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Lenient Entry, Stringent Exit

A Political Economy of Foreign Exchange Reserve Demand and Policy in the People's Republic of China

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Abstract: This thesis explores the links between China's demand for foreign exchange reserves and the political economy aspects of China's monetary policy framework since the start of reforms in 1978. In a single-country approach focused on China, this study combines an assessment of the politico-economic factors that may have influenced China's demand for foreign exchange reserves with a cointegration analysis of the macroeconomic determinants of the demand for reserves. The assessment suggests that China's monetary policy framework has been geared to accomplish the government's long-lived goal of high export- and investment-led growth, at the expense of the wealth of Chinese households. The empirical findings support the premise of a strong connection between China's growth model and the demand for international reserves, which is noticed by a dominance of current and capital account considerations in China's short- and long-term demand for foreign exchange reserves.

Key words: Foreign exchange reserves, China, political economy, monetary policy, reserve demand.

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List of abbreviations and acronyms

ADF (test)	Augmented Dickey Fuller (test)
CIC	China Investment Corporation
EMDCs	emerging markets and developing countries
EME(s)	emerging-market economy(ies)
FDI	foreign direct investment
GDP	gross domestic product
IMF	International Monetary Fund
PBoC	People's Bank of China
PRC	People's Republic of China
RIF(s)	reserve investment fund(s)
RMB	renminbi
SAFE	State Administration of Foreign Exchange
SDR(s)	Special Drawing Right(s)
SWF(s)	sovereign wealth fund(s)
VEC(M)	vector error correction (model)

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1 Introduction

“In deciding the right amount for this [foreign exchange] reserve he endeavoured to arrive at a reasoned estimate of the magnitude of the drain which India might have to meet through the sudden withdrawal of foreign funds, or through a sudden drop in the value of Indian exports (particularly jute and, secondarily, wheat) as a result of bad harvests or poor prices. This is the sort of calculation which every central bank ought to make.”

(John Maynard Keynes, 1930: 276-277)

The global stock of international reserves has grown rapidly over the past two decades. International reserves, or foreign exchange reserves, are defined as the stock of liquid assets - usually in the form of foreign government bonds - which are available to monetary authorities for balance of payments financing (International Monetary Fund (IMF), 1993: §424; 2001: §135). The breakdown of the Bretton Woods regime in the 1970s and the subsequent propagation of exchange rate flexibility among countries was expected to gradually reduce the need for international reserves, because countries would no longer have to defend the peg of their domestic currencies through interventions. Instead, global reserves have quintupled since the 1960s and increased dramatically since the 2000s, covering over \$11 trillion in 2016 (Bloomberg indicators). About half of that amount is kept by emerging markets and developing countries (EMDCs), particularly in the Asian region. The list is headed by the People’s Republic of China (PRC). Since 1981, the PRC has experienced a 25% average yearly increase of its reserve stock and now holds over \$3 trillion in reserves.

The rapid build-up of international reserves by emerging-market economies (EMEs) in recent years, particularly in the Asian region, has renewed old discussions about the reasons why countries hold them in the first place. These discussions have a long tradition of being translated into empirical work. Since the 1960s research has tried to determine which factors influence the demand in terms of how many reserves countries need to address macroeconomic issues, while minimizing the costs of holding reserves. The last twenty years have witnessed a revival of such studies which attempt to explain the reserve build-up by EMDCs. The majority of studies analyse multiple countries or regions at once and often only explain the phenomenon in economic terms, yet in so doing tend to disregard the political economy motivations that affect this demand. This study argues that the Chinese experience of reserve accumulation is significantly different from other countries. Apart from the colossal

size of its reserve holdings that dwarf the holdings of other EMDCs, China's history of planned economy and unique political economy of market transition may impact its demand for international reserves in completely different ways.

This thesis holds that we cannot fully grasp the empirical evidence on China's reserve demand without an understanding of the political and institutional environment surrounding it. The IMF has been at the forefront of the reserve debate and rightly warned us that "using regressions to provide guidance on the adequacy of individual countries' reserves depends on an assumption that there are no systematic biases towards over- or under-insurance for the sample as a whole" (IMF, 2011). Political and institutional biases in particular have a systematic effect on the size and management of a country's foreign exchange reserves and may have had a decisive influence on the expansion of reserve holdings in the PRC. This makes the case for a single-country analysis of the PRC that combines these approaches. The aim of this study is to explore the links between China's demand for international reserves and the broader aspects of its political economy since the 'reform and opening-up' that was started in 1978. The analysis will revolve around the following research question:

How has the structure of China's politico-economic model been associated with the management of and the demand for foreign exchange reserves?

This thesis is organized as follows. Section 2 will start with a discussion of the political economy aspects of China's monetary and foreign exchange reserve policy. This section will explain how China's reserve management is positioned within the country's institutional and political frameworks. Section 3 will provide an overview of the academic debate and the economic theory which defines the demand and need for international reserves among countries. The fourth section will review the empirical literature since the 1960s, including the existing but limited empirical work focused on the PRC. Based on the theoretical considerations and previous econometric applications, this study will introduce a reserve-demand model in section 5 to analyse the impact of changes in China's (macro)economic fundamentals on the short- and long-run demand for international reserves. The results section will attempt to interpret the empirical dynamics of China's demand for international reserves in the light of its politico-economic model.

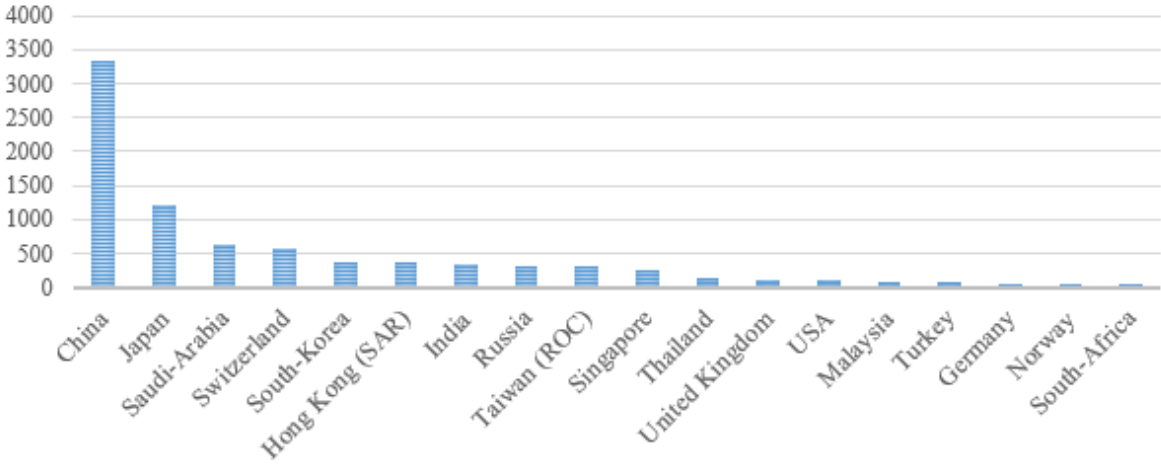
2 Reserve demand and policy in China: Trends and explanations

International reserves are a normal item in the toolkit of central banks. Every country engaged in international trade and investment, regardless of size or level of development, holds at least some quantity to pay for imports and to insure against exogenous shocks and international liquidity shortages. While the growth of foreign exchange reserve holdings has been a world-wide phenomenon among EMDCs over the last 20 years, holdings of the PRC have grown at unprecedented rates. This section will take a political economy perspective to explain the dynamics of China’s monetary policy and the build-up of foreign exchange reserves, its close relationship with the fundamentals of China’s export- and investment-led growth model, as well as the current and future implications of this economic model both for the PRC and the global economy.

2.1 Stylized facts and trends

Barring developed countries like Switzerland and Japan, international reserves are now increasingly concentrated in developing countries, ranging from major oil-exporters in the Middle-East to EMEs in South-America and Asia. In real terms, growth rates have been especially high for the Asian region. As of December 2016, no less than eight Asian countries

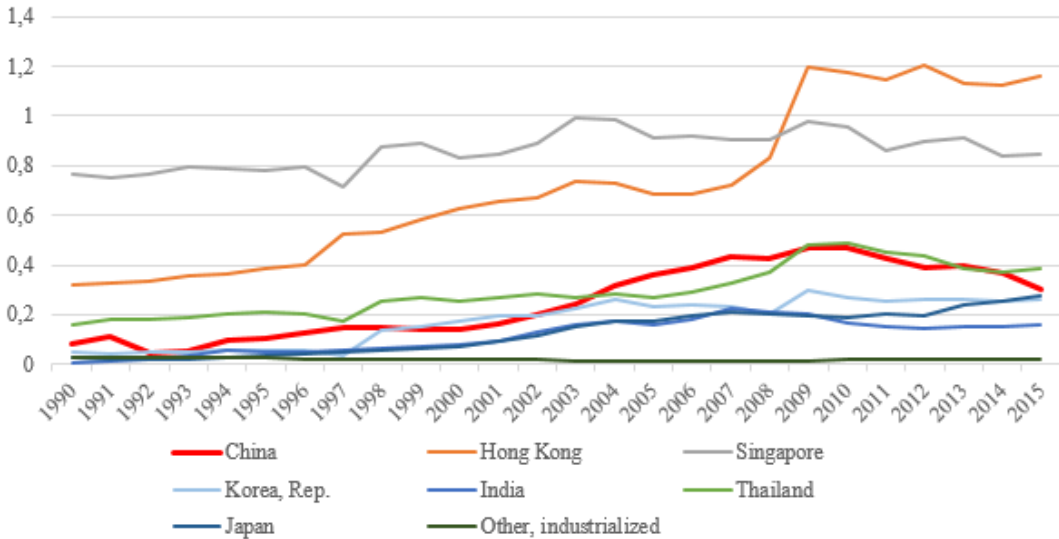
FIGURE 1: OFFICIAL RESERVE HOLDINGS MINUS GOLD, SELECTED COUNTRIES IN US\$ BILLION (2015)



Source: PBoC; World Bank Development Indicators

were among the world’s largest holders of foreign reserves: Japan, Taiwan (Republic of China), India, South-Korea, Hong Kong, Singapore, Thailand and the PRC. The PRC surpassed Japan as the world’s largest holder of foreign exchange in February 2006. China’s reserves have grown by 25% per year since 1981 and it is now by far the world’s biggest holder, with around \$3.2 trillion in (mostly dollar-denominated) reserve assets. With that, China is dwarfing notoriously large hoarders such as Japan, South-Korea and Saudi-Arabia (figure 1).

FIGURE 2: RESERVES-TO-GDP RATIO, EMERGING ASIA AND JAPAN (1990-2015)



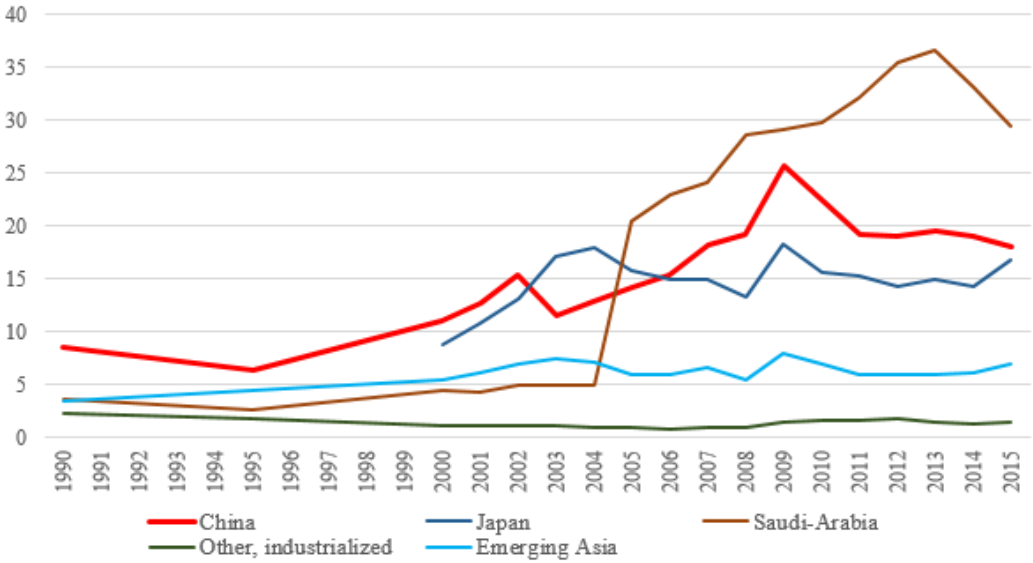
Source: World Bank

Since the growth of a country’s international reserves tends to reflect the growth of total output, it is helpful to scale reserve holdings by standard ratios. These ratios have been used extensively in formal and more informal assessments that try to demonstrate the differences in reserve demand among countries. Figure 2 scales foreign reserves as a percentage of GDP for a selection of Asian countries and advanced economies, including the United States and Great Britain. While the ratio of reserves to GDP for most industrialized countries has been steady over time at approximately 5 percent, we can see that reserve levels in Asia started to rise in the 1990s. Reserves of the city-states of Singapore and Hong Kong are now about as high as total output. We can see that the reserve-to-GDP ratio for the PRC has decreased by about 20 percent since 2009. This supports the argument of many analysts that the rate of reserve accumulation in China came to a halt in 2010 and has started to decrease since 2013. They attribute the drop mainly to stagnating economic growth in China (Neely, 2017). The PRC

now has roughly 30 percent of GDP invested in foreign reserves and ranks mid-range among its neighbouring countries.

