Copenhagen
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HANDELSHØJSKOLEN

An Exchange Rate Assessment

A Valuation of the Renminbi in Light of Economic Liberalization

Master`s thesis

Copenhagen Business School

M.Sc. in Applied Economics and Finance

Date of submission: 15th May 2017

Andreas Linnerud

Maren Serine Husebø

Supervisor: Karsten Beltoft

Pages: 103

Characters: 179 430

Abstract

In 2005, as part of the liberalization process of China`s economy, the renminbi was de-pegged from the US dollar and allowed to fluctuate under a managed float, referenced to a basket of currencies. The renminbi immediately appreciated, enhancing the suspicion that it had been manipulated to gain competitive trade advantages at the cost of its trading partners, in particular, the US. Recent years, however, the renminbi has seen a depreciating trend, as capitals flee the country and the economy is slowing. This thesis investigates whether the renminbi is fairly valued in today's foreign exchange market, or if Chinas way of conducting monetary policy keeps it misaligned. Through case studies of China`s balance of payments and foreign exchange reserves, a regression model using macroeconomic variables and an analysis of the Purchasing Power Parity exchange rates, we find the renminbi to be slightly above an equilibrium value, but within a range to be considered fairly valued. Moreover, we argue that China`s pursuit of making the renminbi a global reserve currency will keep it from losing substantial value.

Table of contents

Figure list

Abbreviation

BOP: Balance of Payments

CA: Current Account

CFETS: China Foreign Exchange Trade System

CNY: Chinese Yuan

FA: Financial Account

FDI: Foreign Direct Investment

GDP: Gross Domestic Product

IMF: International Monetary Fund

OECD: Organization for Economic Co-operation and Development

OMO: Open Market Operation

PBoC: Peoples Bank of China

PPP: Purchasing Power Parity

RMB: Renminbi

RRR: Reserve Requirement Ratio

SAFE: The State Administration of Foreign Exchange

USD: United States Dollar

WTO: World Trade Organization

Part 1. Introduction

1. Introduction

1.1. Motivation

China`s domestic currency, the Renminbi (RMB), has been subject to multiple exchange rate regimes since its introduction in 1949. Representing a rather small economy in an international context before the 1990`s, China`s choice of regime was probably not something US politicians lost their sleep over. However, with an accumulated GDP growth of about 330% over the period of 1900-2006[1], in large extent driven by exports and investments, China rapidly gained momentum in the world economy, and so did the RMB. With a history of strict capital controls and frequent currency interventions, China was soon accused of being a currency manipulator by several of its trading partners. Especially the US, who developed into one of China`s largest trading partners, accused them of keeping its currency artificially low. The US claimed this to cause huge deficits on the US current account, as well as driving up its unemployment rate.

Whether or not the RMB has been kept artificially low, and consequently is undervalued, has been widely discussed and scrutinized in economic literature. However, the results have varied greatly, in the whole range from substantially undervalued to overvalued. Despite the varying results, the common perception has been that the currency is kept low to maintain a competitive advantage in terms of trade. In addition, two macroeconomic variables that are central in exchange rate development, the balance of payments and foreign exchange reserves, has conducted "never seen before" behavior during the rapid growth of the Chinese economy. These variables raise suspicion that China has been manipulating its currency.

After keeping its currency pegged against the dollar during the period 1994-2005, China, in its pursuit to make the RMB an international currency reserve, let go of some control by introducing a less rigid exchange rate regime, as well as easing up on capital controls.

[1] IMF World Economic Outlook Database, April 2006

Cline and Williamson (2012) found that the RMB was undervalued by 28.15% against the US dollar (USD) in 2011. Moreover, by conducting the same research a year later, they found it to be undervalued by only 3% as of 2012, and in 2015 IMF stated that the RMB no longer was undervalued.

Motivated by the development in the Chinese economy and economic policy, and the ongoing accusations about currency manipulations, this thesis aims to contribute to the continuing discussion of whether the RMB is fairly valued. The conclusion will be based on case studies of balance of payments and foreign exchange reserve developments, a linear regression model using fundamental macroeconomic variables and a purchasing power parity analysis.

1.2. Delimitation

When assessing the RMB we have chosen to look solely at the bilateral exchange rate with the USD. As the world`s largest reserve currency[2], and the most influential currency in the global market, we found it natural to base the valuation of the RMB in terms of USD. The US is also the biggest destination for Chinese export, and the third biggest destination for Chinese imports, making the two countries highly dependent on each other's currencies[3]. A bilateral exchange rate depends as much on one currency as the other, so optimally one would analyze both economies to uncover any possible explanations for exchange rate movements. However, the purpose of the thesis is to analyze the development of the RMB and answer whether it is fairly valued. Thus, to stay within the framework of the thesis, we will direct the main focus on Chinese economic factors.

The main conclusion will not give an exact value as to how far away or close the exchange rate is to its fair value, as this would require the assessment of an actual equilibrium rate. For the time being, it exists no commonly accepted model for this purpose, and different models may have different relevance under different circumstances (Cheung et al., 2010). Thus, we see this as beyond the scope of the thesis. The conclusion will instead provide an indication to whether the RMB is fairly, over- or undervalued.

[2] IMF (2017)
[3] Office of the United States Trade Representative (2016)

The regression model will be based on data from the period of July 31. 2005 to December 31. 2016. Analyzes conducted elsewhere in the thesis are subject to different time periods for the purpose of illustrating trends, developments or include specific events.

1.3. Problem statement

The problem statement is the foundation of the thesis. It has to be precise, relevant and feasible as the objective of the thesis is to serve a thourough analysis and a complete answer to the problem. Through the thesis we will therefore attempt to answer the following question:

How has the liberalization of the Chinese economy affected the RMB and is China`s long run nominal exchange rate with the US fairly valued?

To discuss the problem and draw a final conclusion, we have divided it into six sub-questions which will guide our research, analyses and emipirical study:

- *How is China affected by the "impossible trinity" in its use of monetary policy, and choice of exchange rate regime?*
- *How has China`s Balance of Payment affected its internal and external balance?*
- *How are China and the US related through the balance of payments?*
- *How has China`s use of foreign exchange reserves affected the RMB?*
- *How is the CNY/USD affected by macroeconomic fundamentals after the release of the dollar peg?*
- *Does the purchasing power parity hold for the CNY/USD exchange rate?*

1.4. Literature review

An extensive amount of assessments of the RMB equilibrium rate has been conducted throughout the last couple of decades, while research on the different assessment methods using macroeconomic variables goes even further back. Up until 2010, it seemed to be a general belief that the RMB was undervalued, even though the degree of undervaluation differed significantly dependent on the models used. For instance, during 2009-2010, research found the RMB to be anywhere between 12%-50% undervalued against the dollar, using different approaches such as the PPP

(Subramanian, 2010, Reisen, 2010), fundamental equilibrium exchange rates (FEER) (Cline & Williamson, 2009), and unit manufacturing wage costs (Ferguson & Schularick, 2009).

In more recent years, conclusions seem to spread from undervaluation to overvaluation, and many results points towards a fair value. Yearly, the IMF assesses the value of the RMB using three different macroeconomic balance approaches. In its latest report from 2016, it concludes that the RMB has moved from being "moderately" undervalued in 2014, to fairly valued in 2015, while Cline (2016) finds the RMB to be at its FEER level.

Research on different assessment methods diverges in a much larger sense, and there seem to be no consensus as to what are the best methods (Cheung et al., 2010). In the empirical part of this thesis, we will use a linear regression model with macroeconomic variables to explain exchange rate movements, and use the results to support our assessment of the RMB. Previous research disagrees upon the effectiveness of economic models contra random walk models for exchange rate determination. Meese and Rogoff (1983) tested various economic models and found that random walk models outperforms economic models in exchange rate determination, but that they ignored economic theory. However, Wright (2003) finds evidence that some economic models may produce better forecasts than random walk models, indicating that macroeconomic fundamentals have an explanatory value in exchange rate determination.

While exchange rate assessment is commonly directed on real exchange rates, this thesis aims to assess the fair nominal value of the RMB in terms of USD, based on analyses of macroeconomic fundamentals. Zhang and Zuohong (2004) use macroeconomic variables to assess what the nominal value of the RMB in terms of USD would have been, had the Chinese government not intervened in the exchange rate market, and conclude with an undervaluation of 15% -22%. We seek to further contribute to the discussion of the RMB misalignment, by looking at the development in the nominal exchange rate in a period with a managed float.

To answer our problem statement, we have based our analyses on carefully selected theory and findings from numerous academic books, news-articles and scientific papers. As economic conditions change rapidly, it is important to use data with caution. The

econometric analysis of our study is mainly based on data collected from Bloomberg, with origin from IMF`s database. It should be taken into consideration that China has a history of manipulating numbers. We do however consider numbers from Bloomberg to be reliable. The statistical tests in the econometric analysis are based on the books, *Basic Econometrics* by Gujarati and Porter (2009), and *Econometrics by example* by Gujarati (2012).

1.5. Structure

The structure of the thesis is intuitively structured and provides the reader, in an orderly manner, the necessary understanding to grasp the problem statement in its entirety. This section introduces the structure to a greater extent than the table of content, as it provides a brief description and the intuition behind each part of the thesis.

Part two aims to set the scene by making the reader familiar with the terminology, concepts and theories used throughout the thesis. It will describe Chinas exchange rate regime and use of monetary policy in light of the impossible trinity. Part three aims to assess the exchange rate based on a theoretical analysis of two fundamental macroeconomic variables, the balance of payments and foreign exchange reserves. Part four aims to assess the exchange rate based on a linear regression model, mainly using macroeconomic variables discussed in part two and three. Some additional variables will be introduced along with the reasoning for its inclusion. Moreover, the methodology and empirical analysis will be explained. Part five aims to assess the exchange rate based on the theory of power purchasing parity (PPP). Both relative and absolute PPP will be discussed and used for assessment purposes. Part six summarize the thesis by addressing the sub-questions from part one, and provides a final conclusion to the exchange rate assessment, based on the assessments from part three, four and five.

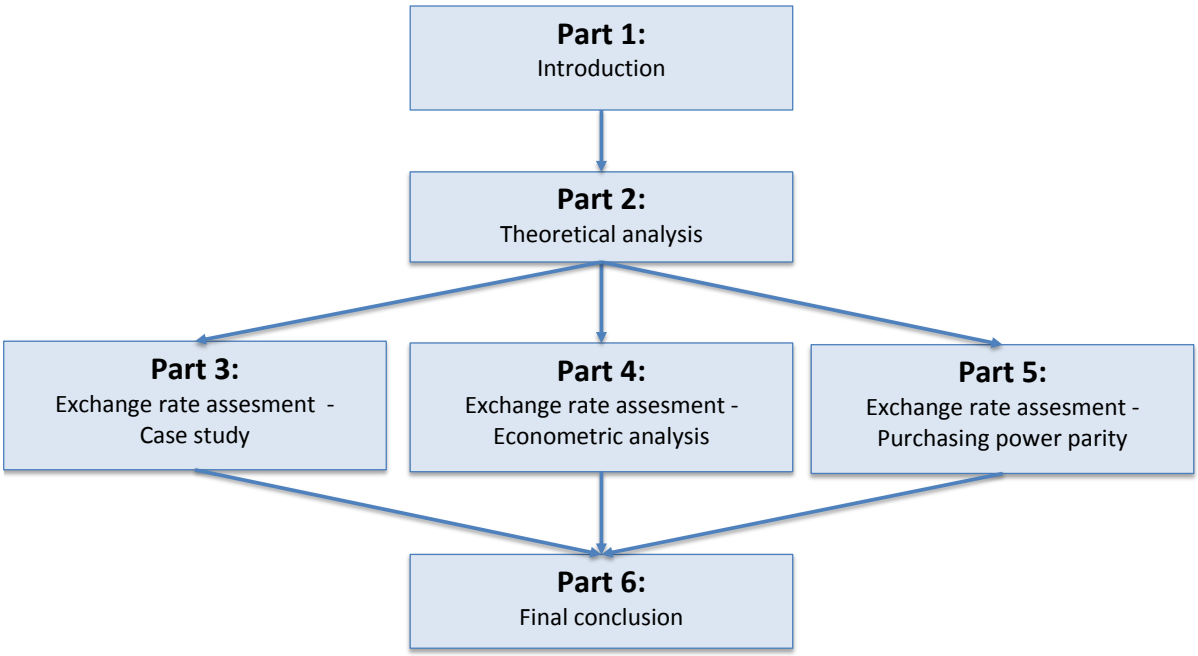

Figure 1. Thesis structure.

Part 2. Theoretical analysis

2. Exchange rate regimes

To understand the movements of the currency and how China have managed its exchange rate over the years, this chapter will discuss the different types of exchange rate regimes and the underlying theory of exchange rate movements. Further, we will present, in detail, the history of China´s exchange rate regime and the theory of the impossible trinity.

2.1. Exchange rates – a brief introduction

The exchange rate can be defined as the value of a currency against a foreign currency or a basket of multiple currencies. These two types of exchange rates are also often referred to as *bilateral* and *effective* exchange rates. A bilateral exchange rate is a rate between two currencies, for example the price of RMB in terms of USD. Movements in this rate are either due to changes in the USD or the RMB. It may be of interest to look at a currency in relation to several other currencies, often called an effective exchange rate. The effective exchange rate of a country measures the currency against a weighted average of other currencies. The weights of these currencies are usually a proportion of the trade with the respective countries. As an example, we have graphed China`s nominal exchange rate against the USD and its nominal effective exchange rate (NEER) in figure 2:

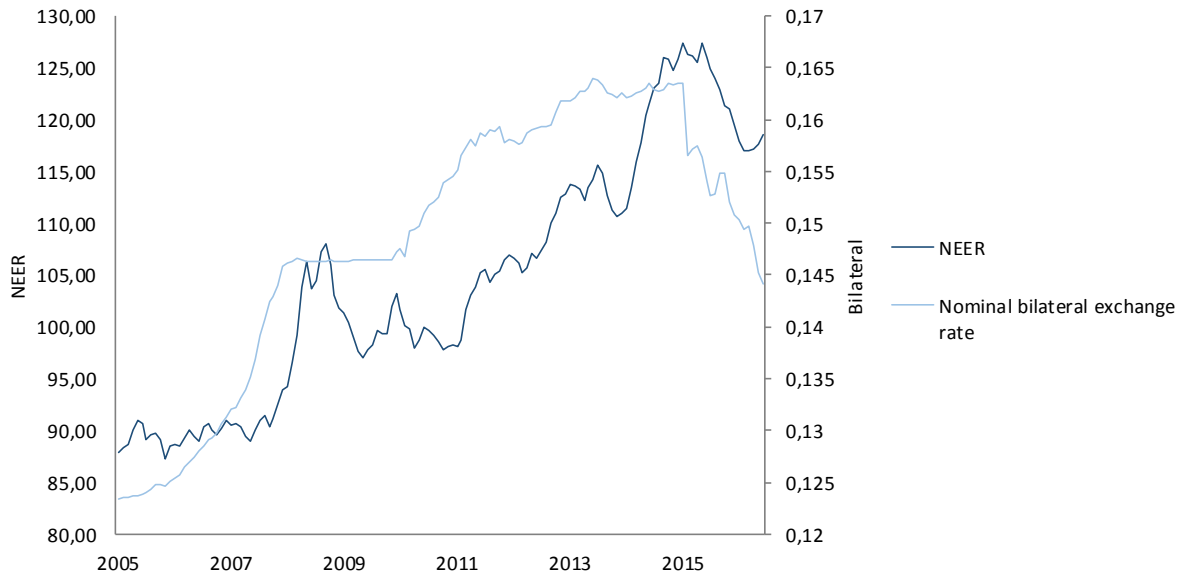

Figure 2. NEER and nominal bilateral exchange rates (CNY/USD).
Source: Federal Reserve Bank of St. Louis.

As shown in figure 2, the two currencies do not correlate perfectly. Since the bilateral exchange rate is relative to the U.S. dollar exclusively, while the effective exchange rate is subject to movements in several currencies, only weighted 17,8%[4] against the USD, this comes as no surprise. However, both rates show that the RMB has appreciated remarkably from 2005 to around 2014 when it started depreciating. The similarities in the overall movements indicate that the development in the bilateral exchange rate is caused by movements in the RMB, and not solely by the USD.

An exchange rate can either be quoted in real or nominal terms. The real exchange rate (RER) is the nominal exchange rate multiplied by the ratio of prices between two countries and can be illustrated mathematically as follows:

$$RER = e\frac{P^*}{P}$$

e = nominal exchange rate quoted as domestic currency per unit of foreign currency
P = foreign price level*
P= domestic price level.

The real exchange rate will then reflect the relationship of the price levels in the two respective countries. As with the multilateral exchange rate, it can sometimes be more relevant to look at the movements against several other currencies. The real effective

[4] BIS Effective exchange rate indices, 2017

exchange rate (REER) is an average of the bilateral RERs of the country´s trading partners. The nominal exchange rate, on the other hand, is the market price of one currency against another, and does not adjust for different price levels.

Since an exchange rate is a relative measure between currencies, fluctuations in the rate will be caused by a change in the value of either of the components. These components are determined by the supply and demand of the currencies. To understand the drivers behind the supply and demand of a currency, we can divide them into three groups: (Copeland, 2004)

- Exporters
- Foreign investors
- Speculators

When trading goods between countries, the transactions will be done across currencies, which creates a demand and supply through the exchange of currencies. When a country exports goods to another country, the receiving country has to exchange its own currency in order to pay for the goods. This creates a demand of the exporting country`s currency and a supply of the importing country`s currency. Similarly, investors who for example wish to invest in property or other assets in a foreign country will demand the currency of this country, which will have an appreciating effect of the currency. Then we have speculators, who buy and sell currency with the intention to earn profit of short-term currency movements. These effects will also work the other way around, as currency fluctuations will affect the actions of these agents.

Another factor that plays an essential role in currency fluctuations is the exchange rate regime. The degree of flexibility in the exchange rate is subject to the regime practiced by the government. Depending on how flexible the rate is, the degree of control needed to maintain the chosen regime will vary. Controlling the currency can be done in several ways, but in the end, they are all based on adjusting the supply and demand. Countries, such as China, that have practiced a fixed exchange rate regime, have tried to control the supply and demand to adjust the value of their currency. This type of policy will cause the exchange rate to adjust to other levels than in the case of a floating exchange rate regime.

2.2. De facto classification

As market conditions and countries objectives` changes, many countries have adjusted their exchange rate regime over time. To separate these regimes from eachother, IMF has made a classification, with four main types based on the rigidity of the regime: *hard pegs, soft pegs, floating regimes and a residual type*. The type of regime a country chooses will affect the country`s inflation and degree of independent monetary policy (IMF, 2006).

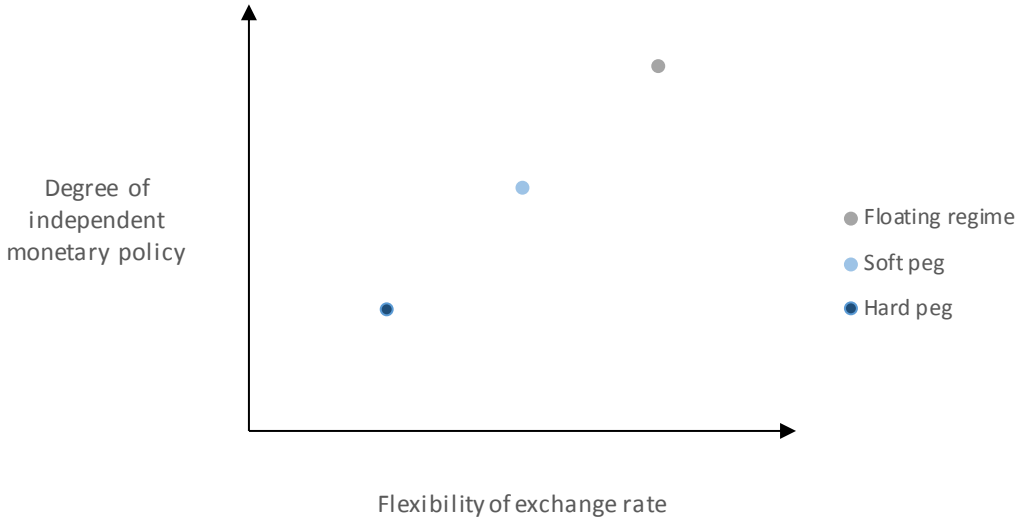

Figure 3. Independent monetary policy in relation to exchange rate regimes.

As illustrated in figure 3, a country that has a hard peg will have to sacrifice its monetary policy, as this responsibility will be relocated to the country where its currency is pegged to. In contrast, countries with a floating regime gain the advantage of having an independent monetary policy. Countries with soft pegs will be able to maintain some degree of independent monetary policy, depending on the flexibility of the exchange rate, as discussed later in this chapter.

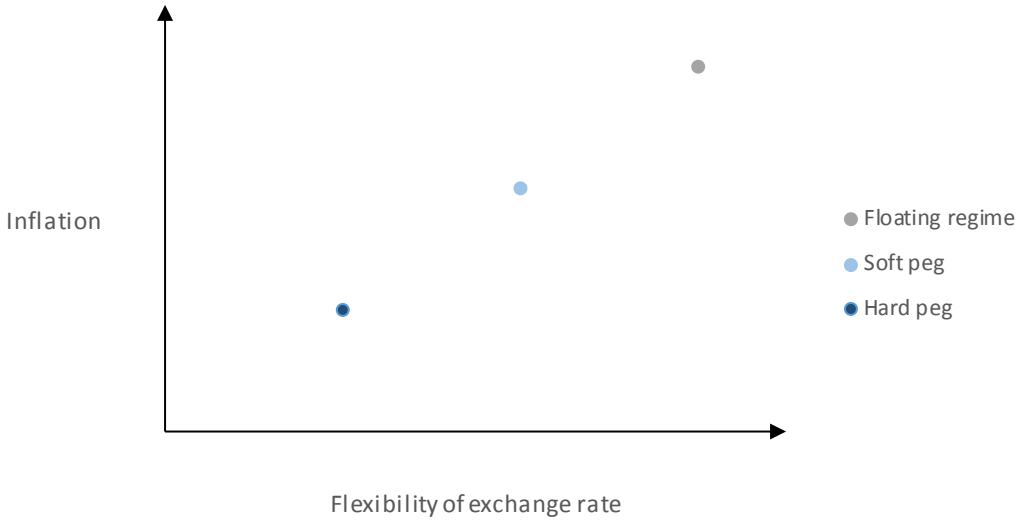

Figure 4. Inflation in relation to exchange rate regimes.

Inflation will also typically be low in countries with hard pegs (IMF, 1996) as shown in figure 4. One reason for this is that the predictability and confidence that comes with a pegged exchange rate will make it more desirable to possess domestic currency. Since inflation is associated with large supply of domestic currency, the high demand created will mitigate inflation. A country that has a floating regime will on the other hand be exposed to higher inflation, as the currency is allowed to float freely and movements are less predictable. Soft peg arrangements can experience less inflation than floating regimes, but higher inflation than countries with hard pegs. This is due to the degree of fluctuations in the exchange rate as it is subject to some restrictions concerning movements in the exchange rate. (IMF, 1996)

The main types of exchange rate regimes can again be divided into categories. Since countries often announce one regime but conducts another, it is two ways to classify a country´s exchange rate regime: *De jure* and *de facto.* A de jure classification is based on what is actually *observed* in a country, given its actions. De facto classification is what regime the country itself *announces*. The classifications IMF reports, and the classifications discussed in this thesis, are based on de facto classifications.

Type	Categories				
Hard pegs	Exchange arrangement with no separate legal tender	Currency board arrangement			
Soft pegs	Conventional peg	Pegged exchange rate within horizontal bands	Stabilized arrangement	Crawling peg	Crawl-like arrangement
Floating regimes	Floating	Free floating			
Residual arrangements	Other managed arrangement				

Figure 5. Types and categories of exchange regimes.

Source: IMF, 2015.

2.2.1. Hard pegs

IMF has identified two types of regimes that can be classified as hard pegs: *Exchange arrangement with no separate legal tender* and *Currency board arrangements.*

Exchange arrangement with no separate legal tender

Having an exchange arrangement with no separate legal tender means having the same currency as another country or belonging to a monetary or currency union. When adopting such a regime, the country sacrifices its domestic monetary policy. This is beneficial for countries with governments that are unreliable. The responsibility of the monetary policy will then be relocated to the country which the currency originally belongs to. An example of countries that uses this type of exchange rate regime is the

Economic and Monetary Union that has the Euro as a common currency.[5] Another well-known example of regimes with no separate legal tender is formal dollarization, which means adopting the dollar as domestic currency. Ecuador, El Salvador and Panama are economies that are well known for this type of regime (IMF, 2015).

