bust, cities that experienced larger negative house price growth increased their home bias the most. We find that a one percentage point reduction in house prices is associated with a decrease in mean distance between a mutual fund and its holdings by 36 km and increases the fraction of local assets in a fund's portfolio by 0.73 percentage points. Figure 3.2 depicts our basic reduced form results. The figure contains four panels, where the panels on the left show two key relationships during the housing boom. In particular, the top left panel shows that housing prices grew more in cities that were more constrained. In the bottom left panel, we show that home bias *decreases* more in constrained cities. The panels on the right document the symmetry of our results: more constrained cities had larger declines in house prices and *increases* in home bias.

In order to better understand these results, we investigate whether local economic conditions are related to other types of shifts in portfolio composition. To do this, we use stock quality and safety measures constructed by Asness et al. (2013). We create an index of portfolio quality for each fund by computing a share weighted average of asset quality. We construct an index of portfolio safety in the same way. We show that shifts in portfolio quality and safety are strongly related to house price growth. In particular, when house prices fall, funds increase both the safety and quality of their portfolios. This is suggestive evidence that mutual fund managers may be responding to perceived risk or uncertainty when local economic conditions shift. We further investigate this by splitting the holdings of each fund into local and distant stocks, and examine quality and safety shifts within each of these sub-portfolios. We find that mutual funds adjust the quality of both the local and distant components of their portfolios in response to house price shocks, but only adjust the safety of the distant portfolio. This may suggest that fund managers perceive local holdings to be safer.

Finally, we investigate the consequences of house price driven portfolio shifts in terms of fund performance. To begin, we relate future fund performance directly with local house price shocks. We find that a one percentage point reduction in local house prices is associated with a 25 bsp and 51 bsp decrease in future 3- and 6-month characteristic-adjusted returns, respectively. We then split fund portfolios into local and distant stocks, and calculate the future performance of each sub-portfolio. We find that underperformance is concentrated in the portfolio of local stocks. We view these relationships as reduce-form, but we are more interested in the relationship between future performance and changes in funds' home bias. To overcome endogeneity issues, we instrument our measures of home bias with the Saiz (2010) measure of local land constraints. Not surprisingly given our results above, local land constraints are strongly related to measures of home bias. In particular, during the housing bust, mutual funds in more constrained cities became more home biased, and vice versa in the boom period. Our two-stage least squares estimates suggest that home bias causes underperformance. A one percent increase in the fraction of local stocks in a portfolio decreases 6-month characteristic-adjusted returns by 69.9 basis points. The negative relationship between future performance and shifts in favouritism toward local stocks are robust across different measures of home bias and stronger after 5 months. Thus, our results suggest that shifts in portfolio composition that are driven by housing price shocks are not informed adjustments.

Our paper contributes to the active and growing literature that investigates the relationship between portfolio decisions and the experiences of managers. This literature documents that portfolio decisions are impacted by manager age, gender, experience, political views, manager-director college networks, or even local religious beliefs.[4] Additionally, mutual funds have been shown to be home bias in their preference for domestic assets over foreign ones, and also within the US for geographical proximate firms. Our paper investigates how the *strength* of these local preferences shift with local external conditions. We show that city-level housing price shocks (1) do not impact fund tangibles, such as net-flows, and thus create no fundamental need to alter funds' portfolios, (2) symmetrically impact measures of funds' home bias, and portfolio quality and safety, and (3) drive shifts in fund home bias that are significantly related to fund performance. While the finance literature largely focuses on the information advantages and familiarity hypothesises to explain home bias, our results

[4]Barber and Odean (2001) find that male investors are more overconfident and are characterized by excessive trading. Cohen et al. (2008) document that a fund manager asset allocation decision is strongly influenced by connections with firm board members, that used to go to the same collage as the fund manager. Hong and Kostovetsky (2012) find evidence that fund managers who donate money to political campaigns are less likely to invest in socially irresponsible companies. Shu et al. (2012) document that mutual fund located in areas with high fraction of Catholics have stronger preferences for high volatility assets than funds domiciled in Protestant-dominated areas.

suggest that other biases are at play. In particular, the symmetry of the impact of positive and negative house price shocks suggests that fund managers are responding to perceived risk and view local assets as relatively safe. The behaviour we document cannot be explained by information advantage, since negative shocks lead to fund underperformance. Nor can they be explained by familiarity since positive shocks reduce local favouritism and, thus, funds do not simply "invest in what they know" (Pool et al., 2012). Rather, our findings suggest that fund reaction to house price shocks reflects a response to perceived risk and fund managers view local assets as being safer, and this behavioural bias leads to poorer fund performance.

The paper is organized as follows. In the next section, we relate our analysis to the existing literature. In section 3.2, we describe the data and the variable construction in detail. In Section 3.3, we explain our approach to estimation. Section 3.4 reports the empirical results. Section 3.5 concludes.

3.1 Related Literature

This paper is related to, and combines, three lines of literature. First, we contribute to the discussion on the origin of home bias. Second, the paper adds to a relatively new and growing strand of literature discussing the impact of personal traits and biases on investors' decisions. The third contribution of our analysis lies in an examining how mutual fund manager's decisions are affected by changing local (economic) conditions.

3.1.1 Importance of mutual fund location

This paper contributes to the literature on the importance of mutual fund location. Previous studies mainly focus on informational advantages versus behavioural biases stemming from fund location relative to the stocks in his portfolio. Yet there is little consensus regarding the importance of a manager's familiarity with a stock in portfolio selection decision. Coval and Moskowitz (2001) argue that fund managers have superior information about local stocks, which is reflected in high abnormal returns generated by those holdings. Ivković and Weisbenner (2005) come to similar conclusion by looking at individual investors' portfolios. However, Grinblatt and Keloharju (2001), Huberman (2001), and Seasholes and Zhu (2010) find opposite evidence. They argue that fund managers familiarity bias results in overweighting local stocks in a fund's portfolio and consequently in a lower fund's performance. Fund manager's behaviour can also be affected by local culture. According to Shu et al. (2012), local religious beliefs affect mutual fund managers' risk taking behaviour (return volatility, portfolio concentration, turnover, absolute return gap, and tournament-related competition), though highly competitive environment. Previous studies provide evidence of information spill-over effects within a city. Hong et al. (2005) document that fund's manager trading decisions are more susceptible to the trades of other managers in the same city than to the trades of managers from a different city, suggesting an information transmission across mutual funds located in the same city. A city's demographics also seem to notably affect fund manager behaviour.[5] Christoffersen and Sarkissian (2009) document a positive correlation between mutual fund performance and the city size. They argue that this relationship is mainly due to managers with greater experience. This indicates that large cities produce learning externalities that fund manager take advantage of.

3.1.2 Personal traits and biases

Our paper contribute to existing literature on investors personal biases and traits. The effect of overconfidence on managers' decision making has been studied by both empiricists and theorists. For example, Daniel et al. (1998) and Odean (1998) argue in their theoretical frameworks that overconfident investors trade more frequently, which may not counterbalance average trading costs. According to Odean (1999) and Barber and Odean (2001), overconfidence induced excessive trading is associated with underperformance among individual investors. Christoffersen and Sarkissian (2011) relate a mutual fund turnover to manager's biases and characteristics. They find that inexperienced, more educated male managers located in financial centres increase their trading after recent good performance. But gradually, they recognize their true abilities and decrease their trading frequency over time. Bodnaruk and Simonov (2016) investigate how institutional investors aversion to losses (disposition effect) affects a portfolio's composition and performance. They argue that institutional investors with loss-aversion manage portfolios with lower downside risk, perform more poorly, and have shorter careers in asset management. Managers' personal traits and biases do not only affect asset allocation decision of institutional investors, they are also reflected in corporate finance decision making.[6]

3.1.3 Time-varying economic conditions

Finally, this paper is related to studies that link both mutual fund performance and manager's behaviour to the variation in economic conditions over time. Previous research pro-

[5]See Christoffersen and Sarkissian (2011).

[6]See e.g. Malmendier and Tate (2005), Cronqvist et al. (2012), or Malmendier et al. (2011).

vides an evidence of time-varying mutual fund alphas and betas.[7] Glode (2011) claims that while mutual funds underperform in expansion periods, they outperform in recessions. Kacperczyk et al. (2014) argue that mutual fund manager's skills varies overtime. Their results suggest that successful managers adroitly pick stocks in booms and time the market well in recessions.[8] Further, mutual fund managers actively manage portfolio's liquidity in response to time-varying market volatility. Rzeźnik (2016) shows that fund managers actively tilt their portfolio towards more liquid assets in face of market volatility induced outflows.[9] Last, our study is closely related to Pool et al. (2014). They focus on the impact of shocks to manager's wealth (due to real estate bubble burst) on his risk-taking behaviour. They argue that a manager experiencing shocks to his wealth decreases the riskiness of his portfolio relative to a manager who does not experience any wealth shock. Our analysis, however, uses the variation in house price changes to provide a potential explanation for fund manager's preferences toward geographically proximate securities. We show that a mutual fund adjusts its degree of home bias in response to changes in local economic conditions. This suggest that mutual fund's preferences for local stocks are unrelated to informational advantages or manager's familiarity.

3.2 Data and methodology

We use data from three main sources: CRSP, Morningstar and Zillow. This section provides a brief summary of those datasets. We also define and describe the construction of our main variables.

3.2.1 Data and sample

Stock returns, headquarter addresses, and other relevant market and accounting data come from the intersection of the CRSP daily and monthly files as well as COMPUSTAT. We restrict our analysis to common stocks (share codes 10 and 11) with a valid postal address. We include penny stocks into our analysis, though eliminating stock with share price lower than 5 dollars does not quantitatively affect our results.

Data on mutual fund holdings comes from Morningstar. Our focus is on US active mutual funds investing in US equity. We include funds with at least 1 million dollars of

[7]E.g. Ferson and Schadt (1996), Christopherson et al. (1998), and Moskowitz (2000) relate fund performance to business-cycle variation.

[8]See also Kacperczyk et al. (2016) for a theoretical model of time-varying managerial skills.

[9]Vayanos (2004) provides a theoretical model, where fund managers actively adjust the liquidity of their portfolios in response to the changes in market volatility.

total net assets (TNA) in order to reduce the incubation bias.[10] We require funds to have available information about the value of their holdings at the end of 2001 for mutual funds in the boom period and at the end of 2005 for the bust period. We discard mutual funds with missing postal addresses.

3.2.2 Measuring investors' biases

To estimate our main relationship of interest, we need to construct variables that capture mutual fund manager's preferences towards local stocks. We propose three measures: a mean *distance* between a mutual fund and its holdings, a *fraction of portfolio held locally*, *home bias* measure proposed by Coval and Moskowitz (1999) estimated with all US equity holdings and for the 10 biggest US equity positions.