Yet another way to assess the relative growth of foreign exchange holdings is by looking at the number of months for which a country can use reserves to support current import levels. The ratio of reserves to imports is an indicator of the probability and severity of an economic crisis, as it reflects the amount of time that a country could withstand a potential

FIGURE 3: TOTAL RESERVES TO MONTHS OF IMPORTS, SELECTED AND COUNTRY GROUPS (1990-2015)



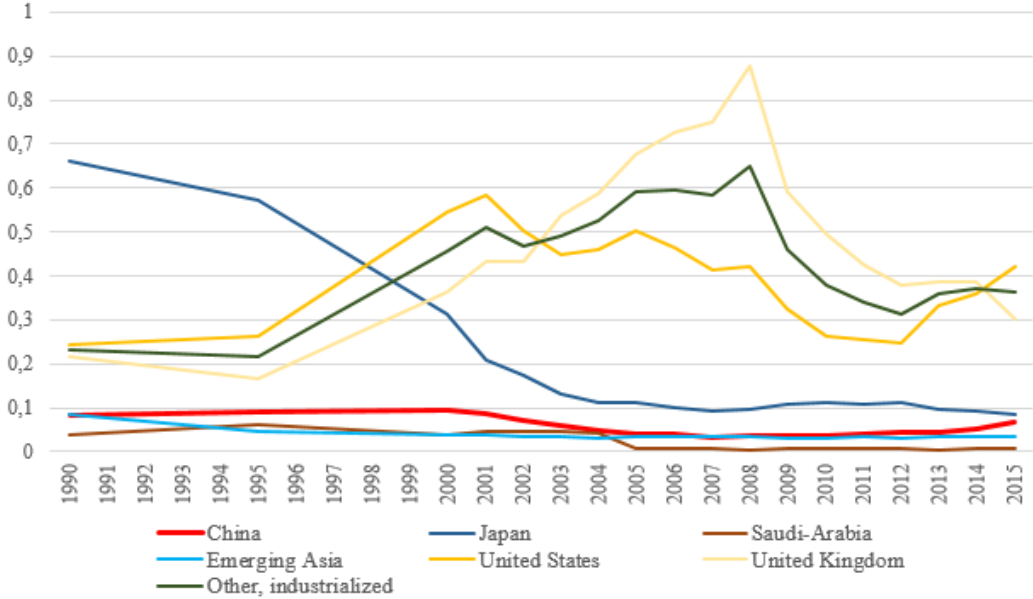
Source: World Bank; OECD Country statistics

stand-still of in- and outflows. Figure 3 shows that the ratio is especially high for major oil-exporters such as Saudi-Arabia that deal with market price fluctuations and the risk of falling exports on a daily basis. This is also a reality for manufacturing-driven economies like China who are dependent on a constant stream of raw materials to feed their industries. We can see that China has the highest level of reserves to imports in the Asian region, which should be regarded in relation to the total volume of trade.

A final measure worth looking at is the ratio of exchange reserves and the money supply. Indicators for the money supply in a country are typically divided between ‘narrow’ money (M0 or M1) and ‘broad’ money (M2 or M3). Narrow money is the amount in circulation of material currency, including coins and notes (M0), complemented by deposit accounts that can be easily converted into cash (M1). The broad money supply resembles M1 plus short-term time deposits in banks and 24-hour money market funds (M2), as well as

longer-term time deposits and money market funds with a maturity of more than 24 hours (M3). This study uses the broad money supply (M2) as an indicator of changes in the domestic money supply. Like the measure of reserves to months of import, this ratio is an indicator of the adequacy of reserves in the event of a crisis but from the perspective of a country’s capital account. The ratio is widely used as a measure of the potential for and depth

FIGURE 4: RESERVES-TO-M2 RATIO, SELECTED AND COUNTRY GROUPS (1990-2015)



Source: World Bank; OECD Country statistics

of resident-based capital flight from the domestic currency (Edison, 2003). Figure 4 indicates that, compared with the amount of renminbi (RMB) flowing around in the Chinese economy, the size of China’s exchange reserves and thus its capacity to attenuate capital outflows is limited. The PRC has a ratio below 10 percent, while the IMF recommends a 20 percent upper-bound threshold (IMF, 2011).

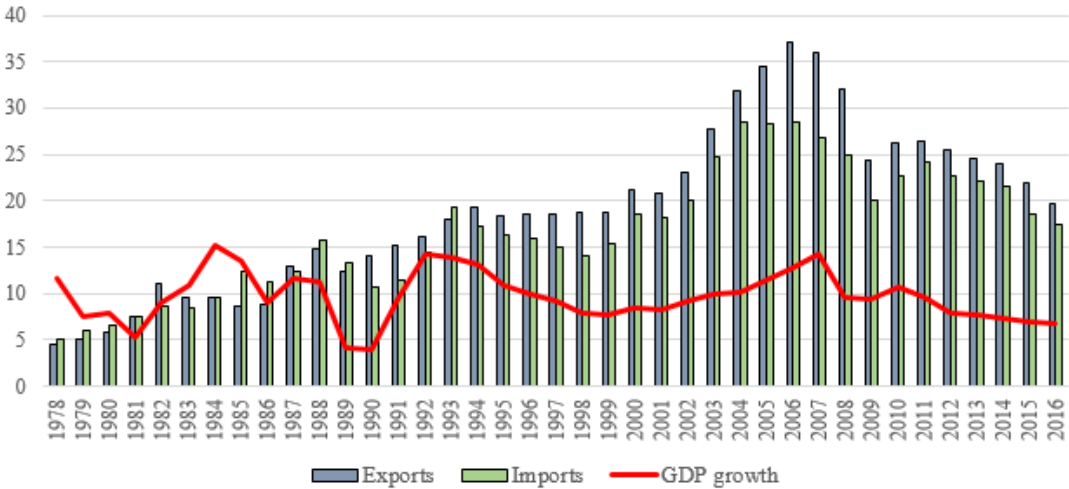
In short, China’s \$3 trillion-plus international reserves look formidable by all measures, except for the ratio of reserves and the broad money supply. The remainder of this section will attempt to explain how these observations relate to China’s monetary and international reserve policy characterized by managed exchange rates, capital controls and financial repression.

2.2 Explanations for China’s reserve accumulation

2.2.1 China’s growth miracle

Ever since the start of reform and opening-up policies in the late 1970s, a rapidly growing export sector and high inflow of FDI helped to transform the PRC from a poor and nearly autarchic country into the world’s largest manufacturing economy. By the time Deng Xiaoping made his famous ‘Southern Tour’ in 1992 that gave the final push for China’s economic development, the Chinese economy was looking at double-digit growth averaging 10 percent per year (figure 5). Per capita GDP has grown at a similar pace, which drastically increased the standard of living and altered the lives of over 600 million Chinese that were pulled out of (extreme) poverty (Lin, 2011). Considering its remarkable rise as a global manufacturing economy, the PRC was famously presented as the ‘new workshop of the world’ in the popular press after the example of 19th century Britain. (The Economist, 2002).

FIGURE 5: SHARE OF EXPORTS AND IMPORTS IN GROSS DOMESTIC PRODUCT, PEOPLE'S REPUBLIC OF CHINA (1978-2016)



Source: World Bank Development Indicators

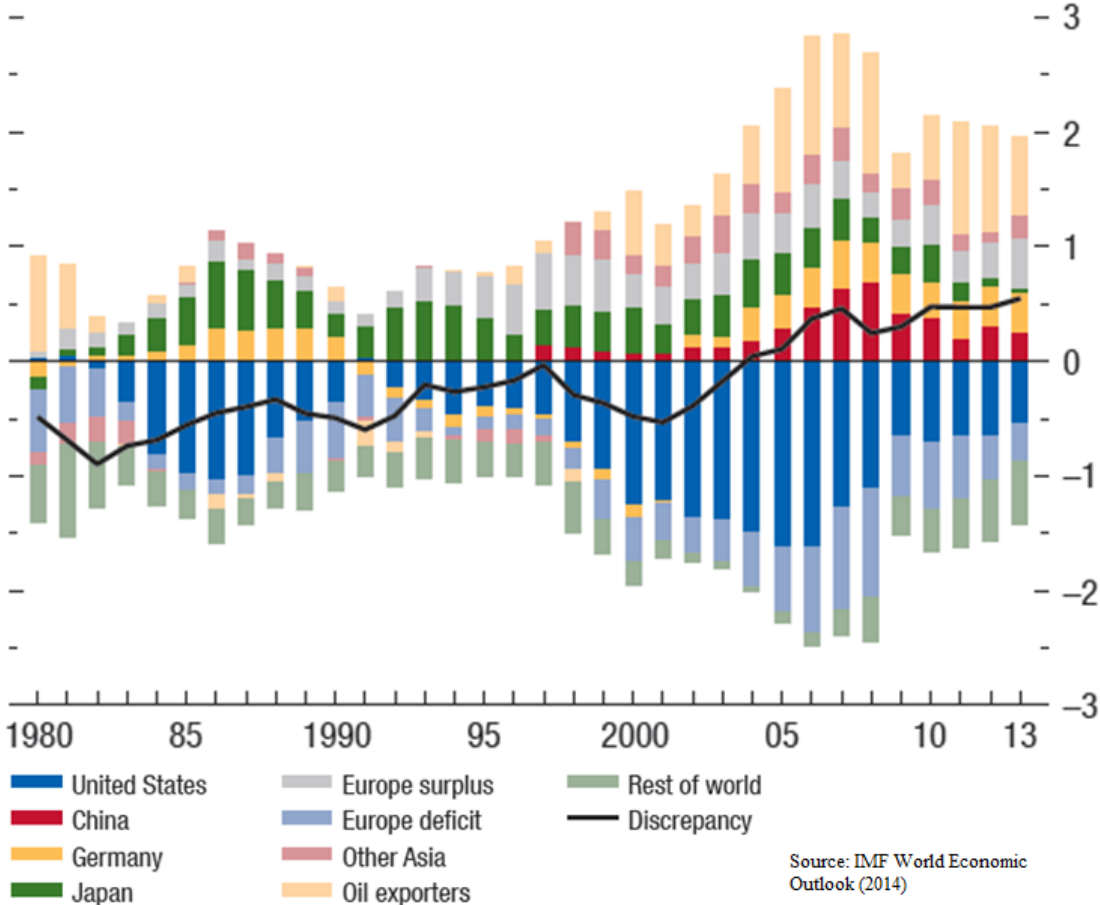
Figure 5 shows that China now depends for a quarter of its GDP on exports, with peaks above 35 percent in the early 2000s in the run-up to the global financial crisis. To illustrate this in real terms, in 2016 the PRC imported for about \$1.6 trillion from the rest of the world, while export levels amounted to a staggering \$2.1 trillion (CIA World Factbook). This level of

exports is almost 1.5 times the size of that of the world’s second largest exporter, the United States and two times that of Germany, the third biggest exporting economy.

2.2.2 *The (im)balance of payments*

While the numbers look bright, the focus on export-led growth has caused a number of distortions in China’s pattern of trade which are associated with the influx of foreign reserves. One side-effect of its workshop status is that the Chinese economy has run surpluses in the current account since the early 1990s (figure 5). These are reflected by current account deficits in other countries that have a higher ratio of imports over exports. At a superficial level, the accumulation of international reserves by the PRC seems like a natural consequence of imbalances that have characterized global trade for more than two decades. As depicted by figure 6, since the 1990s the PRC has run structural current account surpluses on the left-hand side with evenly large trade deficits chalked up by Western countries (particularly by the

FIGURE 6: GLOBAL CURRENT ACCOUNT IMBALANCES, % OF GDP (1980-2013)



United States) on the right-hand side of the balance sheet. As a rule, exports are paid for in dollars and to a lesser extent in euros, pounds or other currencies from the IMF's Special Drawing Rights (SDRs) currency basket.¹ Since exports exceed imports, China experiences a net inflow of international reserves. In this respect, the situation in the PRC is not much different from oil-exporting EMDCs and the more advanced surplus economies like Germany and Japan.

However, these events only partly explain China's surging exchange reserve holdings. China's reserves seem to be much larger than the amount that would result from extensive trade and current account imbalances, let alone needed for day-to-day macroeconomic purposes. While China's current account channel dominates the accumulation of international reserves (Jeanne, 2007), it is not the only channel through which it is taking in reserves. In theory, a country's balance of payment equals zero meaning that the current account on the one side and the capital and financial account on the other should balance each other out. Under normal macroeconomic conditions (hence, without any government intervention) a surplus in the one account is reflected by a deficit in the other, and vice versa. This rule does not apply to the PRC, however. China has run so-called 'twin' surpluses, reflecting not only the dominance of exports over imports but also inbound foreign direct investment (FDI) over outward investment, which has resulted in the surplus in the capital account.

The growth of reserves in China's capital and financial account can be explained from a deeper, more systemic point of view. China's financial system is considered the least market-oriented institution of the Chinese economy. Historically, capital flows have been controlled by the Chinese government which upholds a policy of 'lenient entry and stringent exit'. The capital account is effectively closed and it is nearly impossible for Chinese citizens to invest in international asset markets (Chun, Zheng and Spiegel, 2015). While domestic financial flows as well as outward investment are subject to strict regulations, inbound FDI has always been stimulated by the Chinese government because it fuels the government's overall goal of rapid economic growth (Chen et al., 2007; Sauvart and Nolan, 2015). As such, the accumulation of international reserves on the capital account balance sheet reflects the interplay of China's underdeveloped and highly controlled financial system, combined with its monetary policy characterized by managed exchange rates.