Currency board arrangements

A currency board arrangement includes having full convertibility of domestic currency into a foreign currency. This also means pegging the currency rate against a foreign currency at a fixed exchange rate. In 1983 the currency board was introduced in Hong Kong and was, in 2015, still categorized as a currency board arrangement according to IMF. The Hong Kong dollar has then been fixed at a rate of HK$ 7.8 against the USD ever since the board was introduced. The board is in possession of foreign exchange reserves that it uses to intervene when necessary, to control the exchange rate. It is required that the reserves are equal to minimum 100% of the domestic currency that has been issued. This requirement is set to make sure the country can defend themselves from attacks on the currency. (IMF, 2015)

Having a currency board also removes some of the functions that the central bank normally has, like the printing of money. This implies that the central bank is unable to print notes and coins freely, and can only issue currency as long as there are foreign exchange reserves to back it. This meaning that the amount of domestic currency cannot exceed the value of the reserves. Having a currency board arrangement will therefore limit the monetary control (IMF, 2015). Currency boards also lack the possibility to lend money to banks and financial institutions that experience financial difficulties. In other words, a currency board does not function as a lender of last resort. (IMF, 2015)

2.2.2. Soft pegs

Within soft pegs there are five subcategories: *Conventional peg, pegged exchange rate within horizontal bands, stabilized arrangement, crawling peg* and *crawl-like arrangements.*

[5] The EMU countries are since January 2007 no longer classified as Exchange arrangement with no separate legal tender due to a definitional change done by IMF and not because of any change in the exchange arrangement (Revised System for the Classification of Exchange Rate Arrangements, 2009)

Conventional peg

Similar to the currency board arrangement, conventional peg also ties the domestic currency to a foreign currency or a basket of currencies. What separates this regime from having a fixed exchange rate is that the currency can float within a certain band. When having a conventional peg, the currency is pegged within a band of +/- 1%. This allows the currency to appreciate or depreciate by maximum 1% against another chosen reference currency. The exchange rate can also keep a maximum and minimum value within 2% for at least six months for it to be classified as conventional peg arrangement. (IMF, 2015)

Conventional peg allows independent monetary policy to some degree, depending on the width of the currency band. To maintain an exchange rate within these chosen bands, intervention is required to stabilize the currency. As discussed later in the thesis, this means that the central bank sells and buys local currency in the foreign exchange markets to control the domestic currency. Inflation also tends to be higher than in countries with hard pegs as the fluctuations in the exchange rate will be higher than with a fixed rate.

Pegged exchange rate within horizontal bands, Stabilized Arrangement and Crawling-like Arrangement

Pegged exchange rate within horizontal bands functions as the conventional peg but has a wider band of +/-1% or more. To classify as a stabilized arrangement, the exchange rate has to be within a range of 2% for a minimun of 6 months. A crawling-like arrangement also has to vary within a band of 2% but in relation to a trend. An example of a crawling-like arrangement is the current regime in China where the exchange rate is allowed to fluctuate with a maximum of 2% relative to previous day`s closing price.

Crawling peg

Crawling peg is an arrangement where the rate will be adjusted modestly by a fixed rate or in connection to market factors, as for example inflation. The rate can be set depending on past movements, or forward-looking movements built on projections of future outlook. A motivation behind choosing a crawling peg is to avoid a devaluation of the currency as a consequence of inflation. This regime would then be most beneficial in countries where high inflation is a threat. The country can then adjust its currency to

counter inflation and price volatility. To maintain this currency, the country can use its foreign exchange reserves to control the demand and supply to assure the "appropriate" exchange rate level. A disadvantage of this regime is the risk of a *broken peg*, which is what happened in Thailand in 1997 and triggered the Asian Financial crisis.

2.2.3. Floating arrangements

Floating arrangements differ from soft and hard pegs in the way that the exchange rate is highly determined by market forces. This makes the exchange rate a lot less predictable compared to a pegged rate. Further, this will typically cause a higher degree of inflation than in countries with a fixed exchange rate. If an exchange rate fulfills the criteria for soft peg regime in terms of movements, it will be classified as one if this is caused by official actions. If these movements are a result of market movements and *not* official actions, it can be categorized as a floating regime. The classification is in other words dependent on the cause of the movements in the exchange rate.

Within floating arrangements, IMF has chosen to separate between *floating* and *free floating* exchange rate regimes. The difference between these to categories is the level of intervention conducted by the central bank. When having a floating regime, intervention may be used with the purpose of mitigating large fluctuations in the exchange rate. Intervention should not be used to reach a certain targeted exchange rate, for it to be described as a floating regime. IMF separates between floating and free floating regimes depending on the frequency of intervention. Floating regimes are common among advanced economies such as a lot of European countries. Examples of countries with a free floating arrangement is the European Economic and Monetary Union (EMU) countries in the way that the Euro is a freely floating currency. An advantage that comes with having a floating exchange rate is the benefits of maintaining an independent monetary policy.

2.3. History of China`s exchange rate regime

China`s exchange rate regime has been changed a lot over time because of changing market conditions due to liberalization of the economy. From 1997 to 2005[6], China`s exchange rate regime has been classified as different categories, all within soft pegs

[6] From Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Classifications from before 1997 are not available.

(IMF, 1997-2005), but the exchange rate has moved towards a much more flexible rate during the last decades. This liberalization may be seen as a step towards internationalizng its currency and opening up towards the global economy.

In December 1978, Deng Xiaoping announced an ”open door”-policy, which was a new reform that intended to open up the economy to foreign investors (Chow, 2004). Despite the policy, China did not fully open up to the global market. At this time, China had a dual exchange rate regime. This meant having one official exchange rate and an additional exchange rate, determined to a certain degree, by supply and demand in the foreign exchange market. The official exchange rate was undervalued relatively to the dollar, which made it cheaper to buy dollars with the official exchange rate than with the market exchange rate. Buying dollars at this official exchange rate was limited by both supply and access. For example, the official exchange rate was used for buying import goods such as food and other essentials and thus working as a form for subsidiary. Meanwhile, import goods such as luxury goods could be imported at the higher exchange rate to work as a “tax”. This regime lasted until 1994 when it was no longer possible to maintain, as the People`s Bank of China (PBoC) started running out of foreign exchange reserves.

In April 1994, China devalued its official exchange rate so it reached the level of the market exchange rate. This resulted in a depreciation of 33%[7] of the RMB overnight and one unified exchange rate. The new exchange rate regime implied a fixed exchange rate where the RMB was pegged at approximately 8.28 to the U.S. dollar. During the Asian financial crisis, many Asian countries suffered a sharp devaluation of their currencies. This made China lose exports because its currency became more expensive relative to the others`. Despite the temptation to devaluate the RMB to be competitive in the market, China maintained its fixed exchange rate, to secure stability and development in the region (Ministry of Foreign Affairs of the Peoples Republic of China).

PBoC decided to move to a less rigid exchange rate regime in July 2005. The RMB was then determined by the supply and demand in the foreign exchange market but at the same time pegged to a basket of currencies calculated as an index, instead of just the dollar itself. These weights were not officially published before China`s Foreign

[7] Reuters 2012

Exchange Trade Systmen (CFETS) announced the composition of the basket in 2015. The way the managed floating regime worked was that PBoC announced a reference rate, also known as *central parity,* before the currency trading started that day. The exchange rate was then allowed to rise or fall by no more than 0,3% from the current day´s reference rate. In theory this allowed the RMB to rise by 0,3% additionally every day. But in practice this did not happen as the central parity was set close to the previous reference rate instead of the last day's closing price. Even though the difference in the day-to-day central parity was quite small, the currency was still allowed to fluctuate. After the transition from the fixed exchange rate regime, the RMB started appreciating. In May 2007, the band of 0,3% was increased to +/- 0,5%, meaning the currency could increase or decrease by 0,5% from the central parity each day. At this point the RMB had appreciated with around 7,6%[8] against the USD since the end of the fixed rate regime.

In September 2008, when the global financial crisis occurred, People´s Bank of China again decided to peg its currency to the US dollar at a fixed rate of around 6,83, as a measure to avoid currency fluctuations. When the world economy eventually started stabilizing, the PBoC loosened its peg in June 2010.

[8] Own calculation from Bloomberg data.

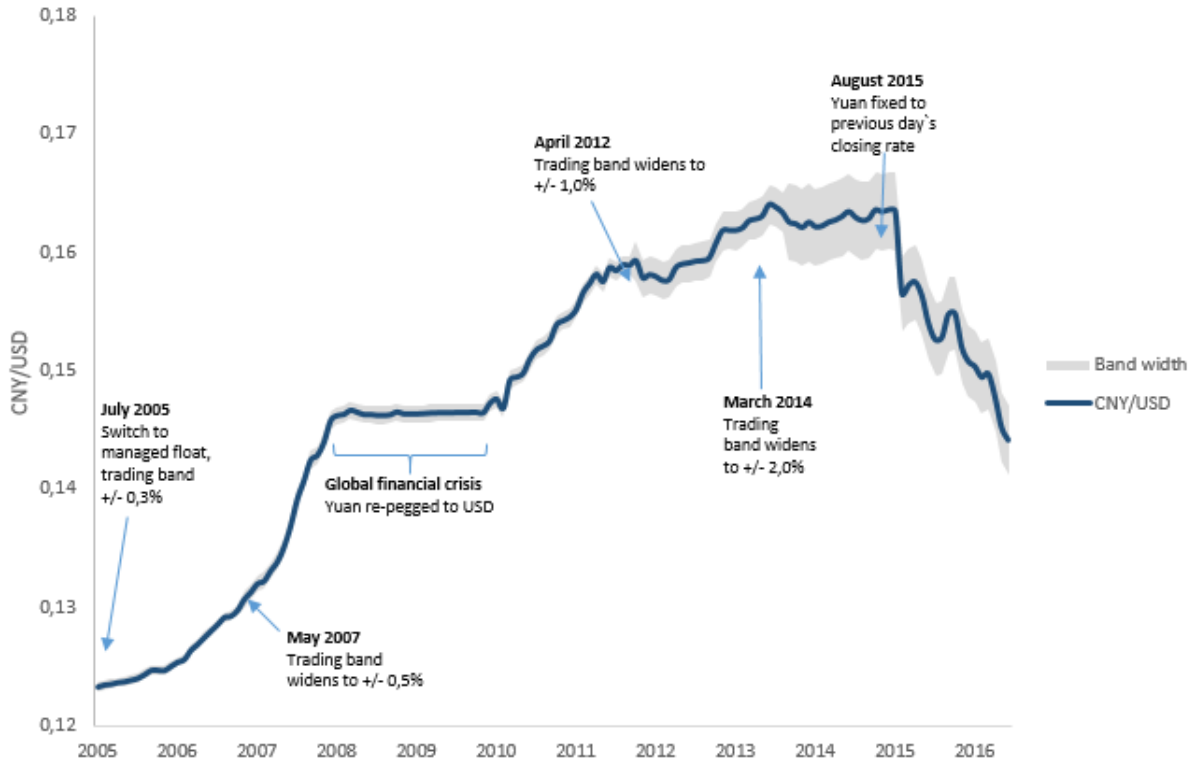

Figure 6. History of China`s exchange rate regimes (2005-2016).

Source: Mercer, 2015 and Bloomberg.

The response China received when moving back to the managed floating regime was positive. Both IMF and former U.S. president Obama supported China`s decision. The expectations were a strengthening of the RMB, which would reduce the competitiveness of China`s export sector. IMF also stated that a stronger RMB could contribute to an increase in households` consumption thus support China`s GDP growth.

After this, China continued to widen the currency band several times. First in April 2012, the band was increased from +/-0,5% to +/-1% and further up to +/-2% in March 2014. From the widening of the spread in March 2014 and up to May 2015, the RMB had depreciated by around 0,5% against the USD. As this depreciation took place, China´s foreign exchange reserves peaked in June 2014 and then started decreasing after a long period of accumulation of reserves[9]. PBoC was selling the dollar reserves and buying RMB to mitigate the depreciation and smoothen the currency movements. One year after the foreign reserves peaked in June 2014, China had used 7,5%[10] of its reserves to

[9] See figure 20

[10] Own calculation based on Bloomberg data.

stabilize the exchange rate. This accounts for a decrease of almost 300$ billion in reserves.

August 11, 2015, the PBoC again announced it would change its exchange rate regime and devaluated its currency by 1,9% relative to the dollar.[11] The spread of +/-2% was kept, but the central parity is to be set closer to the previous day's closing price. This makes the exchange rate more affected by supply and demand in the market compared to earlier as the fluctuations in theory can be bigger with this regime. Ma Jun, chief economist at People`s Bank of China, announced to Financial Times[12] after this change, that it will continue to intervene by using foreign exchange reserves to avoid large currency fluctuations. The RMB is in other terms not floating but more flexible than under past regimes.

From January 1. 2017, CFETS states that the reference basket used to manage the RMB will consist of 24 currencies. This is an increase of 11 currencies from the former key index. Among the currencies, CFETS has announced that the U.S. dollar will be weighted with 22,4% and the Euro with 16,34%, reduced from 26,4% and 21,39% in 2016, respectively.[13] According to IMF`s annual report on exchange arrangements and exchange restrictions from 2015, China`s exchange rate regime is to be classified as a crawl-like arrangement.

2.4. The impossible Trinity

2.4.1. Concept

As briefly discussed above, a country´s degree of independent monetary policy will depend on which type of regime the country has. In relation to this, the *impossible trinity* explains how it is impossible for an economy to have independent monetary policy, a fixed exchange rate and free capital flow, simultaneously. (Aizenman and Ito, 2014) The triangle shows the three possible combinations in relation to different exchange rate regimes.

[11] Bloomberg news, August 2015
[12] Financial times, August 2015
[13] Reuters, December 2016

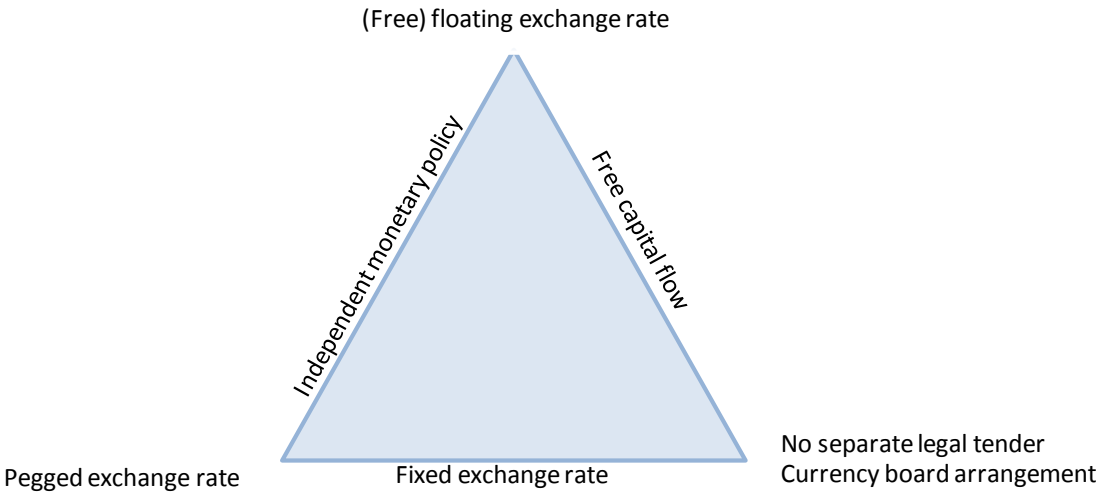

Figure 7. The impossible trinity by exchange rate regime.

The theory discusses that a country can only maintain two of these policies at the same time. Having all three is impossible because of market mechanisms that force a country to give up one. All three policy choices have their positive and negative sides which makes the choice differ, depending on the country`s preferences.

Free capital mobility

Having no restrictions on capital flows can contribute to a country`s economic growth as it can provide more efficient resource allocation between countries, increase productivity and enhance domestic savings (Aizanman, & Ito, 2014). The downside with no capital control is the instability it may cause as capital can fluctuate during recession while better times will attract foreign capital. This can enhance the economic instability in the country.

Exchange rate management

Having a fixed exchange rate creates certain stability in the sense that it can reduce inflation through the stability in the exchange rate. This again leads to less uncertainty and can encourage investments and foreign trade. During times of crisis, a pegged currency will also provide some degree of stability. For instance, during the financial crisis, as China was able to maintain its peg to the dollar, it was a not exposed to the great depreciation that many other Asian countries experienced. On the other hand,

having a fixed exchange rate can also be a source of imbalance when this type of shock occurs. Even though China maintained a stable exchange rate through the Asian financial crisis, it did not remain competetive with the other Asian countries as their currencies depreciated relative to the RMB, leading to cheaper export goods among its competitors. In this sense, China lost competetiveness because of the fixed exchange rate.

Monetary independence

With monetary independence, policymakers can freely control its monetary policy without being subject to another country`s monetary policy, like countries with a currency board or monetary union. This should ideally increase stable growth in an economy but can also be abused by authorities, causing a destabilized economy.

In short, there are both upsides and downsides related to all combinations of the triangle. It is also worth mentioning that the effect of each of the policies will differ, depending on which side of the triangle the country chooses. Which sides to take will therefore depend upon what factors that are most valued by the country.

Let us assume a country wishes to have a fixed exchange rate to assure stable inflation. If this country also wishes to have free capital flow, this will cause difficulties when combined with an independent monetary policy. For example if the central bank wishes to attract foreign capital, it will raise the interest rate. This creates a demand for domestic currency, which puts pressure on the exchange rate, and will eventually cause the peg to break. The country is therefore forced to give up one of the sides of the trilemma.

Many emerging economies, such as China to some degree, value a stable inflation and will therefore prioritize to keep a fixed exchange rate and rather sacrifice either free capital flow or independent monetary policy. For most developed economies, as for example the US, it is more common to keep an independent monetarty policy and remain free capital flows. This forces these countries to have an exchange rate determined by market forces. Ireland is an example of a country that has an exchange rate arrangement with no separate legal tender, as the Euro is its official currency. This means that it has sacrificed independent monetary policy for the advantages of having free capital flow and a stable exchange rate.

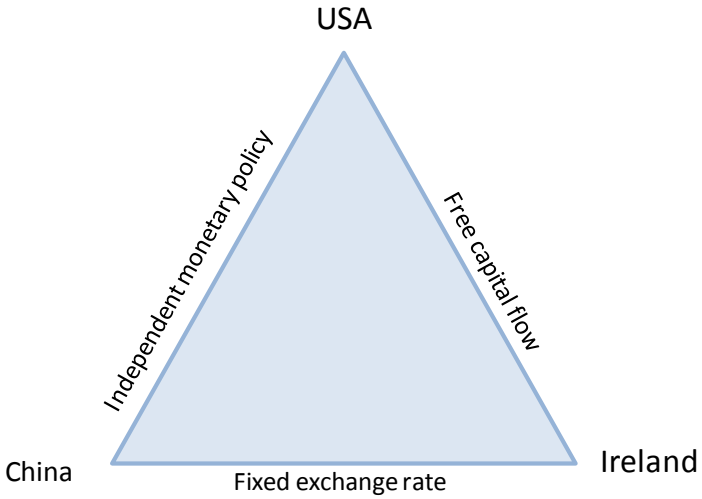

Figure 8. The impossible trinity by country.

2.4.2. Criticism

There are some criticisms of the model as the theory makes a lot of assumptions, which does not necessarily apply perfectly in reality. First, the theory assumes that capital flows are extremely sensitive to interest rate differentials. In reality, capital flows are often not that sensitive because of imperfection in the markets, such as imperfect substitutability of assets between countries. So if a central bank increases its interest rate, this is not sure to attract foreign capital. In reality, countries have found a way around the theory by using sterilized intervention when managing the exchange rates. A sterilized intervention is in short, as it will be discussed in chapter 5.3.1, when a central bank sells or buys foreign currency, while using monetary policy instruments to offset changes in the monetary base. In other words, sterilized intervention is a way to "escape" the impossible trinity, but it is a costly method that only works in the short run.

2.4.3. China

Because of China`s use of sterilized intervention it has, to some degree managed to escape the impossible trinity. With a more free capital flow, the RMB has been under a lot of pressure, as China experienced net capital inflows from 2002 to 2010, causing upward pressure on the RMB. (Lo, 2015 p.2) For China to maintain its soft peg regime, it needed to intervene in order to keep the exchange rate at the required level. The PBoC

then bought foreign currency with RMB to increase the supply and put downward pressure on the currency. To sterilize the intervention, the PBoC used monetary policy through open market operations and raised the reserve ratio requirement. When sterilizing, China was able to maintain a fixed exchange rate, independent monetary policy and at the same time receive large capital inflows (Hu, 2011). In more recent years, capital outflows have increased and created an unwanted downward pressure on the RMB. This has halted the liberalization process of the capital controls.

3. Monetary Policy

Monetary policy is a macroeconomic policy driven by central banks or other regulatory government to control inflation and employment, through an increase or decrease in the money supply. Most countries operate its monetary policy through three main tools; interest rates, open market operations and reserve ratio requirements. In this chapter, we will discuss the meaning of these tools and China`s use of them over the last two decades. Less transparent economies, such as China, also use capital controls in its monetary policy. This instrument has its own side in the impossible trilemma, and can help explain the Chinese twin surplus phenomenon, which will be introduced in the balance of payments chapter later in the thesis. Thus, we see it as appropriate to dedicate attention to this aspect of the monetary policy conducted by China.

3.1. History of Chinese monetary policy

The PBoC has been the country`s central bank since 1983. From the law of the People`s Republic of China on the PBoC, Article 3, we have that *"the aim of monetary policies is to maintain the stability of the value of the currency and thereby promote economic growth" (PBoC, 1995,2003).* Despite the lack of transparency from the PBoC regarding its monetary policy, it is a common assumption that its main aim has been growth of money reserves (M2) and bank credit (Song, Storesletten and Zilibotti, 2014). He and Wang (2012) made an analysis of the conduct of PBoC`s monetary policy and concluded that, even though the framework never has been officially defined, it can be described in the following manner:

Monetary Policy Framework	
(Implicit) Final targets:	Infalation, growth and financial stability
(Indicative) Intermediate targets:	M2, banking-system credit and fundraising in money and capital markets
(Implicit) Operating targets:	Reserve money and money- and bond-market interest rates
Policy instruments:	Various policy interest rates (including rediscount, re-lending, banks` benchmark lending and deposit rates), reserve requirements, open market operations and foreign exchange intervention.

Figure 9. Monetary policy framework.
Source: He, & Wang, (2012, p. 930.)

Geiger (2008) argues that even though PBoC officially conducts China`s monetary policy, it is not independent when deciding its conduct, but is influenced, mainly by the central government. Thus, the PBoC is neither independent when setting its final targets nor in its use of instruments, as it needs the approval of the central government. This way of conducting monetary policy is in strong contrast to other large economies such as the US and the EU, where the standard is political independency amongst the central banks. This independency is important for central banks so that they can conduct the monetary policy in line with the main targets, without being affected by a political agenda. Goodfriend and Prasad (2006) also pointed out the importance for China, as a country in rapid integration in to the global economy, to have an independent and effectively conducted monetary policy objected on the domestic economy. However, there is another distinct difference between the monetary policy conducted in China than that conducted in advanced economies, and it may contribute to explain the political dependency of PBoC. While advanced economies usually conduct a monetary policy that aims at one single target, using one main instrument, The PBoC aims at multiple targets using several instruments. (He and Wang, 2012). In relation to China`s economic transition, The Governor of the PBoC, Zhou Xiaochuan, spoke at the "Michel Camdessus Central Banking Lecture 2016" about managing a monetary policy with multiple targets and central banking independency: *"For central banks with a single objective, it is relatively easy to be independent. However, if a central bank has multiple objectives, it may be harder to be immune from the political reality."*

3.1.1 Interest rates

Interest rates have a direct effect on the demand of a currency, and hence on its exchange rate. As interest rates increase, and so does the return on deposits in that currency, the demand for that currency increases and leads to an appreciation. The opposite happens with a decrease in the interest rates. Ofcourse, this interaction is only possible with a floating exchange rate, and as we already know, this is not yet the case of the RMB.

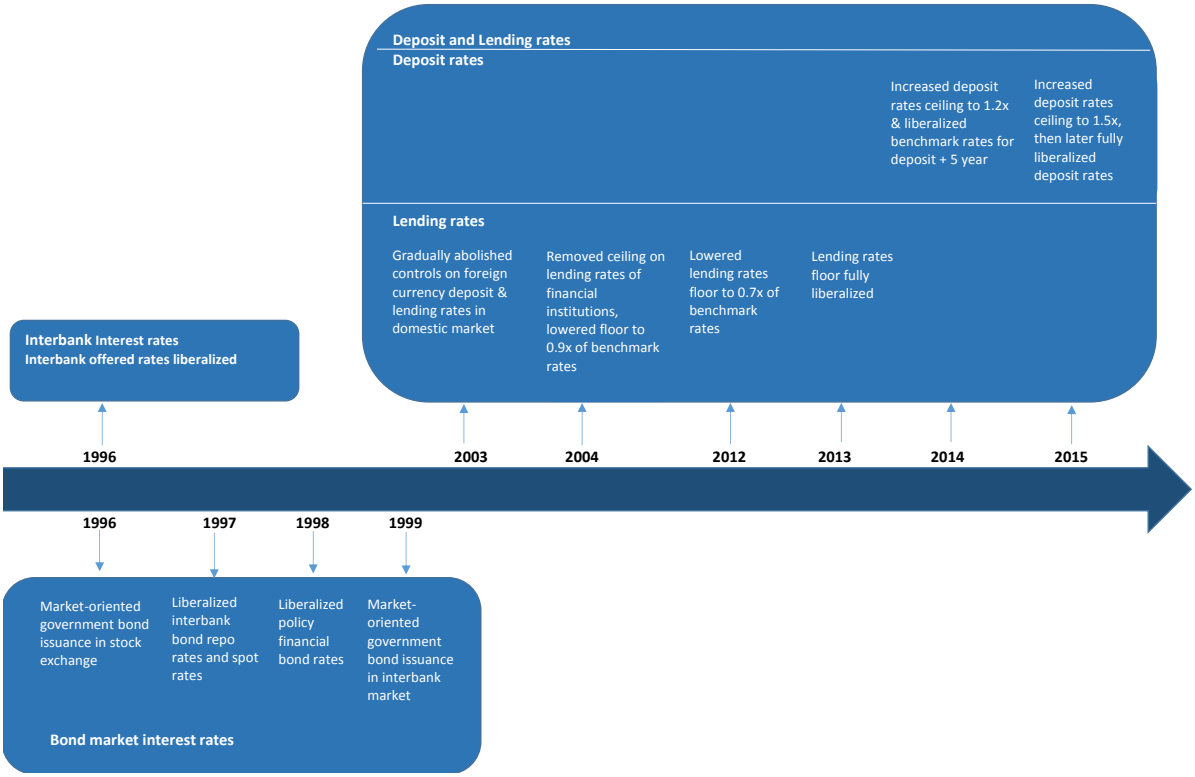

Figure 10. Timeline of liberalization process of China`s interest rates (1996-2015).
Source: J.P. Morgan Asset Management, 2015.

