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International Currencies:

Prospect for the Chinese Renminbi

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Preface and acknowledgements

This master thesis is the final project for receiving the Master of Science degree in Financial Economics at the Erasmus University Rotterdam. The topic was not chosen randomly. China has always been an interesting an appealing country to me, especially after my visit to the country in the spring of 2009. For the last few centuries, the birth of a new superpower often went hand in hand with the international use of its domestic currency. We have seen the Dutch guilder, the pound sterling and the Spanish dollar as major examples. Although there are several bumps in the road to a widely used renminbi, the emergence of China surely increased its potential. It will be interesting to witness the impact of a different future economic hierarchy on the status of the world's currencies.

I would like to thank Agnieszka Markiewicz for her advice and helpful comments. Finally I would like to thank my parents for always supporting me over all these years.

Rotterdam October 19th, 2009

Mark Verwest

Abstract

On the long road to become a country that issues an international reserve currency China has to go through many more economic and institutional reforms. These include full convertibility of the currency and the establishment of well developed and independent financial markets. Based on the experience of other international currencies, it is possible to judge the potential of the renminbi. Thereby the assumption is made that China succeeds in creating the appropriate environment in the future. The findings indicate that the Chinese renminbi has the potential to become an important player in the reserve currency market and that it will exceed the share of the Japanese yen and pound sterling. Factors that seem to influence the size of a currency on an international level are a country's national income and the relative appreciation of the currency. Furthermore, evidence is found for deflation to have a negative effect on a currency's status and for the presence of network externalities, which predict a tipping phenomenon.

Keywords: *reserve currencies; renminbi; panel data; currency internationalization*

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1.   Introduction

March 24th, 2009, China calls for a new reserve currency and a new global system controlled by the International Monetary Fund (IMF).[1] The governor of the Chinese central bank said the goal would be to create a reserve currency "that is disconnected from individual nations and is able to remain stable in the long run, thus removing the inherent deficiencies caused by using credit-based national currencies".

In a reaction U.S. Treasury Secretary Timothy Geithner and Federal Reserve (FED) Chairman Ben Bernanke dismissed the suggestion that the global economy should move away from the U.S. dollar as the leading reserve currency.[2] Another opponent is the EU's economy commissioner Joaquin Almunia. He does not envisage major structural changes in the role the dollar plays today as a major reserve currency. "Everybody agrees that the main present reserve currency, the dollar, is there and will continue to be there for a long period of time.[3]

The past year was not only very turbulent for financial markets but also for other building blocks of the global economy, such as reserve currencies. In today's world, reserve currencies are still connected to a single country or region. This potentially makes them vulnerable to local developments. Benjamin Graham, one of the most influential strategists during the Great Depression and the Second World War already proposed the introduction of a single generic international reserve currency in 1940. While supported by John Maynard Keynes, the proposal was set aside in favor of a gold-based dollar standard, introduced after the signing of the Bretton Woods Agreements in July 1944.

One of the first to analyses reserve currencies, their key determinants and the theory of international money were Swoboda (1969) and Cohen (1971). Building on their research, different papers were written about the emergence of the pound sterling in the 19th century and its replacement by the U.S. dollar in the first half of the 20th century.

Although the introduction of a new global reserve currency seems to be unrealistic at this time, there is some movement in terms of the importance of the current dominant currencies. Since the introduction of the euro in 1999, its share rose from 18% to 26% of total reserves holdings that were allocated to the IMF. This largely came at the expense of the U.S. dollar and the Japanese yen, demonstrating their relatively declining importance.

Consider the following passage of Avinash Persaud (2004) of the U.S. Sate Street Bank and Trust. "Reserve currencies come and go. Over the past two and a half thousand years there have been a dozen reserve currencies that no longer exist. Sterling was the last to lose its status in the first half of the 20th century and the dollar will lose its status in the first half of this century. Losing reserve currency status

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[1] The Financial Times, March 23rd, 2009: *China calls for a new reserve currency*
[2] Reuters, March 24th, 2009: Geithner, *Bernanke reject new global currency idea*
[3] The EUobserver, March 25th, 2009: *EU rejects proposal for new reserve currency*

will lead to a series of economic and political crisis in the united States".[4] Although this quote might sound rather dramatic, based on historical evidence it sure isn't an unrealistic perspective. While stating this there is one remark that has to be made. The shift from pound sterling to the U.S. dollar is the only one we can reasonably compare as preceding reserve currencies were sometimes not more than just coins circling the globe and did not have the monetary function reserve currencies have today.