¹ The RMB was included in the SDR basket in 2015 and has effectively become an official reserve currency since October 2016. It has a weight of 10.92 percent, which is more than the pound and yen (8.09 and 8.33 percent respectively) but is still dwarfed by the US dollar (41.73) and euro (30.93 percent). IMF (2015).

2.2.3 *Monetary policy and exchange rate management*

Until the 1990s, the PRC maintained a dual-track exchange rate regime which offered two different foreign currency prices of the RMB. The dual-track system was unified in 1994 and China employed a fixed regime until the early 2000s with the RMB pegged to the value of the dollar. Influenced by a round of financial reforms, which included the listing of state-owned banks and limited capital account liberalization, China decided to de-peg from the dollar in 2005 and to fix the price to a basket of world currencies instead. The reforms resulted in the adoption of a ‘managed floating band’, which is a hybrid of a ‘purely’ fixed and floating rate regime. In China’s current currency regime, the value of the RMB is allowed to float within a predetermined band with a price floor and ceiling. This allows China’s central bank, the People’s Bank of China (PBoC), to intervene “when the exchange rate exceeds the predetermined band, or when the capital account experiences large imbalances (...) or the financial market falls into crisis-scale turmoil” (PBoC Deputy Governor Yi Gang, 2012).

By way of the price ceiling the PBoC is allowed to intervene in currency markets to hold down the RMB exchange rate against other currencies, most notably against the US dollar. Historically, exchange market intervention has been an important element of China’s export-led growth strategy because it holds down relative prices of Chinese exports and thus stimulates external demand. Intervention basically entails that the central bank goes out to buy the equivalent of its balance of payments surplus in US dollars (or euros, yen or pounds) to maintain the domestic exchange rate against this currency. For this purpose, the PBoC collects the foreign-currency receipts of exporters on a large scale. The central bank will have to issue more RMB to be able to purchase these receipts, which will increase the domestic monetary base and thus leads to inflation.

The PBoC, in turn, will try to offset inflationary pressures by ‘sterilizing’ reserves (Mohanty and Turner, 2005; Rodrik, 2006;). A report by the Federal Reserve’s Working Group on Exchange Market Intervention provides a formal definition for sterilization: “Sterilized intervention means a change in the monetary authorities’ net foreign currency assets which is offset by a corresponding change in their net domestic assets, so that their monetary liabilities (or, specifically, the monetary base) remain unchanged” (Jurgensen, 1983). The PBoC issues government bonds and other local currency assets in exchange for the increased RMB in circulation, which are bought by commercial banks and other financial institutions. In the case of China, the sterilization bonds largely end up on the balance sheets

of its state-owned banking sector.

Even though sterilized intervention seems like a basic ‘pay out and claw back’ arrangement (after all, sterilization bonds end up on the balance sheets of the ICBC and other commercial banks, which are to a greater or lesser extent tied to the state), there is a limit to the amount of bonds that can be absorbed by the market. When the accumulation of reserves continues it will eventually result in higher interest rates. Also, there is a limit to the central bank’s discretionary supply of government bonds. In order to achieve its larger policy goal, the PBoC started issuing its own bonds and other lower-quality local currency assets. In an attempt to hold down the issuing costs central bank bonds typically bear low, below market interest rates. In China they are sold nevertheless, in high volumes, to China’s commercial banks of which many are legally required or ‘morally persuaded’ by the PBoC to purchase central bank bills. By selling bills to commercial banks against low rates, the central bank essentially shifts some of the costs of sterilization onto the domestic banking sector. Zhang, (2012) estimates that the total cost of sterilization shared by the banking sector from 2003 to 2010 reached RMB 1.3 trillion, or \$200 billion.

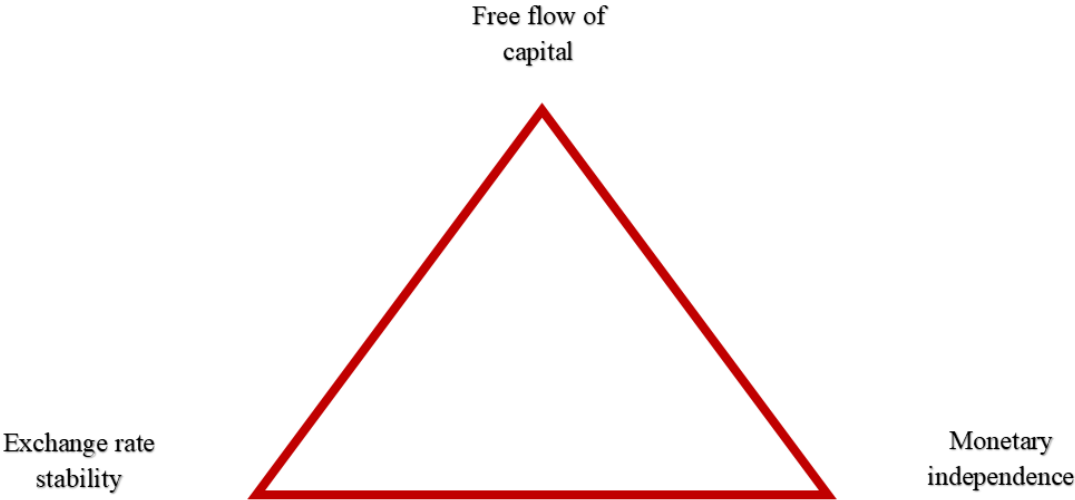
2.3 Domestic effects

China’s commercial banks, in turn, distribute the cost of reserve sterilization to households in the form of impaired access to finance. Zhang (2012) describes this arrangement as a ‘sterilization cost-sharing mechanism’ established by the Chinese government, involving the PBoC, commercial (state-owned) banks and Chinese households. The government has kept this mechanism in place by imposing interest-rate regulations and asymmetric capital controls on households. As mentioned earlier, China’s capital account has not been fully liberalized which limits the opportunity of Chinese households to invest in foreign assets. Domestic asset markets have either been unstable or overwhelmed by demand, such as the Chinese real estate market (Glaeser, 2017). This leaves very few options for households to invest their wealth but to deposit it in China’s domestic commercial banks.

Even though interest rates in China have been liberalized to some extent in recent years, the consumer deposit rate and the benchmark loan interest rate are still tightly regulated by the PBoC. The spread between these rates represents the profit margin of China’s commercial banks. By enforcing a stable interest rate spread between banks and end-users, the central bank can shift some of the cost of sterilization to the banking sector by lowering the

yield on central banks bonds, while making sure that commercial banks will continue to receive a reasonable profit. Households, on the other hand, are faced with very low or even persistently negative deposit rates. Zhang (2012) argues that the combination of predatory interest-rate regulations and capital controls represents a form of financial repression, in which Chinese households bear most of the costs of exchange rate fixing by the PBoC. Liberalization of interest rates and a relaxation of capital controls on Chinese households would put the full cost of sterilization on the PBoC and China's state-owned banks. This would make sterilized intervention unsustainable in the long run.

FIGURE 7: Impossible Trinity



The persistence of interest-rate regulations and other repressive financial policies supports the argument by international economists that the Chinese government is facing the classic trilemma in its policy goals of maintaining high external demand and FDI (Chi Lo, 2015). Figure 7 illustrates this policy trilemma, or impossible trinity, which holds that a country can never accomplish more than two out of the three policies of exchange rate fixation, sovereign monetary policy and capital account openness. The PBoC conducts independent monetary policy and strictly controls the value of the RMB exchange rate. However, in order to accomplish these goals it has to restrict international capital flows because further liberalization of the capital account would put pressure on domestic interest rates and, eventually, on the value of the exchange rate.

To put it in different terms, the Chinese government applies a monetary policy which

essentially maximizes GDP growth at the expense of domestic consumption and households' standard of living. Financial repression in the form of capital controls and interest-rate regulations essentially works as a tax on households and a subsidy to investors (Dollar, 2013). Because of the impaired access to finance, Chinese citizens see no other way than to stack up their wealth. This has, inter alia, resulted in a large domestic savings glut which has been regularly observed in the literature (Bernanke, 2005; Dollar, 2013; Lardy and Borst, 2013). At the same time, the rapid growth of per capita GDP has created a Chinese middle-class which is eagerly looking for ways to diversify its wealth. Recent reports have pointed at the increased resident-based capital flight resulting from Chinese households and companies looking for ways to invest their money abroad and circumvent capital account restrictions (Chan, 2017).

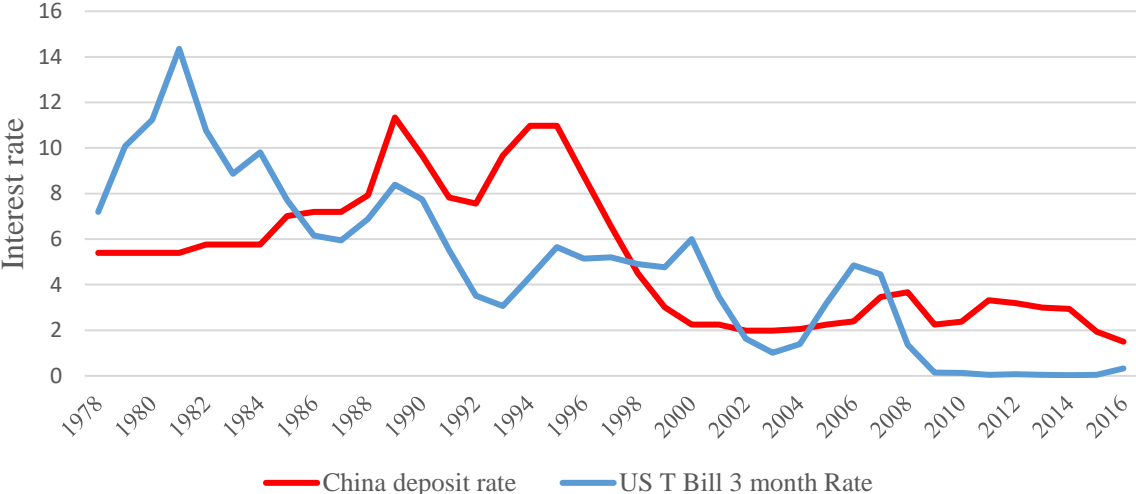
2.4 International implications

The PBoC's far-reaching interventions in the exchange market have been criticized in recent years by foreign policy-makers and other observers outside the region. While China's ample monetary policy has boosted economic growth at home, it not only puts pressure on the domestic economy but has also contributed to the growth of global imbalances. An often-heard critique is that the PRC has pushed other economies out of the market by combining a favourable exchange rate regime with low labour costs. China's terms of trade are regarded as unfair competition by advanced economies, an argument which cropped up once again during the recent elections in the United States. Critique also comes from other EMEs, such as Russia and Brazil, which argue that China's currency interventions are costing them market share.

A second international implication is related to the active management of reserves. The PBoC invests large amounts in the debt of advanced economies, especially in US Treasuries. China reportedly holds as much as 70 percent of its foreign reserves in US government paper, competing with other countries for US bonds which drives up the price. This has caused the peculiar situation in which the PRC accumulates international reserves at high rates and lends them straight back to the United States and other deficit countries at much cheaper rates (Cho, 2014). This 'Sino-American co-dependency' situation has continued since the late 1970s, in which China structurally finances American deficits so that the US will continue to provide the much-needed external demand for Chinese products

(Eichengreen, 2005; Bond, 2010; Bonatti and Fracasso, 2010; 2013). Hence, while China’s monetary and exchange rate policy tends to suppress consumption at home, it has the opposite effect for the United States and other deficit countries.

FIGURE 8: CHINESE DEPOSIT RATE VS. US TREASURY BOND RATE, 3-MONTH MATURITY (1978-2016)



Considering the size of China’s reserve holdings, which amount to over \$3 trillion, the opportunity cost of holding reserves in a traditional central bank portfolio of foreign bonds is high. Opportunity cost is the difference between the average yield on international reserves and the marginal productivity of alternative investments (usually proxied by the value of short-term deposit rates). While China’s deposit rates used to be below the interest rates of targeted foreign bonds, global interest rates on government paper have dropped significantly since the financial crisis. Figure 8 shows that the spread between China’s 3-month deposit rate and the equivalent US Treasury bill has increased since 2007 and currently stands at around 1.5 percent, which suggests that the Chinese monetary authorities face significant opportunity cost over its foreign exchange reserve holdings. In response, China’s monetary authorities try to find other outlets with a higher risk-return profile. As part of this active management of reserves it created so-called reserve investment funds (RIFs), a specific type of sovereign wealth fund (SWF) that invests reserve money in fixed income, equities, real estate and a variety of other higher risk-return assets around the world.

SWFs are designed as standalone investment funds with a legal mandate that is less tight and allows for a more explicit return objective than do central banks (Balding, 2012;

Meggison and Fotak, 2014). The purpose of these funds is to increase returns on reserves and to reduce the opportunity cost of carrying excessive foreign exchange reserves on the central bank's balance sheet. China currently runs two RIFs. SAFE Investment Company is connected to the State Administration of Foreign Exchange (SAFE), a branch of the PBoC. According to the Sovereign Wealth Fund Institute, a US-based think-tank, the fund manages an estimated \$450 billion of foreign financial assets. A second SWF, China Investment Corporation (CIC), was created in 2007 and has around \$800 billion of assets under management.