China`s interest rate is undergoing a liberalization process, that started over two decades ago. This ongoing process has provided China with a so called dual-track interest rate system, where interest rates on bank lending and deposit rates are regulated, while bond and money-rates are market determined (He and Wang, 2012). The regulations come in form of a deposit rate ceiling and a lending rate floor set by the central bank. In figure 10 above, the liberalization process is illustrated in form of a timeline, highlighting the most important measures made on the way towards liberalization.

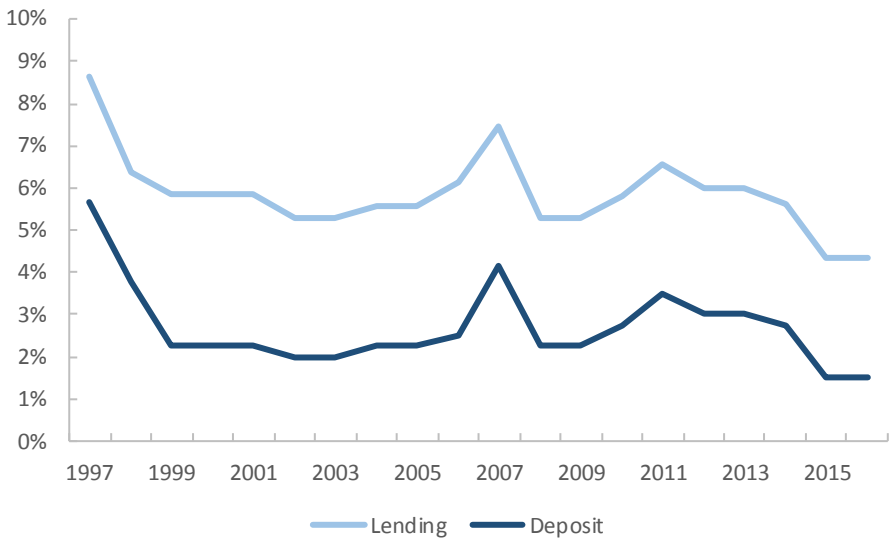

Figure 11. Benchmark interest rates in China.

Source: Bloomberg.

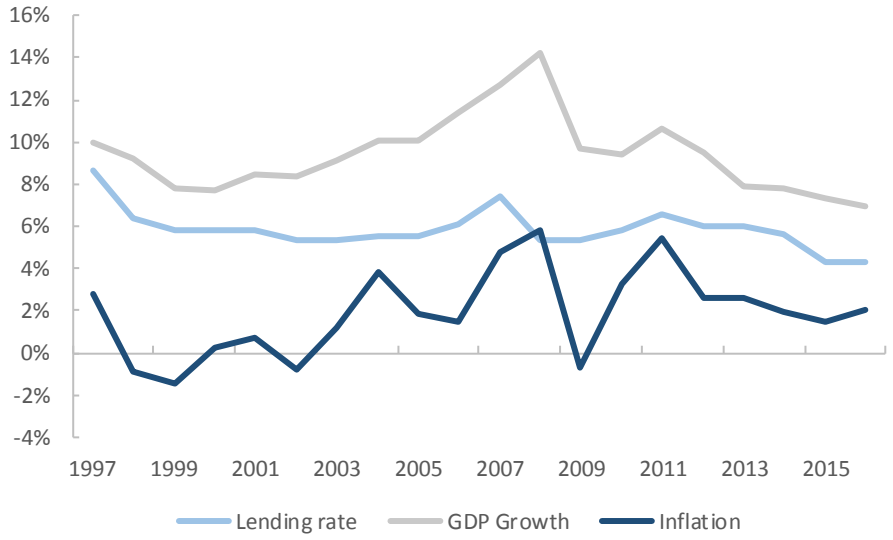

Figure 12. Benchmark interest rate, GDP growth and inflation rate in China.

Source: Bloomberg.

From figure 11 and 12 we can see how the PBoC actively uses the interest rate to affect changes in the economy. The interest rate was increased several times during the years 2006 and 2007, a period when China experienced an exceptional economic growth, mostly to fight accelerated inflation and an overheating economy. However, a contrasting period was right around the corner. The global financial crisis struck and caused a decrease in external demand, one of China`s main growth factors. The slowing growth made China cut interest rates multiple times during 2008 to spur domestic

economic activity. In 2010-2011, again faced with growing inflation, PBoC increased the interest rates several times. Between the years of 2012-2015, the interest rate has gradually been cut together with further liberalization of the rates. Mostly to fight an inflation rate way below the PBoC`s targets and a weak economic growth.

The dual interest rate system driven by the PBoC has had its effects on the Chinese economy, and they seem far from positive. For instance, the regulations have halted the competition in the banking sector. The restrictions have prevented private banks from obtaining market shares by offering better conditions on loans and deposits. They have also reduced the banks incentives to improve efficiency and risk pricing, as the prices are set administratively by the PBoC. The regulations have favored the large state owned banks, making the Chinese banking sector a quasi-monopoly. China has four major state owned commercial banks and Geiger (2008) reports that the «big four» [14] occupy around 80% of the banking sector`s assets and liabilities, and provides 80% and 70% of the lending and deposit services conducted in China. This further affects the liberalized interbank interest rates, which are seemingly market determined. Wu and Porter (2009) finds in their study, a clear connection between the controlled benchmark interest rates and the interbank market rates. Yuyan, Yang and Yiping (2016) argues that the commercial banks have favored state own enterprises (SOE), providing them with cheap loans, while privately owned enterprises are crowded into the curb market with high interest loans. Thus, commercial banks work as a tax scheme, reallocating income from households, through low yielding deposits, to cheap lending to SOEs. This should make a significant impact in a country where the national savings rate has fluctuated around 40% to 50%[15].

The underdeveloped financial system and its failure to meet the credit demand of privatly owned enterprises, has contributed to the growth of the shadow banking system in China. IMF defines shadow banking as *"credit intermediation outside the conventional banking system".* This system has established a strong foothold in the Chinese financial markets since the global financial crisis. The actual size of the shadow banking system in China has been estimated by several independent analysts with

[14] The «big four»: Bank of China, China Construction Bank, Industrial and Commercial Bank of China, The Agriculture Bank of China
[15] the World Bank data (2017)

various results. IMF estimated that in 2014, the shadow banking sector equaled 35% of GDP, while JP Morgan`s estimates for 2013 equaled 81,2% of GDP. The variation in estimates is caused by fundamental differences in the definition of shadow banking and further aggravated by the necessity of estimating important statistics due to the absence of regulations (Elliott, Kroeber & Qiao, 2015). On an international scale, in terms of GDP, the Chinese shadow banking system is not particularly large, but it is by far the fastest growing. The main reason behind the large growth is due to regulatory arbitrage (Elliott, Kroeber & Qiao, 2015). However, chinese authorities has welcomed the system, but aims to reform it, leaving them with the difficult task of encouraging the supply of credit to sectors not well served by the traditional banking system, while at the same time ensuring financial stability and the protection of investors.

As China abandoned the lending rate floor in 2013 and lifted the deposit rate ceiling in 2015, it has come fairly close to fully liberalizing its interest rates, but still has some work to do. As Yuyan, Yang and Yiping (2016, p.12) wrote: *"The final goal of interest rate liberalization should be to establish a system where all kinds of interest rates are determined by market forces and are transmitted smoothly to every part of the market and economy"*. They further state that for this to happen, all market participants must conduct a market-oriented behavior. This appeals to the central bank and the commercial banks, as well as to the savers and borrowers.

3.1.2. Open Market Operations (OMOs)

When a central bank is buying or selling government securities to adjust the money supply and liquidity in the banking system, in order to affect the interbank interest rates, it is called Open Market Operations (OMOs). China introduced OMOs as a monetary instrument in 1993, but due to its lack of a functioning interbank market and controlled interest rates, the instrument had little impact on the economy. It was used sporadically on a low scale during the following years and was removed as an instrument in 1997, only to be reinstalled and grow to become one of the most significant instruments a year later. The liberalization of the interest rates in the bond and money market, in addition to the reduced credit control, gave the OMOs a better foundation to make the desired impact. The PBoC initially introduced one trading day a week for OMOs and from 2004 it introduced a second trading day (Geiger, 2008). The

main market operations China use is repurchasing agreements (repos) to reduce the money supply in the banking system, or reverse repurchasing agreements to boost the money supply. It also introduced a third option, Central Bank Bills, when the PBoC ran out of government bonds (the collateral of the repos) in 2002 and converted bonds to bills worth USD 23,8bn (Green, 2005).

When the PBoC issues bills, it withdraws money from the banking system and injects money with its redemption (Dai, 2003). These interactions have been diligently used since they were introduced in 1998, and Geiger (2008) analyzes the use of OMOs from 1998 to 2006. He finds that from 1998 to the mid-2000, the PBoC mainly did reversed repos to inject money in to the system. From 2003, he saw a drastic change in the monetary policy, as the fundament shifted from reversed repos to repos. In addition, the PBoC issued its first bills since the conversion of bonds in 2002. The increase in repos and bills maintained during the analysis period, while the reversed repos sank drastically. In the same period, China experienced growing foreign exchange reserves as a result of trade surpluses and capital inflows. The sudden need to withdraw money was due to the foreign exchange interventions that caused the RMB base money amount to increase, as China had to buy foreign exchange with RMB to keep the exchange rate pegged[16].

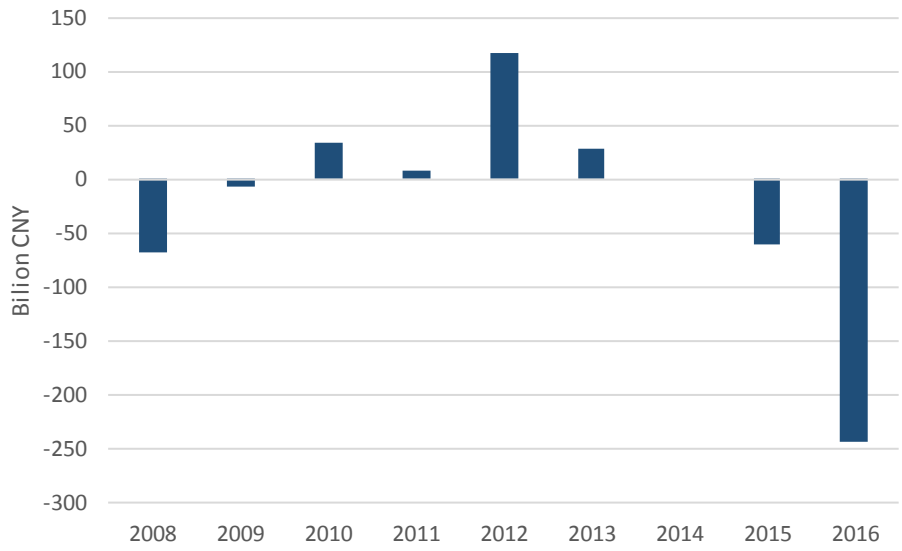

Figure 13. PBoC`s net input of money in the banking system.
Source: Bloomberg.

[16] Ref. chapter 5.3.1. about sterilized intervention

From figure 13 above we can see the net injection of money, conducted by the PBoC over the latter part of the analysis period. The flows have varied between negative and positive throughout the period, with four years standing out with respect to magnitude. Over the year of 2008, PBoC reduced the money base by issuing central bills and repos. In 2012, a net amount of about 120 billion CNY was injected in the system. This was a response to the balance of payments experiencing its first net capital outflow since 1998, the RMB moving towards equilibrium and the European sovereign debt crisis causing turmoil on the global financial market. These factors caused the inflow of foreign exchange to decline, which again called for less interventions in the exchange rate movements, and so the growth of RMB holdings fell more than 2 trillion CNY compared with the previous year (PBoC, 2012). In 2015 and 2016 the liquidity needs and supply in the banking system was very uncertain and volatile. This was due to several factors causing opposing effects, such as changes in the RMB expectations, The Federal reserve`s interest-rate hike, large issuances of government debt, volatility in stock markets and IPO`s. PBoC ended 2015 and 2016 with net withdrawals of 60 and 245 billion CNY, mainly through repos and issuance of t-bills.

As we can see, the PBoC uses OMOs regularly, and as of 2016 it introduced the opportunity to use them every day during the week. However, during recent years, another instrument called reseve ratio requirements has also become broadly used by the PBoC, often as a substitute or a complimentary for the OMOs.

3.1.3. Reserve Ratio Requirements (RRR)

The commercial banks are required, by the central bank, to have a certain amount of cash “at hand” at any time. This amount is determined as a ratio of the total deposits held by the bank, and are called the reserve ratio requirement (RRR). The RRR is set to guarantee that the commercial banks are able to meet the money requirements when depositors withdraw money. (PBoC, 2008) In China, the required reserves are deposited in the PBoC. By adjusting the ratio, the central bank influences how much money the banks can lend out, and subsequently it influences the money supply (PBoC, 2008).

Even though the PBoC introduced some form of minimum requirements in 1984, it did not start to use it regularly as an instrument before 1998. Geiger (2008) points out some distinct features of the Chinese RRR. For instance, the minimum requirements and

excess reserves are subject to interests. During the 1990`s, when interests on reserve deposits was very high, some banks chose to pile up high reserve deposits in the PBoC rather than to fund risky projects. Also, in 2004, the PBoC introduced a differentiation system that assessed required ratios based on indicators of financial performance. This incentivized the banks to increase efficiency, giving well performing institutions low required ratios so they had better capacity to lend out and accept deposits.

Reserve ratio requirements in China: 1997-2016		
Year	**RRR**	**Change**
1997	13,00%	-
1998	8,00%	-5,00%
1999	6,00%	-2,00%
2003	7,00%	1,00%
2004	7,50%	0,50%
2006	9,00%	1,50%
2007	14,50%	5,50%
2008	15,50%	1,00%
2010	18,50%	3,00%
2011	21,00%	2,50%
2012	20,00%	-1,00%
2015	17,50%	-2,50%
2016	17,00%	-0,50%

Figure 14. Reserve ratio requirements in China (1997-2016).
Source: Bloomberg.

From figure 14 we can see that PBoC has used the RRR actively as a monetary instrument. Especially in the period 2006-2012, it made changes every year except in 2009. The changes have mainly been increases of the ratio to sterilize the liquidity increase and maintain the money making creation power. The increases have also made funding through bank debt harder, causing an increasing demand in the shadow banking market. In the later years, the PBoC has reduced the RRR to adjust liquidity in the banking system and to fill the long term liquidity gap due to a decrease in net purchases of foreign exchange (PBoC, 2015, 2016).

3.1.4. Capital control

This instrument controls the in- and outflow of capital by foreign and domestic investors. Geiger (2008) categorizes it as a quantitative-based instrument, and describes its goal as *"the quantitative limitation and guidance of financial flows between China and*

the rest of the world". It is particularly interesting to analyze in light of the exchange rate, as it is part of the impossible trinity discussed in chapter 2.4, and was mainly introduced to keep the RMB pegged to the dollar in the period of 1994-2005. While most advanced economies withstand from using significant capital controls, and with emerging markets following its example, China still use this as a monetary instrument. The State Administration of Foreign Exchange (SAFE), a branch of the PBoC, conducts the capital controls in China.

Just like its interest rates, though not as far in the process, China`s capital flows are undergoing a liberalization, with the goal of being fully liberalized in 2020 (Storesletten, Song, & Zilibotti, 2014). Ever since the start of its economic reformation, China has gladly welcomed foreign direct investments (FDIs), as they tend to cause positive spillover effects and increase productivity, under the right circumstances (Navaretti, 2004). Over the years, different strategies have been used to encourage these types of investments, such as reducing bureaucracy and offering tax rate reductions to foreign invested firms (Prasad, 2016). Other in and outflows of capital have been strictly controlled. Especially the portfolio flows have been heavily regulated by the government, making domestic investors and households unable to diversify their investments. Capital controls have, like interest rates, inhibited the competitiveness in the banking sector by protecting it from the possible entrance of foreign banks (Glick & Hutchison, 2009). Today, the only flow the RMB is fully convertible over is the flow over the current account, for trade transactions, as it has been since 1996 (Storesletten, Song, & Zilibotti, 2014). However, in 2002, the year after China`s accession in The World Trade Organization (WTO), it introduced an investment scheme aimed at further liberalizing portfolio inflows to the country. The "Qualified Foreign Institutional Investors" (QFII) programs allowed foreign investors to buy bonds and stocks on the Chinese market. Four years later, in 2006, a similar program called the "Qualified Domestic Institutional Investors" (QDII) was launched, giving domestic investors access to foreign capital markets (Storesletten, Song, & Zilibotti, 2014). As liberalizing as this may seem, the programs were highly regulated by reporting requirements, quotas and different restrictions. The QFII was also restricted to foreign currency trades only, something that was further liberalized in 2011 through the introduction of the "RMB Qualified Foreign Institutional Investor" (RQFII), that allowed foreigners to trade in RMB. Glick &

Hutchison (2009) argues that the QDII program, along with relaxed restrictions on foreign currency conversion by domestic citizens, was a result of the appreciation pressure the RMB experienced after the de-pegging in 2005.

Another form of flows that China has kept under strict regulations, and given little focus, is the issuance of external debt. As of 2013, its external debt represented only 13% of GDP (Prasad, 2016). In comparison, The US and Germany had external debt to GDP ratios of 97%[17] and 159%[18] in 2016, respectively. Witnessing other emerging countries, such as the "victims" under the Asian Crisis, suffer from large external debts, China has discouraged its corporations from raising funds through foreign lenders (Prasad, 2016). This subsequently enhances the motives for shadow banking activities and reduces competition and incentives to increase efficiency in the Chinese banking sector.

In 2014 and 2016 China further liberalized the portfolio flows through the establishment of the Shanghai and Shenzhen-Hong Kong stock connect. The connect allows foreign investors to trade through brokers on the Hong Kong Stock Exchange. These connects are far less regulated than the previous GFII, QDII and RQFII, though trades are restricted to a determined amount of stocks with a predetermined daily and total cross border quota (Prasad, 2016).

The asymmetric capital controls conducted by China, favoring inward FDIs and highly regulating outward FDIs and in- and outflow of portfolio investments, can be reflected in economic data. He et al. (2012) finds that as of 2010, stock of inward FDI amounted to 25% of GDP, which is slightly below the average for open economies of 33%, while the stock of outward FDIs and in- and outflow portfolio investments amounted to a mere 5% of GDP. The effect of the capital control is also reflected through analysis of the deviation of covered interest parity (CIP), which would result in an arbitrage opportunity and thus cause short-term exchange rate movements, unless capital controls prevented it. When analyzing the effectiveness of capital controls in China, Shu et al. (2008) found that during the period of 1999-2007 CIP deviated significantly. However, despite the broad use of capital control, some flows appear to go «under the radar», causing short-term changes in the exchange rate. One argument is how the "hot

[17] Treasury TIC Data, 2017
[18] Deutsche Bundesbank, 2017

money" flows tend to move according to speculations of RMB appreciation and carry trade opportunities. Another one, is the change of domestic foreign exchange holdings in Chinese banks, that tend to increase with expectations of an appreciating RMB and decrease with expectations of the opposite (Glick & Hutchison, 2009).

China may have eased controls on cross-border transactions, but few if any flows are free of restrictions, halting the RMB`s potential as an international currency. For instance, without more liberalized capital accounts[19], China will have a hard time developing its foreign exchange market. Following decades of pledges to fully liberalize its capital account, China has made a change of direction in the recent years. In April 2015, the governor of the PBoC argued, in a meeting at the IMF, that the meaning of capital account convertibility had changed after the global financial crisis, and that China no longer was working towards the regular concept of free or full capital account convertibility. He stated that China would rather aim for a managed convertibility, and conduct capital control in four cases. First, they will monitor cross-border capital flows to detect misconducts. Second, they will keep regulating the issuance of external debt by banks and corporations. Third, they will control short-term flows of a speculative character that may influence financial stability. Fourth, they will strengthen the monitoring of balance of payments statistics to be able to use temporary capital controls in response to abnormal market fluctuations, or critical balance of payments changes. (Prasad, 2016)

3.2. Summary

With the aim of opening its economy to the rest of the world, China is gradually making progress in liberalizing its economy to make it more market oriented. The gradual liberalization of the interest rates has made OMO`s and RRR more effective in adjusting liquidity in the money market, and capital floats more freely with the aim of being liberalized completely by 2020. However, years of multiple controls and restrictions, mostly favoring SOEs, have prohibited China´s financial system from developing. The underdeveloped system makes it hard for domestic companies to raise funds and finance investments domestically, while capital controls on the other hand, makes it

[19] IMF`s definition of Capital Accounts: Capital Account = Capital account + Financial Account

hard to raise funds or finance investment through foreign sources, resulting in the growth of the shadow banking market.

For China to further integrate in the global economy, it is dependent on a solid and independent monetary policy framework aimed at the domestic economy. Despite the positive development over the analysis period, the monetary policy is still held back by a managed exchange rate regime, and an immature financial system unable to fully transmit the effects from monetary policy measures (Parsad & Zang, 2014, p.194). From the theory of the impossible trinity we know that independent monetary policy comes at a high price for the Chinese government, which is, letting go of exchange rate controls, or completely disrupting the liberalization process of the capital controls. However, despite the 2020 milestone, risks of increasing outflows causing volatile capital markets, suggest that the liberalization of its capital accounts should be conducted carefully, with the support of a well-developed financial system. Thus, China should be in no hurry to fully liberalize its capital flows. As for now, with the gradually widening of the exchange rate band, China seems to be experimenting with partly liberalizing all sides of the impossible trinity.

Part 3. Exchange rate assessment – Case study

4. Balance of Payments

The following chapter explains the concept of Balance of Payments (BoP) and its effect on the currency. It is the first out of four chapters that aims to contribute with a sub-conclusion to whether the CNY/USD is fairly valued. The sub-conclusion will be based on an analysis of the China`s BoP development, future outlook, and its relationship with the internal and external balance of the economy. It will also lean on a comparison with the US BoP and the Chinese trade relationship with the US.

Economic literature normally divides BoP into current and capital account, while the IMF, further divides the capital account into a capital account and a financial account. Because all the BoP statistics are gathered from the IMF, we will use IMF`s definition in this analysis. The statistics is gathered from IMF`s "analytic" presentation[20].

4.1. Concept

A country`s BoP is a summary of its economic transactions with the rest of the world. More accurately, defined by the IMF as *"a statistical statement that summarizes transactions between residents and nonresidents during a period"* (IMF, 2013, p.9). The current account shows the difference between exports and imports of goods and services and the difference between received and distributed primary and secondary income. The capital account balances international capital transfers and acquisitions or disposals of nonfinancial and non-produced assets. Last, the financial account shows the difference between net acquisition of financial assets and net incurred financial liabilities. As the BoP follows the double entry bookkeeping principle the sum of the current and capital accounts should always equal the financial account. Intuitively, the sum of the balances of the current and capital accounts will represent a country`s net lending or net borrowing with the rest of the world, dependent on if it is a surplus or a

[20] See appendix, 1

deficit respectively. The financial account will on the other side of the equation explain how the net lending or borrowing is financed[21]. (IMF, 2013)

In our analysis we will limit our focus to the Current Account (CA) and the Financial Account (FA). The argument for excluding the capital account is that it holds insignificant values in China`s and the US` BoP with no magnitude to affect our conclusion in any way.

As the BoP is based on the double bookkeeping principle, there should be an inverse relationship between the CA and the FA. This means that a surplus on one account should be compensated for by a relatively equal deficit on the other. Thus, if a country is running surpluses or deficits on both the CA and the FA, it may be an indication that it is manipulating its currency (Eiteman, Stonehill, & Moffett, 2016).

The BoP and the domestic currency are strongly connected. IMF uses the CA as a key factor when assessing real exchange rates through the External Balance Approach. The relationship between a country`s exchange rate and its BoP is mutual. Meaning that you can alter the exchange rate to adjust your BoP, and the BoP will theoretically, especially in the medium to long term, adjust the exchange rate. How they will affect each other depends on the exchange rate regime.

Hard or soft peg regimes

As explained earlier, a currency managed by these types of regimes, is either pegged to or managed in relation to some foreign currency, or a basket of foreign currencies. Thus, the government must intervene to keep its currency at the right value. If the balance of the CA adds up to a deficit, there will be an excess supply of the domestic currency in the world money market. To keep its currency from depreciating, the government must use its foreign reserves to buy back its own currency, and guide the BoP into balance. The opposite is the case when the CA is at a surplus. Another alternative is to affect the exchange rate and BoP by motivating market activity through monitary policy instruments. By changing the domestic interest rate, capital in- and outflow will adjust the BoP and the exchange rate. If a country experiences a CA deficit, it can support its currency by raising the domestic interest rate and attract capital inflow, and eventually

[21] See appendix 2

guide the BoP into balance. This type of intervention will only work with free capital flow, and in theory contradicts the impossible trinity.

Floating exchange rate regime

Under this regime, the exchange rate is solely determined by market forces. Thus an imbalance in the BoP will theoretically, in the long run, drive exchange rates up or down to create balance. Let us explain the market powers through an example of a CA surplus. High exports produce an excess demand of domestic currency on the international money market. As economic theory suggest, excess demand of something increases its value, and with no intervention from the government, the domestic currency appreciates. This increase in value makes export less competitive as foreigners must pay more for the goods and services. In contrast, importers will now pay with a more valuable currency and imported goods and services will become cheaper. This shift will eventually drive the BoP in to equilibrium.