The introduction of the euro greatly improved the functioning of the euro financial markets; witch is a necessary condition for a currency to play an international role. The prologue of a common currency and efforts to synchronize the financial markets lowered transaction costs as well as country specific risk. So far the dollar has maintained its role as the most important reserve currency, possibly carried by the size of dollar financial markets as well as inertia[5]. The latter is typical concerning the status of international currencies. (Galati and Wooldridge, 2006)

Apart from the euro, another potential future substitute of the U.S. dollar as the dominant reserve currency is the Chinese renminbi (RMB, ¥)[6], also called yuan (CNY). Since 2007, China is the fourth largest economy in the world measured by gross domestic product (GDP), already outrunning the United Kingdom. Currently they are the third largest global trading partner, with an average annual growth of 25% over the full length of the decade before 2008.[7] Still the growth of the renminbi's global use is limited due to their peg to the U.S. dollar and other restrictions that are put on by the Chinese authorities.

According to Wu Xiaoling, the former vice governor of the People's Bank of China and now the depute head of the Financial and Economic Committee, the renminbi is likely to join other currencies to be used on a global scale. "China should create conditions for the renminbi to become an international settlement currency" she stressed.[8] Half a year later in July 2009, three Shanghai companies were allowed to settle import and export contracts in renminbi for the first time ever. Maybe this can be seen as one of China's first steps in that direction.

This paper considers the potential for the Chinese renminbi by drawing on the experience of other major currencies. More specifically, this paper estimates the main factors that determine the share of the five major currencies (the U.S. dollar, the British pound, the euro, the yen and the Swiss franc) in reserve holdings of the world's central banks after the introduction of the euro in 1999. This model is then used to judge the potential for the renminbi by discussing the current situation with respect to the significant explanatory variables that are found. Apart from an overview of recent movements towards the internationalization of the renminbi, this paper will focus on the prospect given that China's

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[4] Persaud (2004), p. 1
[5] The resistance to change in a state of motion
[6] The renminbi has the same currency symbol as the Japanese yen (JPY)
[7] IMF, *International Financial Statistics*
[8] China view, December 25th, 2008: *Senior official: Renminbi likely to be used as currency for forex reserves*

currency fulfills the demands to be an international currency as full convertibility and no discouraging regulations and restrictions.

The remainder of this paper is organized as follows. The next section discusses the definition of an international currency, provides an historic overview of previous literature and discusses the advantages and disadvantages of issuing such a currency. Section 3 starts with describing and advocating the chosen determinants used for the empirical part of the paper. In addition it presents the methodology of the panel estimation that is utilized and analyses the forthcoming results. Section 4 continues with a counterfactual exercise for the Chinese renminbi and discusses its potential as a future player in the international reserve currency market. Some conclusions are presented in the fifth and final section of this paper.

2.   International currencies

2.1   Properties of international currencies

A currency is an international currency when it's used by non-residents as a medium of exchange, store of value or unit of account. Although this role can be fulfilled by different currencies, historically the most dominant currency in terms of medium of exchange has also served as the main store of value and unit of account. (Truman, 1999)

Cohen (1998) calls this phenomenon the "deterritorialization of money", where the use of a currency is no longer confined within the territorial frontiers of a country but extends to a far broader spectrum. The result was a dramatic reconstruction of the global currency space. The once existing predominantly insular monetary systems were replaced by a more intertwined and hierarchical landscape of currencies.