In political circles, the large holdings and active management of reserves by EMDCs is regarded with suspicion because it seems to have shifted financial firepower away from, predominantly Western, deficit countries to surplus countries in the traditional 'East'. Being the main debtor country, public debate in the United States is frequently dominated by the doings of China. The intensity of the debate was famously illustrated in 2007 by the reactions to an article by Chinese scholar He Fan, who unintentionally added fuel to the flames by stating that "(...) thanks to the trade surplus, China has accumulated a large sum of US dollars and its world largest foreign exchange reserve is mostly in US dollars" (...), and that "the Chinese central bank will be forced to sell US dollars once the renminbi appreciates dramatically, which might lead to a mass depreciation of the US dollar against other currencies" (He Fan, 2007). The column triggered alarming stories in the Western popular press suggesting that China was considering the so-called 'financial nuclear option'. It was believed that by dumping its substantial holdings of dollar-denominated government debt, China could instantly tip the US economy into recession (Panzner, 2009; Navarro and Autry, 2011).

2.5 The future of China's economic model

The reasons that motivate the Chinese government to maintain a monetary policy based on financial repression, capital regulations and currency interventions have been a matter of debate. Arguably, it is the inevitable consequence of the leadership's long-lived goals of stimulating economic growth, creating jobs and maintain social stability. Since the start of reforms in 1978, China's institutional framework has been geared to generate high external demand and the foreign investment necessary to pull the country out of the abyss. The Chinese government now desperately tries to preserve the status quo, but recent developments seem to catch up with the aims of the government. Since 2012, the Chinese economy has been

showing signs of a declining export sector and GDP growth. This has, inter alia, influenced the size of its reserve holdings. According to analysts, the rate of reserve accumulation came to a halt in 2012 and has started to decrease since 2013 as a result of stagnating economic growth in the PRC. Whereas the PBoC was used to purchase dollar-denominated assets, it has recently been selling off its dollars and buying RMB to sustain the value of the domestic exchange rate (Neely, 2017).

With the slowdown of the economy there are voices both within and outside the country for a ‘rebalancing’ of the Chinese economy, away from export- and investment-led growth towards an intensive growth path underpinned by domestic consumption. Chinese Premier Wen Jiabao told the National People’s Congress in 2007 that “unbalanced, uncoordinated and unsustainable development remains a prominent problem” in China. Outside the country, the 2000s has seen an increasing number of studies that advocate a rebalancing and offer recommendations for a smooth transition towards a more consumption-driven economy (Prasad & Rajan 2006; Blanchard & Giavazzi 2006; Lardy 2007; Zheng, Bigsten & Hu 2009; Dollar, 2013; Lardy and Borst, 2013).

3 Theory and related literature

This section will discuss the origins and development of modern economic theories that try to explain the demand for international reserves among countries. The analyses in this thesis are primarily built on the concept of ‘optimal’ reserves, which evolved from Keynesian micro-theories of the demand for money and has been a leading theory since the 1960s. The concept of optimal reserves is closely related to theories on the motives for holding international reserves, as well as the welfare effects of reserve accumulation. Paragraph 3.2 will discuss the motives that underpin the decision for countries to hold on to foreign currency, followed by the welfare economic approach which is mainly concerned with the effects of the growth of reserves on a global scale. The last paragraph will introduce the theory of optimal reserve levels, which is based on a cost-benefit approach to the demand for international reserves and represents the main theoretical underpinning for the analysis in this study.

3.1 (Post-)Keynesian approaches to the demand for money

Research on the demand for international reserves has a long tradition in Keynesian economics. As one of the principal architects of the Bretton Woods Agreement, Keynes' was involved in the institution of the fixed exchange rate regime and the US dollar as a global reserve currency after the Second World War. Contemporary research in monetary economics has elaborated extensively on his views to explain the interactions of surplus and deficit countries, as well as on Keynesian theories about the demand for (international) liquidity. Keynes' liquidity preference theory was further developed (and challenged) by other economists of Keynesian persuasion. The main contributions discussed in this paragraph were made individually by Tobin (1956; 1958) and Baumol (1952), who's inventory approach to the transactions demand for money provides the theoretical basis of the macroeconomic theory of optimal reserve levels.

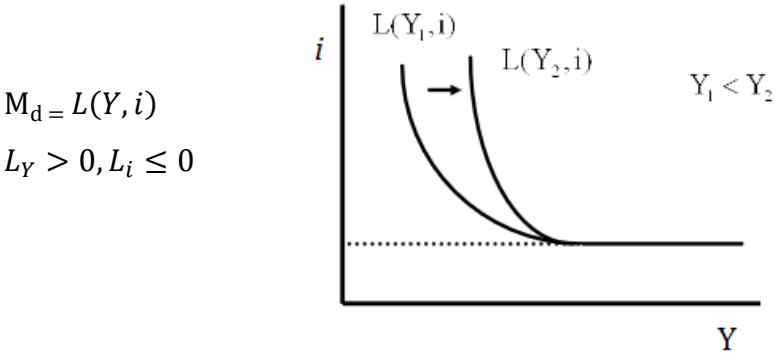
3.1.1 Liquidity preference theory and the motives for holding money

Modern theories on the demand for reserves can be traced back to Keynes' theory of the micro-demand for money, or what he called 'liquidity preference' (1936). Up until then, monetary economics had been dominated by a single focus on the supply-side of money as a medium of exchange. Theoretical perceptions on the demand for money were restricted to the so-called transactions motive of holding money, in which demand is a function of an individual's income, the number of transactions, the price of those transactions and the quantity and velocity of the money supply. Classical economists such as Irving Fisher (1911), who's famous Quantity Theory of Money only considers the function of money as a medium of exchange, or the Cambridge Cash-balance approach purported by Neoclassical economists Pigou (1917) and Alfred Marshall (1923) did recognize its function as a store of value but their analysis did not account for influencing factors such as wealth, interest rates and speculation. In particular, Pigou acknowledged the precautionary motive where money holdings act as a hedge against unforeseen contingencies.

Keynes' liquidity preference theory represented a resolute break with the dominant school of thought at the time because it laid emphasis on a third motive. The main question coined by Keynes (himself a Cambridge economist) is why people should hold their money in liquid form just so they can make transactions, while they can receive interest by lending it out or by investing it in bonds. In his ground-breaking work, the *General Theory of Employment, Interest and Money* (1936), Keynes posited that the desire to hold money is prompted by three main motives. Similar to the classical monetary view on money as a

medium of exchange, the first is the transactions motive which refers to the public’s demand for material currency to be able to make transactions at all times. Secondly, Keynes supported Pigou’s proposition that money is held for precautionary reasons. The final motive for people’s liquidity preference identified by Keynes is the *speculative motive*. This was a revolutionary contribution to the theory of the demand for money, as the motive explains why the public holds ‘surplus’ money (that exceeds the amount necessary due to the other two motives) in the face of interest-yielding bonds and other financial assets they can invest in to “secure profit from knowing better than the market what the future will bring forth” (Keynes, 1936: 170-171).

By acknowledging the speculative motive Keynes not only introduced the asset function of money but also the interest rate as a determinant of its demand, instead of just real income which had been the leading Neoclassical stand. Keynes argued that income as a single variable only explains the transactions and precautionary demand for money, but not the speculative demand resulting from the speculative motive for holding cash. Money held under this motive would be used to speculate in bond-dealings with fluctuating interest rates. According to Keynes, there is an inverse relationship between the interest rate on these bonds and money holdings due to opportunity cost. When people anticipate on rising bond prices they will expect falling interest rates in the future causing them to invest all their money in bonds and sell at high prices, and vice versa. At a lower rate of interest people lose less by not investing their money and subsequently hold all of it in cash, while they would lose more by not lending it out when interest rates are higher. This can be written as:



, where M_d is the aggregate demand for money and a function of two separate components: $L(Y)$ represents the transactions and precautionary demand which is an increasing function of real income only; and $L(i)$ the speculative demand as a decreasing function of the rate of interest (Keynes, 1936: 166-168).

3.1.2 *Tobin's portfolio selection model*

In his famous article, "Liquidity Preference as Behavior Towards Risk" (1958), James Tobin formulated a risk aversion theory about the demand for money for what he believed "is essentially the original Keynesian explanation" (Tobin, 1958: 70). In his approach based on portfolio selection, Tobin aimed to correct two defects of Keynes' theory of liquidity preference. The first defect is that Keynes does not relate the demand for money to the existence of uncertainty about the potential risk of an investment, which is demonstrated in the inelasticity of expectations about future rates of interest. The second is the Keynesian assumption that money is held in either cash or bonds.

The first drawback observed by Tobin is that the theory of liquidity preference presumes that people know the interest rate on bonds with certainty. Moreover, the theory also holds that the transactions demand for money is only a function of real income and therefore 'interest inelastic', in that demand is not affected by the rate of interest. In Keynes' representation, an investor always has full information about the expected future interest rates of the bonds he may bet his money on. Tobin's theory opposes this and builds on the idea that money held under the transactions motive is, in fact, interest elastic. It therefore assumes that the expected gains and losses from holding interest-yielding assets is always zero and independent of the current level of interest. His article then introduces the concept of uncertainty under which individuals have to make decisions to either hold money or invest it.

To demonstrate his point, Tobin describes three types of investors: risk-lovers, who put their money all in bonds to maximize risk-return; plungers, who either invest all the way in bonds or in cash; and risk-averters who "will not be satisfied to accept more risk unless they can also expect greater expected return" (p. 69-70). According to Tobin, the majority of investors belong to the last category and are risk-averting, which brings him to a second critique on Keynes' liquidity preference theory. Keynes' model assumes that people hold their assets either all in cash or all in bonds, like plungers, which is an unrealistic assumption to Tobin. In line with his theory on risk-aversion, he argues that the majority of investors who face various risk and return options will diversify their wealth in a mixed portfolio of cash, shares, bonds, and other money market instruments. By diversifying their money they strike a balance between safe financial assets such as cash, that will neither impose risks nor returns, and riskier assets like bonds that "offer the investor the chance of large capital gains at the price of equivalent changes of large capital losses" (p. 72).

3.1.3 *The Baumol inventory theoretic approach*

William Baumol (1952) interpreted the interest elasticity of the transactions demand for money from the perspective of cash balances held by individuals or firms. His theory intends to arrive at an ‘optimal cash balance’, in which the combined transactions cost and the cost of holding money are minimized. The inventory, or optimal cash balance, model has become known as the Baumol-Tobin model, dedicated to both Baumol and James Tobin who wrote an almost identical piece four years after Baumol’s publication. In a footnote Tobin acknowledged that “The importance of these costs [of transactions] in explaining the demand for cash has been explicitly analyzed by W.J. Baumol, (...), a paper which I should have read before writing this one but did not.” (Tobin, 1956). For simplicity reasons, this study refers to Baumol’s contribution.

Baumol distinguishes between two types of costs that arise from holding money in either cash or bonds: transaction cost and opportunity cost. The inventory approach suggests that an individual or a firm normally holds an inventory of cash because income and expenditure usually do not coincide, and because expenses are not always known beforehand. Having a large amount of cash is beneficial because the individual can make every transaction he wishes, while saving the cost of having to pay a fixed bank (or what Baumol calls a ‘broker’s’) fee every time he withdraws or lends money, or has to liquidate bonds for cash (Baumol, 1952: 545-546). This is the transactions cost element. However, holding cash comes with opportunity cost. While a certain amount of ready money is beneficial to provide for (un)expected payments, it is expensive to hold excessive amounts of capital in the form of cash balances because the money could have been invested otherwise in the firm or in interest-bearing securities (bonds). Thus, the total costs of cash balances = transaction cost + opportunity cost. This can be written as:

$$\frac{C}{2}r + \frac{T}{C}F$$

, where C is the amount of cash raised by withdrawals or selling bonds; $\frac{C}{2}$ the average cash balance; r the opportunity cost represented by the interest rate on bonds, which is a decreasing function of the cash balance; T the total cash needed to make transactions; $\frac{T}{C}$ the number of transactions; and F the transaction cost of withdrawing or borrowing cash, which increases with the number of transaction $\frac{T}{C}$.

FIGURE 9: BAUMOL INVENTORY MODEL

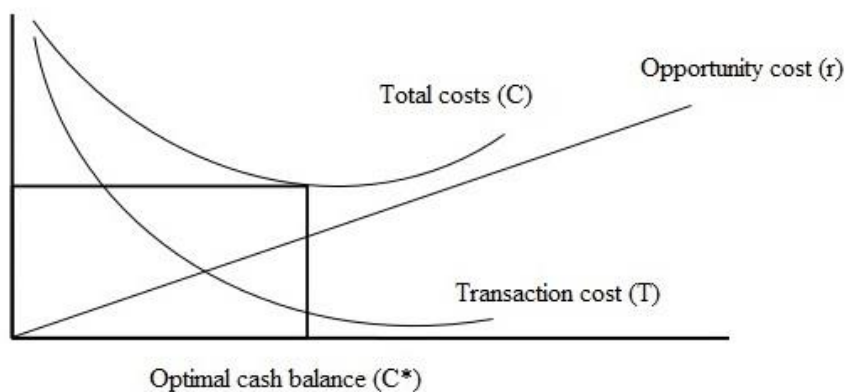


Figure 9 illustrates that - in deciding on the level of cash balances - individuals or firms will face a trade-off between the transactions costs of having to go to the bank, with the opportunity cost of foregone interest on holding money. Individuals will therefore pick a level that minimizes the total costs of holding money. The trade-off can be written as:

$$C^* = \sqrt{\frac{2FT}{r}}$$

, where C^* represents the optimal cash balance.