When analyzing the development of the BoP it is important to have in mind that, even though economic literature often characterizes external equilibrium as a CA in balance[22], this does not always have to be the desired state. In an open economy, we find the relation; domestic savings (S) = CA + domestic investment (I). By rearranging the equation, we can analyze the CA = S – I. Emerging economies often run CA deficits because its domestic savings is too small to cover all profitable investments. So, other developed economies with CA surpluses that find these investments more profitable than their own domestic investments, finance this deficit with their own capital. This is an example where different economies benefit from a non-balanced CA (Eiteman, Stonehill, & Moffett, 2016).

4.2. China's historical BoP

From figure 15 we can see that China has run a surplus on both the CA and the FA for 17 years, only offset by a slightly FA deficit in 1998 and 2012, which is a remarkably long period. The drivers behind China`s abnormal BoP values has been widely discussed among economists, and a rather common interpretation is that the twin surpluses is a combination of an export oriented trade policy and the savings gap.

[22] CA balance: Export – Imports = 0

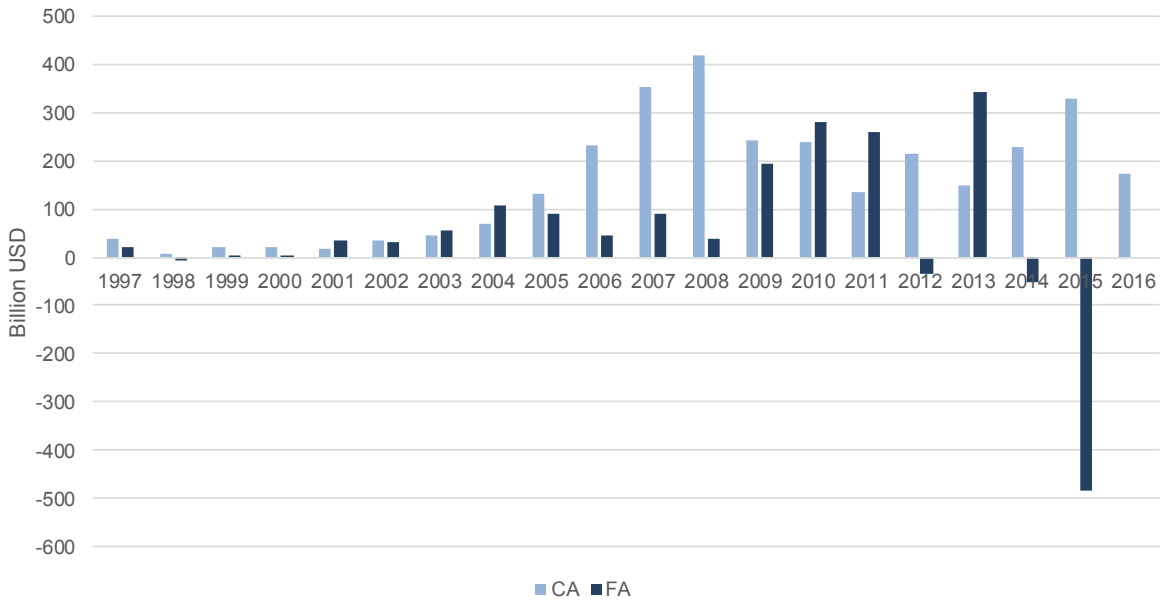

Figure 15. Balance of payments, China.

FA numbers from analytic presentation for 2016 was not available for the study

Source: Various Balance of Payments Statistics yearbooks (2000-2015) and AllThatStats.

Even though China escaped the Asian crisis relatively unharmed, its CA and FA surpluses fell during that period. In 1998 the FA even fell to a deficit. This may come from the reduced exports to fellow Asian countries that experienced a rapid decrease in its currency values compared to the USD-pegged RMB, during the crisis. By joining the World Trade Organization (WTO) in 2001, China communicated its willingness to adapt and take part in world trade on more fair terms, as it was forced to remove a bundle of trade barriers, placed both by itself for protectionism and by the West for sanction reasons. Following the admission, the CA started growing rapidly every year until it peaked in the wake of the financial crisis in 2008. Notably, between 2005 and 2008 the CA surplus grew by more than an astonishing 200%. Anderson (2008) and Corden (2009) have analyzed this exceptional growth, and points out two main factors. The trade balance started growing as export growth accelerated while import growth abated even more in comparison. Anderson (2008) explains this sudden drop in import growth as a result of investments in heavy industrial products made in the early 2000s. These investments were made as an answer to an increasing demand for such products. While Corden (2009) adds that it had also been a constant increase in the productivity of labor-intensive export sectors. The second point, made by Anderson (2008) was that

during 2002-2006 the savings rate grew by a mere 10% of GDP, mainly in form of corporate savings.

The FA account also had a positive growth after China joined the WTO. The opening of China`s economy made foreign investors more positive towards placing its money in China. With the solid growth China started to experience, it became an attractive destination to invest money. China had introduced reforms as early as in the 70`s, that incentivized local government officials to attract FDI (Yongding, 2012). This has caused the capital inflows to grow, and the twin surplus started accumulating large amounts of foreign exchange reserves, which will be discussed in the next chapter. However, unlike the CA, the FA did not continue this extreme growth pattern in the years following the liberalization of the RMB in 2005, when China switched to a less rigid exchange rate regime.

In 2008 the financial crisis struck the global economy. China`s exports were hit hard and to dampen the effect, it once again pegged the RMB to the USD, keeping it pegged until 2010. Regardless, the CA almost halved during the following year and continued to fall gradually until it reached its lowest surplus since 2005, in 2011. IMF points out several reasons for the decline in the CA since the financial crisis in 2008, such as the appreciation of the RMB, slower growth in advanced economies, worsening of trading terms, and a high growth in domestic investments. In recent years the CA has experienced a modest growth despite a fall in exports. The boost has come from a compression of imports partly caused by lower commodity prices and lower imports of investment goods. (IMF, 2015)

In contrast to the CA, the FA grew following the financial crisis until a sudden shift in 2012, when China had its first FA deficit since 1998. This deficit reflected a change in exchange rate expectations as well as increased global risk aversion (IMF, 2013). A reduction in FDI`s in emerging markets may also have augmented this effect (IMF, 2013). The following year, the FA bounced back up to a sufficient surplus due to high real return on capital and expectations about RMB appreciation (IMF, 2014).

In the years following this boost in the FA, China has experienced a growing deficit, reaching the lowest point of the analysis period in 2015. This sudden net financial

outflow, measuring a mere 6% of GDP, was a result of multiple factors such as reduced exports, uncertainties around China`s future growth, the relative returns on RMB denominated assets, the directions its policy was taking and the down payment of external debt.

As mentioned above, China`s BoP development can be explained by two different effects. First, the government has driven an export-oriented policy by imposing barriers on imports and keeping the exchange rate artificially low. Second, the savings gap, caused by a high national savings rate. This high savings rate, which since 2006 has been fluctuating around 50% of GDP, is said to be caused by the lack of social security offered by the government, after the shift to a more privatized and liberalized economy (Krugman, Obstfelt, & Melitz, 2015).

The twin surplus China has experienced for such a long period is unique, but not necessarily optimal for its economy. As Yongding (2012) argues, it makes no sense for a developing economy to lend out resources to rich economies, as the developing economy should use these resources to finance domestic investments with high returns. This is exactly what happens when a country runs a CA surplus. A developing country should, in theory, run a CA deficit financed by a FA surplus. When China runs a twin surplus, it borrows money through the FA surplus, and lends the money back to the original creditors. This way of organizing the economy creates significant welfare losses, as China borrow foreign money for high yielding domestic investments, while lending back foreign money from exports to low yielding investments, such as US Government securities. The World Bank and the US Conference Board estimated that for 2008 multinational investments in China generated a return of 22%, and 33% for US investments in China, while China earned a simple 3% return on its investments in US Government securities.

In the latter part of the analysis period, China has moved away from the twin surpluses to more sustainable BoP levels, even running a negative overall balance in 2015, for the first time in over two decades. However, Chinese authorities expect the outflows to moderate in 2016, as a result of decreased external debt levels and a better understanding in the market as to how the more market oriented and flexible exchange rate regime works. (IMF, 2016) Further, we see that the CA fell in 2016 compared to

2015. China is making progress in rebalancing its economy, and external imbalances are evening out, as can be seen from the BoP development over later years. However, growth contribution from exports has been relatively low since the global financial crisis, recently fluctuating around zero, which made China turn to investments in pursuit of growth. Thus, internally, the rebalancing aims to switch the economy from investment to consumption driven and from industry to service driven. It also aims to diversify its investments by selling of some of its low yielding positions and increase more high yielding investments such as outbound foreign FDIs (IMF, 2016).

4.3. Future Outlooks

Looking forward, IMF predicts weaker external demand to drag exports down and an increase in outbound tourism to raise the service deficit, causing a raise in imports up. Further, it predicts the deficit on primary and secondary income balance to stay at its current level (IMF, 2016). Looking at its 13th five-year plan, we can see that China`s own views are in consensus with those of IMF. As the world`s leading exporter, further increasing exports in line with a slowing global growth would be a hard task to manage. Thus, briefly mentioned above, China is further extending the work on rebalancing its economy, shifting from an external demand and investment-driven to a domestic consumption-driven economy. A consumption-driven economy demands less industry heavy goods, and more service and consumer goods. Thus, secondary and tertiary industries will grow relative to primary industries. This will create more labor-intensive work places and general wealth and disposable income will increase, which again will lead to higher household consumption and contribute to a more sustainable long term growth. With the desirable growth in consumption, savings and investments are expected to fall. By looking at the relationship CA = S-I, the two variables should decrease in a relatively equal pace, to keep a stable CA. The investment level is expected to fall in response to diminishing returns in a slowing economy. Government saving is expected to fall as China aims to build a better social security system, by increasing expenditures on healthcare and education. This again creates less need for households` precautionary saving, lowering national savings in general. In addition, Chinas aged dependency ratio[23] is expected to increase over the next 15 years. Grigoli, Herman, &

[23] $Aged\ dependency\ ratio = \frac{number\ of\ people\ aged\ 65\ and\ over}{number\ of\ people\ aged\ 15-64} x100$

Schmidt-Hebbel (2014) find that a one percentage point increase in the ratio cause a 0,4 to 1 percentage point decrease in the savings rate.

Based on these factors, we expect the CA to remain in a moderate surplus, and decrease further within the next five years. However, volatility in the CA may occur if the rebalancing process happens unevenly. For instance, if a fall in the savings rate fail to occur due to insufficient development of social security systems, or less sensitivity to an aging population, while the investment rate falls as expected, growing CA surpluses would occur, with excess savings exported to foreign destinations. On the other hand, if saving rates drops faster than expected due to the aging population, or more efficient development of social security systems than expected, while China keep boosting growth with excessive investment, its CA will fall to a deficit. To finance this deficit, it would have to import foreign capital, which might become difficult, as returns on investments most likely would fall further.

The first quarter of 2016 ended as 2015 ended, with FA deficits larger than CA surpluses. IMF predicts that the FA will remain in a deficit position briefly in excess of the CA surplus over the next 5 years. It states that the liberalization of the capital controls will lead to increased flows, both inward and outward. (IMF, 2016)

The development of the BoP we are seeing should continue in the forthcoming years and we do not expect to see any Chinese twin surpluses in the near future. The more balanced values on the BoP will end the accumulation of foreign exchange reserves and ease the appreciating effect on the RMB.

4.4. US BoP

The US and China`s BoPs are similar in the extreme values, but in contrast to China, the US has been a net importer, running substantial CA deficits over larger parts of the analysis period. As we see from figure 16, the CA and the FA have an inverse relationship. This is in line with the double bookkeeping principle of the BoP accounts, and shows us that the US finance its large CA deficits with equally large FA surpluses. The US has no periods of twin surpluses over the analysis period, which is no surprise as the USD is subject to a free float regime.

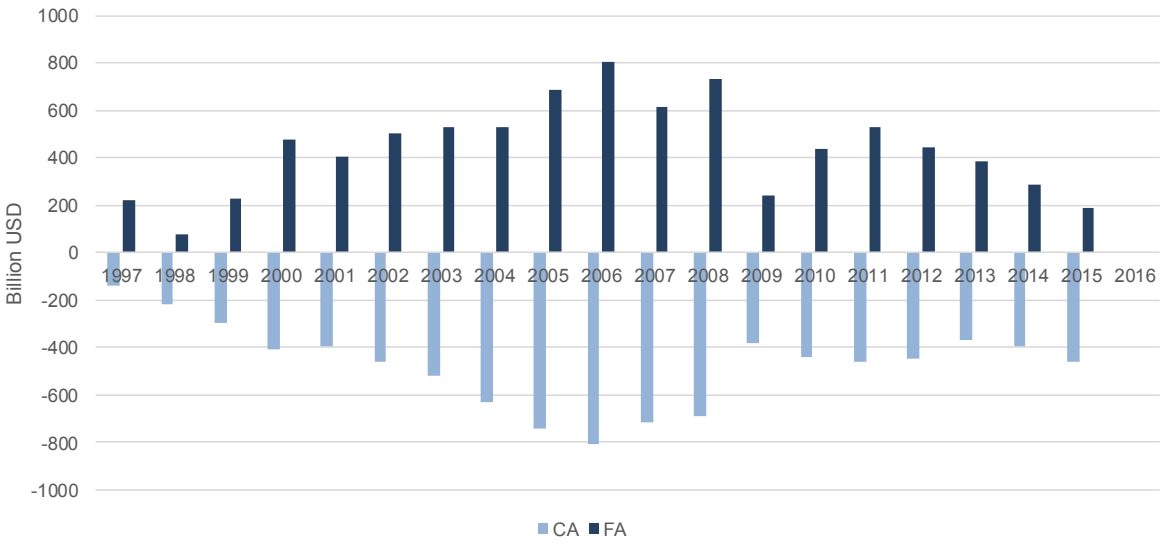

Figure 16. Balance of payments, USA.

Source: Various Balance of Payments Statistics yearbooks (2000-2015) and AllThatStats.

The large and persistent US CA deficits has been a hot topic of international economic discussion over the last decade, resulting in suggestions of protectionism measures by the US, in particular directed towards China. However, some economists argue that the inflow of foreign capital to the US are driven by the need to cover the S-I gap, rather than financing imports, and that these inflows are the main determinant of the international value of the USD. The large capital inflows over the FA appreciate the USD, worsening the competitiveness of US exports, increasing the CA deficits. The Congressional Research Service supports this argument by pointing to the recent fall in oil prices. It argues that, since the US is a large oil importer, the steep fall in the oil prices should reduce the deficit on the US trade balance. Even though the average annual price of imported oil declined along with the ratio of imported oil to total trade during 2014 to 2016, the CA deficits rose as the oil imports was substituted with a larger amount of non-oil related import. (Jackson, 2016)

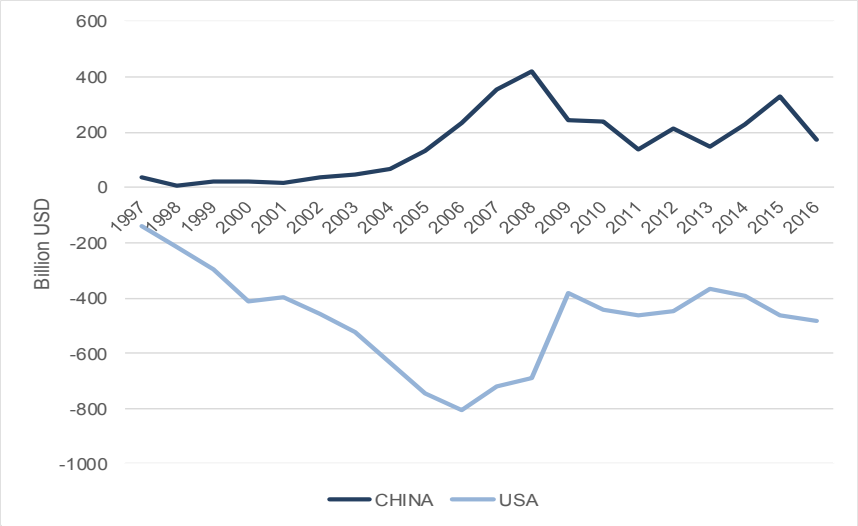

Figure 17. Current account, China and USA.

Source: Various various Balance of Payments Statistics yearbooks (2000-2015) and AllThatStats.

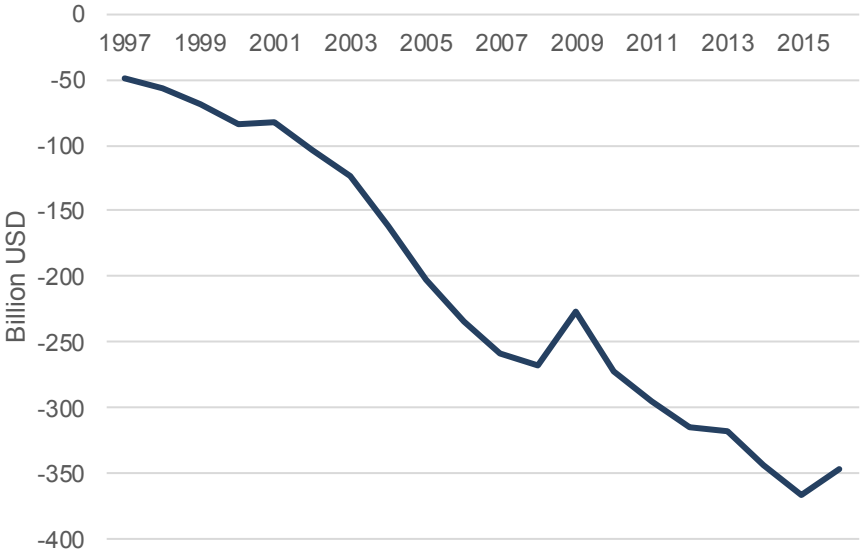

Figure 18. USA`s traded goods balance with China.

Source: United States Trade Representative.

Nonetheless, China is the US largest trading partner and over the entire analysis period, the US has imported more Chinese goods than it has exported US goods to China, and the growth of the deficit has been astonishing. In fact, the total growth of imported goods from China has been 382% from 2000 to 2015. Certainly the CA deficit consists of more than trade in goods, but this is where the momentum lays. For instance, the US export more services to China then it imports from them, but the surplus on the service trade

balance of 29,5 billion USD in 2015 is far from enough to offset the goods trade deficit of 366 billion USD the same year[24]. (United States Trade Representative)

On the other side of the balance, we find the relationship over the FA. Indeed, the US invested 56,3 billion USD more through FDI in China, than China invested through FDI in the US, in 2014. However, since the US run such large deficits on its CA, it has to finance this over the FA. With China`s desire to accumulate large amounts of foreign exchange reserves, it has become a large investor in US assets, particularly in US government bonds and treasury bills. Only recently surpassed by Japan, China was the largest holder of US debt[25]. This means that the US sends dollars to China through imports and finances these imports with dollars through the issuance of government bonds and treasury bills to China.

The IMF predicts US CA deficits to increase moderately from the low point in 2014 (IMF, 2016). However, based on the rebalancing of the Chinese economy, we assume that the deficit on the US trade balance of goods with China will continue to decrease over the next five years, as China moves its focus away from exports towards consumption and as costs on Chinese labor increase. We also expect the surplus on the US trade balance of services with China to increase over the next five years, as a result of a growing Chinese middleclass, more outbound tourism and the shift towards consumption driven growth.

The FA surpluses are expected to rise with the increased deficit in the CA, creating balance between the two accounts (IMF, 2016). Even though China has started selling of dollar denominated assets, the US dollar`s status as a safe haven and reserve currency continues to increase the foreign demand for US treasury bonds, assuring the US with cheap funding. The liberalization of the Chinese capital account should increase private capital inflow from China, by investors looking to diversify its portfolios.

4.5. Subconclusion

The development of the Chinese BoP over the period has been astonishing. No other countries in recent time can refer to similar behavior with twin surpluses over such a lengthy time. This is partly reflected by the unique growth China has experienced,

[24] Primary and secondary income balance between the two countries was not available.
[25] Dep. of the Treasury/Federal Reserve Board. (2017)

tempting investors with positive prospects, causing large inflows of capital into the country, making them both a net supplier and a net lender of capital on the international market. Economists and researchers has pondered over what the effects have been and will be, and if such an imbalance is favorable for China. Yongding (2012) argues that the twin-surpluses represents a huge misallocation of resources and that it is in China`s best interest to correct it.

For a country to sustain that many successive years with twin surpluses, it would have to intervene with the currency value to keep a competitive advantage. As we know from market theory, CA surpluses should appreciate the domestic currency. From July 2005, the PBoC let go of some control of the CNY, which is reflected through the appreciating effect the currency experienced relative to the USD in the years that followed. However, the CA surpluses kept rising, despite the appreciation, until the financial crisis struck the world economy and the CNY again was pegged to the USD until mid-2010. This development points towards an undervalued currency during large parts of the analysis period. Nonetheless, we base our assessment on the following:

- Recent years' development in the BoP with expected negative balances in the future.
- The ongoing and far from completed rebalancing process pointing towards lower CA surpluses.
- IMF`s prediction on a continuing trend of higher imports and abating exports as well as continuing deficits on the primary and secondary income balance, also pointing towards lower CA surpluses.
- The depreciation of the CNY against the USD over the last two years, despite increased US CA deficits.

Given the abovementioned factors, we find it fair to assume that the RMB is fairly valued in terms of USD.

5. Foreign exchange reserves analysis

By running consequtive BoP surpluses the RMB has been subject to upward pressure, while foreign exchange reserves have accumulated to record heights, giving China plenty of ammunition to intervene in the foreign exchange market. This chapter explains the concept of intervention, what motives a country has to intervene and the mechanisms behind intervention. It is the second out of four chapters that aims to contribute with a sub-conclusion to whether the CNY/USD is fairly valued. The sub-conclusion will be based on an analysis of how China has used its foreign exchange reserves to intervene in the foreign exchange market over the last two decades.

5.1 The mechanisms of intervention

Foreign exchange reserves are foreign currency denominated assets held by the country`s central bank. These reserves are used by the central bank as a tool in the country`s monetary policy and can be used to affect the domestic currency. The most common reserve currencies are US Dollars (USD), the British Pound Sterling (GBP), the Euro (EUR), the Renminbi (CNY) and the Japanese Yen (JPY) (IMF, 2017). As reported to IMFs Composition of Foreign Exchange Reserves (COFER) at the end of 2016, the worlds foreign reserves are composed as follows:

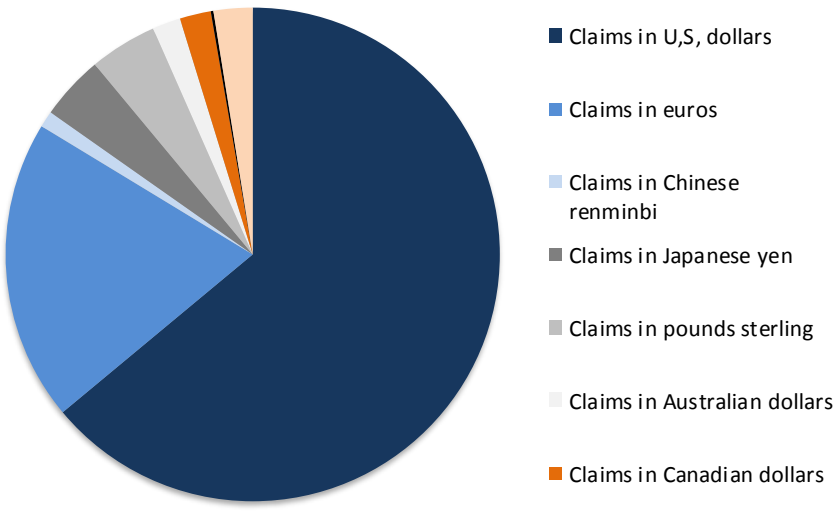

Figure 19. Composition of foreign exchange reserves in the world (2016).

Source: IMF, 2017.

Reserves here are defined as: banknotes; bank deposits; treasury bills; other short- and long-term government securities; and other claims usable in the event of a balance of payments need (IMF, 2017, ¶5).

The central bank can use its foreign exchange reserves to affect the supply and demand of its own currency by either selling or buying domestic currency against foreign currency. If the central bank wishes to raise the value of the domestic currency, it can use its foreign exchange reserves to purchase domestic currency. This will increase the demand of the domestic currency and have a strengthening effect on the currency. A strengthening of a currency can either result in an appreciation or have a mitigating effect on a depreciation of the exchange rate. If the goal is to depreciate or lower the effect of an appreciation of the domestic currency, the central bank can buy foreign currency by selling its domestic currency to increase the supply. Alternatively, it can accumulate foreign currency from exports instead of exchanging it into domestic currency. This use of foreign exchange reserves is called intervention and is especially important in economies with a fixed exchange rate regime, as they have to control the exchange rate to maintain the fixed rate.

5.2. Motives for intervention

To affect a currency through exchange rate intervention can serve several purposes which Bank of International Settlements (BIS) groups as follows (BIS, 2015):

- *Leaning against the wind:* When a currency is either appreciating or depreciating, intervention can be done in order to mitigate this trend. As when the RMB had an appreciating trend after moving away from the fixed exchange rate regime, the central bank intervened by accumulating reserves to slow down the appreciation of its currency. According to a survey on central banks done by BIS, leaning against the wind is the most common reason for intervening in emerging markets (BIS, 2005).
- *Reducing exchange rate misalignment:* If a currency appears to be under- or overvalued, a central bank might intervene to reach an equilibrium value of the currency. Having an overvalued currency will make export goods more expensive and therefore weaken the country´s competitiveness. On the other hand, an undervalued currency will for example make import goods relatively more expensive and can further lead to inflation. Because it is hard to detect the exact equilibrium of an exchange rate, it makes it difficult to distinguish between manipulation and adjusting for an under- or overvalued currency. This has lead

to accusations concerning manipulation of currencies, especially towards China´s use of reserves over the last years.