We use the mean latitude and longitude assigned to each zip-code, in order to match each mutual fund and the headquarters of each US company with the latitude and longitude coordinates. We calculate the *arc* length - the distance $d_{i,j}$ between fund i and company j:

$$d_{i,j} = \arccos(deg_{i,j}) \cdot \frac{2\pi r}{360},$$

where

$$\begin{aligned} deg_{i,j} = \; & \cos(lat_i) \cdot \cos(lon_i) \cdot \cos(lat_j) \cdot \cos(lon_j) \\ & + \cos(lat_i) \cdot \sin(lon_i) \cdot \cos(lat_j) \cdot \sin(lon_j) \\ & + \sin(lat_i) \cdot \sin(lat_j). \end{aligned}$$

The latitudes and longitudes of a fund i and a company j are given by lat and lon, and r is the radius of the earth.[11] As our first measure of home bias, we use the distance to compute a mean distance between a mutual fund and its holdings:

$$\textsc{Distance}_{i,j,t} = \sum_{j=1}^{J} \omega_{i,j,t} \cdot d_{i,j}, \tag{3.1}$$

where $\omega_{i,j,t}$ is a fraction of mutual fund i's portfolio held in stock j in month t.

A second measure of manager's preferences towards geographically proximate stocks is

[10] See Evans (2010) for more information on incubation bias.
[11] We use $r \approx 6,374$ kilometers, see Coval and Moskowitz (1999).

the fraction of a portfolio held in stocks with headquarters within 100 km radius:

$$\textsc{Local}_{i,t} = \sum_{j=1}^{J} I_L \cdot \omega_{i,j,t}, \tag{3.2}$$

where I_L is an indicator variable that is equal to one if a company's headquarters are within 100 km radius away from mutual fund i, and zero otherwise.[12]

Finally, we use a local bias measure constructed by Coval and Moskowitz (1999), which is defined as:

$$\textsc{Local Bias}_{i,t} = \sum_{j=1}^{J} (m_{i,j,t} - h_{i,j,t}) \cdot \frac{d_{i,j}}{d_i^M}, \tag{3.3}$$

where $m_{i,j,t}$ is a portfolio weight of stock j in the benchmark portfolio, $h_{i,j,t}$ is the fraction of the fund i's portfolio invested in stock j, $d_{i,j}$ is the distance between fund i and stock j, and $d_i^M = \sum_{j=1}^{J} m_{i,j,t} d_{i,j}$. We also use the same local bias measure that assesses manager's preferences towards local stocks within top ten largest holdings.

3.2.3 Summary statistics

Table 1 presents summary statistics for our home bias proxies that capture mutual fund managers' preferences towards local stocks, where the cities correspond to mutual fund location. An average distance between a mutual fund and its holdings varies noticeably by fund location from 482.88 km for funds located in Syracuse, NY to 2865.52 km for funds located in Seattle-Tacoma-Bellevue, WA during the boom period. In the bust period, mean distance ranges from 825.57 km (Syracuse, NY) to 2760.14 (Seattle-Tacoma-Bellevue, WA). In 6 cities (Abilene, Des Moines-West Des Moines, Madison, Santa Fe, Tuscon, and Tulsa) mutual funds do not hold any local stocks in either the boom or the bust period. On the other hand, for funds located in cities like Lancaster, Reading, San Francisco-Oakland-Hayward, and Syracuse, local holdings on average constitute more than 5% of a fund portfolio value. During the boom, mutual funds with headquarters in one of 27 cities seem to overweight their portfolios towards geographically proximate stocks (Local Bias > 0), whereas in the bust times, funds located in 33 cities display preferences towards local holdings. Broadly speaking, this evidence is consistent with firms increasing local holdings during economic downturns. Column 4 and 8 presents mutual fund preferences towards geographically proximate stocks within 10 largest holdings. Mutual funds located in majority of the cities underweight in their portfolio geographically remote assets.

[12] Our choice of 100 km for a local threshold is based on Coval and Moskowitz (2001).

3.3 Methodology and identification strategy

Our goal is to model average city-level behaviour of mutual funds and its relationship to the growth in house prices. Since the main source of variation that we are interested in is at the city-time level, we use a common two-step estimating procedure. In the first-step, we estimate an equation and the fund level to form regression adjusted, city-averages of fund behaviour, which form the dependent variable in our second-step. To begin, consider a fund-level model of portfolio choice, $Y_{i,t,m}$, where i indexes fund, m denotes the Core Based Statistical Area (CBSA) in which a given fund is located, and t indexes time:

$$Y_{i,m,t} = D_{i,m} + D_{m,t} + D_{i,t} + D_m + D_i + D_t + \epsilon_{i,m,t}.$$

This specification models mutual fund portfolio choice as a function of city-fund fixed-effects, $D_{i,m}$, city fixed-effects, D_m, fund fixed-effects, D_i, and time fixed-effects, D_t. We also allow for time-varying behaviour at the city-level, $D_{m,t}$, and the fund-level $D_{i,t}$. $\epsilon_{i,m,t}$ is an idiosyncratic error term. This specification is, of course, quite general. In order to make headway, we will have to impose some functional form. We begin by working in differences. In particular, we model the changes in fund behaviour over the boom (2002-2005) and bust (2006-2009) periods, to arrive at:

$$\Delta Y_{i,m,t} = \Delta D_{m,t} + \Delta D_{i,t} + \Delta D_t + \Delta\epsilon_{i,m,t}. \tag{3.4}$$

$\Delta Y_{i,m,t}$ captures fund-level changes in behaviour in terms of portfolio choice over the boom and bust period. An important feature of our identification strategy is that this specification eliminates all time invariant fund- and city-level characteristics determining portfolio choice through differencing. The term $\Delta D_{m,t}$ captures time varying city-level factors that are common to all funds in city m and $\Delta D_{i,t}$ captures time-varying fund behaviour.

We model $\Delta D_{i,t}$ as a linear function of fund style. Thus, we allow fund style to impact portfolio choices in two ways. First, as a fixed-effect that is differenced away. Second, as a fund fixed-factor that has time-varying effects. For example, different fund styles might behave differently over time due to different investment strategies. The ΔD_t term can simply be captured with a period dummy. We model $\Delta D_{m,t}$ as an unrestricted set of city-time dummies, imposing no functional form at this point. In particular, the first-step in our empirical procedure estimates:

$$\Delta Y_{i,m,t} = \alpha_0 + \alpha_1 \cdot \textsc{Bust} + \alpha_2' \cdot \textsc{Style} + \mu_{m,t} + \Delta\epsilon_{i,m,t} \tag{3.5}$$

In this specification, Bust is an indicator for the (2006-2009) period, and Style is a vector that includes indicators of fund styles.[13] $\mu_{m,t}$ is a vector of coefficients capturing a full set of unrestricted city-period effects. When estimating (3.5), we use weighted least squares where the weights are equal to the the size of the fund in the initial period.[14] From this regression, we extract the estimated coefficient vector $\hat{\mu}_{m,t}$, which we interpret as regression adjusted, weighted city-average changes in portfolio choice. For notational simplicity, we define $\Delta\bar{Y}_{m,t} \equiv \hat{\mu}_{m,t}$.

Our goal is to model city-level fund behaviour as a function of changes in house price growth. Thus, the second-step in our empirical procedure estimates an equation of the form:

$$\Delta\bar{Y}_{m,t} = \beta_0 + \beta_1 \cdot \textsc{Bust} + \gamma \cdot \Delta \ln \textsc{House Price}_{m,t} + \Delta\varepsilon_{m,t} \tag{3.6}$$

The main coefficient of interest in this model is γ, which captures the impact of house price growth on regression adjusted, city-average fund behaviour. The $\Delta\varepsilon_{m,t}$ is a new city-level error term. Since our empirical approach already controls for unobservable fixed-factors at the city-level, this term only contains unobserved time-varying city-level factors. OLS estimation of (3.6) will yield unbiased estimates of γ if shifts in $\varepsilon_{m,t}$ are unrelated to house price growth. In practice, this may not occur because of an omitted time-varying city-level factor that influences both the price of houses and fund portfolio choice, or because of reverse causality or simultaneity bias. We discuss how we address these possibilities below.

Our two-step estimation procedure is common but particularly well suited to our empirical goal. First, since we aim to capture the impact of shifts in house prices on fund behaviour at the city-level, our main source of variation is at the city-period level. By working directly at this level of aggregation, we obtain standard errors that already account for clustering.[15] Second, in the construction of $\Delta\bar{Y}_{m,t}$, we want to take weighted averages to account for the fact that we are dealing with funds of different sizes. This is done by estimating (3.5) with weighted OLS where we weight by the size of the funds. However, we do not want to impose these same weights while studying city-level responses to changes in house prices as in (3.6), since this would allow the behaviour larger cities to overly influence the parameter estimates due to the fact that some cities are home to larger funds. At the same time, we want to

[13]We allow for 9 possible fund styles, capturing small, medium, and large funds of each value, blend and growth types.

[14]In particular, we use as weights the market value of US equity held by a mutual fund at the end of 2001 and 2005 for the first and second period, respectively. We choose to use fixed weights to account for the fact that a fund's market value and portfolio decisions could be jointly determined.

[15]Accounting for clustering is particularly important in our context, as recent literature points out the similarity in investment behaviour of mutual fund managers within a city. For example, Hong et al. (2005) document information flows and knowledge spillovers between managers in the same city. Christoffersen and Sarkissian (2009) provide evidence that more skilled managers tend to work in financial centres.

account for fact that $\Delta\bar{Y}_{m,t}$ is estimated more precisely in cities with more funds. To do this, we estimate (3.6) using weighted OLS, where the weights are number of funds in each city. Finally, our two-step approach allows us to construct $\Delta\bar{Y}_{m,t}$ while taking into account that the composition of fund styles may vary across cities.

Identification of γ so far relies on the assumption that movements in house prices are uncorrelated to changes in the city-level error term of equation (3.6). While this assumption may be plausible, we aim to establish causality by dealing directly with the potential for an omitted variable or simultaneity regarding fund behaviour and house prices.[16] To do this, we exploit the well-known fact that during the housing boom and bust, house price growth was strongly correlated with fixed geographical features of cities. In particular, in a series of papers by Mian and Sufi (2011; 2013; 2014), the authors show that house price growth is strongly influenced by land constraints that limited the elasticity of housing supply: cities where the amount of land available for building is scarce experienced particularly strong growth in house prices while, during the bust, these cities experienced larger falls in housing prices. We apply their insight by using the percentage of land unavailable for building as an instrumental variable for house price growth in a two-stage least squares procedure. In our framework, we allow land unavailability to have differential effects in the boom and bust period. Consider the model for house price growth:

$$\begin{aligned} \Delta \ln \textsc{House Price}_{m,t} &= \delta_0 + \delta_1 \cdot \textsc{Bust} + \delta_2 \cdot \textsc{Unavailable}_m \\ &\quad + \delta_3 \cdot \textsc{Bust} \times \textsc{Unavailable}_m + u_{m,t}, \end{aligned} \tag{3.7}$$

where Unavailable is the Saiz (2010) measure of the fraction of land unavailable for building in city m. Equation (3.7) constitutes the first-stage of our two-stage least squares procedure for estimating equation (3.6). Figure 3.3 shows the variation in topologically constrained housing supply across cities. The variable $\textsc{Unavailable}_m$ takes into account geographical terrain and water features to determine the degree to which the housing supply in different metropolitan areas is constrained. Cities (e.g. San Francisco or San Diego) located near the sea and surrounded by a mountain range are characterized by a high fraction of land that is not available for development, resulting in more constrained housing supply. On the other hand, cities located in flat areas away from major water bodies (e.g. Lincoln in Nebraska or Abilene in Texas) are characterized by highly elastic housing supply.