3.2 The motives for holding international reserves

Monetary authorities can have several reasons for holding international currency and, by definition, these motives are not mutually exclusive (Cooper, 1970). Nonetheless, Keynes' conventional identification of the three motives behind liquidity preference can be applied, to

a broad extent, to the demand for international reserves.

3.2.1 *Transactions motive and balance of payments financing*

In the tradition of classical economic views on the demand for money, the early literature typically explained the demand for international reserves exclusively in terms of what monetary authorities need to finance short-term balance of payments deficits. According to Stockholm School economist Bent Hansen, the international reserves held for transactions purposes could be seen as a central bank's working balance used to meet temporary inconsistencies in foreign receipts and international payments made by the state. Hansen argued that this working balance would increase in proportion to the growth of national income, the volume of trade and other economic fundamentals (Hansen, 1962). This single view on the transactions motive for international reserves was contested in later research, because it seemed to suggest that central banks actively engage in the financing of international transactions (Heller, 1966). In fact, in a free-market setting the transactions demand for international payments is mainly exercised by commercial banks. The role and influence of the central bank is negligible, even though it must guard itself against market fluctuations just like any private party does. In this respect, we can say that international reserves are only held by central banks for precautionary reasons (Beaufort Wijnholds, 1977: 92-93).

3.2.2 *Precautionary motives and self-insurance*

The second motive holds that the holding of international reserves, as noted early on by Keynes (1936), “depends on (...) the desire for security as to the future cash equivalent of a certain proportion of total resources;” (p. 170). Keeping a higher amount of international reserves allows a country to ‘buy time’ in case of economic shocks and thereby lowers the probability of a crisis. This *self-insurance, or precautionary, motive* suggests that the main purpose of accumulating reserves is to fill up the national ‘war chest’, which can be used by central banks as a hedge against international liquidity shortages, trade imbalances and other exogenous shocks (Baltensperger, 1974; Rodrik, 2006; Park, 2008; Calvo, Izquierdo and Loo-Kung, 2013). In the early 1990s studies already pointed at the use of international reserves to stabilize output and to curb costly sovereign defaults, particularly for export-dependent economies like China which are typically prone to economic swings (Ben-Bassat and Gottlieb, 1992). The impact of their observations was limited, however, in the relatively

buoyant economic situation of the nineties.

The experiences of the 1997 Asian financial crisis gave a new impetus to the reserve adequacy debate and increased the focus on self-insurance. The increased risk of capital market stops as witnessed during the ‘Asian contagion’ caught many observers by surprise (Aizenman and Marion 2003). The IMF responded in orthodox ways, forcing Asian countries that were in trouble to cut government spending and raise interest rates to prevent capital flight. These measures had adverse effects and further devastated Asia’s already fragile economic situation. Asian countries concluded that they never again be put in the situation of having to ask the IMF for support, and subsequently decided to accumulate large international reserves that would provide a buffer in case of another crisis (Allen and Hong, 2011). Discussions in the academic literature started to focus on the post-crisis prevention measures taken by Asian central banks and other authorities to hedge against sudden liquidity stops (Calvo 1998; Radelet and Sachs, 2000). Triggered by these discussions, policy papers by the IMF more and more emphasized the relationship between short-term external debt and currency crises, suggesting that accumulating foreign reserves could be considered a precautionary requirement for countries that regularly experience (temporary) impaired access to capital markets (Calvo and Reinhart 2000; Edwards 2004).

The IMF subsequently started to issue policy recommendations that encouraged the use of the standard ratios applied in the previous section of this study in order to determine the precautionary level in relation to a particular country’s external vulnerabilities, such as the ratio of reserves to total imports (Triffin, 1947; 1960), reserves to the domestic money supply (Johnson, 1968) and the size of reserve holdings relative to a country’s external liabilities (Brown, 1964). Most of these rules of thumb and ratios had been around since Bretton Woods and were reformatted by the IMF to fit the needs and characteristics of developing countries - and crisis-ridden Asia in particular. For instance, a modified version of the reserves-to-debt ratio came to be known as the Guidotti-Greenspan rule, which states that the size of liquid reserves for developing countries must be equal to its short-term external debt coming due within one year (while this used to be three months in the original set-up) (Greenspan, 1999). This simple metric of reserves to external short-term debt was long used as a main indicator in IMF Article IV country reports during the 2000s (Beaufort Wijnholds and Kapteyn, 2001; Banerji and Martinez, 2012).

3.2.3 *Speculative motives and monetary mercantilism*

Consistent with Keynes' speculative liquidity preference, a third motive for holding international reserves is that countries can use it for speculative reasons. They can use reserves to control exchange rates and invest overseas in high risk-return and strategic assets, as well as other operations that aim to stimulate domestic growth. On this side of the table we find observers who argue that the surge in foreign exchange reserves in recent years, especially by emerging Asia, has little to do with precautionary reasons but is motivated by the region's overreliance on exports and FDI. The literature refers to this as *mercantilist (or export-promoting) motives* (Dooley, Folkerts-Landau and Garber, 2004; Aizenman and Lee, 2007, 2008; Park and Estrada, 2009; Durdu, Mendoza and Terrones, 2009; Bonatti and Fracasso, 2013). According to this approach, the hoarding of international reserves by many developing countries represents a modern version of 'monetary mercantilism', reminiscent of the economic theory and practice common in 18th century Europe (Aizenman and Lee, 2008). The principle question in the literature on the mercantilist motive is whether reserve holdings are 'excessive', in that they surpass levels that are deemed necessary for normal macroeconomic adjustment. It is assumed then that these excess amounts are the result of export-promoting policies or serve as collateral for encouraging FDI (Calvo, Izquierdo and Loo-Kung, 2013).

A contemporary version of the mercantilist approach argues that exchange rate intervention to maintain undervalued exchange rates can in fact be a rational and sustainable development strategy. According to this view, the accumulation of reserves by emerging economies serves as collateral which is being used to attract foreign investment – mainly in the light of the co-dependent relationship between the United States and the PRC (Dooley, Folkerts-Landau & Garber, 2004; Bonatti and Fracasso, 2013). The authors argue that the wide-scale market interventions by EMDCs that have their currencies pegged to the dollar is characteristic of a stable global monetary regime, which is in many ways a contemporary version of the original Bretton Woods regime. Within this 'revived' Bretton Woods system, also called 'Bretton Woods II', the United States serves as the asymmetric centre (by running current account deficits) and emerging markets as the periphery, by serving as dollar peggers and accumulators (Dellas and Tavlas 2011; Hall and Tavlas 2013) .

3.3 The welfare economic approach

The welfare economic approach to the demand for reserves was developed in the 1960s by IMF-economist Marcus Fleming. The welfare approach considers the potential effects of the increase in global reserves on *world* economic welfare, in which “[international] liquidity is optimal if no change having a desirable effect on economic welfare can take place” (Fleming, 1961). It explicitly looks at the growth of international reserves in terms of its effect on policy objectives, “given the probable reactions of governments, central banks, and individuals of increasing total reserves or rates of reserve growth, the increases being distributed among countries in some specified way” (Fleming, 1967). The methodology used by Fleming is basically a cost-benefit analysis in which the positive effects of further increases in reserves - in the form of trade liberalization, higher global employment or even the willingness to provide foreign aid - are contrasted with the potential negative effects, such as imbalanced trade relations or inflation. This trade-off results in a global optimal rate of the growth of reserves.

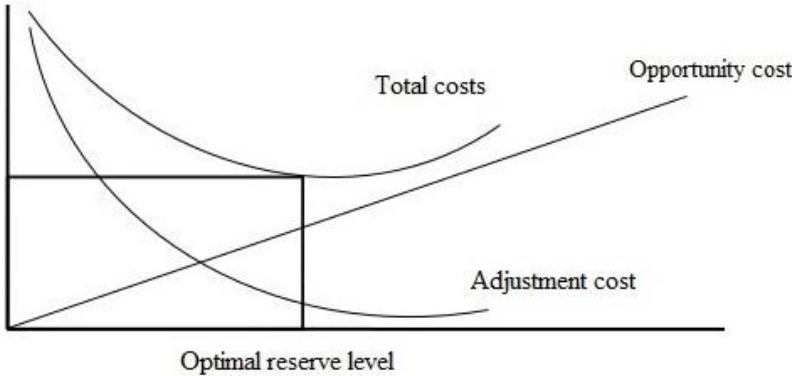
An often-heard critique on Fleming’s methodology is that it presents a rather static and mathematical approach to determine the optimal stock of international reserves, which “must (...) be determined at dynamic and administrative levels – and not at the level of static welfare theory” (Little, 1957: 184). Another problematic feature of the welfare economic approach is that it only considers welfare effects on a global level and is therefore unsuitable to be applied to individual countries or country groups. Fleming acknowledged this and in his work he attempted to estimate national optima in relation to policy objectives on the country-level but finds that the effects of reserve growth (and reserve levels) will always, to a greater or lesser extent, be internationally distributed. He also finds that the effects can be ‘abnormally maldistributed’ among countries, in the sense that temporary fluctuations in economic fundamentals of an individual country can significantly distort the welfare analysis. His solution then is to scale up the effects of policies on the country-level, so “they can be aggregated, subject to an adjustment to be mentioned below, to provide an estimate of the global optimal rate of reserve growth”. (Fleming, 1967). Unfortunately, this solution does not solve the applicability problem to single countries.

3.4 Theory of optimal international reserves

In managing a country’s foreign reserves, a central bank is essentially responsible for two aspects: deciding upon the desired *amount* of reserves and the currency *composition* of the reserve portfolio (Roger, 1993). The literature on international reserves has traditionally been separated between these two aspects and regards the level of foreign reserves and their portfolio allocation as independent decisions (Beck and Weber, 2011). While recent research indicates that the adequate diversification of the portfolio over different currencies may be as critical as the level of international reserves, in particular for large(r) reserve holders like China (Beck and Rahbari, 2008; Beck and Weber, 2011; Yu and Gao, 2011; Zhang et al., 2015), this aspect is less studied and falls outside the scope of this thesis. The second, more prominent, aspect of reserve management is the notion of optimal reserve levels – or which level provides an optimal balance between the benefit (of being able to utilize the reserve stock for macroeconomic adjustment) and the costs of holding reserves.

The theory of optimal reserve levels was developed in the late 1960s and early 1970s under the umbrella of the IMF, most notably by Robert Heller (1966) and complemented by economists like Clark (1970), Kelly (1970) and Flanders (1971). The examination of the demand for reserves in terms of a cost-benefit analysis is essentially an elaboration of the welfare economic approach, but the analysis has a dynamic component and can be applied to individual countries (and country groups) rather than to the world at large (Beaufort Wijnholds, 1977: 99-100). Inspired on Baumol’s inventory model, optimal reserve theory suggests there is a trade-off between transaction cost (which, in macroeconomic terms, refers to the cost of adjustment) and opportunity cost. In deciding on an optimal level of international reserves, a country’s monetary authority will therefore balance the potential cost

FIGURE 10: BAUMOL'S MODEL FOR OPTIMAL RESERVE LEVELS



of economic adjustment that would arise in case reserves are exhausted, with the opportunity cost of holding those reserves.

Figure 10 depicts the Baumol inventory model redesigned in terms of the demand for international reserves. In the macroeconomic application, transaction cost is replaced by the cost of adjustment. For practical reasons, the opportunity cost of holding reserves is usually measured in terms of the interest rate differentials on capital, which is the difference between the average yield on reserves and the marginal productivity of alternative investments (usually proxied by the value of short-term deposit rates). It is difficult to measure other, economic and social, costs. While this study uses a similar, limited, approach to the opportunity cost structure, it recognizes that there are broader economic costs to reserve accumulation (inflation, interest rate pressures) that should be kept in mind.

3.4.1 The benefit of holding reserves

As noted by Clark (1970), “the benefit derived from holding reserves is [essentially] the avoidance of the costs of adjustment” (Clark, 1970). In other words, it represents the national income that would have been lost to pay for balance of payment deficits and other macroeconomic issues, may it not be financed out of reserve holdings. The cost-benefit approach introduced by Heller (1966) measures the cost of adjustment only in limited terms for what he calls ‘expenditure-changing policies’, because of difficulties in quantifying other potential determinants (p. 297). However, over the years the literature has related the cost of adjustment to more financial-economic categories and developed proxies to measure the impact of these factors. These include the following categories:

* *Economic size*. In theory, since the volume of a country’s international transactions tends to increase with economic size so does its demand for international reserves. The literature uses GDP, GDP per capita and population size as proxies.

* *Balance of payments*. The balance of payments records an economy’s transactions with the rest of the world and can be divided into the capital/financial account and the current account.

Indicators for *capital account vulnerability* include the supply of money (M2), FDI, (short-term) external debt and other measures and indices of financial openness or globalization. The capital account becomes more vulnerable in the face of financial openness because it will increase the potential for residential capital flight from the domestic currency. In other words, a higher degree of financial openness is associated with higher crisis vulnerability and will encourage monetary authorities to hold more reserves.

Likewise, a high degree of *current account (trade) openness* exposes the domestic economy to external shocks from exports and will increase reserves held for precautionary reasons. For similar reasons, an increase in imports is generally expected to increase a country's demand for international reserves.

* *Exchange rate flexibility*. Theoretically, greater flexibility/volatility of the domestic exchange rate is associated with falling demand for foreign exchange reserves because central banks have to purchase less to fix exchange rates.