Table I gives a summary of the three classic domestic functions of money – store of value, medium of exchange and unit of account – and transfers them to an international level. Besides this subdivision it's important to note that there is a difference between private use and official use of a currency. Monetary authorities might hold an international currency to intervene in foreign exchange markets, to safe keep wealth or to support their use of the exchange rates in monetary policy. The currency that fulfils these functions for the official sector is generally referred to as a reserve currency. (Frankel, 2000)

Table I: International functions of a Currency

	Official use	**Private use**
Medium of exchange	Vehicle currency for foreign exchange intervention	Invoicing trade and financial transactions
Store of value	International reserves	Currency substitution
Unit of account	Anchor for pegging local currency	Denominating trade and financial transaction

Each function is specified with a central example of how private actors and government authorities choose to use a currency that is not the original mean of payment in their country. Historically, the predominant role of an international currency is functioning as a medium of exchange. This is strongly related to the choice of monetary authorities in which exchange rate to intervene. To fulfil this role, converting assets into cash at a short notice, low cost and a trustworthy functioning in solid as well as in difficult market conditions should be self-evident. (Galati & Wooldridge, 2006)

The second major function of an international currency is functioning as a store of value. Kenen (1983) states that in the strictest sense, this is a currency that is reliable in terms of future purchasing power, implicitly requiring a sustainable monetary macroeconomic policy. In recent decades this role has gotten increasingly important. The accumulation of reserves in the past decade has outpaced the growth rate of international trade and world GDP. Figure I shows that total currency reserves rose from just over 5% of world GDP in 1999 to more than 11% in 2008. The graph also shows that the difference between currency reserves that are allocated to the IMF and total currency reserves has increased. This might result in a reduced reliability when analysing data from the IMF's Currency Composition of Foreign Exchange Reserves (COFER) database. Although there is a difference, measured in percentages the amount of reserves allocated to the IMF only declined from 72% to 64% of total foreign exchange reserves held by central banks.

Figure I. Currency reserves to world GDP
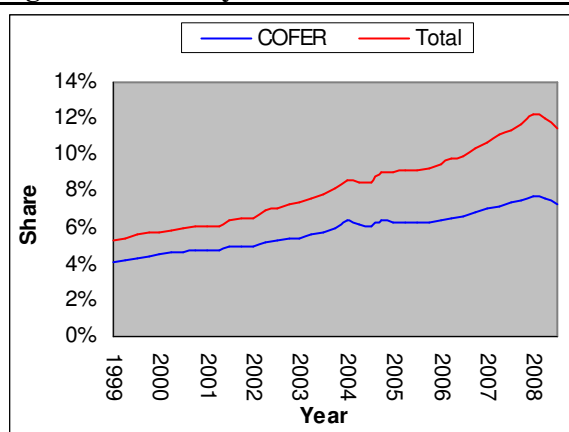
Source: IMF, COFER and IFS

Operating as a unit of account is the third role of an international currency. While in private use this relates to the currency chosen for invoicing, in official expression it is linked to the choice of an exchange rate as a monetary anchor. One way of discussing the role of a currency as a unit of account is by looking at the number of pegged currencies. A research by the ECB (2008) reported that 29 countries use the euro as anchor for their exchange rate policies. When countries are added that use a basket of currencies in which the euro is used as one of the points of reference, this number increases to 40[9]. The U.S dollar used to be the most popular currency to use as an anchor up to the fall down of the Bretton Woods Agreements in 1973. Afterwards it declined significantly in popularity since the collapse gave rise to an increased number of free floating currencies and because countries started using other currencies to peg their exchange rate, especially the German mark.[10]

According to Galati & Wooldridge (2006), a second approach is to look at the co-movement with other currencies. By measuring the volatility of the exchange rate or the sensitivity of currencies to

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[9] Out of the 150 pegged currencies listed by the IMF in 2004

[10] For a detailed overview of the history and evolvement of pegged currencies, see Meissner & Oomes (2008)

particular exchange rates, one can determine the role as unit of account. Low volatility or high sensitivity with respect to the dollar indicates that the dollar plays an important role as a unit of account in the corresponding country.

2.2   *History of international currencies*

2.2.1   Pre World War II

Compared to the existence of money as a mean of payment, the use of currencies on an international scale is a relative recent development, arising only in the beginning of the 19th century. The upcoming use roughly coincided with the emergence of the first international gold standard, in which the British pound became the leading international currency. The 1844 Bank Charter Act[11] marks the establishment of a full gold standard for British money. Lindert (1969) estimated that by the end of the 19th century, the share of the pound in foreign exchange holdings of official institutions was more than twice the total of the French franc and the German mark combined. The U.S. dollar did not even come close to any of these currencies from the European mainland. At that time not only the role of the dollar was small but economically the U.S. did not play an important role either.