Our main empirical specification is a first-differenced, two-stage least squares procedure relating changes in city-average fund behaviour to house price growth. This identification strategy eliminates time-invariant fund- and city-factors affect shift in fund behaviour

[16] See e.g. Gyourko and Keim (1992), Quan and Titman (1999), and Okunev et al. (2000).

through differencing, and potential confounding unobservable city-level factors through an instrumental variables framework, where our exclusion restriction is the fixed availability of housing supply due to geographical features of cities. The validity of our exclusion restriction relies on the assumption that changes fund behaviour are not directly influenced by the fixed geographical features of cities.

In our baseline analysis, we concentrate on 46 cities located in 33 states across the US. Table 2 reports summary statistics on the distribution of mutual funds across US cities in our sample. There are 727 (1,023) funds in in the boom (bust) period. One fifth of the funds are located in New York, 8% of the funds have their headquarters in San Francisco or Philadelphia, and 6.5% in Chicago. Salt Lake City is the most topographically constrained (71.99%), whereas Dayton in Ohio has the fraction of land available for development (98.96%). In Los Angeles, which has 52.47% land unavailability, the average house price increased by over 250 thousand dollars during boom and fell by almost 175 thousand during bust period. On the other hand in Lincoln (Nebraska), where developable land is abundant, prices for an average house barely increased (decreased) by 12 (2.5) thousand in the boom (bust) period. As we document below, these examples are typical of the relationship between house price growth and land constraints, forming the basis of instrumental variable strategy.

3.4 Estimation and Results

We design our empirical strategy to estimate the effect of house prices on mutual fund portfolio allocation decision. In order to identify a causal relationship between local house price growth and fund manager investment decisions, we proceed with two stage-least-square (2SLS) analysis. Figure 3.4 supports the choice of geographical land unavailability measure as an instrument variable for house price growth. Areas with the most topographically constrained housing supply experienced the greatest growth in house prices during the boom, and drop during the bust. Table 3 shows more formally a strong relationship between house prices and land unavailability, which is necessary for the instrumental variable approach. We predict house price changes $\Delta \ln$ House Price by means of geographical land unavailability (Unavailable) measure, bust period dummy variable, and the interaction of those two. A positive Unavailable coefficient implies that CBSAs with topographically constrained housing supply experience higher price growth in the expansion period. However, the estimated coefficient on the interaction term is negative. This indicates that from 2006 to 2009 the house prices dropped more in cities where land availability was scarce. The first stage F-test for excluded instruments yield a F-statistics of 9.82 and a p-value of 0.0000, which suggests that there is a significant relationship between land unavailability in booms/bust and house price growth.

3.4.1 Tangibles

Investors cash-flows into and out of a mutual fund constitute one of the main reasons why a fund manager alters his portfolio composition. In the first step of our analysis, we investigate whether mutual fund flows vary with local house prices. Table 4 columns 1 and 2 suggest that local house price growth is not associated with mutual fund net-flows. The $\Delta \ln$ House Price coefficients in both OLS and IV regression are insignificant. This result seems reasonable, since mutual funds invest on behalf of investors domiciled in different cities, states, or even countries. Thus changing local economic conditions in one CBSA do not affect liquidity needs of an investor living in another CBSA hundreds kilometres away. Regression estimates in columns 3 – 8 of table 4 further show that fund managers do not noticeably change their portfolio compositions in response to changing local house prices. Indeed, they appear to keep the same fraction of the portfolio in form of equity (columns 3 and 4) or cash (columns 5 and 6). Local house price growth does not affect a fund manager's liquidity preferences (columns 7 and 8). In total, these results suggest that "tangible" attributes of fund behaviour do not very with local house market shocks.

3.4.2 Home bias

Previous studies suggest that localities are strongly related to investors' trading behaviour. Engelberg and Parsons (2011) show that geographic variation in the media coverage of information events is associated with magnitude of local trading. Goetzmann et al. (2014) relate local weather conditions (cloud coverage) to an institutional investor's mood, which in turn partly determines his trading decision.

Consequently, we focus on the effect of local economic conditions on fund manager's behavioural biases, in particular home bias. Figure 3.5 relates a fund manager's industry allocation decision to a mean distance between a fund and an industry. We group all stocks into 10 main industries following Kacperczyk et al. (2005). We calculate a mean distance between a fund and an industry. Next for each mutual fund we assign each industry into a quintile based on the mean distance to a given fund and estimate a mean fraction of a portfolio held in each industry quintile. In the left panel, we cannot find any observable relationship between a fund's proximity to an industry and a fraction of a portfolio held in that industry. However, the right panel presents a clear pattern in mutual fund preferences towards geographically proximate industries for funds located in cities with little developable land (Land Unavailability > Median). By comparing the 2005 bars with 2009, we can infer that fund managers increase a fraction of their portfolio held in nearby industries (top three quintiles) and decrease the fraction of their holdings invested in distant industries in response to a sharp drop in local house prices.

Next, we investigate this relationship more formally in a regression framework. We use a two stage-least-square regression approach to estimate the effect of local house price growth on fund manager's home bias measures. Regression estimates presented in table 5 suggest that locally changing house prices affect a fund manager's decision regarding investment into local versus distant stocks. According to both OLS and IV regression results, funds with headquarters in the areas, where house prices decreased the most, seem to invest in those stocks that are located more closely. In columns 3 and 4, we use local bias measure proposed by Coval and Moskowitz (1999) and defined in equation 3.3. Whereas the OLS regression coefficient on change in house prices is negative yet insignificant, IV regression yields a significant result indicating a strong negative relationship between local house price changes and mutual fund home bias. This result suggest that fund managers increase (decrease) their investment in geographically proximate stocks in response to negative (positive) shock to local house market. This effect is even more pronounced, when we look at ten largest holdings (columns 5 – 6). In the areas, where house prices decrease (increase) the most, fund managers even more noticeably select local (distant) stocks for their top ten largest holdings. In the last two columns, we differentiate between a local component of a portfolio and a distant one. A stock is defined as a local holding if the headquarters of a firm are within 100km radius away from a mutual fund. In columns 7 – 8, we regress the fraction of a portfolio held locally (defined in equation 3.2) on house price changes and other control variables. Especially, the IV regression estimates indicate a strong and negative relationship between local house price growth and fraction of a portfolio held locally. A decrease in a local house prices by 1% is associated with 0.73 percentage point increase in a portfolio share invested in local stocks.

3.4.3 Quality and safety

In face of deteriorating local economic conditions fund managers may prefer stock with known risks (e.g. local stocks) over unknown. Resent research suggests that uncertainty about the environment affects fund managers' asset-allocation decision and may result in a flight-to-quality.[17] When local economic conditions deteriorate, fund managers may be willing to reduce the undesirable exposure to local risk by shifting their portfolio towards safer and higher quality firms. The reason for this shift in mutual fund manager's preferences

[17]See e.g. Beber et al. (2009), Caballero and Krishnamurthy (2008), and Chen et al. (2016).

arises from a manager's concern that cash-flows of low quality firms can be fairly sensitive the systematic risk.

Consequently, we analyse, how local house price growth affects a mutual fund portfolio composition in terms of quality and safety. For this, we use stock quality and safety measures constructed by Asness et al. (2013).[18] The quality measure captures four dimensions of quality: profitability, growth, safety, and pay. In addition to the quality of the assets in a portfolio, we focus on their safety. We expect a fund manager to increase the quality and safety of his portfolio in response to deterioration in local house prices. Table 6 provides support for our hypothesis. In areas with the greatest drop in house prices, portfolio's quality and safety increase the most. The change in house prices estimated OLS and IV coefficients are negative and statistically significant for both safety and quality regressions (columns 1 – 2 and 7 – 8). In order to isolate a change in a portfolio's quality/safety due to active modification of portfolio composition in terms of holdings, we follow Rzeźnik (2016):

$$\begin{aligned} \mathrm{AQM}_{i,t} &= Quality_{j,t-1} \cdot p_{j,t-1} \\ &\cdot \left(\frac{shares_{i,j,t}}{\sum_{j=1}^{J} shares_{i,j,t} \cdot p_{j,t-1}} - \frac{shares_{i,j,t-1}}{\sum_{j=1}^{J} shares_{i,j,t-1} \cdot p_{j,t-1}} \right), \end{aligned} \tag{3.8}$$

where $\mathrm{AQM}_{i,t}$ is active quality management of fund i in period t, $p_{j,t-1}$ is price of stock j at the end of period $t-1$, $Quality_{j,t-1}$ is quality rank of stock j at the end of period $t-1$, and $shares_{i,j,t}$ is a number of shares of stock j held by fund i at the end of period t.

We separately analyse active quality/safety management of assets purchases and sales. Based on the reported results, fund managers shift their portfolio towards assets of higher quality and safety in response to deterioration in local economic conditions, by purchasing high quality and safe stocks. On the other hand, in the IV regression of active quality/safety management of sales (columns 6 and 12), the estimated coefficient on house price change is positive, yet insignificant. This suggests, that fund managers seem to reduce their position in lower quality and less safe stocks, when they face locally plummeting house prices.

Having established that fund managers exhibit preferences towards local versus distant assets and actively improve portfolio's quality and safety in response to deterioration in local economic conditions, we investigate whether managers employ different portfolio strategies regarding distant and local stocks. Especially, we look at the trading behaviour concerning quality and safety. In our analysis we divide holdings into local and distant positions. Local holdings consist of those stocks with headquarters within 100 km radius away from the mutual fund and constitute part of the fund portfolio. Then, we look at a change

[18]We thank Lasse Heje Pedersen for sharing this quality measure.

in a quality/safety of local versus distant component of a portfolio. Table 7 show the estimation results. Consistent with the previous results, mutual funds located in areas with deteriorating local economic conditions tilt their portfolios towards high quality and safer stocks. A fund manager seems to be concern about quality of both local and distant components of a fund's portfolio. Therefore, in a face of locally falling house prices, a fund manager increases quality of local and distant holdings. The $\Delta \ln$ HOUSE PRICE estimation coefficients in OLS and IV regressions of a quality change in local (columns 1–2) and distant (columns 3–4) holdings are negative and significant. The coefficient on $\Delta \ln$ HOUSE PRICE in the local quality regression is more than twice as larger as the coefficient in the regression of distant holdings' quality. This may suggest that, while funds shifts toward local stocks, they first and foremost choose local stocks of high quality. The last four columns indicate that locally changing house prices are associated with the shift towards/away from safer stocks primarily in the distant component of a portfolio. The coefficient on $\Delta \ln$ HOUSE PRICE in the regression of local holdings' safety (columns 5–6) is negative, yet insignificant.