3.3.2 *Opportunity cost*

In economic terms, holding exchange reserves in excess of what is necessary to cover macroeconomic adjustment reduces allocative efficiency. It reduces welfare by definition because the marginal cost of holding an additional unit of foreign-denominated currency is higher than the marginal benefit - of spending it in domestic outlets, or investing it in less liquid but higher rate-of-return assets. From the previous analysis, we can deduct that the cost of sterilizing reserves is roughly equal to the interest paid on (government and central bank) debt issued by the central bank, minus the interest that is earned over its foreign reserves. Reserves are typically invested in liquid but low-yielding securities such as short- and medium-term US Treasuries. As Dani Rodrik noted in a 2006 paper, "Holding high reserves is the price to be paid for not managing the capital account more actively (...), involving a "(...) trade-off between financial globalization and avoiding the cost of high levels of reserves". She estimates the opportunity cost for developing countries of holding reserves in a traditional central bank portfolio (invested in short-term government bonds and money market instruments) to be around 1 percent of GDP (Rodrik, 2006). Rodrik dubbed this the 'social cost of self-insurance': the opportunity cost for a country investing reserves is equal to the costs of external borrowing by that same country.

4 A survey of the empirical literature

This section will explore how the theoretical framework for optimal reserve levels has evolved since the sixties and how these theoretical considerations have been translated into analytical and empirical approaches towards modelling the demand for international reserves. Following the discussion of the literature in the first two paragraphs, paragraph 4.3 will summarize the variables that have been developed in empirical work as proxies for the cost of

adjustment identified in the theory of optimal reserve levels. Paragraph 4.4 will review the, still scarce, empirical literature focusing on China.

4.1 Optimal reserves and the buffer-stock inventory model

Early empirical studies on the demand and management of reserve holdings are limited (Grubel, 1971). Much of the quantitative work has been built on the initial line of theory developed in the late 1960s, concerned with the demand for international currency and reserve level optimization. Heller (1966) was among the first to quantify optimal reserve levels on the basis of the cost-benefit inventory approach. He noted that international reserves must fulfil two criteria in order to be suitable as an economic measurement. In the first place, “they must be acceptable at all times to foreign economic units for payment of financial obligations”, and secondly, “their value, expressed in foreign units of account, should be known with certainty” (pp. 296-297). According to Heller’s criteria, international reserves are comprised of gold holdings, official convertible foreign exchange, SDRs and reserve positions (unconditional drawing rights) within the IMF.

The first reserve-demand models developed by Heller, Clark (1970), Kelly (1970) and Flanders (1971) to assess the benefits and costs of holding international reserves were so-called ‘buffer-stock’ models. Consistent with the theory of optimal reserves, the buffer-stock approach assumes that when determining optimal levels a monetary authority will balance the costs of adjustment in case reserves are exhausted (the ‘buffer’) with the opportunity cost of holding reserves (stock). The buffer-stock model represented a fairly stable formula of a nation’s current account vulnerability and opportunity cost. Overall, the empirical literature of the 1970s-80s demonstrated the explanatory power of the traditional buffer-stock model and expanded the model with proxies for other determinants, such as exchange rate flexibility, GDP, population growth and import volatility (Frenkel and Jovanovic, 1981; Edwards, 1983, 1985; Frenkel, 1983; Lizondo and Mathieson, 1987).

The globalization of financial markets starting in the 1990s and the aftermath of the 1997 Asian financial crisis led to a revision of the traditional buffer-stock model. A collection of influential papers in the late 1990s and early 2000s had raised doubts about the explanatory power of the model in case reserve holdings would vary across time and country. Furthermore, the traditional models seemed to perform badly in accounting for and explaining the surge of reserve holdings by EMDCs and their interconnectedness with the global economy (Flood and Marion, 2002; Edison, 2003). Opportunity cost in particular proved

difficult to measure due to inconsistencies in the costs of depleting and replenishing reserves, all the more so because many developing countries did not have market-oriented interest rates until the 1990s (and some, like China, still have not). This often led to insignificant results causing many authors to exclude opportunity cost from the analysis (Edwards, 1985). These findings led, inter alia, to a search for new analytical and empirical frameworks which were able to account for the globalization of financial markets and the growing role of developing countries in global finance and trade.

Since the 2000s, a growing number of studies have attempted to theoretically model and empirically estimate optimal reserve levels for developing countries and EMEs. In determining the relationship between reserve holdings and economic determinants, these studies largely depend on aggregated country data under the assumption that reserve levels adjust to long-run equilibrium (Lane and Burke, 2001; Aizenman and Marion, 2003, 2004; Edison, 2003; Mendoza, 2004; Jeanne and Ranci re, 2008; Park and Estrada, 2009). The recent literature takes better account of the multidimensionality of exchange rate fluctuations, as well as the increasing exposure of emerging markets to financial turmoil (Hawkins and Turner 2000). The empirical work followed in tandem with the debate on the role of foreign exchange reserves in the rapid economic development of the traditional South in the 1990s and the Asian financial crisis, where large holdings were either seen as a hedge against economic shocks (self-insurance motive) or as a stimulant for exports and thus economic growth (mercantilist motive).

4.2 Extensions to the inventory model

4.2.1 *The self-insurance conundrum*

A considerable branch of the empirical literature has attempted to put flesh on the bones of the self-insurance approach to the demand for international reserves. The findings from these studies provided valuable input for the IMF and fed the changing perception on the role of reserves as a stabilizing tool in case of sudden liquidity stops and financial crises. Early publications were relatively simple and informal examinations in which reserve levels were measured against the rules of thumb mentioned earlier in this study, such as the ratio of reserves to imports and exports, broad money (M2) and short-term external debt (that is, the Guidotti-Greenspan rule of thumb). The simple rules of thumb were often contested in the literature and ignored by countries that were expected to apply them. The experiences of the

1997 crisis and the devastating economic effects caused by IMF regulations were still fresh in the minds of Asian policy-makers, which provided an argument to change the perceptions on crisis prevention. Triggered by these arguments, later recommendations by the IMF emphasized that the use of single and constant benchmarks was not sufficient to determine reserve levels and should only be a starting point for further analysis - taking into account country-specific characteristics such as economic size, exchange rate regimes and the opportunity cost a country would have to incur for holding additional reserves (IMF 2011).

These recommendations paved the way for more rigorous empirical work taking hold of multiple economic indicators. The rather informal examinations of the rules of thumb quickly evolved into the use of econometric models to assess the adequacy of reserve holdings in terms of its precautionary function. Many of those empirical studies were performed in the 2000s in response to the experiences of the Asian financial crisis, and later to the global crisis that started in 2007. A publication by the research department of the Bank of Chile formalized the output stabilizing argument in an analytical framework measuring the effect of foreign exchange reserves relative to short-term debt and the probability of a crisis. The authors concluded that the international reserve-to-debt ratios were consistent with optimal precautionary levels in the light of the potential costs of a crisis (Garcia and Soto, 2004). Another landmark study was by Dani Rodrik (2006), who's arguments are in favour of self-insurance but shows the social cost of holding reserves. Rodrik's paper fits in a long line of the academic literature which propagate the use of international reserves for precautionary purposes (Beck and Rahbari, 2008; Beck and Weber, 2011; Gallagher and Shrestha, 2012).

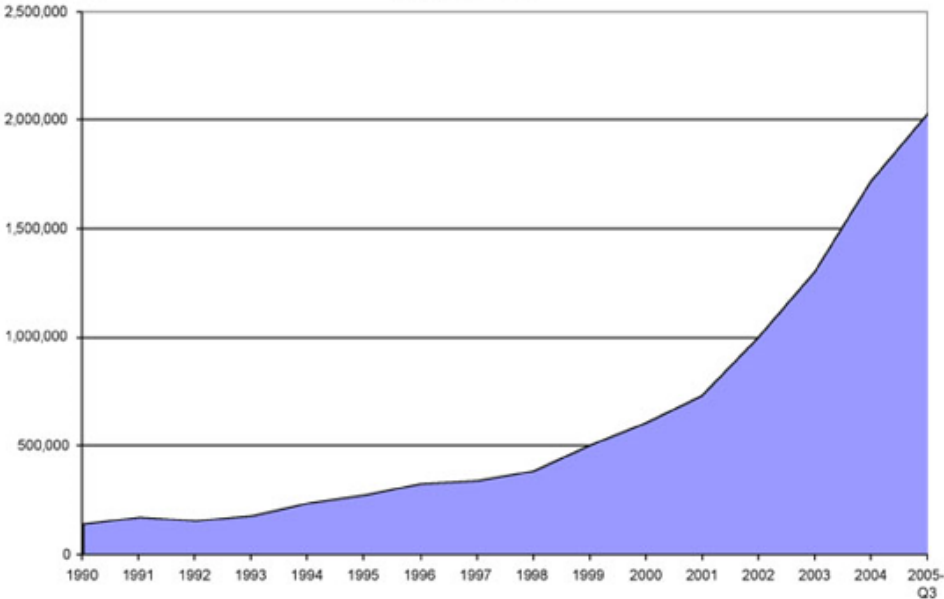
IMF-adviser Joshua Aizenman has been responsible for most of the (IMF-affiliated) output in support of the self-insurance motive. Using a comprehensive data sample of 125 developing countries, Aizenman and Marion (2003) show that reserve levels until 1996 corresponded well with the predicted outcomes of key determinants such as exchange rate flexibility, the size of international transactions and political factors. For the period following the Asian crisis their estimations began to structurally under-predict reserve holdings for East-Asian countries, suggesting that precautionary motives are the main cause of the rise in reserve holdings. In a later article, the conventional econometric specification for international reserves is augmented with variables associated with mercantilist and precautionary demand approaches, represented by crises dummies. While the variables are statistically significant for both approaches, the ones that represent self-insurance purposes play a greater economic role in accounting for the trend of growing international reserves in East-Asia (Aizenman and Lee, 2007; 2008).

Aizenman and his cohorts tested the robustness of their findings in later articles, expanding the model with variables that represent political aspects (Aizenman and Marion, 2004). The authors suggest that reserves are primarily held to hedge against external shocks, but the optimal size may be reduced by political factors such as corruption, low democracy scores and political instability (Aizenman and Marion, 2004). They also validated the self-insurance motive for the case of South-Korea (Aizenman, Lee and Rhee, 2007). Overall, the authors conclude that the empirical results are robust and support precautionary motives. In addition, Aizenman (2011) performed a similar analysis after the recent global financial crisis to demonstrate how developing countries, unlike many countries in the West, were able to benefit from their precautionary reserve pool to support their currencies and deleverage their domestic private sectors.

4.2.2 Evidence for monetary mercantilism

At the same time, a counter-movement in research attempted to find empirical evidence for the mercantilist motive in accumulating reserves. Recall that the main question in the theoretical literature on the mercantilist argument is whether countries hold excess reserves that go beyond the amount that is needed to guard the economy against economic shocks, drops in global demand or an unforeseen drying-up of foreign lending.

FIGURE 11: EXCESS RESERVES BEYOND 1-YEAR SHORT-TERM DEBT (1990-2005)



Source: Summers (2006)

One branch of empirical work tries to answer this question by simply looking at whether real reserve holdings over the years tend to comply with basic rules of thumb (Bussière and Mulder, 1999; Beaufort Wijnholds and Kapteyn, 2001). Larry Summers (2006) presented a measure on global reserves of emerging markets as a whole during a lecture at the Reserve Bank of India, looking at whether the Guidotti-Greenspan rule has historically been a guideline for the size of reserve holdings. Summer's main conclusion is that reserve levels for EMEs have far exceeded the 1-year short-term debt rule since 1990 (figure 11). In similar attempts, Jeanne and Rancière (2008) and Jeanne (2007) estimated optimal reserve levels in relation to the Guidotti-Greenspan rule, using a sophisticated cost-benefit analysis. The theoretical basis of their model consists of a trade-off between domestic consumption-smoothing in case of a sudden stop and the cost of carrying reserves. In line with Summers' observation, they found that reserve holdings have been excessive and in some cases multiples of the IMF's precautionary prescription based on the conventional rules of thumb.

In addition to the previous, relatively simple and informal, examples, the dilemma of excess reserves is tested in more rigorous regression analyses. A landmark study in this respect appeared in the September edition of the 2003 World Economic Outlook. IMF researcher Hali Edison (2003) provided a methodology in which a country's reserves are related to a limited set of variables which are believed to determine reserve demand. The analysis employed in her essay, entitled "Are Foreign Exchange Reserves in Asia Too High?", depends on five categories of variables: economic size, the capital account, the current account, trade openness (measured by exchange rate flexibility) and opportunity cost.² Edison's specification combines the traditional rules of thumb and macroeconomic fundamentals identified in earlier work by authors like Robert Heller (1966), Heller and Khan (1978), Edwards (1983, 1985) and Lizondo and Mathieson (1987). The model is estimated using a large panel covering 122 developing countries with annual data for the period 1980-1996 and is able to explain around 90 percent of the variation in reserve holdings by emerging markets. The findings suggest that most emerging economies in Asia have built up reserves in the 2000s that are well in excess of what can be expected based on economic fundamentals. Moreover, Edison finds that the growth of GDP per capita, Asia's population, import propensity and the volatility of the exchange rate are significant drivers of Asia's reserves.

Edison's model was replicated and refined in a large number of follow-up papers (Park and Estrada, 2009; Ruiz-Arranz and Zavadjil, 2009; Obstfeld, Shambaugh and Taylor,

² The specification by Edison (2003) is the basic model framework used for the analysis in this thesis.