- *Managing or accumulating foreign exchange reserves:* Intervening by accumulating foreign exchange reserves is not necessarily done with the intention to depreciate the domestic currency, but can also be to increase the amount of reserves in the country. In case of future needs to intervene, having large reserves will make the country better prepared. After the Asian financial crisis in 1997, many Asian countries started accumulating reserves in order to be precautionary against future unwanted movements in the currency.
- *Ensuring liquidity*: Many central banks intervene by using its foreign exchange reserves to dampen volatility in the exchange rate market. This can be beneficial to reduce fluctuations in capital inflows due to rapid exchange rate movements, for example during financial crisis or other stressfull episodes. By supplying liquidity in foreign exchange markets through intervention, central banks also contribute to correction of dysfunctional exchange rate markets. (BIS, 2015)

5.3. How does intervention work in theory?

When a central bank intervenes to affect the exchange rate, this mechanism can work through three different channels (Adler, & Tovar, 2011):

In economies where there is imperfect substitutability between foreign and domestic assets, the intervention can work through *the Portfolio Balance Channel.* When the central bank intervenes, it either buys or sells domestic assets. As the supply of domestic assets changes when the central bank intervenes, the spot rate shifts. This occurs as agents rebalance their portfolios by buying or selling foreign assets.

The Signaling Channel is built on expectations in the market under the assumption that the authorities have superior information, and therefore will reveal this information through its operations. The effect on the exchange rate will then be caused by expectations created by the intervention. Despite this effect, many central banks believe discrete intervention will maximize the impact on the market. With less transparency, the effect through the signaling channel is reduced, as the market cannot observe the intervention. It is therefore expected that this channel will have larger impact in an economy where the central bank has a high degree of transparency and credibility. For

an intervention to have any impact through the signaling channel, the intervention should be done visibly. Another argument in favor of a visible intervention is the avoidance of the noise that can be created by the market as a consequence of uncertainty regarding the monetary policy. In contrast, if a central bank wishes to intervene without affecting the exchange rate, a quiet intervention would be preferable (Canales-Kriljenko, Guimarães, & Karacadag, 2006). The intention behind such an action can be to accumulate foreign exchange reserves without creating expectations in the market exchange rate, as the market cannot observe the intervention as easily. Another reason why a central bank could prefer to do a quiet intervention is to avoid speculative attacks. Individuals and companies will always act to protect themselves from losses or take advantage of possibilities to earn from movements in the exchange rates. Interventions can send signals, which can further trigger speculative attacks on a currency. Thus if a silent intervention is noticed by the market, it can be perceived as if the central bank has failed to hide its actions and interpreted in the wrong way.

The *Order Flow Channel,* often called the *Microstructure Channel* explains how the trading done by the central bank affects the total order flow. The order flow is the net purchase in the foreign exchange market. This channel is, as the signalling channel, built on the assumption that the central bank has superior information. The effectiveness of the intervention can be interpreted by comparing the size of the intervention to the market turnover. The greater intervention compared to market turnover, the higher effect on the exchange rate. Because of this measurement, the mechanisms from the order flow channel will be stronger in developing economies because of less liquid foreign exchange markets. (Adler & Tovar, 2011)

5.3.1. Sterilized intervention

From the The Impossible Trinity we know that a country must forsake monetary policy autonomy or free capital flows if it wants to control the exchange rate. However, in an effort to keep control on domestic money supply it can try to sterilize the intervention through the use of the monetary instruments such as OMO`s and RRR.

If a central bank wants to purchase foreign currency to prevent or mitigate unwandet appreciation on the domestic currency, this can be done in two ways. It can either reduce its net domestic assets or sell domestic currency. When the central bank sells

domestic currency, it increases the domestic money supply, wich may cause unwanted inflationary pressure. To sterilize this increased supply, the central bank may use OMO`s, in the form of repos or the issuing of central bank bills, to subtract money from the open markets, as explained in chapter 3.1.2. Another way to sterilize the increased money supply is to raise the RRR, forcing banks to deposit more money with the central banks preventing excess money from circulating around in the domestic market.

In the case of a desire to sell foreign currency the opposite effects and measures apply. The central bank sells foreign currency in exchange for domestic currency and therby decrease the domestic money supply. Unwanted deflationary preasure may occure, and OMO`s in the form of reversed repos are issued, pumping domestic currency back in to the market, to sterilize the effect. Alternatively, the central bank lowers the RRR, allowing banks to lend out more money

By using monetary policy instruments to sterilize the effect exchange rate intervention has on domestic money supply, China is able to maintain, to some extent, an independent monetary policy despite the management of the exchange rate. However, "escaping" the impossible trinity through sterilization operations comes at a cost. The interest paid by the central bank on bonds and central bank bills are often higher than the interest earned on the foreign exchange reserves, making the use of RRR more common in recent years.

5.4. Currency manipulation or intervention?

Some countries attempt to depreciate its currency with the intention to gain a trade advantage, rather than stabilize its economy. Therefore, the IMF has formed some obligations for the member countries to prevent this kind of exchage rate manipulation. As stated by IMF, all member countries shall:

"avoid manipulating exchange rates or the international monetary system in order to prevent effective balance of payments adjustment or to gain an unfair competitive advantage over other members" (IMF, 1975, p.6)

In other words, countries are expected to maintain an exchange rate that ensures economic growth and financial stability, and not to gain competetive advantages. When

a country manipulates its currency, the actual exchange rate deviates from what is expected without intervention. This does not mean that intervention is tantamount to currency manipulation, but can be used as a tool to manipulate a currency. If a country has a fixed exchange rate regime, intervention can be necessary to maintain the fixed peg and does not imply that the country manipulates its currency.

Over the years, many analysts have accused China of having an undervalued currency. This meaning that China have depreciated its currency more than what is ”necessary”, to gain unfair trade advantages. It should however be mentioned that there is no definite solution of how to detect currency manipulation. Among the many different definitions, the U.S. Department of the Treasury Office of International Affairs has made some criterias of its own for a country to be labeled as currency manipulator (U.S. Department of the Treasury Office of International Affairs, 2016, p.32):

- Significant bilateral trade surplus with the United states
- Material current account surplus
- Persistent, one-sided intervention

Based on these criterias, it does not label China a currency manipulator in the fall report of 2016. For a country to be labeled a currency manipulator, all three of these criterias have to be met. As of fall 2016, China only fullfills the first criterion which makes them unqualified to be labeled as a currency manipulator. This is partly due to the recent development in foreign exchange reserves. China has accumulated reserves for a long period of time but started decreasing its reserves in 2014.

The recent change in use of foreign exchange reserves and development in the Chinese currency has changed some opinions towards the value of the RMB. An article by CNBC states in early 2017 that most outside traders now consider the RMB to be *overvalued*. IMF also announced that the RMB no longer is undervalued in May 2015. This does however not remove the accusations of the manipulation which still is a discussed topic. Earlier, China was accused of keeping the RMB weak, but with its economy internationalizing and changing towards new growth factors, it values a stronger currency. With more people around the world possessing RMB, and now with the RMB as a part of the Special Drawing Right (SDR) basket, China will gain more power in its

decision making. This has risen the question of whether China now manipulate its currency to be artificially *high*.

5.5. Historical movements

Since China decided to open up to the outside world in 1978, China has accumulated large amounts of dollar reserves. As of today, China is by far the country that has the largest amount of reserves in the world (U.S.-China Economic and Security Review Comission, 2014 p.1). The open door policy has caused the trading volume and GDP to grow drastically. From 1978 to 2005, China`s share in the world trade went from 0,8% to 7,7% (BIS, 2008). After the Asian financial crisis occurred in 1997, Chinas accumulation of foreign reserves began to rise drastically, as shown in figure 20.

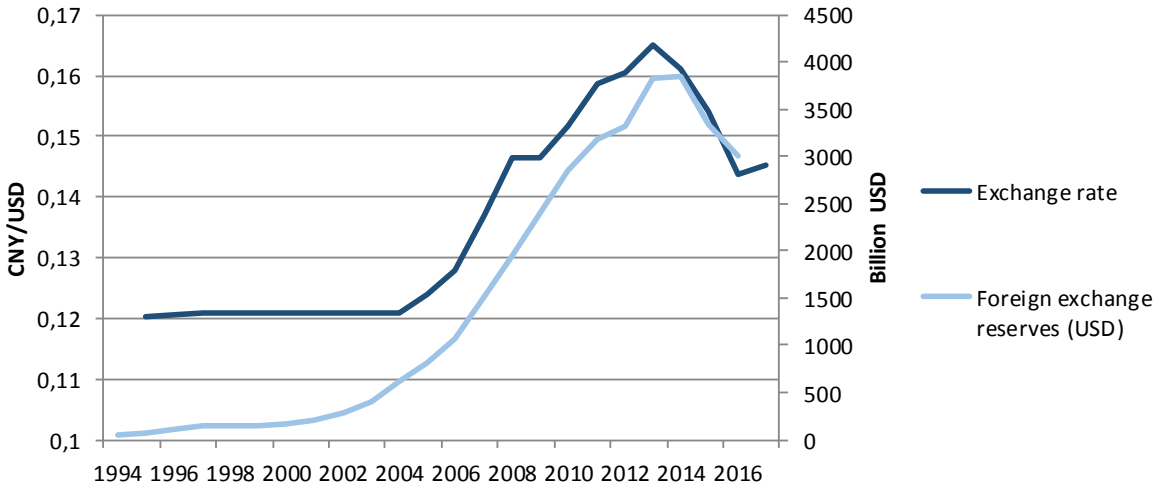

Figure 20. Foreign exchange rate (CNY/USD) and China`s foreign exchange reserves (USD).
Source: Bloomberg.

As the figure indicates, the accumulation of foreign exchange reserves has grown rapidly since 2005, when China in July the same year moved from the former fixed exchange rate regime to a less rigid exchange rate regime with reference to a basket of currencies.

As discussed in chapter 4.2., China`s export-oriented and inward FDI-oriented policy has attracted enourmous amounts of foreign capital thourgh trade and investment, which has contributed to the long period of BoP twin surpluses. As can be seen in figure 15 from chapter 4.2., these consequitve twin surpluses have a strong connection with the enormous growth in China´s foreign exchange reserves. When a country receives more

foreign currency from export and inward investments than it forsakes domestic currency through imports and outward investments, which is the case of twin surpluses, it accumulates foreign exchange reserves, which China has done over a long period of time. Most of the foreign exchange reserves are U.S. Dollars (USCC, 2014), which further is invested into U.S. treasury securities because it is assumed to be a safe investment. As the RMB increased, China continued to accumulate reserves in order to mitigate the appreciation. This accumulation of reserves continued until August 2014 when the reserves reached a turning point. In China`s case, the intervention has caused a reduction in the appreciation of the RMB against the USD. As mentioned earlier, this way of intervening is also called *Leaning against the wind,* which has as an objective to smoothen exchange rate fluctuations. Below, figure 21 shows the relationship between China`s change in foreign exchange reserves in relation to its BoP.

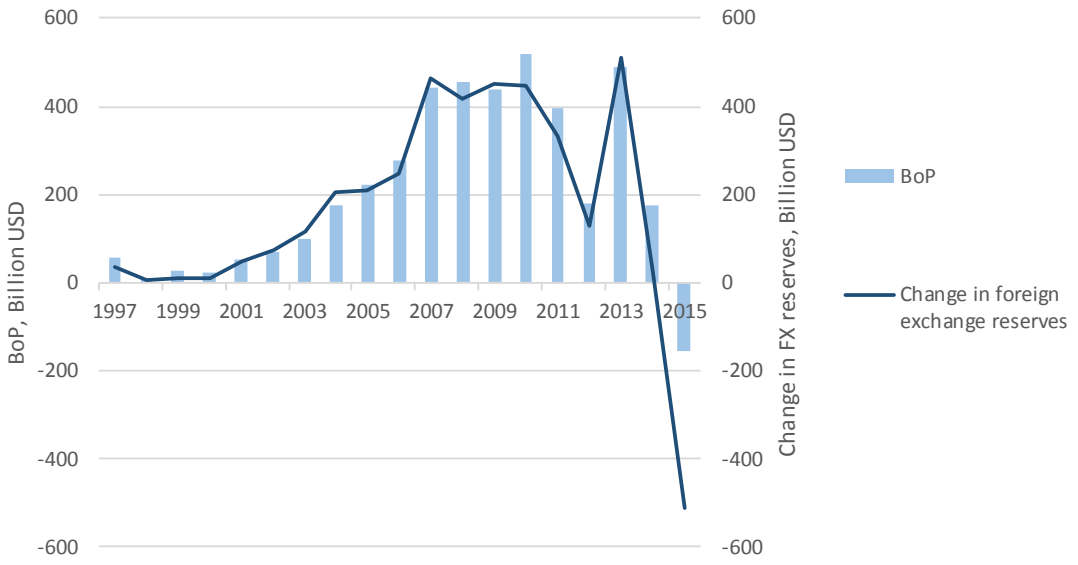

Figure 21. Balance of payments and change in foreign exchange reserves, China.
Source: own calculations based on Bloomberg data.

The Economist states in 2016 that the Big Mac Index estimates the RMB to be undervalued by as much as 46,27% against the dollar. The trade advantages by keeping a low exchange rate cause an increase in China´s GDP. This is in line with its 11th five-year plan that has as an objective to reach an annual GDP growth rate of 7,5% from 2006 to 2010 (NDRC, 2006). In its 13th five-year plan, the GDP growth is targeted at 6.5%

avarage annual growth by from 2011 to 2015 (Central Committee of the Communist Party of China, 2016). These plans may explain the motivation behind China´s efforts to intervene in order to mitigate the appreciation of its own currency. Among others, president-elect Donald Trump, has then accused Chinese government of manipulating its currency to gain competitive advantages through a weaker currency. At a news conference in 2011, former president Barack Obama stated that: "China has been very aggressive in gaming the trading system to its advantage and to the disadvantage of other countries, particularly the United States,"[26] and further acknowledged currency manipulation as an example of it.

Shortly after the widening of the currency band in 2014, the Chinese currency started to depreciate after a longer period of appreciation. The government then went from accumulating to reducing its foreign exchange reserves, by selling of its dollar-denominated assets, in an attempt to mitigate the depreciation of the RMB that appeared after the currency devaluation. During 2015 the reserves went from 3843,02 billion USD to 3330,04 billion USD which equals a decrease of approximately 13,35%[27].

Despite the trade advantages that come with depreciating the domestic currency, a relatively lower exchange rate will also cause costs of dollar-denominated debt to rise. Spending foreign exchange reserves to mitigate the sudden depreciation of the RMB will then prevent these costs from increasing too much. A stronger currency will also make it more attractive as a reserve currency.

5.6. Subconclusion

As this chapter discusses, foreign exchange reserves is a tool used by several countries to intervene in the foreign exchange market. When we study the movements of the RMB over the last two years, we can see that it has depreciated relative to the USD with about 12%. During the same period, the foreign exchange reserves have decreased by about 22%. The reduction in reserves is a result of the PBoC supporting domestic currency by selling off foreign exchange reserves. Considering the magnitude of the decrease in the reserves, the intervention should have had a significantly mitigating effect on the depreciation of the RMB, and can indicate that the currency has been manipulated. Thus,

[26] Reuters.com
[27] Own calcultions based Bloomberg data

we assume that the recent depreciation of the RMB would have been greater given absence of intervention lead by the PBoC, and thereby conclude that the RMB is *overvalued*.

Part 4. Exchange rate assessment - Econometric analysis

6. Methodology

In addition to our case studies in part 3, we wish to do a time series regression on a multiple linear regression model using an ordinary least squares procedure in SAS[28] to estimate how, and if, a carefully selected combination of variables affects the RMB. In relation to this, this chapter will present the theory behind four statistical tests done to obtain a model with reliable results.

6.1. Multiple regression model

The purpose of the multiple linear regression model is to provide an output which estimates if each explanatory variable has any impact on the dependent variable or if the coherence is purely random. The results will also give an indication to what degree each explanatory variable does affect the dependent variable. The linear regression model can be written as follows:

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \cdots + \beta_k X_{ki} + u_i$$

(Gujarati, 2012)

where Y=dependent variable, β_1 *=constant,* $\beta_{2,3\ldots k}$ *=coefficient, X=explanatory variable, i=observation, u=error term*

Our regression analysis tests the following hypotheses:

H_0: *None of the variables have any significant impact on the independent variable.*
$\beta_j = 0$

H_1: *One or more of the independent variables have a significant impact on the independent variable.*
$\beta_j \neq 0$

[28] Statistical Analysis Software

Before regressing our variables and interpreting the result, we will do four statistical tests based on the assumptions of the classical linear regression model (CLRM).

6.2. The classical linear regression model

According to Gujarati and Porter (2009, p. 61.), the classical linear regression model (CLRM) is built on seven assumptions. When these assumptions are fulfilled, the ordinary least squares estimators (OLS) are also BLUE (best linear unbiased estimators) according to the Gauss-Markov theorem. The OLS method is a common approach to estimate the coefficients in a regression. This method estimates the coefficients that *minimize* the error sum of squares (ESS).

The CLRM model assumes the following:

1. The regression model is linear in the parameters.
2. The independent variables are fixed in repeated sampling.
3. Given all the independent variables, X, the conditional expectation, or mean, of the error term is equal to zero.
$$E(u_i ! X) = 0$$
4. The error term in the regression has equal variance (homoscedasticity) across all observations.
$$var(u_i ! X) = \sigma^2$$
5. No autocorrelation, meaning no correlation between two error terms.
$$cov(u_i, u_j ! X) = 0 \qquad i \neq j$$
6. No exact relationship among the independent variables. In other words, no multicollinearity.
7. Number of observations is higher than number of estimated parameters.

(Gujarati, 2012, pp. 8-9)

With an additional assumption of normal distribution, the CLRM will be normal classical linear regression model (NCLRM).

6.3. Time series

Regression analysis of time series data is used to predict future outlook by using historical data. For the forecasts to be reliable, the future should be like the past in order for it to be used as predictors for future outlook. If this is not the case, the historical data might not give reliable forecasts. One critical assumption when working with time series data is therefore *stationarity.* Stationarity is necessary to generalize each time series to other time periods.

6.3.1. Stationarity

For a time series to be stationary, the mean and variance have to remain constant over time. Another criterion for stationarity is that the covariance for a certain period depends on the period of time and not the actual point in time in which the covariance is computed. Making sure the time series is stationary is a measure in order to make the time series generalized to other time periods, and further to be able to use the time series data to forecast. Another problem caused by nonstationary time series is spurious regression. This can occur when one or more time series are nonstationary. When regressing a stationary time series on one or more nonstationary time series, the R^2 might be unreasonable high and too many of the variables may be statistically significant because the t-, and F-tests are only reliable under the assumption of stationarity. (Gujarati, 2012)

6.3.2. Dickey Fuller test

One way to test for stationarity is to do a unit root test. An example of a test that checks for a unit root is the Dickey Fuller (DF) test. The unit root test can be derived as follows:

I: $Y_t = \rho Y_{t-1} + u_t$

II: $Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + u_t$

III: $\Delta Y_t = \delta Y_{t-1} + u_t \quad where \quad \delta = (\rho - 1)$

H_0: $\delta=0$ and $\rho=1$ (nonstationary)

H_A: $\delta<0$ and $\rho<1$ (stationary)

(Gujarati & Porter, 2009, pp. 754-755)

Reject H_0: tau-value > DF critical value

Keep H_0: tau-value < DF critical value

When using statistical software as SAS, the tau-value is estimated and should be measured against the DF critical values. If the tau-value is greater, in absolute value, than the critical value, the null-hypothesis of a unit root is rejected and the time series is stationary. Opposite, if the tau-value is lower in absolute value than the DF critical value, the time series is nonstationary.

The DF test uses its own critical values that will vary depending on the form of the regression. The regression can take on one of the following forms:

1. Y_t is a random walk:
   $\Delta Y_t = \delta Y_{t-1} + u_t$
2. Y_t is a random walk with drift:
   $\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t$
3. Y_t is a random walk with drift around a deterministic trend:
   $\Delta Y_t = B_1 + \beta_2 t + \delta Y_{t-1} + u_t$

(Gujarati & Porter, 2009, p.755)

A DF test assumes that the error term, u_t ,is uncorrelated, which is not necessarily the case. In that case the Augmented Dickey Fuller (ADF) test can be applied. The ADF test differs from the regular DF test because it includes the lagged values of the dependent variable. The hypothesis and the critical values are the same as in the DF test. (Gujarati & Porter, 2009)

As stated earlier, nonstationary time series causes several problems when running a regression. If there is proof of a unit root after testing for stationarity through a DF or ADF test, one action against nonstationary time series is to first differentiate the time series. If this makes the time series stationary, then the regression can be used to analyze further as stationarity is one assumption when working with time series data.

6.4. Multicollinearity

As stated above, one of the assumptions for the CLRM is that there is no perfect linear relationship among the independent variables. This means no presence of multicollinearity. To have perfect linear relationship between two variables, meaning perfect collinearity, is very rare. There is on the other hand a possibility that two independent variables are *highly* correlated, which can be categorized as imperfect collinearity. (Gujarati,2012) Having imperfect collinearity is undesireable because of the following reasons:

1. Precise estimation is difficult as variances and covariances are large.
2. The null hypothesis of the true coefficient being zero, might not be rejected as a consequence of wider confidence intervals.
3. The t-ratio of the coefficients are likely to be statistically insignificant.
4. The R^2 might be too high even though some regression coefficients are insignificant.
5. The OLS estimators and the standard errors can be sensitive to minor changes in the data.

(Gujarati & Porter, 2009, p.327)

When two regressors are perfect or highly correlated, it will cause some difficulties to separate its effect on the dependent variable. In some cases of multicollinearity, it is impossible to estimate the regression as some statistical software programs refuses to run a regression when two regressors are perfectly collinear. In the presence of imperfect multicollinearity, it is possible to estimate coefficients, but the estimates might be wrong. Some of the consequences of imperfect collinearity might be insignificant coefficients, and despite this, a possible high R^2.

6.4.1. Variance-inflation factor

To detect imperfect multicollinearity there are several tests to analyse the degree of multicollinearity. We have chosen to look at the variance-inflating factor (VIF). VIF is computed as follows, where $r^2_{2,3}$ is the coefficient of correlation between X_2 and X_3:

$$VIF = \frac{1}{1 - r^2_{2,3}}$$

(Gujarati & Porter, 2009, p.328)

According to Gujarati (2012, p.70) the VIF value can be defined as: *A measure of the degree to which the variance of the OLS estimator is inflated because of collinearity*. Depending on $r^2_{2,3}$, VIF will have a value between 1 and infinite limit. As $r^2_{2,3}$ approaches 1, in other words towards perfect correlation, VIF moves towards an infinite number. The higher the VIF is, the higher degree of imperfect multicollinearity. Other way around, as $r^2_{2,3}$ moves towards zero, VIF will move towards 1 which implies a lower degree of imperfect multicollinearity. (Gujarati and Porter, 2009)

Unlike the DF test, there is no critical level that decides whether there is imperfect multicollinearity or not. As a rule of thumb, a VIF value of 10 can be applied as a maximum value to accept (Kleinbaum, Kupper, Nizam, and Rosenberg, 2014), even though there is no specific value that indicates if the variable is highly collinear.

6.5. Heteroskedasticity

Another assumption for the CLRM is homoscedasticity in the error term. For this assumption to hold, the error term has to have equal variance for all observations. If this does not apply, the error term is heteroskedastic. One of the consequences of heteroskedasticity is that the estimation of the coefficients might be incorrect because of unreliable t- and F-tests. (Gujarati, 2012)

6.5.1. White test

To test for heteroskedasticity in our regression, we have chosen to use the White test.

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + u_i$$

When running the regression above, the $\hat{u}_i$ is obtained and then we run the auxiliary regression. The auxiliary regression includes the residuals from the original regression, the squared value of the regressors and the cross product of the regressors:

$$\hat{u}_i^2 = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_3 + \alpha_4 X_{2i}^2 + \alpha_5 X_{3i}^2 + \alpha_6 X_{2i} X_{3i} + v_i$$

From this, a chi-square value is obtained which determines whether to reject the null hypothesis of no heteroskedasticity or not.

H_0: no heteroskedasticity (homoscedasticity), $\alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$

H_a: heteroskedasticity

Reject H_0: chi-square value > critical value

Keep H_0: chi-square value < critical value

(Gujarati & Porter, 2009)

6.6. Autocorrelation

As our final action to make sure we get reliable results in our regression, we have to test for autocorrelation. The absence of autocorrelation is also one of the assumptions behind the CLRM. If there is autocorrelation in a regression, it means that the error term at one point in time (*t*) is correlated with the lagged error term (*t-1*). If autocorrelation is detected, this has to be corrected for, to achieve reliable results. One way to take care of autocorrelation is to use the Newey-West method of correcting OLS standard errors, also known as heteroskedasticity and autocorrelation consistent (HAC) standard errors. (Gujarati, 2012)

6.6.1. Generalized Durbin-Watson *d* test

Since we are working with time series data there is a chance for autocorrelation. We have therefore chosen to test for higher-order autocorrelation through the generalized Durbin-Watson test. The test gives a d-value that is derived mathematically as:

$$d = \frac{\sum_{t=2}^{t=n}(\hat{u}_t - \hat{u}_{t-1})^2}{\sum_{t=1}^{t=n}\hat{u}_t^2}$$

(Gujarati & Porter, 2009, p.434)

The *d*-statistics is compared with some limits defined as d_U and d_L from the Durbin-Watson tables depending on the number of observations and regressors. The Durbin-Watson test consists of six decision rules with different null hypotheses. Which decision that should be made, is decided from a certain criterion towards the *d*-statistic when measured against the upper and lower critical value. The decision rules are as follows:

d-value	Decision
$d < d_L$	There probably is evidence of positive autocorrelation.
$d > d_U$	There probably is no evidence of positive autocorrelation
$d_L < d < d_U$	No definite conclusion about positive autocorrelation may be made.
$d_U < d < 4-d_U$	There is probably no evidence of positive or negative autocorrelation.
$4-d_U < d\ 4-d_L$	No definite conclusion about negative autocorrelation may be made.
$4-d_L < d < 4$	There probably is evidence of negative autocorrelation.