Our empirical results suggest that mutual fund have preferences towards geographically proximate, safe and high quality stocks when they are located in areas with deteriorating local conditions. This finding leads to an intriguing question: Where do these preferences originate from? Are they due to a manager's familiarity bias? Or do they result from manager's superior information about geographically proximate assets? We address these questions by looking at mutual fund performance.

3.4.4 Mutual fund performance

In our analysis, we focus on uncovering the origin of mutual fund preferences towards geographically proximate assets. We proceed in three steps. First, we test the relation between mutual fund returns and local house price growth. The underlying reason behind this test, is to examine whether local house prices are reflected in mutual fund performance.[19] Second, we compare the response of returns on local and distant holdings to the local house price growth. If local informational advantages induce a fund manager to overweight local stock in the period of locally falling house prices, then we expect the performance of local holdings to exceed the performance of distant holdings in face of deterioration in local conditions. Third, we directly look at the impact of shocks to house market on home bias on fund performance. If preferences toward geographically proximate stocks in times of deteriorating local economic conditions arise for informational advantage, then mutual fund performance should increase with local bias.

[19]See Bernile et al. (2015) for the evidence that local conditions affect liquidity of local companies.

Table 8 summarizes the result for the first part of mutual fund performance analysis. We regress change in 3- and 6-month future return on instrumented house price growth. We use three measures of mutual fund performance: raw returns, Daniel et al. (1997) (DGTW) adjusted returns, and market adjusted returns (excess of market return).[20] DGTW returns are constructed by subtracting from each holding's return the return on a portfolio of firms matched on market equity, market-book ratio, and prior one-year return quintiles. The IV regression estimates in the table suggest that deterioration in local economic conditions negatively affect mutual fund performance.[21] One percentage point decrease in house price is associated with a 25 bsp and 51 bsp decrease in future 3- and 6-month DGTW adjusted return, respectively. The analysis of house price growth impact on raw and market adjust returns provides comparable results, indicating that mutual fund performance significantly deteriorates (improves) in areas where house prices decrease (increase) the most.

In sum, the evidence in table 8 show that there is a direct relationship between mutual fund performance and local economic conditions. In the next step, we examine whether this relation can be attributed to a fund's manager asset allocation decision concerning local and distant stocks. In table 9, we relate returns on the local and distant components of a portfolio to the local house price growth. In columns 1–6, we regress change in future returns generated by distant and local components a fund's portfolio. We report the regression estimates for DGTW adjusted returns, though the results remain qualitatively and quantitatively the same if we use raw or market adjusted returns instead. The presented results suggest that while future returns on local holdings strongly respond to the local house price growth, returns on distant holdings remain unaffected. A one percentage point decrease in local house prices is associated with 155 bsp drop in a 3-months future return generated by local holdings. Also the difference between returns on local and distant parts of a portfolio significantly decreases in response to a deterioration in local economic conditions. This points out the local part of a portfolio underperforms (outperforms) the distant component in face of a decline (an increase) in local housing market. The regression results for 6-month future return are somewhat weaker. However, the pattern remains the same. At the 10 percent level of significance, a one percentage point decrease in local house price growth is related to 187 bsp drop in a 6-month future return generated by local holdings. The regression results of the difference in local and distant 6-month future returns, though insignificant, suggest that a local portfolio component underperforms (outperforms) the distant one in face of deterioration (improvement) in local economic conditions.

Finally, we focus on a plausible explanation for an underperformance (outperformance)

[20]The DGTW benchmarks are available via `http://www.smith.umd.edu/faculty/rwermers/ftpsite/Dgtw/coverpage.htm`.

[21]The OLS regression coefficients are also positive, yet insignificant.

of mutual funds located in the cities experiencing a decline (an increas) in house price growth. In particular, we focus on the response of mutual fund performance to home bias induced by changes in local house prices. In order to examine this relationship, we proceed with 2SLS approach.

When analysing the impact of fund manager's preferences towards geographically proximate assets on a mutual fund performance, a possible omitted variable problem arises. Unobservable fund's manager attention or time-varying strategy may determine both asset allocation decision and a fund's performance.[22] Thus, we use exogeneous variation in Saiz (2010) land unavailability as an instrument for mutual fund preferences towards local stocks.

Table 10 shows first stage regression estimates for four proxies of a mutual fund's home bias: Coval and Moskowitz (1999) measure of local bias for entire portfolio and for the ten largest holdings, mean distance, and a fraction of a portfolio held locally (withing 100km radius). In all four first stage regression UNAVAILABLE and its interaction with a bust period dummy variable BUST $\times$ UNAVAILABLE are strongly significant with F-test for excluded instruments yielding p-values smaller than 0.01. In booms, mutual funds located in areas with scarce developable land become less home bias, increase the distance to their holdings, and hold less local stocks. The situation is, however, reversed in the bust period. They tend to exhibit strong preferences towards geographically proximate assets.

The effect of a mutual fund's local bias measured for the ten largest holdings on a change in fund's future performance is presented in table 11, Panel A. Both OLS and IV result suggest that an increase in local bias within top ten holdings is associated with a decrease in a mutual fund performance. The negative impact of local preferences on fund performance monotonically increases with the future return horizon. While OLS coefficients are significant for all reported time periods, IV estimates yield significant results in regressions of 4-, 5-, and 6-month future returns. Panel B presents the regression estimates of the change in mutual fund future returns on the change in the mean distance. The reported results provide a support to the findings in Panel A. A decrease in a mean distance (shift towards more proximate stocks) is associated with a decrease in fund's future returns. According to IV regression estimates, a 100 km decrease in a mean distance is associated with a decrease in future fund performance by 2.9 bsp for 2-month future return and up to 8.1 bsp for 5-month future return. In Panel C, we examine how mutual fund performance is affected by holding local stocks. We regress the change in a mutual fund future performance on a change in the fraction of a portfolio held locally and we find again a negative and significant relationship. This indicates that investing a greater fraction of a portfolio into local stocks is harmful for future fund performance. A one percentage point increase in fraction of local

[22]See Lynch and Musto (2003), Kacperczyk et al. (2014), and Kacperczyk et al. (2016).

holdings is related to a significant decrease in 2-month (5-month) future fund performance by 27.5 bsp (73.9 bsp). Finally, Panel D relates future fund performance to the measure of local bias for the entire portfolio. Both OLS and IV regression estimates point out that preferences towards geographically proximate stocks have a negative impact on fund performance. While all OLS coefficients remain highly significant, IV estimates are marginally significant, or insignificant.

The results presented in table 11 suggest that the effect of local house price growth on fund manager preferences towards geographically proximate assets is of first-order importance, because it is directly related to mutual fund performance. Based on our four proxies for home bias, we find that a shift in preferences towards local stocks is associated with a mutual fund underperformance. This result eliminate local informational advantage as an origin of fund manager home bias. Next, the symmetry of our results implies that fund managers invest in less known stocks, when house prices increase locally, which makes familiarity hypothesis implausible. Thus, our findings suggest that investors time-varying preferences towards geographically proximate assets originate in previously undocumented behavioural bias.

3.5 Conclusion

We contribute to the empirical asset pricing literature by investigating a potential source of investor's home bias. While existing research remains divided on the origin of home bias, we argue that funds' time-varying preferences towards local stocks cannot be explained by informational advantages or manager's familiarity.

In this paper, we study how local house market shocks affect a mutual fund asset allocation decision. Specifically, we examine the effect of local house price growth on fund manager's home bias. Our key finding is that deterioration (improvement) in local economic conditions is associated with a shift in fund manager's preferences towards (away from) geographically proximate assets. A one percentage point drop in local house prices is related to a decrease in mean distance between a fund and its holdings by 36 km and increase in a fraction of portfolio held locally by 0.73 percentage point. We find also that in face of locally decreasing house prices, mutual funds put the value of quality and safety before its cost, and actively increase the quality and safety of their portfolio.

Investigating the impact of local economic conditions on a fund manager home bias, allows to set informational advantages and familiarity bias apart as a potential source of home bias. In our analysis, we focus on US equity mutual funds, because they manage money on behalf of their investors domiciled across the world by investing it into companies spread out across US. Therefore, it seems highly unlikely that informational advantages of mutual funds located in a given city are link to a variation in local house price growth.

Using a two stage-least-square estimation approach, we document a series of novel findings. We find that mutual funds located in areas where house prices decrease (increase) the most, shift the composition of their portfolios towards (away from) geographically proximate assets and consequently generate significantly lower (higher) future returns. Deterioration in local economic conditions is also related to underperformance of a local component of a fund's portfolio relative to a distant one. Finally, we find that a shift in a fund's manager preferences towards (away from) local stocks induced by a decrease (increase) in local house prices is associated with significantly lower (higher) future fund returns. Symmetry of our results suggest that fund manager react to positive shocks to local house market by investing in what they *do not* know. All together, these results undermine informational advantage and manager's familiarity as potential explanations for time-varying home bias among mutual funds.

This paper contributes to the literature along a number of dimensions. Our primary contribution is to show that a variation in local economic conditions affect mutual fund managers' preferences towards geographically proximate assets. We also document a strong shift towards safer and higher quality stocks in face of locally decreasing house prices. Last but not least, we argue that our analysis provides evidence of previously undocumented behavioural bias. We find that deterioration in local economic condition induced shift in preferences towards local assets is associated with a significant decrease in a fund's performance. Overall, our evidence highlights the importance of local economic conditions in fund managers' asset allocation decision making.

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3.6 Tables

Table 1: Mutual fund's bias - summary statistics. This table reports the mean Core Bases Statistical Area (CBSA) characteristics concerning a mutual fund's preferences towards geographically proximate assets. The mean values are displayed separately for boom (2002–2005) and bust (2006–2009) period. DISTANCE (in km) is a value weight distance between a mutual fund and headquarters of its holdings. LOCAL FRACTION (in %) stands for a fraction of a fund's portfolio held in local stocks (within 100 km radius from a mutual fund). LOCAL BIAS is a measure of home bias constructed by Coval and Moskowitz (1999) and defined as: $\sum_{j=1}^{J}(m_{i,j,t} - h_{i,j,t}) \cdot \frac{d_{i,j}}{d_i^M}$, where $m_{i,j,t}$ is a portfolio weight of stock j in the benchmark portfolio, $h_{i,j}$ is the fraction of fund i's portfolio invested in stock j, $d_{i,j}$ is the distance between fund i and stock j, and $d_i^M = \sum_{j=1}^{J} m_{i,j,t} d_{i,j}$. TOP 10 LOCAL BIAS is a local bias measure based on the ten largest holdings in a fund portfolio. The analysis includes equity mutual funds domiciled in US and actively investing in US equity.