2010). Notable are Gosselin and Parent (2005) who perform a cointegration analysis arriving at a long-run reserve-demand function for a panel of eight Asian economies (China, India, Indonesia, South-Korea, Malaysia, the Philippines, Thailand and Singapore). The authors control for the Asian financial crisis and other structural breaks by running separate regressions. They find that reserve levels in Asia were positively related to the ratio of broad money to GDP, imports to GDP and exchange rate volatility prior to the Asian financial crisis. In the period following the crisis, current account developments such as increases in the volatility of imports and exports start to play a less important role in the decision to hold more reserves, while the coefficient associated with the broad money supply (m_2) increases. The authors conclude that increasing financial globalization since the 2000s has put more weight on financial openness (and thus the risk of capital flight and sudden financial stops) and less weight on trade openness in determining the size of reserve holdings in Asia.

4.3 Summary of categories and variables

Table 1 summarizes the categories and associated variables which have been identified and used in the empirical literature since Heller (1966). The use of the original (macro)economic determinants that affect the cost of adjustment has been fairly stable in the literature. We can see that the inventory specification has not changed dramatically since the 1960s, apart from the addition of variables that control for political factors, financial development, globalization, financial openness and other proxies that may capture the changing patterns of reserve holdings and the higher exposure of developing countries to short-term capital inflows.

TABLE 1
Determinants

Categories	Variables
Foreign exchange reserves	- Real foreign reserves, including or minus gold - Ratio of reserves to GDP
Economic Size	- GDP, per capita GDP - Population size

Balance of Payments	
Capital Account	<ul style="list-style-type: none"> - Capital account balance - (Short-term) external debt ratios - Money supply: M1 and/or broad money M2/M3 to GDP - FDI in total output
Current Account	<ul style="list-style-type: none"> - Current account balance - Share of imports and exports in GDP - Other measures of trade openness and globalization
Exchange Rate Flexibility	exchange rate volatility
Opportunity cost	Interest rate differentials
Political factors	<ul style="list-style-type: none"> - (Political and civil) freedom indices - Corruption indices - Measures of political stability

Whereas the choice of variables has not changed much, the empirical methods have. We have seen that recent studies increasingly rely on panel data and error correction models and are thus able to capture the fixed and long-term effects of changes in fundamentals on reserve demand and policy (Gosselin and Parent, 2005; Prabheesh, Malathy and Madhumati, 2007; Durdu, Mendoza and Terrones, 2009; Obstfeld, Shambaugh and Taylor, 2010).

4.4 Empirical studies on China

Compared to the rich empirical literature on the Asian region as a whole, econometric studies which focus exclusively on China's reserve demand are few. Despite the growing interest in China's monetary affairs in recent years, China's unique experience of central planning and rapid market transition seems to be difficult to capture in the traditional models from which most have a long tradition in more advanced market economies. Furthermore, historical data on China's economy are frequently unreliable, unavailable, of low quality or too short for a proper analysis (Ford and Huang, 1994). The lack of proper data presents an obstacle when determining the dynamics of reserve holdings over time, relative to the rapidly changing economic conditions in the PRC. Another factor is that capital flows in China had been fairly one-dimensional until the 2000s. The country has experienced huge inflows of FDI which are viewed as being driven by economic fundamentals, potentially influencing any further

analysis of the dramatic increase in foreign exchange reserves (Prasad and Wei, 2005).

Nevertheless, the reserve adequacy literature focusing solely on China started to emerge in the mid-1990s in the wake of Deng Xiaoping's 'Southern Tour'. The first comprehensive quantitative studies came from Hong Kong universities (Ford and Huang, 1994; Huang, 1995). The authors argued that despite the obstacles mentioned previously, most importantly the unique composition of China's economic and growth model, there is no apparent reason to believe that reserve holdings should be determined differently from other countries. Following the methodology of Elbadawi (1988) who had composed a reserve demand model of labour-exporting countries based on the Sudan, their papers employ error correction models to assess China's long-run demand for reserves for the period 1950-1990 and 1980Q1-1990Q4, respectively. Both studies suggest that there is a significant and stable relationship between China's reserve holdings and the traditional economic determinants of the inventory model. Overall, the authors conclude that the long-run demand has been influenced mainly by precautionary motives. Furthermore, their analyses indicate that the authorities have the ability to adjust deviations from the desired level of reserves, suggesting that reserve management has high priority in China.

However, in contrast to the general perception in economic theory Huang (1995) finds that Chinese reserve levels are negatively related to imports and the money supply (M2). A possible explanation given by the authors is that, up until the 1990s, China's foreign exchange reserves were strictly allocated by the state. Domestic enterprises (which, at that time, were mostly state-owned) needing foreign exchange for international transactions had to buy it from the state for imports, and sell it immediately after exporting. The government has maintained a policy of foreign exchange retention since the 1980s under which enterprises can retain a share of their reserves in quotas. When they need to import enterprises no longer have to opt for government allocation, although companies are still not allowed to use reserves beyond their quotas and the unused capital still remains in the hands of SAFE (Hu, 2010). A possible implication of this system with measuring reserves is that scalar variables (such as GDP, imports and the money supply) move in the opposite direction from reserve holdings – an increase in imports literally leads to an outflow of foreign exchange reserves, and vice versa (Ford and Huang, 1994; Huang 1995).

Consistent with the rise of the new mercantilist literature, some studies focus on whether Chinese reserve holdings are 'excessive', particularly in the face of the 'Sino-American co-dependency' view discussed in section 2. The empirical evidence from these studies suggests that China, in contrast to its Asian neighbours after the global financial crisis,

has stuck to a policy of ‘exchange rate mercantilism’ in which it structurally finances American deficits to maintain high exports (Patnaik et al., 2011; Bonatti and Fracasso, 2013; Zhang et al. 2015). Research has also attempted to show that reserve accumulation not only causes distortions in the global exchange and trading markets, but also has negative effects on the Chinese economy. For instance, Frankel (2004) estimates the opportunity cost of holding reserves and concludes that China is paying more to foreign investors investing in China than it receives in returns on its foreign exchange reserves. As previously mentioned, similar attempts were made by Rodrik (2006) who estimated that the opportunity cost on reserve holdings for the average EMDC amounts to 1 percent of the country’s GDP.

The recent literature on China’s reserve demand is now mainly coming from universities on the Chinese mainland. These studies are surprisingly critical and tend to confirm the story told by the rules of thumb of reserve adequacy that China’s current build-up has exceeded its optimal level – although studies vary about *how* excessive it is (Chen et al. 2007). More specifically, the literature generally finds that China’s reserves began to exceed optimal levels around the start of the millennium (Chen and Lei, 2012; Chen and Zou; Li and Tian, 2016). Mainland studies also find a structural increase of foreign reserves in the post-1997 period, which goes hand in hand with a greater emphasis on precautionary reserves in the aftermath of the Asian Financial crisis and the start of the reserve build-up in East-Asia. All things considered, the overall balance of evidence suggests that the ‘Chinese experience’ in in many ways similar to that of other EMEs and should be regarded as such. However, some studies indicate that there are several factors related to China’s former system of planned economy and rapid market transition which impact the demand for reserves differently and may lead to divergent empirical results.

5 Empirical analysis

The following section will introduce a reserve-demand model for the PRC. The proposed model will attempt to quantify the factors that may have had an influence on the demand for foreign exchanges reserves in China since the start of reforms in 1978. The results section 5.4 will attempt to relate the empirical dynamics of China’s demand for international reserves to the premises about its politico-economic model formulated in section 2 of this thesis.

5.2 Data and data management

The empirical analysis in this study relies on macro-level data for a number of economic fundamentals of the Chinese economy, including GDP per capita, current and capital account ratios, exchange and interest rates. The data were obtained from different sources. The rate of foreign exchange reserves was retrieved from the official website of China's SAFE and the IMF's International Financial Statistics (IFS). Values of per capita GDP and the money supply (M2) were calculated from the World Bank and OECD national accounts data. GDP per capita is expressed in current US dollars and calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources (World Bank website). Data on population size, the current-/capital account and exchange rates were provided by China Data Online, a comprehensive database run by the China Data Center at the University of Michigan which collects and publishes official data on China from the PBoC, SAFE and other (public) institutions. The China Data Center is a constituent unit of the university and was established in 1997 to promote the use and distribution of data on China for educational and research purposes. Where necessary, the information on variables related to China's historical balance of payments and currency exchange rates was supplemented by other data sources, including the World Bank Development Indicators, IMF (IFS and cross-country statistics) and the Board of Governors of the US Federal Reserve System. Finally, the interest rates on US Treasury bills and the Chinese deposit rate, needed to calculate the opportunity cost, were retrieved from the US Department of the Treasury and SAFE, respectively.

The dataset has several limitations that may impact the quality of the analysis and the overall explanatory power of the model. Similar to the experiences of Ford and Huang (1994) and other researchers, finding appropriate time-series data for China proved troublesome. Reliable information on government debt, short-term liabilities and political factors was either unavailable or of low quality. If available, only data provided since the 1980s seemed coherent to use for econometric analysis but nevertheless had to be compiled from different sources. Early series were merely available on an annual basis and quarterly data from before 1995 were scarce. Such a short time-span would significantly diminish the explanatory power of the model with regard to China's long-term economic development. For this reason, the subsequent analysis will rely on annual data on a limited set of (macro)economic variables

only, stretching a period of 37 years (1978 to 2015).

5.2 Variables

5.2.1 Variable specification

TABLE 2
Variable specification

Economic Category	Variable(s)	Measure/details	Abbreviation
Foreign exchange reserves	International reserves	Official holdings, SDRs and reserve positions, percentage of GDP, log	<i>fx</i>
Economic size	- Per capita GDP - Population size	Current US\$, no deductions, log	<i>gdp</i> <i>pop</i>
Capital and financial accounts	- Capital account balance - Broad money (M2) - FDI	Real value, US\$ Percentage of GDP, log Percentage of GDP, log	<i>cabal</i> <i>m2</i> <i>fdi</i>
Current Account	- Current account balance - Share of imports - Share of exports	Real value, US\$ Percentage of GDP, log Percentage of GDP, log	<i>cubal</i> <i>import</i> <i>export</i>
Exchange Rate Flexibility	Volatility of the exchange rate	Standard deviation of the RMB-US dollar exchange rate), annualized from monthly data, log	<i>xrt</i>
Opportunity cost	Interest rate differential	Yield on reserves (3-month US treasury bill) minus domestic capital (3-month deposit rate)	<i>occ</i>

Notes: All series in logarithms except current account balance (*cubal*), capital account balance (*cabal*) and interest rate differential (*occ*). The value of these variables is equal to 0 for a number of observed years, which, when logged, would be excluded from the analysis. This would reduce the explanatory power of the model with regard to China's long-term economic fundamentals.

5.2.2 Hypotheses

* *Economic size*. Since the volume of a country's international transactions increases with economic size, reserve levels tend to rise with GDP (per capita) and population. These variables are therefore expected to be positively associated with reserve demand.

* *Capital account*: Exchange rate intervention by China's monetary authorities may reverse the normally positive relationship between the broad money supply and the level of reserves. As mentioned in the previous sections, the PBoC has to print RMB in order to buy US dollars and other foreign currency. The central bank then sterilizes reserves in order to normalize the monetary base and counteract increases of net foreign reserves. Considering the large-scale exchange interventions by China, this study hypothesizes that an increase in the broad money supply will lead to a reduction of the size of China's international reserves.

* *Current account*: A rise in China's *exports* is expected to increase the PBoC's demand for reserves, because it further exposes the domestic economy to external shocks. In line with the findings from previous empirical work on China (Ford and Huang, 1994; 1995), this study hypothesizes that *imports* are *negatively* associated with the size of reserve holdings. From a textbook economics perspective, a country has to pay imports in another currency and will drain its foreign reserves to provide those payments. It was mentioned earlier that this is a rather deprecated view when looking at free-market economies, which assumes that states are still involved in the financing of international trade. However, under planned economy the Chinese government traditionally had full control over cross-border transactions and the allocation of foreign exchange. Companies had to purchase foreign currency directly from the state for imports, and sell it immediately after exporting. While controls have been relaxed over time in both *de jure* and *de facto* terms, the Chinese government has kept a firm grip on the reserves in circulation.

* *Exchange rate flexibility*. Greater exchange rate volatility is generally associated with falling international reserves, because it reduces the need for central banks to buy foreign currency to peg exchange rates. Despite the fact that the PRC has *de jure* adopted a more market-oriented exchange rate regime, the literature has warned for what is called a 'fear of floating' where countries *de facto* do not allow the exchange rate to float (Calvo, 2002). For this reason, flexibility is usually measured by the real-time volatility of the exchange rate. Considering the PBoC's historical and current practice of currency intervention, this study hypothesizes that greater volatility will trigger a fear of floating in policy-makers, resulting in increasing demand for international reserves.

* *Opportunity cost of capital*. In theory, the higher the interest rate differential the less a monetary authority is willing to hold reserves, because the costs outweigh the benefits of

having foreign reserves in the portfolio. China's reserves are mostly dollar-denominated or invested in currency assets from other advanced economies. Since interest rates in these countries stand at an all-time low from easing monetary policy, the opportunity cost associated with holding reserves in these assets has increased in recent years. Considering the size and composition of China's reserve portfolio, an increase in opportunity cost is expected to decrease the demand for international reserves.