Figure 22. Decision rules for Durbin-Watson test.

Source: Gujarati, 2012, pp. 101 – 102

According to the decision rules, the closer to zero the *d*-value is, the greater the evidence of positive autocorrelation. As the value approaches 4, the evidence of negative autocorrelation increases. The last possible outcome is that there is no evidence of neither positive nor negative autocorrelation, which will be the conclusion if the *d*-value is around 2.

7. Econometric Analysis

This chapter will begin by presenting the data used in our analysis. Further we will introduce the composition of our initial model and the hypothesis we wish to test for, which will be the base of our econometric analysis. The variables are presented through a short description and its predicted impact on the dependent variable, following a justification of our selection of macroeconomic factors used in the regression. At last, we will go through the results of each of the statistical tests to create a thorough understanding of the reliability of each variable, both independently and in total.

7.1. Data and limitations

The model regresses monthly changes in currency values dependent on different macroeconomic variables, based on the period 31. July 2005 to 31. December 2016. Not

all variables were available in monthly data. By using the SAS function, Proc Expand, to convert quarterly data to monthly data, we obtain estimated values that may deviate from reality.

Optimally, to assess whether the RMB is fairly valued, we would prefer less frequent data over a longer time period to analyze the exchange rate movements, using macroeconomic variables. Monthly data picks up a lot of random movement in the exchange rate that may be caused by other factors than macroeconomic variables, making it less suitable for discussing long run relationships in the exchange rate. For instance, Flood and Taylor (1996) tested the fit of exchange rate assessments based on macroeconomic models to explain short-term movements. They found that short term exchange rate deviations from that suggested by macroeconomic fundamentals alone, are responsible for the greater part of short run variation in nominal exchange rates, but that these deviations tend to even out over periods of five years or more. As the RMB was pegged to the USD from 1994 to 2005, we found little use in including these years to the analysis period, leaving us with a very small sample size if we had chosen to use quarterly or annual data. Moreover, as mentioned earlier, in the wake of the global financial crisis, China allegedly pegged the RMB to the USD from September 2008 to June

2010. During this period, the CNY/USD show minimal movement, which may reduce the fit of the model and cause it to differ over these 18 observations. This points out the important issue, of whether or not the Chinese foreign exchange market yet can be regarded as being anything close to an efficient market, and if not, we do not expect our model to have any great fit.

We made considerations concerning splitting the regression model into periods subsequent to each time PBoC has widened the spread of the managed float, or changed the way it managed the float. By doing this, we would end up with five different regressions with too few observations to obtain any reasonable results. However, by including the complete period since the managed float was introduced, we obtain the advantages of observing the first natural movements in the exchange rate caused by market forces and basing our discussion on a much larger sample size.

Models using macroeconomic approaches to assess exchange rates, share the common perception that both current and future macroeconomic fundamentals are at the core of exchange rate determination, and that future expectation are critical for current decisions (Flood, & Taylor, 1996). Our model does not take into account any future outlook that may have had an effect on exchange rate movements over the last year, drawing the assumption that past movements alone are representative for future movements. Finally, any regression model should be interpreted with caution and one should remember that a model is not more than a simplification of reality.

7.2. The hypothesis

The main purpose of the regression is to test if any of the macroeconomic factors have significant impact on the exchange rate. We therefore formulate the following hypothesis we wish to test for:

H_1: *One or more of the macroeconomic factors have significant impact on the exchange rate.*

H_0: *None of the macroeconomic factors have any significant impact on the exchange rate.*

If none of the variables turns out to be significant at a 5% level in any of the models, we fail to reject the null hypothesis. In other words, the null hypothesis will be rejected if any of the variables are significantly different from zero at a 5% level.

7.3. Motivation behind choice of variables

CNY/USD (Dependent Variable)

The exchange rate between the RMB (CNY) and the USD is quoted indirectly in our data, meaning that it states how many USD needed to sell or buy to obtain 1 CNY. Thus when interpreting the regression, positive coefficients will indicate a stronger CNY relative to the USD. The exchange rate is quoted in nominal terms as we wish to analyze the actual market value of the CNY in terms of USD. The data is gathered from Bloomberg.

Gross Domestic Product (GDP)

The GDP variable represents the economic growth within the two countries. Our data on GDP is gathered from Bloomberg and is quoted in billions USD for the US and billions

CNY for China, both in nominal values. We will take the natural log of the variables for interpretational reasons.

Economic literature differs when explaining the relationship between exchange rate and GDP growth. Some argue that higher GDP growth cause appreciating pressure on the domestic currency. The reasoning for this is that higher GDP growth often leads to higher interest rates[29]. In contradiction, GDP growth tends to cause income to increase and consumption to rise. This consumption will typically not be limited to domestic goods and services only, but cause an increase in imports, which depreciates the domestic currency. Given China`s history of strict capital controls, discouragement of imports, and a policy promoting foreign direct investments, we expect the GDP growth in China to have had a net appreciating effect on the domestic currency, and the coefficient to be positive. However, we emphasize that the coefficient will be interpreted with caution. As for the US GDP variable, we find it harder to predict the coefficient as it has a more open economy, and that the effect from market forces acts more freely.

What would be interesting to see is how the expected GDP growth compared to the actual GDP growth would affect the currency values. However, we did not find monthly data for expected GDP growth and chose not to estimate these values, as they may have been very misleading and lose its purpose in the regression.

Current Account

The Current Account (CA) and its theoretical effect on currency value is described in detail in chapter 4. It is gathered from the Bloomberg database, and is quoted in percentage of GDP.

China`s substantially large surplus and the US`s substantially large deficit on the CA over the analysis period, should theoretically appreciate and depreciate the currencies respectively. We find it interesting to see how the growing differences between the two countries have affected the exchange rate between them, thus we chose to include these variables in our regression. We expect the CA coefficient for China to be positive and the opposite should count for the US CA coefficient.

[29] Bureau of economic analysis (BEA)

Data for both countries was at highest updated on a quarterly basis, so we used the Proc Expand function in SAS to obtain monthly data.

Interest rate differentials

When discussing monetary policy, the interest rate and its theoretical effect on currency value is closely described. The interest rates used for China are the interest rates on bank credit to the private sector (lending rate), and the interest rates for the US are the US Federal Funds Rate. Both sets of data are collected from Bloomberg.

As theory suggests, interest rates are closely related to exchange rates and that an increasing interest rate should increase the currency value. The variable represents the difference between Chinese Interest rates and US interest rates, meaning that a positive value indicates higher Chinese interest rates relative to US interest rates. Knowing this, we expect the coefficient to be positive.

A limitation for the interest rate differential variable is that both interest rates has been kept unchanged over a significant number of the same observations, causing less variation through the analysis period. Also, the Chinese interest rates have been partly controlled, as described under the monetary policy chapter. These limitations may mitigate effects from the interest rate changes on currency value. It is also important to keep in mind that the variable is endogenous, meaning it does not necessarily have a direct impact on the exchange rate. It may, in times of unwanted exchange rate fluctuations, work as an instrument to dampen the effect, and thus move opposite of what theory suggests. Thus, the coefficient should be interpreted with caution.

Inflation rate differentials

The inflation variables are based on the year on year growth in the CPI. The data is gathered by IMF and collected through Bloomberg. Inflation affect the purchasing power of the currency, i.e how much goods and services you can buy with one unit of the currency.

Theory suggests that inflation and currency value move in opposite directions. Countries with a relatively high inflation rate tend to experience a depreciating effect on their currencies relative to others. The variable represents the difference between Chinese

inflation and US inflation, meaning that a positive value indicates higher inflation rates in China compared to the US. Based on this, we expect the coefficient to be negative.

As currency valuing in large parts are driven by expectations, it would be interesting to look at expected inflation rates and compared with actual inflation rates. We assume that deviations from expected inflation rates would cause changes in the currency value and would be of explanatory value in our regression model. However, on a monthly basis such a variable would be less likely to have a significant effect. Also, finding monthly expected inflation rates for China proved to be very difficult, thus we chose to exclude this variable and depend solely on the inflation rate differentials between China and the US.

Foreign Direct Investment China (FDICN)

The variable represents the accumulated FDI in domestic firms or entities in non-financial sectors and is gathered from the Ministry of Commerce of the People`s Republic of China. It is quoted in billions of USD, and will be presents as a natural logarithm for interpretational reasons.

In theory, large inflows of FDIs will appreciate a currency, as the demand of the currency increases with increasing inflows, everything else held constant. An outward flow of FDIs will have the opposite effect. Our motivation behind choosing to include the variable in the regression stems from China`s policy on encouraging inward FDIs while restricting outward FDIs, as discussed under the BoP chapter. Further, there has been an increasing trend of directing FDIs towards companies in developing countries during the period of interest (UN, 2006). While China`s explosive growth over the analysis period has put it in a position as a favored investment destination for foreign investors. Based on this, we expect the FDI coefficient to be positive and have an appreciating effect on the CNY/USD.

Only annual and quarterly data on FDIs in the US was available. We could have used quarterly data and transformed to monthly data using SAS, but chose not to do so, due to very large fluctuations from quarter to quarter.

Foreign Exchange Reserves China (FXRCN)

This variable is discussed and described under the foreign exchange reserves chapter of the thesis. The data is collected from Bloomberg and excludes the gold reserves. The variable is quoted in billions of USD and is logged using natural logarithm for interpretational reasons.

As discussed earlier, China has had an exceptional growth in its foreign exchange reserves during the analysis period. The large BoP surplus, which should have an appreciating effect on domestic currency, accounts for most of the increase. However, countries that drive a currency intervention policy use or accumulate its foreign exchange reserves to do so, and reserves should accumulate if the policy is to depreciate or mitigate appreciation, as is the assumed case for China over the larger part of the period. We know from our analysis on the foreign exchange reserves that China´s reserves mostly have accumulated together with the appreciation of the domestic currency. This indicates that the effect from the use or accumulation of reserves has had a mitigating effect on exchange rate developments. Given the correlation and movement of the two variables over the period, it seems likely to obtain a positive coefficient, but this coefficient should be interpreted with caution.

As the US`s reserves have been relatively unchanged over the period, and as it does not use them as means of currency interventions, we saw no relevance of including this variable in our regression.

Political Stability Index (PSI)

The Political Stability and Absence of Violence/Terrorism variable measures "perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism". The numbers represent an index that fluctuates between -2,5 to 2,5, where the lower number indicates weak governance and the higher number indicates strong governance. The index is found in the Worldwide Governance Indicators (created by Daniel Kaufmann and Aart Kraay)[30]

Theory would suggest that political instability or the risk of it would affect a country`s currency. If it is high political risk, future growth is more uncertain and investors seek

[30] See appendix 3 for detailed aggregation methodology.

more stable currencies. Cosset and Rianderie (1985) argued that foreign investors respond to political risk with avoidance and that news regarding political risk may lead to currency depreciation or appreciation. Theory therefore suggests that the PSI-China coefficients should be positive and have an appreciating effect on the CNY, while the PSI-USA variable should have a negative coefficient and an appreciating effect on the USD.

The PSI-variables contain a limitation when fitted into our regression, as the index is updated on a yearly basis. We saw no advantages in using SAS to interpolate the values on a monthly basis, so to account for the different frequencies we repeated the index score for each month in the respective year, causing the score to vary only each 12th observation. Bloomberg points out that the variable may be subject to a one-year lag, so in our dataset we have lagged the variables manually by assigning 2004 numbers for 2005 and so on.

National account (NA)

The national account variable represents the surplus or deficit on the government budget and explains the balance between government income (taxes) and government spending. The data is gathered from the Federal Reserve Bank of St.Louis, and is quoted in percentage of GDP. The National Account`s effect on the exchange rate has been under scrutiny for decades, and is somehow ambiguous. With regards to the strong USD during the 1980s in combination with high US NA deficits, Feldstein questioned the perception that budget deficits weakened the currency (Stoker, 1999). Reasoning would be that the high interest rates required to issue a satisfying level of debt to finance the government spending, and would eventually lead to a stronger currency. A counter argument offered by Evans (1985) suggests that budget deficits is a sign of weakness in the economy and may possibly be followed by inflation. James Stoker (1999) based his research on the two aforementioned empirics. He finds that NA deficits strengthen the currency in the short run, and that the increase is not solely caused by Feldstein`s proposition, but also by the increased government spending allowed by the deficit. Further he states that, in the long run, the currency will temporarily decrease if the debt is repaid using taxation and permanently decrease if it is paid through money growth.

During the analysis period the US has had outstanding large deficits on the NA. In 2009 it amounted to 9% of GDP. These abnormal values are the motivation behind including

this variable. Based on James Stoker`s (1999) research, we expect the US NA coefficient to have a negative sign in our regression, as the analysis period is quite short, and the US is still running a large deficit.

We were not able to find more frequent data then annually updated values of China`s NA. Thus, it is not included in the regression.

Varaible name	Acronym	Units	Source	Expected sign
Nominal Bilateral Exchange rate	CNY/USD	USD	Bloomberg	
Gross Domestic Product China	GDPCN	CNY	Bloomberg	+
Gross Domestic Product USA	GDPUS	USD	Bloomberg	?
Current Account China	CACN	% GDP	Bloomberg	+
Current Account USA	CAUS	% GDP	Bloomberg	-
Interest rate Differential	IRCN_IRUS	% - points	Bloomberg	+
Inflation rate Differential	INFCN_INFUS	% - points	Bloomberg	-
Foreign Direct Investment China	FDICN	USD	MOFCOM	+
Foreign Exchange Reserves China	FXRCN	USD	Bloomberg	+
Political Stability Index China	PSICN	Index	Worldbank	+
Political Stability Index USA	PSIUS	Index	Worldbank	-
National Account USA	NAUS	% GDP	St. Louis FED	-

Figure 23. Variables - expected coefficient signs.

MOFCOM: Ministry of Commerce of People`s Republic of China,

St.Luois FED: Federal Reserve Bank of St.Louis

7.4. The Model

We will use 11 macroeconomic factors as independent variables and investigate their relationship with, and how, they influence the exchange rate. The technique of regression modelling is commonly used to estimate coefficients for independent regressors, hypothesis testing and evaluating the importance of each independent regressor when explaining changes in the dependent variable. We will be using Statistical Analysis Software (SAS) to regress the following model:

$$y = \alpha + \beta_i x_i + \cdots + \beta_n x_n + \varepsilon, \qquad i = 1, \dots, n$$

Where

$y = ln(\frac{CNY}{USD})$

$\alpha = Intercept$

$\beta = Estimated\ coefficient$

$i = List\ of\ variables$

$x_1 = \ln(Gross\ Domestic\ Product\ China\ (GDPCN))$

$x_2 = \ln(Gross\ Donmestic\ Product\ US\ (GDPUS))$

$x_3 = Current\ Account\ China\ (CACN)$

$x_4 = Current\ Account\ US\ (CAUS)$

$x_5 = Interest\ Rate\ Differential\ (IRCN - IRUS)$

$x_6 = Inflation\ Rate\ Differential\ (INFCN - INFUS)$

$x_7 = \ln(Foreign\ Direct\ Investment\ China\ (FDICN))$

$x_8 = ln(Foreign\ Exchange\ Reserves\ China\ (FXRCN))$

$x_9 = Political\ Stability\ Index\ China\ (PSICN)$

$x_{10} = Political\ Stability\ Index\ US\ (PSIUS)$

$x_{11} = National\ Account\ US\ \ (NAUS)$

7.5. ADF-test

In order to test if the variables are stationary or not, we did an Augmented Dickey Fuller test on all variables[31]. As mentioned earlier, the ADF test is based on different critical values depending on the form of the regression. To see if there was a trend or not, we ran a regression of the differenciated variable on a trend and the natural form of the variable.[32] If the p-value of the trend variable was less than 0,05 we used the tau- and critical value related to a model with a constant and trend. In case of a p-value higher than 0,05, we used the tau- and critical value related to a model with a constant and no trend (single mean). Since an ADF-test tests for stationarity at different lags, we used a partial autocorrelation function plot to detect number of lags. We then chose the model that gave the lowest AIC value as this model is preferable when comparing two or more models (Gujarati & Porter, 2009, p.494).

[31] See appendix 4 for total SAS output.
[32] See appendix 5

Constant, no trend (single mean)						
	Δ(0)			Δ(1)		
Variables	Tau-value	Critical value (	Result	Tau-value	Critical value (	Result
GDPCN	0,19	-2,89	Nonstationary	**-9,06**	**-2,89**	**Stationary**
CACN	-1,93	-2,89	Nonstationary	**-4,9**	**-2,89**	**Stationary**
PSICN	-2,86	-2,89	Nonstationary	**-3,63**	**-2,89**	**Stationary**
PSIUS	-2,04	-2,89	Nonstationary	**-5,18**	**-2,89**	**Stationary**
NAUS	-1,29	-2,89	Nonstationary	**-4,61**	**-2,89**	**Stationary**
INFCN_INFUS	**-4,39**	**-2,89**	**Stationary**			

Constant and trend (trend)						
	Δ(0)			Δ(1)		
Variables	Tau-value	Critical value (5%)		Tau-value	Critical value (	Result
CNY/USD	2,03	-3,45	Nonstationary	**-7,57**	**-3,45**	**Stationary**
GDPCN	-1,22	-3,45	Nonstationary	**-3,9**	**-3,45**	**Stationary**
CAUS	-1,85	-3,45	Nonstationary	**-7,52**	**-3,45**	**Stationary**
FDICN	-2,56	-3,45	Nonstationary	**-5,28**	**-3,45**	**Stationary**
FXRCN	0,81	-3,45	Nonstationary	**-4,53**	**-3,45**	**Stationary**
IRCN_IRUS	-1,3	-3,45	Nonstationary	**-3,98**	**-3,45**	**Stationary**

Figure 24. ADF-statistics. SAS output.

We first tested without differenciating the variables. As seen in figure 24, the null hypothesis of nonstationarity failed to be rejected at 5% significance level for all variables except the inflation differential variable, meaning all variables except this was nonstationary without being differenciated. As a measure to make the variables stationary, we took the first difference of all the nonstationary variables. All these variables turned out to be stationary at a 5% significance level after being first-differenciated. We will therefore procede with all variables, except the inflation differential variable, in first difference, in further statistical tests and the final regression model.

7.6. VIF-test

To detect the degree of multicollinearity, we will look at pair-wise correlation between all variables combined with a VIF-analysis. Since there is no exact value when it comes to detecting multicollinearity both concerning correlation and VIF-value, we choose to follow some suggested thresholds. According to Gujarati and Porter (2009), a suggested measure is that a high correlation between two regressors that exceed 0,8 will cause a serious problem of multicollinearity.

	CNY/USD	FDICN	PSICN	PSIUS	CACN	CAUS	FXRCN	NAUS	GDPCN	GDPUS	IRCN_IRUS	INFCN_INFUS
CNY/USD	100.000											
FDICN	0.01588	100.000										
PSICN	-0.01622	0.22445	100.000									
PSIUS	0.00013	-0.06252	-0.00630	100.000								
CACN	0.03363	-0.01024	0.01289	0.12181	100.000							
CAUS	-0.13887	0.00026	0.02744	0.01552	-0.13786	100.000						
FXRCN	0.49581	-0.13271	-0.08044	0.03173	0.03610	-0.03811	100.000					
NAUS	-0.13900	0.18765	0.06948	-0.06649	0.00682	0.00261	-0.09336	100.000				
GDPCN	0.47962	0.01662	-0.05007	0.03777	0.07366	-0.12279	**0.53214**	0.00797	100.000			
GDPUS	0.06025	0.02754	0.14986	-0.01244	0.04832	-0.10392	0.09565	-0.04856	-0.06454	100.000		
IRCN_IRUS	0.30963	0.00391	0.12850	0.00411	-0.03954	0.05881	0.27487	-0.07736	0.32587	-0.08114	100.000	
INFCN_INFUS	0.18207	0.00219	-0.02788	0.03908	-0.10533	0.01984	0.02253	0.01398	0.25479	-0.01753	0.36089	100.000

Figure 25. Correlation matrix. SAS output.

In our correlation matrix, there are no pair-wise correlation close to 0,8. As seen from figure 25, there is only one pair-wise correlation coefficient that exceeds 0,5 and only a few that are close to this value. Since low pairwise correlation is no guarantee for the absence of multicollinearity, as high pairwise correlation does not necessarily prove multicollinearity, we choose to support this analysis with a VIF-test.

Variable	Variance inflation factor
FDICN	1,13762
PSICN	1,14818
PSIUS	1,05099
CACN	1,33140
CAUS	1,55909
FXRCN	1,72524
NAUS	1,06107
GDPCN	1,62127
GDPUS	1,09603
IRCN_IRUS	1,39177
INFCN_INFUS	1,28047

Figure 26. VIF-test. SAS output.

From figure 26 it can be seen that all VIF-values lie below 2. We have chosen to accept a VIF lower than 10 and therefore assume absence of multicollinearity and imperfect multicollinearity.

7.7. White-test

To test for homoskedasticity in our error term, we do a White-test on our regression. The result obtained provides a p-value of 0,3038 as seen in figure 27.

DF	Chi-Square	Pr > ChiSq
64	69,28	0,3038

Figure 27. White test. SAS output.

A p-value that exceeds 0,05 means we keep the null hypothesis of no heteroskedasticity. Since our p-value is larger than 0,05, we assume there is no heteroskedasticity and therefore the assumption about homoskedasticity is fulfilled.

7.8. Generalized Durbin-Watson

To test for higher order autocorrelation, we use the generalized Durbin-Watson test with 12 lags since our dataset consists of monthly observations.

		1%- level		5%-level	
Order	d-statistic	dL	dU	dL	dU
1	2,1311	1,27	1,841	1,393	1,974
2	2,2348	1,27	1,841	1,393	1,974
3	1,8722	1,27	1,841	1,393	1,974
4	1,6637	1,27	1,841	1,393	1,974
5	2,0111	1,27	1,841	1,393	1,974
6	2,0121	1,27	1,841	1,393	1,974
7	**1,2526**	**1,27**	**1,841**	**1,393**	**1,974**
8	1,5506	1,27	1,841	1,393	1,974
9	1,6837	1,27	1,841	1,393	1,974
10	1,4728	1,27	1,841	1,393	1,974
11	1,4962	1,27	1,841	1,393	1,974
12	1,5125	1,27	1,841	1,393	1,974

Figure 28. Generalized Durbin Watson test. SAS output.

As seen from figure 28, the test indicates 7th order positive autocorrelation as $d < d_L$ at 1% significance level. This fulfills the first decision rule that "there probably is evidence of positive autocorrelation". One of the drawbacks of the Durbin-Watson test is that it does not give any definite conclusion. Despite this, we assume that positive autocorrelation exists based on the decision rule. As autocorrelation can make the t- and F-tests unreliable, we wish to correct for autocorrelation in our regression. To do this, we continue our analysis using Newey-West HAC standard errors (Gujarati & Porter, 2009).

8. Empirical findings

In this chapter we will present our regression results, with the aim of substantiating if the RMB is fairly valued in terms of USD. When deciding which model has the «best» fit, we will select the variables using stepwise backward regression. After presenting the results of the final model, we will compare the estimated coefficients of the variables to actual movements over the past years. This is done in order to see if the relation between the macroeconomic variables is as expected or if the currency has moved differently, indicating a possible over- or undervalued currency.

8.1. Interpretation of regression results

To detect the "best fitted" model, we have removed the insignificant variables one by one, until we end up with a final model containing only significant variables. As the DW test detected auto correlation at order 7, we use Newey-West Heteroscedasticity and Autocorrelation-Consistent standard errors (HAC) to determine statistical significance. The final regression results are presented in figure 29 below[33]:

[33] See appendix, 6 for total SAS output of final model.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dcaus	**-0,04636*** **	**-0,04715*** **	**-0,04732*** **	**-0,04528*** **	**-0,0450*** **	**-0,04325*** **	**-0,04293*** **	**-0,0429*** **
p value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
std.error	[0,00757]	[0,00761]	[0,00784]	[0,00787]	[0,00784]	[0,00899]	[0,00870]	[0,00867]
dlogfxrcn	**0,017947*** **	**0,018801*** **	**0,019475*** **	**0,019021*** **	**0,019032*** **	**0,018584*** **	**0,018594*** **	**0,018581*** **
	0,0094	0,0055	0,0043	0,0041	0,004	0,0059	0,0061	0,0067
	[0,00681]	[0,00665]	[0,00670]	[0,00651]	[0,00649]	[0,00663]	[0,00666]	[0,00674}
dloggdpcn	**0,037859*** **	**0,034953*** **	**0,033843*** **	**0,034934*** **	**0,035066*** **	**0,036046*** **	**0,035946*** **	**0,035935*** **
	0,0012	0,001	0,002	0,0008	0,0007	0,0009	0,0015	0,0014
	[0,0114]	[0,0104]	[0,0107]	[0,0101]	[0,0101	[0,0106]	[0,0111]	[0,011]
dircn_irus	**0,067069*** **	**0,055898** **	**0,055036** **	**0,050911** **	**0,05058** **	**0,052327*** **	**0,052347*** **	**0,52573*** **
	0,0017	0,0141	0,0177	0,015	0,0148	0,0057	0,0057	0,0048
	[0,0209]	[0,0225]	[0,0229]	[0,0206]	[0,0205]	[0,0186]	[0,0186]	[0,0183]
dinfcn_infus		**0,004502***	**0,004633** **	**0,004796** **	**0,004855** **	**0,004713** **	**0,004762** **	**0,004749** **
		0,0505	0,0409	0,0269	0,0263	0,0249	0,0255	0,0282
		[0,00228]	[0,00224]	[0,00214]	[0,00216]	[0,00208]	[0,00211]	[0,00214]
dlogfdicn			**0,000164***	**0,000203** **	**0,0002** **	**0,000192** **	**0,000193** **	**0,000194** **
			0,057	0,018	0,0146	0,0182	0,0189	0,0256
			[0,000085]	[0,000085]	[0,000081]	[0,00008]	[0,000081]	[0,000086]
dnaus				**-0,01102***	**-0,01119***	**-0,01095**	**-0,01097**	**-0,01095**
				0,0986	0,0966	0,1073	0,1097	0,1117
				[0,00663]	[0,00668]	[0,00675]	[0,00681]	[0,00684]
dpsius					**-0,00017**	**-0,00017**	**-0,00017**	**-0,00017**
					0,1028	0,1187	0,1574	0,1564
					[0,000104]	[0,000106]	[0,000122]	[0,000121]
dloggdpus						**0,0065**	**0,0061451**	**0,006521**
						0,5503	0,5576	0,558
						[0,0109]	[0,0110]	[0,0111]
dcacn							**0,003182**	**0,003197**
							0,9176	0,9172
							[0,0307]	[0,0307]
dpsicn								**-0,00009**
								0,9252
								[0,000968]
Constant	**-0,0048*** **	**-0,0049*** **	**-0,0048*** **	**-0,0005*** **	**-0,0005*** **	**-0,00052*** **	**-0,00052*** **	**-0,00052*** **
	0,0011	0,0008	0,0011	0,0007	0,0007	0,0014	0,0021	0,0021
	[0,000145]	[0,000142]	[0,000145]	[0,000143]	[0,000143]	[0,000165]	[0,000165]	[0,000166]
Observations	137	137	137	137	137	137	137	137
Degrees of Freedom	132	131	130	129	128	127	126	125
R-Squared	0,3377	0,3421	0,3453	0,3541	0,3546	0,3559	0,3559	0,3559

Figure 29. Regression results. SAS output.