	Boom				Bust			
	Distance	Local Fraction	Local Bias	Top 10 Local Bias	Distance	Local Fraction	Local Bias	Top 10 Local Bias
Abilene, TX	1843.3	0	0.02	0.03	1614.38	0	0.09	0.13
Albany-Schenectady-Troy, NY	1242.49	0.13	0.18	0.2	1529.06	0.26	0.09	0.13
Atlanta-Sandy Springs-Roswell, GA	1425.07	1.35	0.01	0.02	1613.63	1.4	-0.07	-0.13
Baltimore-Columbia-Towson, MD	1525.39	1.89	-0.12	-0.13	1578.46	1.85	-0.05	-0.07
Baton Rouge, LA	1610.27	0.09	0.03	-0.05	1617.72	0.24	0.04	0.03
Bloomington, IL	1209.76	0.4	0.08	0.1	1266.74	0.32	0.06	0.15
Boston-Cambridge-Newton, MA-NH	1770.23	0.29	-0.08	-0.1	1787.03	0.36	0	-0.05
Bridgeport-Stamford-Norwalk, CT	1637.36	4.72	-0.11	-0.09	1711.99	4.6	-0.06	-0.08
Chicago-Naperville-Elgin, IL-IN-WI	1361.21	1.39	-0.03	-0.04	1369.51	2.06	0	-0.05
Cincinnati, OH-KY-IN	1191.49	0.18	0.06	0.07	1218.45	0.25	0.09	0.06
Columbus, OH	1402.1	0.18	-0.1	-0.18	1421.82	0.24	-0.04	-0.17
Dallas-Fort Worth-Arlington, TX	1614.39	1.66	0.06	0.07	1577.86	2.74	0.04	0.04
Dayton, OH	1272.84	1.67	-0.01	-0.08	1230.95	1.38	0.09	-0.01
Deltona-Daytona Beach-Ormond Beach, FL	1872.2	0.24	-0.01	-0.03	1863.69	0.22	0.03	0.12
Denver-Aurora-Lakewood, CO	1817.61	0.57	0.05	0.06	1793.99	0.73	0.02	0.01
Des Moines-West Des Moines, IA	1451.59	0	0	0	1437.87	0	-0.01	-0.01
Detroit-Warren-Dearborn, MI	1329.55	0.5	-0.02	-0.12	1388.63	0.34	0.01	-0.07
Hartford-West Hartford-East Hartford, CT	1685.9	1.2	-0.11	-0.15	1807.57	1.41	-0.06	-0.14
Indianapolis-Carmel-Anderson, IN	1225.35	0.15	0.04	0	1276.45	0.21	0.04	-0.05

	Boom				Bust			
	Distance	Local Fraction	Local Bias	Top 10 Local Bias	Distance	Local Fraction	Local Bias	Top 10 Local Bias
Kansas City, MO-KS	1485.74	0.37	-0.02	-0.03	1487.49	0.31	-0.03	-0.06
Lancaster, PA	1312.2	5.48	0.09	0.2	1679.6	3.23	-0.11	0.28
Lincoln, NE	1395.21	1.23	0.21	0.34	1444.36	1.42	0.03	0.1
Los Angeles-Long Beach-Anaheim, CA	2554.57	1	0.08	0.09	2584.06	1.31	0.02	0.01
Madison, WI	1366.48	0	0.01	0.01	1370.21	0	0.03	-0.07
Miami-Fort Lauderdale-West Palm Beach, FL	1760.43	0.28	0.13	0.13	1694.66	1.29	0.19	0.21
Milwaukee-Waukesha-West Allis, WI	1331.45	0.93	0.03	0.02	1357.83	1.13	0.03	0.01
Minneapolis-St. Paul-Bloomington, MN-WI	1500.46	1.87	0.02	-0.01	1466.29	1.9	0.06	0.05
New York-Newark-Jersey City, NY-NJ-PA	1592.78	4.17	-0.12	-0.15	1671.23	4.21	-0.05	-0.08
Omaha-Council Bluffs, NE-IA	1242.68	0.07	0.19	0.18	1142.89	0.15	0.23	0.21
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1558.06	1.34	-0.12	-0.14	1606.19	1.51	-0.04	-0.09
Phoenix-Mesa-Scottsdale, AZ	2305.02	0.35	0.05	0.04	2252.33	0.46	0.02	0.03
Portland-Vancouver-Hillsboro, OR-WA	3111.28	0.09	-0.05	-0.08	3057.9	0.25	-0.08	-0.1
Providence-Warwick, RI-MA	1521.6	0.3	0.02	0.03	1795.5	0.41	0.01	-0.12
Reading, PA	733.18	9.38	0.87	0.88	951.38	4.46	0.65	0.67
Richmond, VA	1204.75	0.85	0.14	0.06	1453.71	0.73	0.04	0.02
Salt Lake City, UT	2002.98	0.12	0.1	0.13	1981.69	0.31	0.08	0.08
San Diego-Carlsbad, CA	2457.06	0.36	0.1	0.09	2544.67	0.89	0.03	0.03

	Boom				Bust			
	Distance	Local Fraction	Local Bias	Top 10 Local Bias	Distance	Local Fraction	Local Bias	Top 10 Local Bias
San Francisco-Oakland-Hayward, CA	2772.79	4.26	0.05	0.06	2710.3	5.22	0.02	0.05
Santa Fe, NM	2019.41	0	-0.02	-0.04	1730.14	0	0.09	0.14
Seattle-Tacoma-Bellevue, WA	2865.52	0.91	0.03	0.07	2760.14	0.73	0.03	0.1
St. Louis, MO-IL	1482.79	0.41	-0.1	-0.11	1227.39	0.27	0.1	0.06
Syracuse, NY	482.88	5.04	0.45	0.45	825.57	3.96	0.47	0.55
Tampa-St. Petersburg-Clearwater, FL	1986.48	0.15	-0.03	-0.03	2035.68	0.14	-0.04	-0.09
Tucson, AZ	2519.45	0	-0.02	-0.02	2432.79	0	-0.05	-0.02
Tulsa, OK	1653.85	0	-0.06	-0.16	1490.81	0	0.01	0.08
Washington-Arlington-Alexandria, DC-VA-MD-WV	1431.01	1.54	-0.05	-0.12	1464.27	1.86	0.02	-0.04

Table 2: Mutual fund and housing market - summary statistics. This table reports basic summary statistics for 46 Core Based Statistical Areas (CBSA) included in the analysis. # OF FUNDS denotes the number of funds located in each CBSA. MEAN TNA (M) is mean mutual fund total net asset represented in millions. Δ IN HOUSE PRICE (K) is a change in mean change in house price displayed in thousands. LAND UNAVAILABLE (%) is a measure constructed by Saiz (2010) and denotes a percentage of undevelopable land within a city. It takes into account geographical terrain and water features to determine the degree to which the housing supply in different metropolitan areas is constrained by topological characteristics.

	# of funds		Mean TNA (M)		Δ in House Price (K)		Land
	2005	2009	2005	2009	2005	2009	Unavailable (%)
Abilene, TX	2	3	11.36	9.07	11.01	5.88	1.95
Albany-Schenectady-Troy, NY	2	6	534.2	118.82	53.32	2.48	23.33
Atlanta-Sandy Springs-Roswell, GA	7	11	802.6	290.77	14.69	-22.09	4.08
Baltimore-Columbia-Towson, MD	46	55	3144.31	1761.5	103.8	-33.74	21.87
Baton Rouge, LA	1	2	78.06	85.28	23.83	15.93	33.52
Bloomington, IL	1	1	188.09	139.87	12.77	6.04	1.4
Boston-Cambridge-Newton, MA-NH	40	60	1817.45	805.31	82.15	-51.28	33.9
Bridgeport-Stamford-Norwalk, CT	17	22	696.2	412.77	129.74	-88.97	45.01
Chicago-Naperville-Elgin, IL-IN-WI	48	67	1014.19	485.73	42.41	-32.29	40.01
Cincinnati, OH-KY-IN	6	10	124.84	54.15	13.73	-11.23	10.3
Columbus, OH	10	16	258.79	94.56	13.77	-9.64	2.5
Dallas-Fort Worth-Arlington, TX	11	19	370.2	549.28	15.88	-9.93	7.03
Dayton, OH	2	2	11.93	9.8	11.94	-9.18	1.04
Deltona-Daytona Beach-Ormond Beach, FL	2	3	30.28	29.72	83.47	-92.11	60.53
Denver-Aurora-Lakewood, CO	36	46	1580.02	1028.63	15.33	-18.7	16.72
Des Moines-West Des Moines, IA	1	1	82.93	27.51	17.92	6.56	6.17
Detroit-Warren-Dearborn, MI	4	4	108.22	60.4	9.49	-53.77	24.52
Hartford-West Hartford-East Hartford, CT	29	44	1330.24	1036.4	64.75	-19.42	23.29
Indianapolis-Carmel-Anderson, IN	5	8	142.66	73.71	0.12	-11.73	1.44

	# of funds		Mean TNA (M)		Δ in House Price (K)		Land
	2005	2009	2005	2009	2005	2009	Unavailable (%)
Kansas City, MO-KS	43	56	2050.72	720.67	5.38	7.88	5.82
Lancaster, PA	1	1	163.83	88.45	38.48	3.03	11.9
Lincoln, NE	1	1	60.92	41.52	12.09	-2.62	1.59
Los Angeles-Long Beach-Anaheim, CA	18	30	1008.64	478.96	251.72	-174.34	52.47
Madison, WI	8	8	255.79	60.87	27.5	-2.33	11.34
Miami-Fort Lauderdale-West Palm Beach, FL	1	1	69.56	59.38	119.2	-130.47	72.12
Milwaukee-Waukesha-West Allis, WI	21	33	732.09	555.64	32.33	-10.94	41.78
Minneapolis-St. Paul-Bloomington, MN-WI	9	15	432.85	254.98	48.5	-42.07	19.23
New York-Newark-Jersey City, NY-NJ-PA	157	205	840.78	609.88	139.92	-65.71	40.42
Omaha-Council Bluffs, NE-IA	1	2	74.28	85.78	12.52	-3.81	3.34
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	58	90	2829.01	2395.79	69.13	-14.01	10.16
Phoenix-Mesa-Scottsdale, AZ	14	29	351.97	396.36	91.07	-98.88	13.95
Portland-Vancouver-Hillsboro, OR-WA	3	4	1001.88	471.44	60.41	-23.73	37.54
Providence-Warwick, RI-MA	4	6	1766.67	810.53	103.19	-58.6	13.87
Reading, PA	1	1	9.64	6.6	34.78	-0.22	16.48
Richmond, VA	1	1	136.48	96.7	48.6	-4.47	8.81
Salt Lake City, UT	6	8	797.31	288.01	13.55	36.14	71.99
San Diego-Carlsbad, CA	2	7	186.66	35.66	215.74	-155.58	63.41
San Francisco-Oakland-Hayward, CA	65	83	1738.03	871.05	229	-168.61	67.4

	# of funds		Mean TNA (M)		Δ in House Price (K)		Land
	2005	2009	2005	2009	2005	2009	Unavailable (%)
Santa Fe, NM	2	2	1088.84	1834.02	38.47	101.98	37.22
Seattle-Tacoma-Bellevue, WA	7	8	482.64	1104.1	76.1	-39.3	40.16
St. Louis, MO-IL	1	1	7.56	6.84	25.48	-9.62	11.08
Syracuse, NY	1	1	5.43	3.3	18.28	6.93	17.85
Tampa-St. Petersburg-Clearwater, FL	13	22	456.11	175.79	67.06	-75.47	41.64
Tucson, AZ	3	3	11748.06	10831.97	67.35	-55.78	23.07
Tulsa, OK	1	1	15.65	12.23	6.53	5.5	6.29
Washington-Arlington-Alexandria, DC-VA-MD-WV	15	24	809.65	253.41	172.13	-105.67	13.95

Table 3: First Stage Regression. This table shows coefficient estimates and F-test statistics for excluded instruments from first stage regression of house price growth $\Delta House$ on Saiz (2010) measure of geographically constraint land UNAVAILABLE, its interaction with a bust dummy variable BUST $\times$ UNAVAILABLE, and a bust dummy variable BUST, that is equal to one for observations within 2006 and 2009, otherwise zero.