Flandreau & Jobst (2005) provided the first empirical study of the determinants of global currency status in the context of the late 19th century. They did not find any evidence that proved currencies to retrieve international status because of the moral appeal of the issuing country. They did find support for trade size as a powerful driver of monetary leadership in the long run. Their most imperative conclusion is that currencies became important due to their low liquidity premium. Consequently a currency could hold or even expand its strong position as subsequently international circulation lowered the average liquidity premium. This finding attributes to the potential for persistence, which will be discussed in more detail later on in this paper.

Although the United States' economy surpassed the British economy in the late 19th century, the development of their financial system and their role in global trade lagged behind. The U.S. did not establish a central bank until 1913, when commercial banks took the initiative to institute the Federal Reserve (FED). In terms of exports they did not substantially overtook the U.K. until 1940, after which their growth rate would continue to be relatively high.[12]

It was only after World War II that the U.S. dollar finally overtook the pound as the key international currency. Due to both world wars in the first half of the 20th century the U.K. moved from a net creditor to a net debtor. At the same time the U.S. moved in the opposite direction, lending money to

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[11] Passed under the government of Robert Peel, restricted the power of British banks and gave the power of issuing notes exclusively to the central Bank of England. The Bank of England was restricted to only issue notes if they were 100% backed by gold.
[12] U.S. data: Historical Statistics of the United States, Colonial Times to 1970, U.S. Census Bureau. U.K. data: Department of Trade and Industry, Global Financial Data

The United Kingdom. While at the start of the Second World War the level of foreign-owned sterling assets was still twice the amount of foreign-owned dollar assets, this had reversed by the end of 1945. (Aliber, 1966)

2.2.2   World War II and Bretton Woods

Although gold was the official international reserve asset after the Bretton Woods Agreement[13] in 1944, the U.S. dollar was the true reserve asset of the new post-war monetary system. With the U.S. government guaranteeing other central banks they could sell dollars at a fixed rate for gold, the dollar was placed at the system's centre. After the war, a lot of European and other currencies were not convertible into gold and were therefore not priced as the dollar was. In 1958, when the major European countries restored their balance of payments, they provided for the free convertibility into gold and dollars as well. As a result their currencies were implicitly pegged to the dollar. (Chinn & Frankel, 2005)

Meanwhile the demand for international currency reserves increased relative to international income and trade. Because of the more or less fixed supply of gold, the U.S. dollar gained importance as a supplementary reserve asset for central banks around the world. Consequently the demand for dollars rose and there was only one way to earn dollars, running a balance of payments surplus with the United States. Later this became known as the Triffin Dilemma (Triffin, 1960). Either the U.S. had to take measures to limit its deficit or it would allow other countries to build up claims against it. The widening of the balance of payments deficit together with the increasingly expensive Viet Nam War led to the end of the Bretton Woods system. By 1973 all industrialized countries no longer kept their currency pegged to the dollar.

To some extent Eichengreen & Flandreau (2008) dispute the findings of Triffin (1960) as they conclude that the predominance of the pound was already successfully challenged in the 1920s. The fact that the pound recaptured this status 10 years later, according to the authors questions the idea that reserve-currency status depends only on economic, commercial and financial size.[14] Furthermore, they note that the coexistence of the pound and the dollar during the Second World War rebuts the general idea that network externalities and economies of scale only leave room for a solitary dominant currency[15].

2.2.3   Free float era after the gold standard

The number of empirical literature rapidly increased after different authors gained excess to – at that time – confidential country-by-country IMF data on the currency composition of foreign reserves.

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[13] Bretton Woods, July 1944. The goal of the negotiations was to set up a system of rules, institutions and procedures to regulate the international monetary system, partly by establishing the IMF and the current World Bank

[14] The main factor emphasized by Chinn and Frankel (2005)

[15] Hartman (1998) shows theoretically that an equilibrium can also exist with more than one vehicle currency

Central bankers used to regard individual country specific data as too sensitive to make available to the public.

Lizondo & Mathieson (1988) studied the determinants of the currency composition of exchange reserves between 1976 and 1984 for industrial as well as developing countries. They find evidence that trade flows with reserve currency countries and exchange rate regimes are empirical determinants of a countries' currency composition of reserves. They concluded that a central bank tended to hold a greater portion of its foreign exchange reserves in assets denominated in a currency if their currency was pegged to that particular currency and if a large share of its exports and imports was with the country issuing that particular reserve currency.