5.3 Empirical model and methods

5.3.1 Model specification

Consistent with the theory of optimal reserves and previous empirical work, the explanatory variables used in the analysis in this study are a representation of five categories of economic determinants: economic size, capital and financial accounts, the current account, exchange rate flexibility and opportunity cost.

The time-series model takes the following functional form:

$$\ln R_{it} = \beta_0 + \beta_1 \ln(\text{size}_{it}) + \beta_2 \ln(\text{capacc}_{it}) + \beta_3 \ln(\text{curacc}_{it}) + \beta_4 \ln(\text{xrt}_{it}) + \beta_5 \text{occ}_{it} + \mu_t \quad (1)$$

, where R denotes the log of foreign exchange reserves to GDP valued in US dollars and minus gold, size the economic size of China measured by population and GDP per capita, capacc the capital account balance, broad money supply (M2) and FDI as a proxy for financial openness, curacc the current account balance and share of imports and exports in total output, xrt the flexibility of the RMB exchange rate against the US dollar, and occ the opportunity cost of capital. The variables specified in model (1) are defined in the variable statistics (Appendix A).

5.3.2 Methods

Time-series analysis relies on the assumption that variables are stationary and do not contain a unit root. Non-stationarity of the series is likely to result in 'spurious regressions', meaning that series which are seemingly related do not possess any statistically significant relationship in reality (Granger and Newbold, 1974). The Phillips-Perron (1988) and Augmented Dickey-Fuller (ADF) (1981) tests are widely applied to detect if unit root may be present in time-

series variables. Appendix B presents the results for the test. The results of both tests show that the majority of the series are (first) difference-stationary, with the exception of the variables FDI and population size which are stationary in levels.

In line with the stationarity tests, the analysis was initially based on a Vector Autoregression (VAR) model containing the full specification as summarized in table 2, with most of the series in first differences. However, the regressions indicated a high degree of multicollinearity, most notably between GDP, FDI and population size, and between the balance of payments (*cubal* and *cabal*) and import- and export ratios. Such a high level of collinearity between series could potentially lead to inconsistent results and it was subsequently decided to exclude FDI, population size and the capital-/current account variables from the analysis. The current model specification still includes at least one proxy per economic category. The remaining seven variables used in the final specification are highlighted in table 2.

Since the remaining variables are all $I(1)$, a natural step is to examine if the series may be cointegrated and thus possibly indicate any long-run relationship(s) between variables. Cointegration refers to the phenomenon in which multiple series, while being non-stationary in levels, share a stochastic trend which resembles a linear relationship of long-run equilibrium between the series that is $I(0)$ (Engle and Granger 1987). This study uses the Johansen's multivariate cointegration procedure to detect the presence and number of cointegrating vectors in the underlying VAR (Johansen, 1995). The most parsimonious Vector Error Correction (VEC) model specification indicating cointegration includes GDP per capita, the broad money supply (M2) to GDP, import- and export-to-GDP ratios, the interest rate differential and exchange rate volatility. The trace-test provides evidence for two cointegrating vectors, suggesting that there exist two sets of cointegrating relationships between the variables. Since we can reject the null-hypothesis of no cointegration for each one of these variables, the results provide evidence for their long-run relationship with China's demand for international reserves.

5.3.3 Model evaluation

Appendix C summarizes the results from several post-estimations of the VECM specification, with a focus on the econometric assumptions stated above and the overall fit of the model. The results of the formal La Grange-multiplier, run for eight lags, indicate that the VEC-model does not have serious issues with serial correlation. The Jarque-Bera test further shows

that the residuals are normally distributed, and detects no severe problems with heteroscedasticity and skewness. The VEC-model and underlying VAR were run with different series, specifications and lag orders. The current model specification represents the best overall fit and results in terms of autocorrelation and the distribution of residuals.

5.4 Results

The VEC-analysis examines the short- (α) and long-term (β) determinants of the demand for international reserves. Table 3 summarizes both the short- and long-run normalized coefficients of the model. The coefficient of the error correction term indicates the speed of adjustment of the model to long-run equilibrium. The error correction coefficient for the first cointegrating relationship equals -0.383, which means that the speed of adjustment to long-run equilibrium in the VECM is 38%. The error coefficient for the second relationship is insignificant. According to the model's average R-squared, the variables used in the analysis in this thesis explain roughly 60 percent of the variation in China's reserve holdings between 1980 and 2015.

The results from the analysis are mostly in line with hypothesized outcomes.

* *Economic size*. Surprisingly, economic size measured by GDP per capita does not show any statistically significant effects on the demand for international reserves. This could very well be explained by the fact that the majority of other variables used in the analysis, including the independent variable, the money supply (M2) and export- and import ratios, are scaled in terms of GDP and 'capture' the effect of GDP growth on the size of holdings.

* *Capital account*. In the short run, the money supply (M2) is found to be a statistically significant determinant of China's demand for international reserves (10 percent level). A 1 percent increase in the broad money supply will increase international reserves to GDP by almost 1.7 times. This finding can be related to the PBoC's practice of sterilized intervention. The central bank has to print RMB in order to buy US dollars and other foreign exchange. The empirical evidence indicates that this leads to a short-term spike in the size of reserves, where the ratio of monetary base expansion to international reserves is equal to 1.7. In the long run, the broad money supply is negatively related to total reserve levels. This result is in line with expectations as well as previous studies by Ford and Huang (1994; 1995), who found that the years characterized by a high supply of money correspond with a reduction of China's holdings of international reserves. It suggests that under such conditions, the PBoC

TABLE 3				
VEC-analysis				
<i>* Foreign exchange reserves</i>	<i>Short-run</i> <i>(normalized α)</i>	<i>Long-run</i> <i>(normalized β)</i>	<i>R²</i>	<i>Notes</i>
Variable:				
Error correction term				
- Cointegrating equation (1)	-0.383*** (0.142)			- 33.6%
- Cointegrating equation (2)	0.1 (0.102)			
Foreign exchange reserves	0.347 (0.253)	1.000	0.484	
GDP per capita	-1.011 (0.848)		0.835	
Broad money supply (m2)	1.675* (0.885)	-1.118** (0.442)	0.771	
Imports	-0.352 (0.543)	-4.64*** (0.677)	0.539	
Exports	-0.178 (0.727)	2.058*** (0.646)	0.639	
Exchange rate flexibility	0.013 (0.017)	-0.111*** (0.03)	0.662	
Opportunity cost of capital	0.007 (0.027)	0.07*** (0.023)	0.241	
Constant	0.254* (0.146)	10.217		
			0.596	59.6%

Notes: Standard deviation in parentheses (). *, ** and *** denote significance at 10%, 5%, and 1% levels, respectively. All series in logarithms except the opportunity cost of capital (*occ*).

can effectively sterilize reserves which ostensibly decreases the size of reserve holdings in relation to other fundamentals.

**Current account.* When looking at the Johansen normalization, we can see that the ratio of *exports to GDP* is highly related to China's long-run demand for foreign exchange. A 1 percent increase in the size of exports more than doubles the size of the stock of reserves. As the largest exporting economy in the world, the PRC evidently accumulates foreign reserves as a hedge against external shocks from export volatility. Consistent with the hypothesis formulated earlier, the results show that *imports* are negatively correlated with long-run reserve demand in China. This could very well be an indicator of the dual-track allocation system for international reserves as part of the planned economy. Although relaxed in both *de jure* and *de facto* terms, the allocation system still plays a role in China.

**Exchange rate flexibility.* This study hypothesized that an increase in volatility of the exchange rate could easily trigger a fear of floating, encouraging policy-makers to increase the size of reserve holdings. Contrary to the hypothesized outcome but in line with general theory, the flexibility of the exchange rate is found to be negatively associated with the long-run demand for international reserves. This finding suggests that the PBoC needs and demands fewer international reserves to peg the exchange rate if exchange rate volatility increases. The results indicate that the gradual introduction of (limited) floating rates leads to an 11 percent decrease in the long-run demand for international reserves.

**Opportunity cost of capital.* Lastly, the opportunity cost of capital is significant in explaining reserve levels and positively related to the dependent variable. This result may seem counterintuitive, but it may indicate that the opportunity cost of capital is not a high priority for the decision to accumulate foreign reserves.

6. Conclusion

In recent years, an increasing number of studies have attempted to empirically explain the rapid surge of foreign exchange reserves among emerging-market economies. The majority analyse the demand for international reserves for country groups in (macro)economic terms and disregard the political economy motivations that underpin this demand. This thesis has attempted to bridge these approaches through a single-country analysis of the People's Republic of China, which explores the links between the structure of China's politico-economic model and the (macro)economic determinants of its demand for international reserves. The assessment of the political economy aspects suggests that monetary and foreign exchange reserve policies have been highly motivated by the Chinese leadership's traditional

goal of rapid economic growth and social stability. Since the start of reforms, China's monetary framework has been geared to generate external demand and inbound FDI which has maximized GDP at the cost of household consumption. Chinese households share in the cost of exchange rate intervention and other export-promoting policies in the form of financial repression. The findings resulting from the cointegration analysis provide evidence for a strong connection between China's export- and investment led growth strategy and the determinants of its demand for international reserves. The results indicate that long-run demand is mainly associated with changes in the current account, which resembles China's dependence on exports and the need for reserves as a precaution for export volatility. Furthermore, it shows that the influx of international reserves is highly related to changes in the money supply. This finding provides a ground to believe that reserve holdings have largely increased as a result of interventions to hold down domestic exchange and interest rates. However, the analysis also provide some evidence that exchange rate reforms have taken effect in recent years, leading to less demand for international reserves to stabilize exchange rates.

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Appendix A

Summary Statistics	Mean	Std. Dev.	Min	Max	Observations
Variable:					
<i>fex</i>	2.457	1.087	0.04	3.856	38
<i>gdp</i>	6.722	1.241	5.053	8.996	38
<i>pop</i>	27.809	0.11	27.592	27.949	38
<i>cabal</i>	1.21e-07	1.78e-07	0	5.87e-07	38
<i>m2</i>	4.569	0.579	3.186	5.309	38
<i>fdi</i>	0.791	0.91	-1.562	1.822	38
<i>cubal</i>	8.65e12	1.22e13	-1.19e12	4.21e13	38
<i>import</i>	2.727	0.457	1.628	3.348	38
<i>export</i>	2.823	0.542	1.516	3.616	38
<i>xrt</i>	-0.409	3.041	-8.225	3.913	38
<i>occ</i>	0.4	3.44	-8.95	6.63	38

Notes: All series in logarithms except current account balance (*cubal*), capital account balance (*cabal*) and interest rate differential (*occ*). The value of these variables equals 0 for a number of observed years, which, when logged, would be excluded from the analysis.

Appendix B

Unit root tests	Phillips - Perron		Coefficient	(Augmented)	Dickey-Fuller	Specification	Order of Integration
	Levels	Difference	Levels/diff.	Levels	Difference		
<i>Variable:</i>							
<i>fex</i>	-3.115	-22.881***	0.905/0.159	-3.055 (-3.560)	-4.900***	Trend, intercept	I(1)
<i>gdp</i>	-2.640	-20.462**	0.941/0.344	-1.191(-3.553)	-4.009**	Trend, intercept	I(1)
<i>pop</i>	-1.247	-0.679	0.967/0.984	-6.406***	n/a	Intercept	I(0)
<i>cabal</i>	1.497	-26.943***	1.044/0.282	-0.330(-3.564)	-4.234**	Trend, intercept	I(1)
<i>m2</i>	-6.798	-26.403***	0.808/0.032	-1.785(-3.560)	-4.661***	Trend, intercept	I(1)
<i>fdi</i>	-4.990	-17.329**	0.85/0.37	-3.18**	n/a	Intercept	I(0)
<i>cubal</i>	-8.580	-26.169***	0.729/0.043	-2.146(-3.568)	-4.938***	Trend, intercept	I(1)
<i>import</i>	-5.667	-23.347**	0.816/0.111	-1.753(-3.552)	-5.083***	Trend, intercept	I(1)
<i>export</i>	-4.248	-24.093***	0.865/0.095	-1.498(-3.552)	-5.212***	Trend, Intercept	I(I)
<i>xrt</i>	-18.788*	-30.838***	0.459/-0.157	-3.517*(-3.552)	-6.729***	Trend, intercept	I(I)
<i>occ</i>	-6.102	-24.105***	0.864/0.218	-1.617(-2.966)	-4.852***	Intercept	I(I)

Notes: The Phillips-Perron and ADF-test reject the null-hypothesis of a unit root at the 1%***, 5%** and 10%* level, respectively (H0=unit root). The PP-test is run with 5 (Newey-West) lags for all variables; 5% critical value in parentheses (); Values for the ADF-test in levels represent the lag-size closest to the 5% critical value.

Appendix C

Model Evaluation	(Jarque-Bera)				(Lagrange multiplier)	
	Normality	Kurtosis	Skewness	Autocorrelation		
Variable:				Lag		
<i>fex</i>	0.012	0.007	0.216	1	0.933	
<i>gdp</i>	0.701	0.444	0.724	2	0.875	
<i>m2</i>	0.697	0.455	0.685	3	0.871	
<i>import</i>	0.711	0.416	0.885	4	0.104	
<i>export</i>	0.542	0.414	0.456	5	0.598	
<i>xrt</i>	0.906	0.816	0.706	6	0.814	
<i>occ</i>	0.226	0.36	0.144	7	0.528	
				8	0.068	
ALL	0.354	0.153	0.7			
Null-hypothesis	H0: Residuals are normally distributed	H0: normally distributed	H0: normally distributed	H0: No autocorrelation at lag order		