	Unavailable	Bust Unavailable	Bust	Constant	Observations	Adjusted R^2	F-test
Δ House	0.335*	-0.632*	-0.272*	0.214*	92	0.781	9.82
	(3.06)	(-4.41)	(-5.23)	(5.36)			0.000

t statistics in parentheses
* $p < 0.05$

Table 4: OLS and IV regressions of funds' tangibles. This table show regression estimates from OLS and two stage-least-sqaure regressions of funds' tangibles on instrumented house price growth $\Delta \ln$ HOUSE PRICE and a bust dummy variable BUST equal to one for observations within 2006-2009, otherwise zero. The dependent variable in columns 1 and 2 is a change in a percentage net flow between 2002 and 2005, as well as 2006 and 2009. In sepcification 3 and 4 (5 and 6), the dependent variable is a change in a fraction of portfolio value held in form of US equity (cash). In sepcification 7 and 8, the dependent variable is active liquidity management measure, proposed by Rzeźnik (2016), and computed for two periods 2002-2005 and 2006-2009.

	Fund Flows		Equity Holdings		Cash Holdings		Active Liq Mgmt	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \ln$ House Price	0.539	0.207	-0.0282	0.0388	0.318	-1.168	-0.349	2.334
	(1.63)	(0.27)	(-1.86)	(1.00)	(0.76)	(-1.11)	(-0.51)	(1.37)
Bust	-0.174	-0.330	-0.0400*	-0.00860	0.639*	-0.0590	-2.639*	-1.383
	(-0.97)	(-0.88)	(-4.83)	(-0.46)	(2.80)	(-0.12)	(-7.12)	(-1.68)
Constant	0.115	0.221	0.0170*	-0.00434	-0.202	0.273	1.523*	0.667
	(0.91)	(0.86)	(2.93)	(-0.34)	(-1.26)	(0.78)	(5.84)	(1.18)
Observations	78	78	92	92	84	84	92	92
Adjusted R^2	0.228	0.217	0.315	0.166	0.166	0.037	0.652	0.591

t statistics in parentheses
* $p < 0.05$

Table 5: OLS and IV regression of funds' home bias proxies. This table show regression estimates from OLS and two stage-least-square regression of four home bias proxies on instrumented house price growth $\Delta \ln$ HOUSE PRICE and a bust dummy variable BUST equal to one for observations within 2006-2009, otherwise zero. The dependent variable in columns 1 and 2 is a change in a value-weighted mean distance between a fund and its holdings' headquarters and calculated for two periods: 2002-2005 and 2006-2009. In sepcification 3 and 4 (5 and 6), we use a change Coval and Moskowitz (1999) local bias measure for entire portfolio (top ten largest holdings). LOCAL BIAS meausre is defined as: $\sum_{j=1}^{J}(m_{i,j,t} - h_{i,j,t}) \cdot \frac{d_{i,j}}{d_i^M}$, where $m_{i,j,t}$ is a portfolio weight of stock j in the benchmark portfolio, $h_{i,j}$ is the fraction of fund i's portfolio invested in stock j, $d_{i,j}$ is the distance between fund i and stock j, and $d_i^M = \sum_{j=1}^{J} m_{i,j,t} d_{i,j}$. In specificantion 7 and 8, the dependent variable is a change in fraction of the portfolio held locally (within 100km radius away from a mutual fund).

	Weighted Distance		Local Bias		Local Bias Top 10		Local Holdings	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Δ ln House Price	0.192*	0.360*	-0.0607	-0.257*	-0.227*	-0.726*	-1.757	-7.349*
	(3.47)	(2.69)	(-1.32)	(-2.22)	(-2.65)	(-3.14)	(-1.93)	(-2.94)
Bust	0.0721*	0.151*	0.00368	-0.0884	-0.0618	-0.295*	-0.157	-2.774*
	(2.40)	(2.33)	(0.15)	(-1.58)	(-1.33)	(-2.64)	(-0.32)	(-2.30)
Constant	-0.0477*	-0.101*	-0.0117	0.0511	0.0432	0.202*	-0.0540	1.729*
	(-2.25)	(-2.28)	(-0.66)	(1.33)	(1.32)	(2.64)	(-0.16)	(2.09)
Observations	92	92	92	92	92	92	92	92
Adjusted R^2	0.111	0.019	0.063	-0.130	0.086	-0.264	0.088	-0.301

t statistics in parentheses
* $p < 0.05$

Table 6: OLS and IV regression of funds' quality and safety management. This table show regression estimates from OLS and two stage-least squared regression of a portfolio's quality and safety management measure on instrumented house price growth $\Delta \ln$ House Price and a bust dummy variable Bust equal to one for observations within 2006-2009, otherwise zero. The dependent variable in columns 1 and 2 (7 and 8) is a change in a portfolios safety (quality) constructed with Asness et al. (2013) safety (quality) measure at a stock level. In columns 3 and 4 (5 and 6), the dependent variable is active safety management measure in terms of purcheses (sales) following Rzeźnik (2016) shift-share analysis and computed for two periods 2002-2005 and 2006-2009. The dependent variable in columns 9 and 10 (11 and 12) is active quality management measure in terms of purcheses (sales) computed in an analogous manner as active safety management measure in columns 3-6.

	Δ Safety Measure		Active Safety Management Purchases		Active Safety Management Sales		Δ Quality Measure		Active Quality Management Purchases		Active Quality Management Sales	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)	OLS (9)	IV (10)	OLS (11)	IV (12)
$\Delta \ln$ House Price	-0.117*	-0.433*	-0.0200*	-0.0279*	0.0130*	0.00652	-0.132*	-0.341*	-0.0269*	-0.0262	0.0166*	0.00976
	(-2.14)	(-2.94)	(-3.31)	(-1.99)	(2.45)	(0.53)	(-2.43)	(-2.52)	(-4.02)	(-1.70)	(2.94)	(0.74)
Bust	0.0769*	-0.0712	-0.0300*	-0.0337*	0.00776*	0.00471	0.0273	-0.0705	-0.0346*	-0.0342*	0.00469	0.00148
	(2.59)	(-1.00)	(-9.12)	(-4.97)	(2.68)	(0.79)	(0.92)	(-1.08)	(-9.49)	(-4.60)	(1.53)	(0.23)
Constant	-0.0125	0.0884	0.0184*	0.0209*	-0.00430*	-0.00222	0.00905	0.0756	0.0220*	0.0217*	-0.00285	-0.000667
	(-0.60)	(1.81)	(7.95)	(4.49)	(-2.11)	(-0.54)	(0.43)	(1.69)	(8.57)	(4.25)	(-1.32)	(-0.15)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	0.463	0.260	0.639	0.632	0.055	0.039	0.300	0.184	0.630	0.629	0.104	0.089

t statistics in parentheses
* $p < 0.05$

Table 7: OLS and IV regression of funds' quality and safety for local and distant portfolio's components. This table show regression estimates from OLS and two stage-least-square regressions of a portfolio's quality and safety on instrumented house price growth $\Delta \ln$ House Price and a bust dummy variable Bust equal to one for observations within 2006-2009, otherwise zero. A fund's holding is defined as local if it is within 100km radius, otherwise it is considered a distant holding. The depentent variable in columns 1 and 2 (3 and 4) is a change in a local (distant) component of portfolio's quality. The dependent variable in columns 5 and 6 (7 and 8) is a change in a local (distant) component of portfolio's safety. The changes in local and distant components in portfolio's safety and quality are constructed using Asness et al. (2013) quality and safety measures at a stock level. All the changes are calculated for two periods: 2002-2005 and 2006-2009.

	Local Quality		Distant Quality		Local Safety		Distant Safety	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta \ln$ House Price	-0.264	-0.965*	-0.181*	-0.395*	-0.250	-0.358	-0.102	-0.508*
	(-1.58)	(-2.29)	(-3.06)	(-2.71)	(-1.60)	(-1.00)	(-1.65)	(-2.92)
Bust	-0.0868	-0.415*	0.0140	-0.0862	-0.0538	-0.105	0.121*	-0.0692
	(-0.96)	(-2.04)	(0.44)	(-1.22)	(-0.64)	(-0.60)	(3.56)	(-0.82)
Constant	0.0847	0.308*	0.00471	0.0730	0.0494	0.0840	-0.0529*	0.0763
	(1.32)	(2.21)	(0.21)	(1.51)	(0.83)	(0.70)	(-2.22)	(1.32)
Observations	92	92	92	92	92	92	92	92
Adjusted R^2	0.012	-0.183	0.325	0.226	0.029	0.024	0.515	0.283

t statistics in parentheses
* $p < 0.05$

Table 8: OLS and IV regression of fund's future returns on local house price growth. This table show regression estimates from OLS and two stage-least-square regressions of future fund returns on instrumented house price growth $\Delta \ln$ HOUSE PRICE and a bust dummy variable BUST equal to one for observations within 2006-2009, otherwise zero. The dependent variable in a columns 1 to 4 is a change in a future (3- and 6-month) fund's value-weighted raw return. In columns 5 to 8, the dependent variable is a change in a future (3- and 6-month) Daniel et al. (1997) (DGTW) fund's adjusted return. DGTW adjusted returns are constructed by subtracting from each holding's return the return on a portfolio of firms matched on market equity, market-book ratio, and prior one-year return quintiles (overall 125 different portfolios). The dependent variable in columns 9 to 12 is a change in a future (3- and 6-month) fund's excess return over the market return. All the changes are calculated for two periods: 2002-2005 and 2006-2009.