Varaible name	Acronym	Units	Significance level	Expected sign	Actual sign
Nominal Bilateral Exchange rate	CNY/USD	USD			
Gross Domestic Product China	GDPCN	CNY	1%	+	+
Gross Domestic Product USA	GDPUS	USD	Not significant	?	
Current Account China	CACN	% GDP	Not significant	+	
Current Account USA	CAUS	% GDP	1%	-	-
Interest rate Differential	IRCN_IRUS	% - points	1%	+	+
Inflation rate Differential	INFCN_INFUS	% - points	Not significant	-	
Foreign Direct Investment China	FDICN	USD	Not significant	+	
Foreign Exchange Reserves China	FXRCN	USD	1%	+	+
Political Stability Index China	PSICN	Index	Not significant	+	
Political Stability Index USA	PSIUS	Index	Not significant	-	
National Account USA	NAUS	% GDP	Not significant	-	

Figure 30. Variables - expected and actual coefficient signs.

The initial model with all 11 regressors show a result of six significant variables and an R-Square of 0,3559. In other words, our model explains 35,59 % of the changes in the exchange rate between China and the US when all variables are included. When removing the US National Account variable, the Chinese Foreign Direct Investment variable becomes insignificant. Further, removal of the FDI variable makes the inflation rate differential variable insignificant at a 5 % level. Thus, the final model includes the

US CA, the Chinese foreign exchange reserves, Chinese GDP and interest rate differentials between China and the US, all significant at a 1% level. We therefore *reject* the null hypothesis as four of the macroeconomic factors have significant impact on the exchange rate.

The regression results show a negative coefficient on the US CA variable, which was in line with our expectations, as CA growth should have an appreciating effect on domestic currency. We see that a one unit increase in the US CA as percentage of GDP, i.e. an increase of one percentage point in CA/GDP, reduces the CNY/USD with 0,0004636 USD, holding all other regressors constant. This would make up a 0,32% depreciation of the CNY in USD terms, based on the exchange rate as of 31.12.2016. Thus we see that for the US CA to have any significant impact on the exchange rate, it would have to be subjected to an unusual change of value, given that the average monthly change over the period has been 0,02 percentage points.

The Chinese foreign exchange reserves have a positive effect on the Chinese currency. The coefficient indicates that a one percent increase in the foreign exchange reserves increase the CNY/USD with 0,00017947, holding all other regressors constant. The positive effect is in line with our expectation, but contradicts theory that increasing foreign exchange reserves should have a depreciating effect on domestic currency. The coefficient makes up a 0,124% appreciation of the CNY in USD terms. Analyzing the development of the variable, we find that it has been subject to a monthly average growth of 1,0525%

The Chinese GDP variable seems to have a positive effect on domestic currency, as we expected, based on economic theory. The coefficient shows that a 1% growth in GDP increases the dollar value of one CNY with 0,00037859, holding other regressors constant. This amounts to an appreciation of 0,263% of the CNY in terms of USD, given the exchange rate as of 31.12.2016.

The interest rate differential variable also behaves as we would expect. Higher Chinese interest rates relative to US interest rates appreciates the Chinese currency in terms of USD. More precisely interpreted, if the Chinese interest rate increase with one percentage point relative to the US interest rate, one CNY increase by 0, 00067069 USD,

holding other regressors constant. This amounts to an appreciation of 0,465% of the CNY in terms of USD, given the exchange rate as of 31.12.2016.

By analyzing the recent development in the variables while using its associated coefficients, we will give an evaluation to whether the CNY is fairly valued or not. From the coefficient we see that changes in the interest rate differentials and US CA in percentage of GDP, has the hardest impact on the CNY/USD exchange rate. However, looking back at last year's development in those two variables, we find little noteworthy movement, except for the decrease in the interest rate differential, caused by the US´s two interest rate hikes of 0,25 percentage points in December 2015 and December 2016. Hence, we assume little explanatory value from them when looking at last year's exchange rate movements.

Concentrating on the two remaining significant variables we see more movement. The GDP has had a steady and modest growth, with no exceptional changes. From the coefficients we see that a percentage change in GDP growth should have twice the impact on the exchange rate, compared to a percentage change in foreign exchange growth. Looking at last year´s development in the two variables, we see that the foreign exchange reserves has fallen with roughly one percent more than the GDP has grown by. This indicates a clear net appreciating effect on the CNY, holding all other variables constant. Nonetheless, the increase in US interest rates, that occurred at the end of year 2015 and 2016, should have had a depreciating effect on the CNY in terms of USD, but acoording to our model, not enough to offset the appricaition caused by GDP growth. In relation to the interest rate hikes, the interest rates tend to have effects on the short run exchange rate, as it attracts capital in the form of «hot money flows». China`s use of capital controls may mitigate these flows, even though it has been proven that capital tends to flow «under the radar»[34]. Despite this recent development, the CNY has depreciated about 6 percent to the USD year on year, which should point to an undervalued exchange rate as of 31.12.2016.

However, as pointed out earlier in this chapter, expected GDP growth should have an explanatory value when looking at exchange rate movements, as predicted future

[34] Ref: Chapter 3.1.4.

growth often are priced into an exchange rate. Thus, deviations from such predictions should intuitively affect exchange rates, no matter the size of the growth.

8.2. Conclusion

Even though we have four statistically significant variables with economically reasonable coefficients, the R-squared value is only 0,3377. Thus, the explanatory value from the model is weak, and changes in the CNY/USD exchange rate seem to be driven by other factors not included in the regression. When comparing the two R-squared values of the initial and the final model, we see that it fell by less than two percent, after the elimination of seven variables. This amplifies our suspicion that the exchange rate movements are hardly caused by macroeconomic factors during the period. As discussed in the exchange rate regime chapter, the Renminmbi was de-pegged from the dollar in 2005, but remained under a managed float over the sample period. The spread of the managed float has widened over the analysis period, but it still seems to undermine the impact macroeconomic variables theoretically has on free floating exchange rates. Given the low explanatory value of our model, it fails to give any reasonable conclusion to whether the CNY are fairly valued or not.

Part 5. Exchange rate assessment - Purchasing power parity

9. Purchasing power parity

This chapter will introduce the concept behind the purchasing power parity (PPP). We will conduct a valuation by comparing the movements of the *absolute* and *relative* PPP-rate against the fluctuations in the actual nominal exchange rate. The analysis will also consider the drawbacks of the model as the theory is based on several assumptions. The purpose of this analysis is to look at longterm movements of the two rates to determine whether the RMB is fairly valued. For these analyses, we have chosen a longer time period than included in the previous analyses, as these methods are based on long-run movements.

9.1. Absolute PPP

The absolute PPP theory is based on the assumption that the exchange rate, in the long run, will move towards equilibrium where price levels are equal, also referred to as "the law of one price". The law of one price means that goods should have the same price in both countries after the exchange rate has been accounted for. If this does not hold, it will open an opportunity for arbitrage of goods between countries. The absolute PPP-theory therefore argues that the exchange rate will adjust in the long run so that the law of one price holds, also what we refer to as *equilibrium*. Absolute PPP-theory is therefore advocated as a satisfactory model (Pilbeam, 2010) and can be used as an indicator of the long run exchange rate.

The price levels can be measured by a weighted basket of several basic goods that are covered by GDP. The PPP-rate is therefore primarily used to compare GDP across countries (OECD, 2002), both in terms of total GDP to measure the size of a country´s economy, and per capita to compare countries' living standards. By comparing today's market exchange rate to the absolute PPP-rate, it will give an indication of whether the exchange rate is priced "correctly".

The absolute PPP is calculated as follows:

$$S = \frac{P}{P^*}$$

(Pilbeam, 2010, p. 290)

Where S is the exchange rate expressed as domestic currency per unit of foreign currency, P is the domestic price level and P is the foreign price level.*

From the formula we see that the exchange rate is expected to adjust if the domestic price level changes relative to foreign price level. For example, if the domestic price level increases by a larger amount than foreign price level, the exchange rate should appreciate according to absolute PPP. The absolute PPP also assumes no transportation cost, perfect information and no tariff or other trade barriers (Taylor, 2010). Because of these assumptions, the rate will probably deviate from the actual exchange rate, even though it might be fairly valued according to other methods. To account for these circumstances, there is a weaker version of the PPP, relative PPP, that might hold independent of these assumptions. Relative PPP theory can therefore hold regardless of absolute PPP. On the other hand, if absolute PPP theory holds, relative PPP has to hold.

9.2. Relative PPP

For the relative PPP theory to hold, the exchange rate has to adjust by the same percentage as the inflation rate differential between the two countries. Relative PPP-rate can be expressed mathematically as:

$$\%\Delta S = \%\Delta P - \%\Delta P^*$$

(Pilbeam, 2010, 291)

Where %ΔS is the percentage change in the exchange rate, expressed as domestic currency per unit of foreign currency, %ΔP is the domestic inflation rate and %ΔP is the foreign inflation rate.*

According to this formula, a domestic inflation rate that exceeds the foreign inflation rate should lead to a depreciation in the domestic currency. Thus, the domestic currency should appreciate if the domestic inflation rate is lower than the foreign inflation rate, for the relative PPP to hold. This meaning that the change in the exchange rate should

offset the difference in inflation between two countries. It is also argued that the relative PPP can hold despite the prescense of transportation cost, imperfect competition, tariffs and trade barriers.

9.3. Drawbacks

As an indicator for a fair value of the currency, both relative and absolute PPP have their flaws which is important to bear in mind when applying them. Lafrance and Schembri (2002), among others, discuss several reasons that substantiate the poor fit of the absolute PPP method.

One of the weaknesses they mention with this method is the stickiness of the two rates. An exchange rate is not constant in the short run, as it fluctuates rapidly when the market forces influences the currencies. The absolute PPP-rate will on the other hand potentially have less movement because price levels are stickier. This is one of the reasons why the absolute PPP-rate might deviate from the market exchange rate, and be misleading as an equilibrium rate.

Another important weakness of the model is that price levels differ drastically across countries. The price of labor will for example be considerably lower in some countries than others, which will affect the price of the non-tradable goods in these baskets, and make them less suitable for comparison. China is a good example since it is known for having cheap labor, which implies cheaper goods. It is therefore unlikely that the exchange rate should offset the difference between price levels when comparing countries with different economic development, such as the US and China. Thus, rich countries with high price levels should have overvalued currencies when measured against the absolute PPP-rate. Opposite, poor countries should have undervalued currencies.

There are some difficulties when estimating the PPP rate concerning which goods to include in the basket, especially whether to separate between traded and non-traded goods. Traded goods, such as most manufactured goods, are subject to international competition, and are therefore likely to be adjusted by international market forces to prevent arbitrage opportunities across bordes. Price of non-traded goods, as for example the Big Mac, services or houses, are on the other hand determined by domestic

market forces, which makes it less suited for comparison. Traded goods are therefore more likely to make the absolute PPP theory hold (Pilbeam, 2002, p. 292).

At last, as mentioned earlier, the absolute PPP-rate assumes no transaction cost, no trade barriers or tariffs and perfect competition. In the prescense of transaction cost and trade impediments, the law of one price does not hold because these barriers will drive prices on similar goods apart. Concerning perfect competition, this would require corporations to refrain from price discriminate between countries, which is highly unlikely. As willingness to pay will differ across countries, firms will charge different prices, which can make price levels misleading in determining the exchange rate. Since distortion factors like these most likely are present, this makes the absolute PPP-rate an often less suitable model.

Even though the relative PPP-rate accounts for weaknesses in the absolute PPP, such as the distortion effects mentioned, it also has its weaknesses. As the absolute PPP-rate is accused of only being a measure of difference in price levels, the relative PPP-rate can be accused of only being a measure of difference in inflation rates, rather than a measure of exchange rate growth.

9.4. Analysis

Despite the weaknesses of both models, we wish to analyze both rates to see if they can contribute to any explanation about the valuation of the RMB. The absolute PPP-rate is the PPP-rate for GDP calculated by OECD[35] while the relative PPP is the inflation differencial between China and the US.[36]

The relative and absolute PPP are built on the same concept but are not necessarily equal. Therefore, the two methods do not have to give the same conclusion to whether the currency is over- or undervalued.

9.4.1. Absolute PPP

We wish to analyze the absolute PPP-rate to see if it can contribute to any explanation about the valuation of the RMB by comparing it to the average yearly nominal exchange

[35] The basket contains around 3000 consumer goods and services, 30 occupations in governments, 200 types of equipment goods and around 15 construction projects.
[36] Relative PPP = Inflation (China) – Inflation (US)

rate. Based solely on the fundamental PPP-theory we would then see whether the currency is over- or undervalued. This is not an accurate assesment, but we will use it as a possible indicator.

Figure 31, below, shows the movements in the average nominal exchange rate and the absolute PPP-rate from 1980 to 2016.

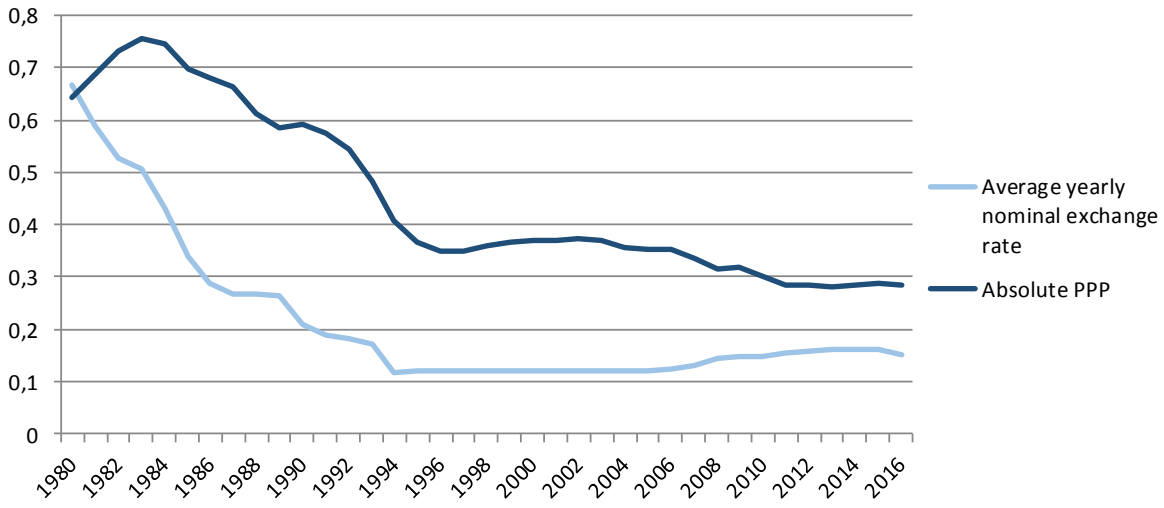

Figure 31. Absolute PPP-rate and average yearly nominal exchange rate (CNY/USD). Source: OECD.

According to absolute PPP, the exchange rate should be equal to the absolute PPP-rate for it to be fairly valued. When the absolute PPP-rate exceeds the nominal exchange rate, as shown in figure 31, it indicates an undervalued RMB. After 2005, the RMB started appreciating while the absolute PPP further depreciated. This has lead to a decrease in the gap between the two rates. Despite the recent depreciation of the RMB, the gap is still smaller than it has been in a long time.

This movement is partly due the development of differences in the price levels between the US and China. As seen from the absolute PPP-formula, the PPP-rate will increase if the domestic price level increases more than the foreign price level. This type of movement in the PPP-rate could also be caused by a larger reduction in price levels abroad than domestically. On average from 2005 to 2016, China has experienced a 0,76%[37] higher inflation than the US which substantiates the proposition of more equal

[37] Own calculation based on monthly inflation year-on-year rates from Bloomberg

price levels over the years. Another reason for this movement might be a consequence of the widening of the exchange rate band in China, which allows the currency to float more freely.

Figure 32 illustrates the deviation between the two rates to see if, and by how much, the RMB has been over- or undervalued by.

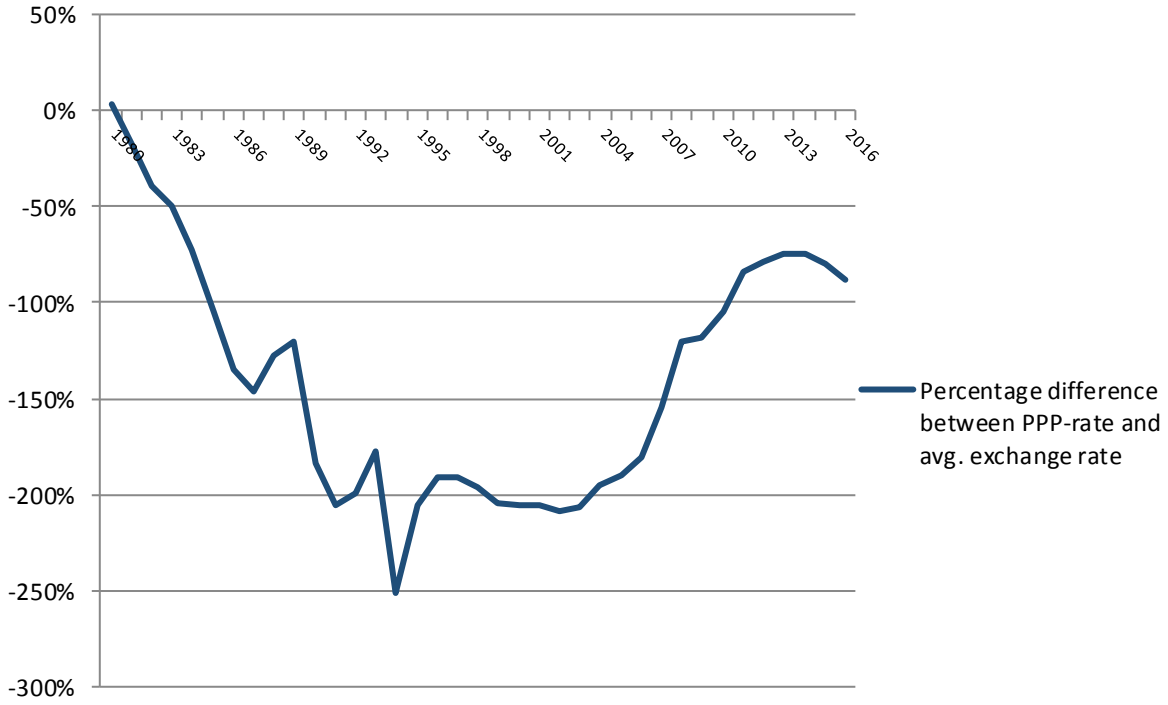

Figure 32. Percentage difference between PPP-rate and average yearly nominal exchange rate (CNY/USD). Source: Own calculations based on OECD data.
A negative percentage difference indicates a nominal exchange rate that exceeds the PPP-rate and opppsite for positive difference.

PPP theory suggests that the RMB has been undervalued since 1981. In 2016, the RMB was undervalued by 89% according to absolute PPP, which is remarkably less undervalued than earlier years. Even though the deviation from the nominal exchange rate is clear when illustrated, theory also suggests that it is fair to expect large differences and that the two rates should be equal only in the longer run. As China`s 13th five-year plan states a future average annual economic growth rate of 6,5% by 2020 (Central Committee of the Communist Party of China, 2016), it is fair to assume that growth in China will exceed economic growth in the US. Further this might contribute to

a smaller difference between the absolute PPP-rate and the actual exchange rate. Thus, it is likely to believe that the two rates might converge in the long run.

9.4.2. The Big Mac Index

A common way to measure the absolute PPP is the Big Mac Index introduced by the Economist in 1986. The purpose of this index is to give an estimate of the "correct" level of a country`s exchange rate, using the price of the Big Mac as a proxy for a country´s price level. Meaning that the "appropriate" exchange rate is derived from the price of a Big Mac in the domestic market relative to the price of a Big Mac in the foreign country. As discussed earlier, there are some complications to what goods to use when comparing price levels between countries regarding traded and non-traded goods. Since our assessment of the absolute PPP uses a basket of both traded and non-traded goods, we wish to compare our findings to the Big Mac index as it consists of a non-traded good to see if there are any interesting differences.

Absolute PPP theory suggests that the currency should converge, in the long run, to a level where a Big Mac should cost the same in two countries when quoted in the same currency. It is however important to keep in mind that the labour costs will cause a tremendous difference in price levels and probably cause an even *higher* price difference, as the Big Mac is not traded. The price of the Big Mac is in other words not exposed to international competition and will be determined by a country`s willingness to pay. As wage levels are lower in China, it will naturally lead to cheaper Big Macs than in the U.S.

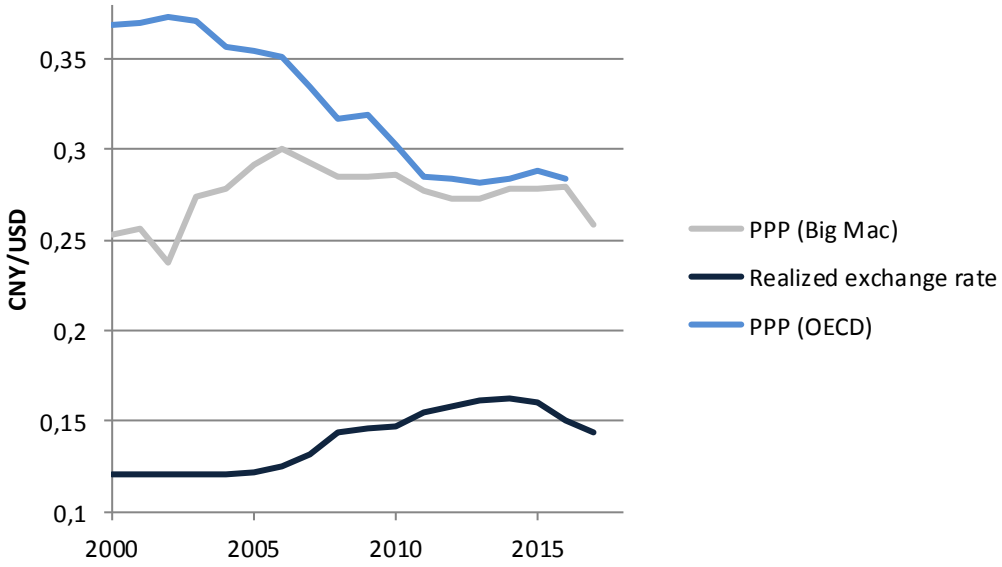

Figure 33. Absolute PPP-rate from the Big Mac Index compared to realized exchange rate and absolute PPP-rate from OECD.

Source: The Economist and OECD.

From figure 33, we see that the PPP-rate derived from the Big Mac index is overall at a lower level than the PPP-rate calculated by OECD.They do however both look out to be converging towards the actual exchange rate. To illustrate how much the RMB has been under- or overvalued, figure 34 shows the deviation of the Big Mac PPP-rate from the nominal exchange rate.

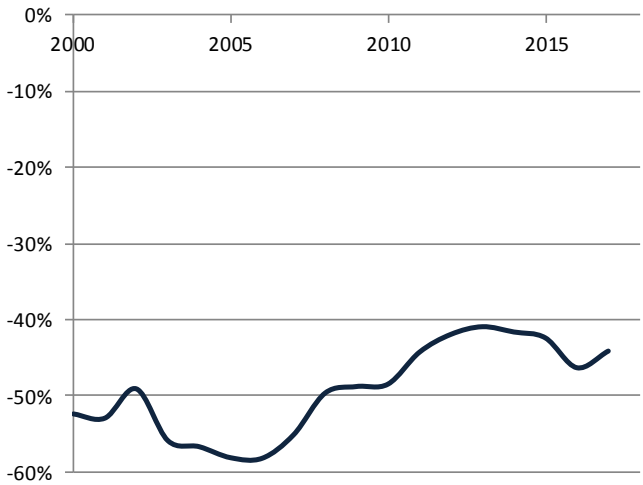

Figure 34. Percentage deviation of the absolute PPP-rate of the Big Mac index from the actual exchange rate.

Source: Own calculation on the Economist and OECD data.

A positive (negative) value indicates an overvalued (undervalued) RMB.