In a more recent study, Eichengreen (1997) considers the euro's outlook as an important future reserve currency by looking at determinants of the shares of the dollar, Deutsche mark and pound sterling. He finds that a one percent increase in the share of a country's share of GDP results in a 0.8% increase in its share of global reserves accounted for by the currency. The effect of an increase of a country's share in global trade has about half that size. Apart form these significant relationships, the author shows that incumbency is an important factor in competition for reserve currency status. As a result the long run effects are larger than the impact effects, emphasizing the role of history and network externalities.

For the period between 1971 and 1996, Eichengreen & Mathieson (2006) analyze the persistence of trends, with special attention to emerging markets. They document that exchange rate pegs, trade flows and financial flows (i.e. the currency composition of external dept) influence the composition of reserves held by central banks of 84 emerging and transition countries. Apart from the significant variables they find what they call: "striking stability over time, not just of the currency composition of reserves but also of its principal determinants: trade flows, financial flows and currency pegs". The authors conclude that the composition of reserves appears to evolve slowly, regardless of the existence of quite marked adjustments in the wider financial environment.

Considering the period up to the prelude of the euro, the study that is most related to the empirical part of this paper is the work of Chinn & Frankel (2005). They study aggregate yearly data for the currency composition of foreign exchange reserves from 1973 up to 1999. The authors regress the currency shares of the then seven main reserve currencies on a variety of characteristics of the currency and the corresponding country. As dependent variable they use the currency's share as percentage of total to the IMF allocated reserves as well as its logistic transformation. The transformation reflects the inherent nonlinearity of the problem, which this paper will discuss later on. Judged by the number of statistically significant variables the non-linear form is more successful. Rather, they state that there may be a *tipping phenomenon*; "If one currency were to draw even and surpass another, the derivative of reserve currency use with respect to its determining variables would be higher in that range than in the vicinity of zero or in the range when the leading currency in unchallenged".

With the logistic transformation they discover support for the size of the home country measured by GDP, the inflation rate, exchange rate volatility and the size of the home financial market as significant determinants. Both GDP and size of the financial market are measured as a ratio to world aggregate. Income shares enter the regression positively, indicating that when a country's GDP grows faster than world GDP, reserves of the matching currency in central bank holdings increases. Inflation is quantified as the differential vis-à-vis average industrial country inflation and shows a negative coefficient, as does exchange rate volatility. Both high inflation rate compared to other industrialized countries and high volatility of the exchange rate have therefore a negative contribution to the share in total foreign currency reserves.

Furthermore, by including a lagged endogenous variable they find that partial adjustment seems to be an important factor. In the different regressions, only 4% to 10% of the adjustment to the long run is estimated to take place in a single year. When considering the logistic transformation, the adjustment rate is a little more rapid and close to 12% per year.

During the examined time frame, the share of the dollar in total currency reserves held by central banks was at its peak in the late 1970s. In 1979 almost 80%[16] of the reported reserves consisted of dollars. Chinn & Frankel (2005) conclude that the downward trend of the dollar came together with a decline in its value and conflict with its trading partners about the exchange rate. According to especially the European countries, the U.S. had failed to provide the world a stable currency. To a certain extent this might have initiated the introduction of the European Currency Unit (ECU) as a rival currency in 1979, which would eventually evolve to the birth of the euro in 1999.

2.2.4   Introduction of the euro

"By introducing the euro, the European central bank developed into a global economic force to be taken seriously and eventually the euro could replace the U.S. dollar as the world's primary reserve currency"[17]. Former Federal Reserve chairman, Allen Greenspan clearly had confidence in the currency that was introduced as accounting currency by the 11 countries of the Euro Zone at January 1st, 1999.[18] The notes and coins of the former currencies were not replaced before the euro counterparts were introduced at the start of 2002.