	Raw Returns				DGTW Adj. Returns				Market Adj. Returns			
	3 months		6 months		3 months		6 months		3 months		6 months	
	OLS (1)	IV (2)	OLS (3)	IV (4)	OLS (5)	IV (6)	OLS (7)	IV (8)	OLS (9)	IV (10)	OLS (11)	IV (12)
$\Delta \ln$ House Price	0.0143	0.0478*	0.0135	0.0620	0.00991	0.0254	0.0122	0.0514*	0.0125	0.0320	0.0143	0.0586*
	(1.46)	(1.99)	(0.70)	(1.35)	(1.59)	(1.71)	(1.34)	(2.22)	(1.72)	(1.83)	(1.33)	(2.17)
Bust	-0.00229	0.0134	-0.00901	0.0137	0.00870*	0.0159*	0.00990*	0.0282*	0.00956*	0.0187*	0.0115	0.0322*
	(-0.43)	(1.16)	(-0.86)	(0.62)	(2.56)	(2.22)	(1.99)	(2.53)	(2.41)	(2.22)	(1.96)	(2.46)
Constant	-0.00165	-0.0123	0.000125	-0.0153	-0.00638*	-0.0113*	-0.00654	-0.0190*	-0.00711*	-0.0133*	-0.00726	-0.0214*
	(-0.44)	(-1.55)	(0.02)	(-1.01)	(-2.67)	(-2.29)	(-1.87)	(-2.48)	(-2.54)	(-2.30)	(-1.76)	(-2.38)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	0.109	-0.009	0.069	0.003	0.062	-0.002	0.027	-0.173	0.045	-0.032	0.025	-0.160

t statistics in parentheses
* $p < 0.05$

Table 9: OLS and IV regression of fund's future returns generated by local and distant holdings. This table show regression estimates from OLS and two stage-least-sqaure regressions of future Daniel et al. (1997) (DGTW) adjusted fund's returns on instrumented house price growth $\Delta \ln$ House Price and a bust dummy variable Bust equal to one for observations within 2006-2009, otherwise zero. DGTW adjusted returns are constructed by subtracting from each holding's return the return on a portfolio of firms matched on market equity, market-book ratio, and prior one-year return quintiles (overall 125 different portfolios). The dependent variable in columns 1 and 2 (7 and 8) is a change in future 3-month (6-month) DGTW adjusted return generated by a distant component of a fund's portfolio. A fund's holding is defined as local if it is within 100km radius, otherwise it is considered a distant holding. In columns 3 and 4 (9 and 10), the dependent variable is a change in a future 3-month (6-month) DGTW adjusted return generated by a local component of a fund's portfolio. The dependent variable in columns 5 and 6 (11 and 12) is a difference between a change in a future 3-month (6-month) DGTW adjusted returns generated by distant and local components of a fund's portfolio. All the changes are calculated for two periods: 2002-2005 and 2006-2009.

	Three Months						Six Months					
	Distant		Local		Difference		Distant		Local		Difference	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta \ln$ House Price	0.0111	0.0137	-0.0207	0.155*	-0.0317	0.141*	0.00963	0.0311	-0.0539	0.187	-0.0635	0.156
	(1.39)	(0.75)	(-0.85)	(2.19)	(-1.30)	(2.00)	(0.80)	(1.10)	(-1.35)	(1.71)	(-1.62)	(1.49)
Bust	0.0105*	0.0117	0.00234	0.0844*	-0.00812	0.0727*	0.0115	0.0215	-0.00533	0.107*	-0.0168	0.0859
	(2.42)	(1.32)	(0.18)	(2.48)	(-0.61)	(2.14)	(1.75)	(1.58)	(-0.25)	(2.04)	(-0.79)	(1.70)
Constant	-0.00646*	-0.00731	0.00317	-0.0528*	0.00963	-0.0455	-0.00572	-0.0126	0.0138	-0.0630	0.0195	-0.0505
	(-2.12)	(-1.20)	(0.34)	(-2.26)	(1.03)	(-1.95)	(-1.24)	(-1.34)	(0.90)	(-1.74)	(1.30)	(-1.45)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	0.059	0.057	0.020	-0.550	0.007	-0.548	0.032	-0.003	0.032	-0.363	0.022	-0.322

t statistics in parentheses
* $p < 0.05$

Table 10: First stage regression of home bias measures. This table shows coefficient estimates and F-test statistics for excluded instruments from first stage regressions of a change in a home bias measure on Saiz (2010) measure of geographically constraint land UNAVAILABLE, its interaction with a bust dummy variable BUST $\times$ UNAVAILABLE, and a bust dummy variable BUST, that is equal to one for observations within 2006 and 2009, otherwise zero. The dependent variable in column 1 (4) is a change in Coval and Moskowitz (1999) local bias measure for top ten largest holdings (entire portfolio). In column 2, we use a change in a value-weighted mean distance between a fund and its holdings' headquarters as a home bias meausre. The dependent variable in column 3 is a change in a fraction of the portfolio held locally (within 100km radius away from a mutual fund). All the changes are calculated for two periods: 2002-2005 and 2006-2009.

	Δ Top 10 Local Bias (1)	Δ Distance (2)	Δ Local Fraction (3)	Δ Local Bias (4)
Unavailable	-0.290*	217.2*	-2.143*	-0.171*
	(-3.08)	(2.12)	(-2.17)	(-3.44)
Bust×Unavailable	0.468*	-424.0*	4.584*	0.179*
	(3.80)	(-3.16)	(3.54)	(2.75)
Bust	-0.101*	93.72	-0.757	-0.0240
	(-2.27)	(1.93)	(-1.62)	(-1.02)
Constant	0.0616	-43.70	0.0560	0.0226
	(1.80)	(-1.17)	(0.16)	(1.25)
Observations	92	92	92	92
Adjusted R^2	0.144	0.094	0.164	0.149
F	7.25	5.09	6.63	5.94
P-value	0.001	0.008	0.002	0.004

t statistics in parentheses

* $p < 0.05$

Table 11: OLS and IV regression of fund's future returns on home bias measures. This table show regression estimates from OLS and two stage-least-square regressions of future Daniel et al. (1997) (DGTW) adjusted fund's returns on instrumented home bias measures (Δ TOP 10 LOCAL BIAS, Δ DISTANCE, Δ LOCAL FRACTION, and Δ HOME BIAS) and a bust dummy variable *Bust* equal to one for observations within 2006-2009, otherwise zero. DGTW adjusted returns are constructed by subtracting from each holding's return the return on a portfolio of firms matched on market equity, market-book ratio, and prior one-year return quintiles (overall 125 different portfolios). In Panel A, we regress a change in a fund's 1- to 6-month future return on a change in Coval and Moskowitz (1999) local bias measure for top ten largest holdings defined as: $\sum_{j=1}^{J}(m_{i,j,t} - h_{i,j,t}) \cdot \frac{d_{i,j}}{d_i^M}$, where $m_{i,j,t}$ is a portfolio weight of stock j in the benchmark portfolio, $h_{i,j}$ is the fraction of fund i's portfolio invested in stock j, $d_{i,j}$ is the distance between fund i and stock j, and $d_i^M = \sum_{j=1}^{J} m_{i,j,t}d_{i,j}$. In Panel B, we use a change in a value-weighted mean distance between a fund and its holdings' headquarters as a home bias measure. Panel C relates changes in future fund returns to changes in a portfolio's fraction held locally (within 100km radius away from a mutual fund). In Panel D, we use a change in Coval and Moskowitz (1999) local bias measure for the entire portfolio. All the changes are calculated for two periods: 2002-2005 and 2006-2009.

PANEL A: Instrumental Variable - Top 10 Local Bias

	1 month		2 months		3 months		4 months		5 months		6 months	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Δ Top 10 Local Bias	-0.007	-0.012	-0.013*	-0.022	-0.016*	-0.032	-0.026*	-0.056*	-0.027*	-0.071*	-0.026*	-0.067*
	(-1.61)	(-1.12)	(-2.21)	(-1.46)	(-2.17)	(-1.61)	(-2.91)	(-2.29)	(-2.88)	(-2.57)	(-2.45)	(-2.22)
Bust	0.002	0.002	0.002	0.003	0.005*	0.005*	0.005*	0.006*	0.005*	0.007*	0.005*	0.007*
	(1.67)	(1.76)	(1.75)	(1.88)	(2.74)	(2.83)	(2.18)	(2.45)	(2.39)	(2.70)	(2.11)	(2.42)
Constant	-0.001	-0.001	-0.002	-0.002*	-0.004*	-0.004*	-0.004*	-0.005*	-0.004*	-0.005*	-0.003	-0.005*
	(-1.05)	(-1.19)	(-1.95)	(-2.07)	(-2.79)	(-2.89)	(-2.30)	(-2.53)	(-2.29)	(-2.58)	(-1.77)	(-2.09)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	0.027	0.007	0.049	0.019	0.084	0.036	0.092	-0.031	0.097	-0.117	0.070	-0.082

PANEL B: Instrumental Variable - Distance

	1 month		2 months		3 months		4 months		5 months		6 months	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Δ Distance	0.005	0.013	0.011*	0.029	0.016*	0.038	0.025*	0.065*	0.026*	0.081*	0.027*	0.077*
	(1.27)	(1.11)	(2.11)	(1.66)	(2.27)	(1.71)	(3.05)	(2.30)	(3.00)	(2.51)	(2.74)	(2.23)
Bust	0.001	0.002	0.002	0.003	0.005*	0.006*	0.004*	0.006*	0.005*	0.007*	0.005*	0.007*
	(1.56)	(1.72)	(1.66)	(1.89)	(2.70)	(2.80)	(2.11)	(2.35)	(2.32)	(2.53)	(2.09)	(2.34)
Constant	-0.001	-0.001	-0.002	-0.002*	-0.004*	-0.004*	-0.003*	-0.004*	-0.004*	-0.005*	-0.003	-0.004*
	(-0.95)	(-1.15)	(-1.87)	(-2.06)	(-2.74)	(-2.84)	(-2.23)	(-2.41)	(-2.22)	(-2.40)	(-1.74)	(-2.00)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	0.017	-0.037	0.045	-0.069	0.088	-0.020	0.100	-0.138	0.104	-0.279	0.085	-0.169

PANEL C: Instrumental Variable - Local Fraction

	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Δ Local Fraction	-0.098	-1.199	-0.463	-2.751	-0.336	-3.531	-1.160	-5.940*	-1.167	-7.385*	-0.869	-6.992*
	(-0.25)	(-1.07)	(-0.83)	(-1.66)	(-0.46)	(-1.62)	(-1.33)	(-2.17)	(-1.25)	(-2.37)	(-0.83)	(-2.08)
Bust	0.001	0.002	0.002	0.004*	0.004*	0.006*	0.004	0.007*	0.005*	0.009*	0.005	0.009*
	(1.39)	(1.72)	(1.50)	(1.99)	(2.36)	(2.68)	(1.90)	(2.43)	(2.08)	(2.64)	(1.80)	(2.39)
Constant	-0.001	-0.001	-0.002	-0.003*	-0.003*	-0.005*	-0.004*	-0.007*	-0.004*	-0.008*	-0.003	-0.007*
	(-0.83)	(-1.30)	(-1.76)	(-2.21)	(-2.43)	(-2.73)	(-2.11)	(-2.62)	(-2.08)	(-2.70)	(-1.55)	(-2.27)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	-0.001	-0.088	0.005	-0.182	0.038	-0.172	0.025	-0.304	0.030	-0.450	0.015	-0.360