As of January 2017, the Big Mac index suggests that the RMB is undervalued by 44,1%. Despite it being based on a non-traded good, the result is more close to a fair value *but* still highly undervalued. When comparing the movements of our PPP calculation against the Big Mac index, it does however show similar movements. This strengthens our argument of the theory to hold in the long run as both PPP-rates seem to move closer to the actual exchange rate.

9.4.3. Relative PPP

In addition to the absolute PPP-rate we also wanted to look at inflation rate differentials between China and the US to see whether the relative PPP holds. The following graph shows the growth of the yearly average nominal exchange rate compared to the relative PPP. The relative PPP is calculated as the inflation in China minus the inflation in the US from 1990 to 2016.

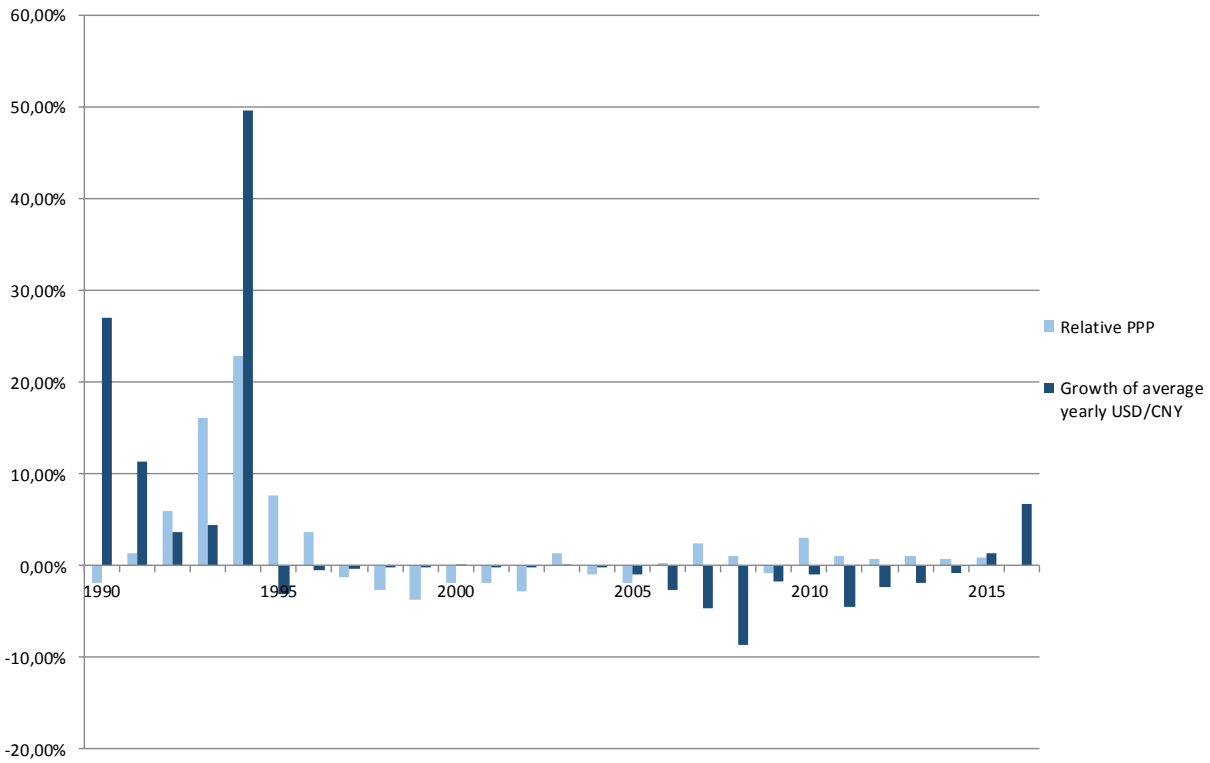

Figure 35. Relative PPP growth and actual growth of average yearly nominal exchange rate (USD/CNY).
Source: Bloomberg and OECD.
A positive (negative) value indicates a depreciation (appreciation) of the CNY relative to the USD.

The illustration shows the growth of the average nominal exchange rate and the growth according to the relative PPP. To see whether the RMB is fairly valued in 2016, we will

look at the development in the two rates over time, since they represent growth, and not the ”correct” value of the currency. Since the RMB was pegged to the dollar from 1994 to 2005, we will not include this period in the discussion because the growth of the RMB was close to zero over this period, as illustrated in figure 35. From 1990 to 1994, prior to the pegging of the currency, the relative PPP theory suggests that the RMB should mainly have depreciated, but less than it actually did. This indicates that the exchange rate was at a lower level than what would be expected if relative PPP theory was to hold. During the period following the peg, the pattern changed. From 2005 to 2016, the relative PPP growth was *lower* than the actual growth of the RMB. Accounting for the whole analysis period, this latest relation between the two rates evens out some of the long run differences, meaning that it might be moving towards a fair value.

Figure 36, shows the difference in the two growth rates to better illustrate our analysis. The difference is calculated as the growth according to relative PPP minus the realized growth rate. A positive value is then implying that the actual exchange rate has depreciated less or appreciated more than suggested by relative PPP theory.

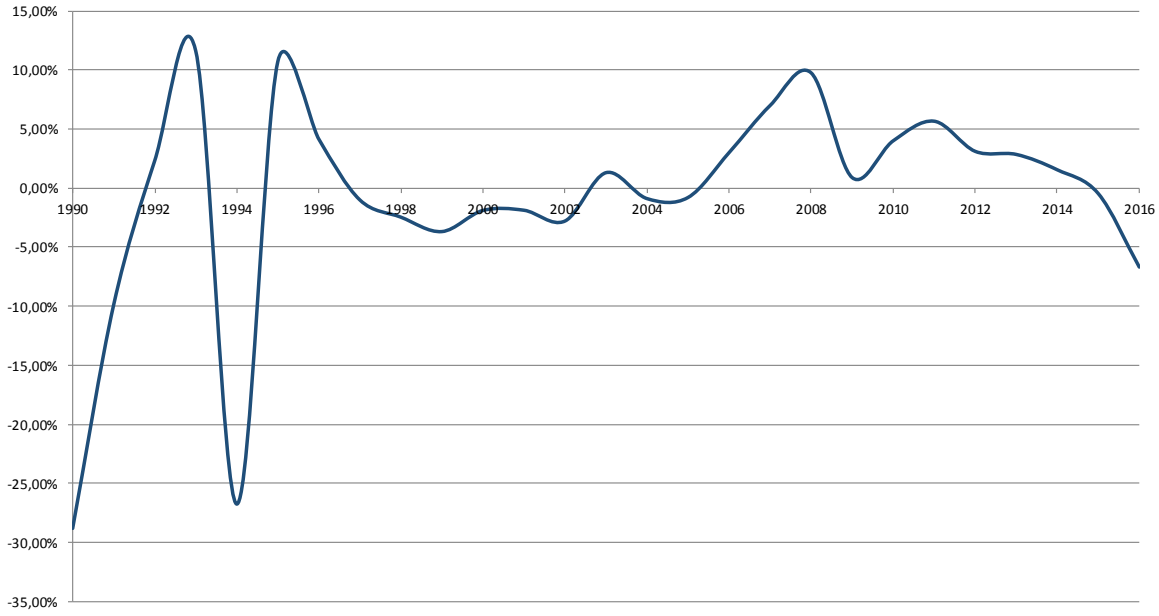

Figure 36. Difference in growth rates between relative PPP and actual growth. .[38]
Source: Own calculations based on Bloomberg and OECD data.

When interpreting the overall movements of the two rates during the chosen timeperiod, we see from figure 36 that the growth seem to almost even out, indicating a

[38] Calculated as: relative PPP – Actual growth

close to fairly valued RMB. Over the last decade, there has been a higher appreciation in the CNY relative to the USD than suggested by relative PPP, indicated by a positive value in figure 36. Thus, it seems as if the RMB might be overvalued when solely looking at the period after the peg. When looking at 2016 alone, the depreciation of the RMB has been higher than suggested by the relative PPP. But as disscussed earlier, the relative PPP is a long run model, which makes it difficult to draw any definite conclusion based on this year alone. When looking at expected inflation, the inflation differential is 0,26% (OECD, 2017) in 2017, which indicates that the RMB is expected to depreciate in 2017 according to relative PPP theory. As this predicts a further depreciation of the RMB, this strengthens our belief of a slightly overvalued currency. In total we therefore conclude that the RMB is converging towards a fair value, but might be slightly *overvalued* at the end of 2016.

It should also be mentioned that this is just the conclusion made from the applied time period. If we were to analyse a longer or shorter timeperiod, the conclusion could be different. This does however not necessarily mean that a wider timeframe would give a more *correct* conclusion.

9.5. Conclusion

To summarize, the absolute PPP indicates an undervalued RMB at the end of 2016, but that it is slowly moving towards a fair value. We see this as a reasonable conclusion because of the ever less rigid exchange rate regime. The currency is therefore possibly more affected by market forces than earlier, and could be moving towards equilibrium. Another reason that substantiates the two rates converging, is the development in the price levels in the US and China. As China aims at an average annual economic growth of 6% within 2020, we assume the difference in price levels to be further reduced and the currency to be fairly valued in the long run.

The relative PPP does on the other hand indicate a possibly overvalued RMB given the timeframe assessed. The latest development in the relative PPP against the actual movements of the exchange rate can be seen as a correction of the misalignment from before the RMB was pegged, indicating a possible movement towards a more fairly valued RMB in the long run.

It is difficult to draw any definite conclusion of the value of the RMB as the rates provides different conclusions. They do however both indicate a development towards a fairly valued RMB. We therefore assume the RMB to be *fairly valued* in the long run.

Part 6. Final conclusion

10. Final conclusion

Over the course of the thesis, analyses of the Chinese liberalization process and its effect on the RMB has been conducted to create a sound fundament for an assessment of the RMB. The analyses are based on the six subquestions in chapter 1.3. leading to a final conclusion to the problem statement.

By de-pegging the exchange rate from the dollar, China`s position in the impossible trinity suddenly became less obvious. The corridor is gradually being widened, allowing the RMB to be affected by market forces, while capital controls are slowly being liberalized. Thus, China experiments with a partial solution, combining all three sides. However, this far, capital is fleeing the country and the RMB is depreciating, forcing the use of foreign exchange reserves to stabilize the currency.

The Balance of payments analysis shows a unique development of the twin surpluses over larger parts of the period. It is argued by economists that these twin surpluses represent a misallocation of resources and a loss of welfare on China`s behalf. Moreover, following the financial crisis, exports`contribution to growth mitigated, and China turned to investments to boost growth. This caused an excess of investment, but due to high savings rates, the CA surplus was maintained. In recent years, the rebalancing process that aims to switch investment-based growth to consumption-based growth, and thereby reduce savings, has guided the CA surpluses to more sustainable levels. Further, the BoP of the US and its trade relationship with China was analyzed. The US finance a lot of Chinas investments through its imports of Chinese goods, while China lend the money back to the US through low yield investments, as part of its monetary policy and exchange rate regime. The chapter provides a subconclusion to the assessment of the RMB and concludes that, in accordance with the common perception, the RMB has been undervalued for a greater part of the analysis period. However, with BoP accounts evening out, it is fair to assume that the RMB is fairly valued.

With the long period of BoP surpluses, China accumulated hordes of foreign exchange reserves, mostly in the form of USD denominated assets. These large reserves have made China capable of stabilizing currency fluctuations through foreign exchange interventions. Over the analysis period, China has used the foreign exchange reserves to *lean against the wind*. In the latter part of the analysis period, the foreign exchange reserves have seen a drastic fall, along with increasing net capital outflows over the BoP and a depreciating RMB. Thus, China sells off its dollar denominated assets to support its currency from the shrinking CA surplus and the increasing capital outflows. The chapter provided the second sub conclusion to the assessment of the RMB. The analysis finds, similarly to the analysis of the BoP, that the RMB has been undervalued over the greater part of the period. Moreover, after the momentum of the RMB shifted and the foreign exchange reserves rapidly started shrinking, the analysis points in the direction of an overvalued RMB.

After running a linear regression model using macroeconomic variables, we reject the null hypothesis as it is found that the variables had a weak, but significant, explanatory power on the changes in the exchange rate. The frequent widening of the band, which the exchange rate is allowed to fluctuate within, may have caused the model to vary over the analysis period. The model fails to give any reasonable conclusion to whether the RMB is fairly valued. Nevertheless, the results indicates that even though the RMB was de-pegged from the dollar it is still regulated through interventions, and seems to undermine the effect from market forces.

According to absolute PPP theory, the RMB is undervalued by 89% on the contrary to the relative PPP theory, which indicates a possible overvalued RMB. Both PPP theories indicate a movement towards equilibrium and a fairly valued currency. When considering the stickyness of price levels and the future economic development, we consider it to be closer to a fair value than indicated by the absolute PPP-rate. The relative PPP also indicates that the currency might be converging towards a fair value. From PPP-theory, we conclude that the RMB is fairly valued in the long run.

By de-pegging the RMB and further liberalizing the way it conducts its monetary policy, China is moving towards the status as a modern advanced economy. The open door policy has made the RMB more sensitive to market forces, causing it to appreciate as

soon as the peg was released, and more recent, with less capital controls and larger capital outflows, depreciate. Our analysis does not determine a specific equilibrium for the exchange rate, therefore this thesis does not provide an exact misalignment of the RMB. It does however show an indication of being slightly above an equilibrium value, but within a range to be considered fairly valued. It is fair to assume that the recent depreciation will abate as net capital outflows abate, with increasing inflows as a result of a more stable economy. With China`s aim of making the RMB a global reserve, competing with the USD, GBP, EUR and Yen, it is dependent on a strong currency and cannot allow it to lose substantial value. Moreover, as the internationalizing of the RMB has accelerated over the last decade, the future should write an even more interesting story.

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12. Appendices

Appendix 1: Balance of Payments analytic presentation description

2. "Analytic" presentation

14.16 The analytic presentation is a reorganization of the standard presentation of balance of payments statistics to facilitate a basic distinction between (a) reserves and closely related items and (b) other transactions. The analytic presentation is an example of a satellite account and is designed to focus on management of reserves and closely related items, but the term "analytic" should not be taken to suggest that this presentation is suitable for all analytical purposes or that other presentations are not useful for other kinds of analysis. Table 14.1 illustrates this presentation. It draws the line between the ways monetary authorities finance transactions (below the line) and other items (above the line).

14.17 This presentation shows how reserves, along with the related items of IMF credit and loans, and exceptional financing (such as accumulation of arrears, debt forgiveness, intergovernmental grants, and debt restructuring) are used to finance other "autonomous" international transactions. Exceptional financing is discussed in detail in Appendix 1. The presentation is useful for monetary authorities that use intervention, including managed exchange rate regimes, with various degrees of flexibility. Arrears related to exceptional financing are recorded below the line as transactions in the analytical presentation with the corresponding entry in the relevant instrument. (This treatment is because, although the accumulation of arrears is not a transaction, it results from the actions of the monetary authorities.) Categories of the balance of the payments above-the-line from which transactions could be taken to below-the-line are marked as "(n.i.e.)."

Source: IMF (2009, p.225)

Table 14.1. "Analytic" Presentation of the Balance of Payments[1]

	Credits	Debits
Current account n.i.e.		
Goods		
Services		
Primary income		
Secondary income n.i.e.		
Balance on current account n.i.e.		
Capital account n.i.e.		
Balance on capital account n.i.e.		
Financial account n.i.e.		
Direct investment n.i.e.		
Portfolio investment n.i.e.		
Financial derivatives and ESOs n.i.e.		
Other investment n.i.e.		
Balance on financial account n.i.e.		
Balance on current, capital, and financial accounts n.i.e.		
Reserves and related items		
Reserve assets		
IMF credit and loans		
Exceptional financing		
Total reserves and related items		

[1]Exceptional financing items are moved from the current, capital, and financial accounts to the reserves and related items heading. For this reason, other items are stated as being n.i.e. (Exceptional financing is discussed in Appendix 1.)

Source: IMF (2009, p.226)

Appendix 2: Balance of payments framework

Balance of Payments framework	Credits	Debits	Balance
Current Account			
Goods and Services	150	75	75
Goods	100	50	
Services	50	25	
Primary Income	60	50	10
Compensation of employees	5	5	
Interest	10	5	
Distributed income of corporations	20	15	
Reinvested earnings	15	20	
Rent	10	5	
Secondary Income	25	30	-5
Current taxes on income, wealth, etc.	0	5	
Net nonlife insurance premiums	5	10	
Nonlife insurance claims	5	0	
Current international cooperation	5	10	
Miscellaneous for change in pension entitlements	10	5	
Current account Balance	235	155	80
Capital account			
Acquisition/disposals of nonproduced nonfinancial assets	0	0	
Capital transfers	5	10	
Capital account balance	5	10	-5
Net lending (+)/net borrowing (-) (from current and capital accounts)			75

	Net acquisition of financial assets	Net Incurrence of liabilities	Balance
Financial account			
Direct investment	25	10	
Portfolio investment	15	5	
Financial derivatives (other rhan reserves) and ESOs*	10	5	
Other investment	20	5	
Reserve assets	30		
Total changes in assets/liabilities	100	25	
Net lending (+)/net borrowing (-) (from financial account)			75
Net errors and omissions			0

* Emlpoyee Stock Options

Source: (IMF, 2009)
https://www.imf.org/external/pubs/ft/bop/2007/pdf/chap2.pdf

Appendix 3: WGI aggregation methodology

WGI Aggregation Methodology

Each of six aggregate WGI measures are constructed by averaging together data from the underlying sources that correspond to the concept of governance being measured. This is done in the three steps described below.

STEP 1: Assigning data from individual sources to the six aggregate indicators. Individual questions from the underlying data sources are assigned to each of the six aggregate indicators. For example, a firm survey question on the regulatory environment would be assigned to Regulatory Quality, or a measure of press freedom would be assigned to Voice and Accountability. A full description of the individual variables used in the WGI and how they are assigned to the six aggregate indicators, can be found by clicking on the names of the six aggregate indicators listed above. Note that not all of the data sources cover all countries, and so the aggregate governance scores are based on different sets of underlying data for different countries.

STEP 2: Preliminary rescaling of the individual source data to run from 0 to 1. The questions from the individual data sources are first rescaled to range from 0 to 1, with higher values corresponding to better outcomes. If, for example, a survey question asks for responses on a scale from a minimum of 1 to a maximum of 4, we rescale a score of 2 as (2-min)/(max-min)=(2-1)/3=0.33. When an individual data source provides more than one question relating to a particular dimension of governance, we average together the rescaled scores.

The 0-1 rescaled data from the individual sources are available interactively through the WGI website here, and in the data files for each individual source. Although nominally in the same 0-1 units, this rescaled data is not necessarily comparable across sources. For example, one data source might use a 0-10 scale but in practice most scores are clustered between 6 and 10, while another data source might also use a 0-10 scale but have responses spread out over the entire range. While the max-min rescaling above does not correct for this source of non-comparability, the procedure used to construct the aggregate indicators does (see below).

STEP 3: Using an Unobserved Components Model (UCM) to construct a weighted average of the individual indicators for each source. A statistical tool known as an Unobserved Components Model (UCM) is used to make the 0-1 rescaled data comparable across sources, and then to construct a weighted average of the data from each source for each country. The UCM assumes that the observed data from each source are a linear function of the unobserved level of governance, plus an error term. This linear function is different for different data sources, and so corrects for the remaining non-comparability of units of the rescaled data noted above. The resulting estimates of governance are a weighted average of the data from each source, with weights reflecting the pattern of correlation among data sources. Click here for the weights applied to the component indicators.

The UCM assigns greater weight to data sources that tend to be more strongly correlated with each other. While this weighting improves the statistical precision of the aggregate indicators, it typically does not affect very much the ranking of countries on the aggregate indicators. The composite measures of governance generated by the UCM are in units of a standard normal distribution, with mean zero, standard deviation of one, and running from approximately -2.5 to 2.5, with higher values corresponding to better governance. We also report the data in percentile rank term, ranging from 0 (lowest rank) to 100 (highest rank).

(Source: World Wide Governance Indicators)
http://info.worldbank.org/governance/wgi/#doc

Appendix 4: Dickey Fuller test

Constant, no trend (single mean)						
	Δ(0)			Δ(1)		
Variables	Tau-value	Critical value (5%)	Result	Tau-value	Critical value (5%)	Result
CNY/USD	-2,23	-2,89	Nonstationary	-6,27	-2,89	Stationary
GDPCN	-2,98	-2,89	Stationary	-0,58	-2,89	Nonstationary
GDPUS	0,19	-2,89	Nonstationary	-9,06	-2,89	Stationary
CACN	-1,93	-2,89	Nonstationary	-4,9	-2,89	Stationary
CAUS	0,02	-2,89	Nonstationary	-7,48	-2,89	Stationary
FDICN	-2,05	-2,89	Nonstationary	-5,07	-2,89	Stationary
FXRCN	-4,55	-2,89	Stationary	-2,2	-2,89	Nonstationary
PSICN	-2,86	-2,89	Nonstationary	-3,63	-2,89	Stationary
PSIUS	-2,04	-2,89	Nonstationary	-5,18	-2,89	Stationary
NAUS	-1,29	-2,89	Nonstationary	-4,61	-2,89	Stationary
INFCN_INFUS	-4,39	-2,89	Stationary	-3,12	-2,89	Stationary
IRCN_IRUS	-1,64	-2,89	Nonstationary	-4,98	-2,89	Stationary

Constant and trend (trend)						
	Δ(0)			Δ(1)		
Variables	Tau-value	Critical value (5%)		Tau-value	Critical value (5%)	Result
CNY/USD	2,03	-3,45	Nonstationary	-7,57	-3,45	Stationary
GDPCN	-1,22	-3,45	Nonstationary	-3,9	-3,45	Stationary
GDPUS	-1,17	-3,45	Nonstationary	-9,04	-3,45	Stationary
CACN	-3,14	-3,45	Nonstationary	-4,98	-3,45	Stationary
CAUS	-1,85	-3,45	Nonstationary	-7,52	-3,45	Stationary
FDICN	-2,56	-3,45	Nonstationary	-5,28	-3,45	Stationary
FXRCN	0,81	-3,45	Nonstationary	-4,53	-3,45	Stationary
PSICN	-2,81	-3,45	Nonstationary	-3,64	-3,45	Stationary
PSIUS	-2,5	-3,45	Nonstationary	-5,68	-3,45	Stationary
NAUS	-1,24	-3,45	Nonstationary	-4,9	-3,45	Stationary
INFCN_INFUS	-3,23	-3,45	Nonstationary	-4,72	-3,45	Stationary
IRCN_IRUS	-1,3	-3,45	Nonstationary	-3,98	-3,45	Stationary

Appendix 5: Test for trend

Parameter Estimates						
Variable	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**	**Variable Label**
Intercept	1	0.000682	0.001300	0.52	0.6005	
trend	1	-0.000021	0.0000167	-1.26	0.2087	
INFCN_INFUS	1	0.1145	0.0401	2.86	0.0050	INFCN-INFUS

Parameter Estimates						
Variable	**DF**	**Estimate**	**Standard Error**	**t Value**	**Approx Pr > |t|**	**Variable Label**
Intercept	1	0.000137	0.000517	0.27	0.7911	
trend	1	-0.000015	5,68E-02	-2.64	0.0094	
IRCN_IRUS	1	0.0226	0.0129	1.75	0.0825	IRCN-IRUS

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.005449	0.001930	2.82	0.0055	
trend	1	-0.000025	0.0000117	-2.14	0.0338	
CAUS	1	0.0963	0.0336	2.87	0.0048	CAUS

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.004154	0.001041	3.99	0.0001	
trend	1	6,37E-02	0.0000123	0.52	0.6056	
NAUS	1	11.161	0.0861	12.96	<.0001	NAUS

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-0.1118	0.1105	-1.01	0.3135
trend	1	-0.000202	0.000126	-1.60	0.0236
GDPCN	1	0.0129	0.0113	1.15	0.2528

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-0.0495	0.0461	-1.07	0.2847
trend	1	-0.000421	0.0000807	-5.22	<.0001
FXRCN	1	0.0115	0.006577	1.75	0.0828

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	-0.002908	0.002341	-1.24	0.2164	
trend	1	6,57E-02	0.0000197	0.33	0.7391	
CACN	1	0.0425	0.0244	1.74	0.0845	CACN

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	0.0323	0.0175	1.85	0.0666	
trend	1	0.000110	0.0000626	1.75	0.0827	
PSICN	1	0.0784	0.0360	2.18	0.0313	PSICN

Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-16.315	0.1590	-10.26	<.0001
trend	1	-0.004780	0.000709	-6.74	<.0001
FDICN	1	0.9356	0.0868	10.78	<.0001

Parameter Estimates						
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|	Variable Label
Intercept	1	-0.005380	0.001552	-3.47	0.0007	
trend	1	-0.000022	3,75E-02	-5.87	<.0001	
CNY_USD	1	0.0476	0.0119	4.01	<.0001	CNY/USD

Appendix 6: Regression results from SAS

The SAS System

The MODEL Procedure

Nonlinear GMM Summary of Residual Errors							
Equation	DF Model	DF Error	SSE	MSE	Root MSE	R-Square	Adj R-Sq
dcny_usd	5	132	0.000090	6.534E-7	0.000808	0.3377	0.3176

Nonlinear GMM Parameter Estimates				
Parameter	Estimate	Approx Std Err	t Value	Approx Pr > |t|
b0	-0.00048	0.000145	-3.33	0.0011
b1	0.017947	0.00681	2.64	0.0094
b2	-0.04636	0.00757	-6.12	<.0001
b3	0.037859	0.0114	3.32	0.0012
b4	0.067069	0.0209	3.21	0.0017

Number of Observations		Statistics for System	
Used	137	Objective	2.146E-31
Missing	41	Objective*N	2.94E-29

GMM Test Statistics			
Test	DF	Statistic	Prob
Overidentifying Restrictions	0	0.00	.