PANEL D: Instrumental Variable - Local Bias

	1 month		2 months		3 months		4 months		5 months		6 months	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Δ Local Bias	-0.019*	-0.019	-0.025*	-0.014	-0.033*	-0.037	-0.051*	-0.075	-0.056*	-0.098	-0.063*	-0.093
	(-2.50)	(-0.86)	(-2.31)	(-0.46)	(-2.32)	(-0.93)	(-3.04)	(-1.54)	(-3.10)	(-1.86)	(-3.16)	(-1.61)
Bust	0.002*	0.002	0.003	0.002	0.005*	0.005*	0.005*	0.006*	0.006*	0.007*	0.006*	0.007*
	(2.02)	(1.67)	(1.91)	(1.37)	(2.90)	(2.49)	(2.39)	(2.27)	(2.63)	(2.61)	(2.47)	(2.35)
Constant	-0.001	-0.001	-0.002*	-0.002	-0.004*	-0.004*	-0.004*	-0.005*	-0.005*	-0.006*	-0.005*	-0.006*
	(-1.57)	(-1.20)	(-2.27)	(-1.50)	(-3.08)	(-2.45)	(-2.73)	(-2.42)	(-2.75)	(-2.61)	(-2.35)	(-2.15)
Observations	92	92	92	92	92	92	92	92	92	92	92	92
Adjusted R^2	0.065	0.065	0.054	0.044	0.091	0.089	0.099	0.079	0.110	0.054	0.107	0.085

t statistics in parentheses

* $p < 0.05$

3.7 Figures

Figure 3.1: Fraction of a fund's portfolio held locally and mean house prices in US. This figure presents a fraction of a fund's portfolio held locally and house price patterns. The US average house price data comes from Zillow Research dataset. The portfolio's local fraction is value-weighted mean of fraction of a portfolio held within 100km radius away from a mutual funds using TNA as weights. The data on holdings of active US funds investing in US equity is provided by Morningstar.

Figure 3.2: House price growth, home bias and land unavailability. This figure relates house price growth and relative change in mean distance to Saiz (2010) measure of land unavailability for each CBSA included in our sample for both boom (2002-2005) and bust (2006-2009) period. The observations are weighted by the number of mutual funds in each CBSA. The straight lines fit linear regression models.

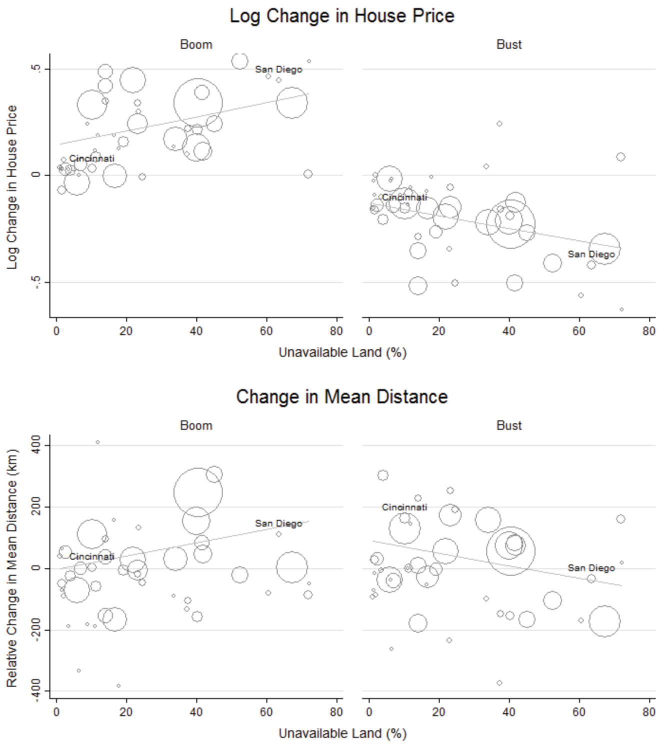


Figure 3.3: Saiz (2010) measure of land unavailability. This figure presents the variation in topologically constraint land across Core Based Statistical Areas (CBSAs). The measure of land unavailability has been constructed by Saiz (2010) and it takes into account geographical terrain and water features to determine the degree to which urban development is constrained by topological characteristics of the land.

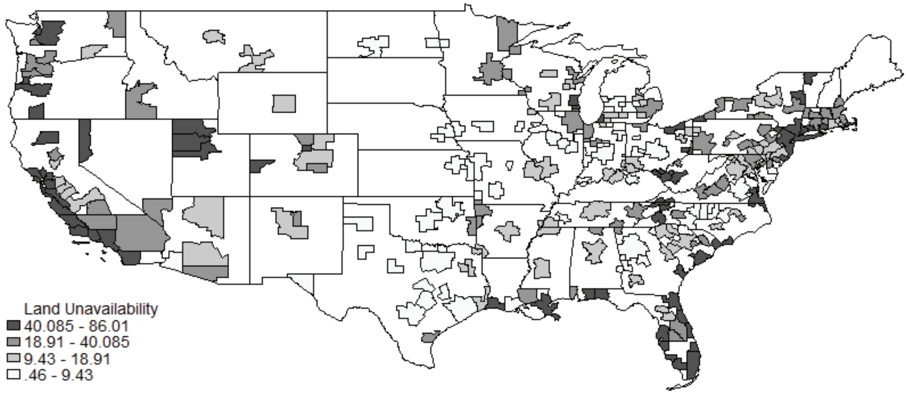


Figure 3.4: House price growth and land unavailability measure. This figure relates house price growth to Saiz (2010) measure of land unavailability for each CBSA included in our sample for both boom (2002-2005) and bust (2006-2009) period. The observations are weighted by the number of mutual funds in each CBSA. The straight lines fit linear regression models.

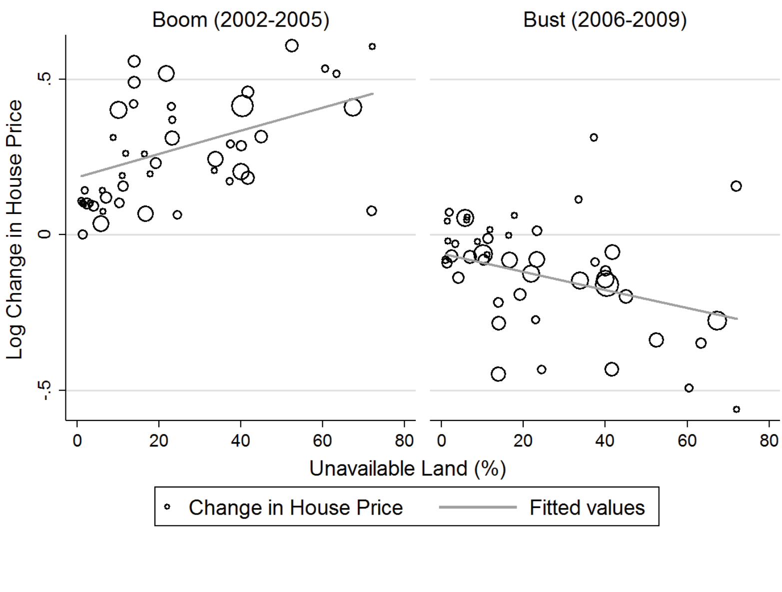


Figure 3.5: Mutual funds' distance to industries. This figure presents a fraction of a fund's portfolio kept in ten industries divided into five groups based on the distance for the end of the boom (2005) and the bust (2009) periods. We assign mutual fund holdings into ten main industries based on Fama and French (1997) industry classification. The industry clasifiaction is available at `http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/Data_Library/det_48_ind_port.html`. Industries assigned to *Close* are the nearest and second-nearest industries to a given mutual fund. Industries grouped in *Far* are the most and second most distant industries from a given fund. The left-hand side panel shows mean portfolio percentage invested in each of 5 industry groups for mutual funds located in areas with land unavailability below the median. The right-hand side panel shows mean portfolio percentage invested in each of 5 industry groups for mutual funds located in areas with land unavailability above the median.

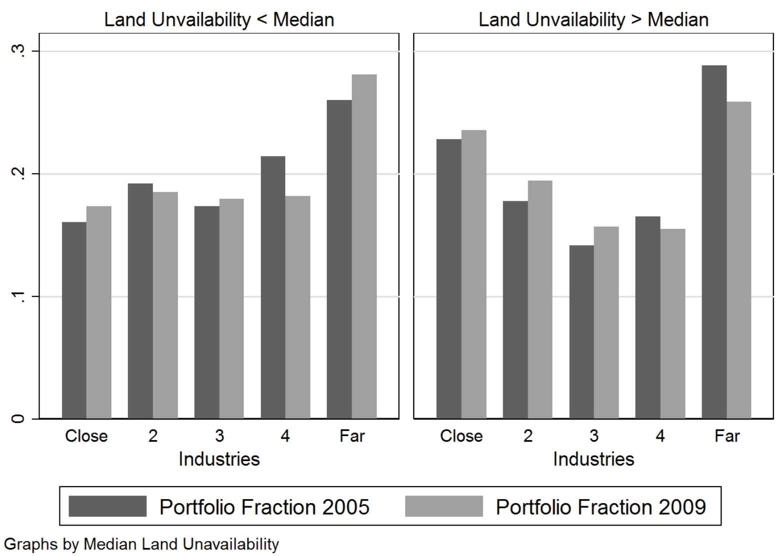
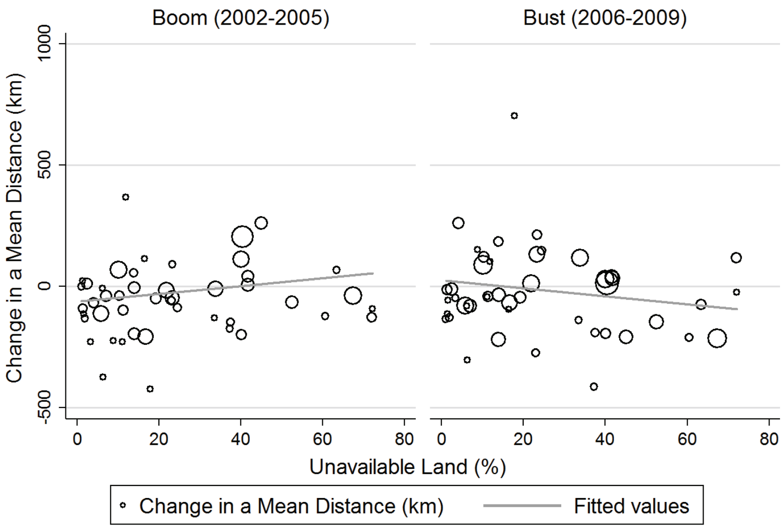


Figure 3.6: Change in mean distance and land unavailability measure. This figure relates a change in a fund's mean distance from its holdings to Saiz (2010) measure of land unavailability for each CBSA included in our sample for both boom (2002-2005) and bust (2006-2009) period. The observations are weighted by the number of mutual funds in each CBSA. The straight lines fit linear regression models.



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