Figures II and III demonstrate the development of currency shares after the introduction of the euro. In the first year the share of the euro was around 18%, for the most part gaining from the German mark, which latest reported share in 1998 was just under 14%. The Swiss franc, once an important reserve currency with a share of almost 3% 1981, saw its stake reduced to less than 0.3% in 1999. The

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[16] All data on the Shares of currencies in central banks reserves are from the International Monetary Fund (IMF). Before 1999: IMF, *Annual Reports*. Since 1999: IMF, COFER. Quarterly COFER data were disseminated for the first time on December 21, 2005. This is the only source of such information worldwide

[17] Reuters, September 17th, 2007: Euro could replace dollar as top currency - Greenspan

[18] Others that were optimistic the euro would immediately challenge and sooner or later replace the dollar are e.g. Bergsten (1997) and Mundell (1998)

Japanese yen showed the relatively biggest decline, losing almost half of its share. During the final quarter of 2005 the pound surpassed the yen, becoming the third largest currency in the sense of central bank reserves.

Figure II: Evolvement of reserve holdings euro and U.S. dollar 1999 – 2008	**Figure III: Evolvement of reserve holdings yen, pound sterling and Swiss franc 1999 - 2008**
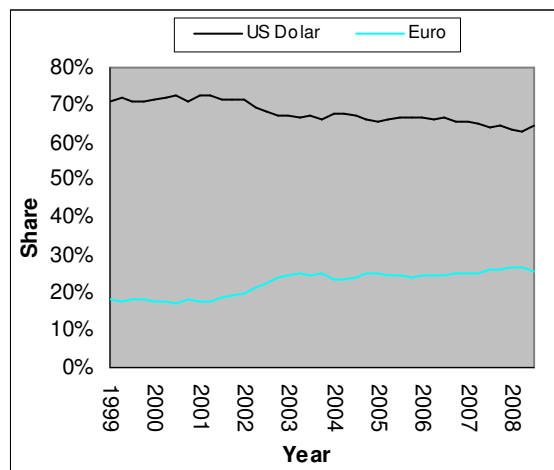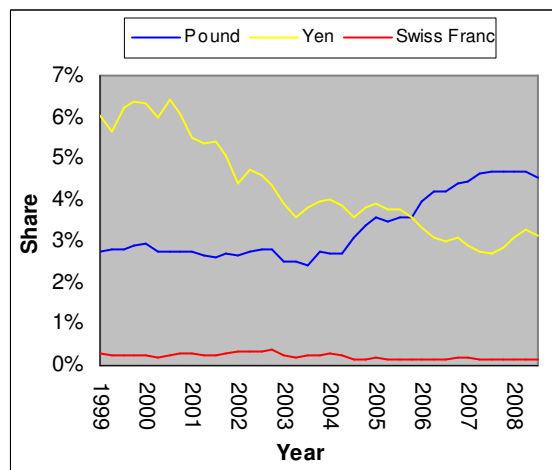
Source: IMF (COFER)

The European Central Bank (ECB) (2008) finds that the volatility in the share of the euro is partly due to exchange rate movements that affect the value of euro-denominated reserves. Measured at constant exchange rates, the overall trends are less pronounced. This indicates that there is a relation between the relative appreciation or depreciation of a currency and its share in central bank reserves. In their research, Chinn and Frankel (2005) report regressions were they use the long depreciation trend as a variable. This trend is defined as 20-year average rate of change of the value of the currency against the IMF's Special Drawing Rights (SDR). They find that this variable is in neither case statistically significant for a sample including all currencies. When they exclude the data for Japanese yen, the results change and show a significant negative coefficient for long term depreciation. The Japanese yen had a strong trend appreciation over the sample period, but failed to accomplish a more prominent position as international reserve currency.

Lim (2007) also attributed to the discussion about the influence of exchange rate changes on the currency reserve portfolios. The author uses quarterly COFER data between 1999 and 2005 and study whether reserve portfolios react to exchange rate changes with a portfolio rebalancing strategy. The econometric results suggest that central banks use portfolio rebalancing as a dominant strategy for reserve management. This strategy requires selling of appreciating currencies and purchasing depreciating currencies. For that reason it tends to have an offsetting impact on the direction of currency movements and helps explain the relative stability of reserve currency shares. In an earlier paper, Truman & Wong (2006) called this process "stabilizing diversification".

Given the fact that quarterly data is only available since 2005 and do not go further back than the introduction of the euro in 1999, the number of comparable empirical papers is reasonably limited. Building on the study of Chinn & Frankel (2005), Chen & Peng (2007) estimate the relationship between currency shares and a number of main determinants, using both a linear and a non-linear model. They find that economic size of the issuing country including financial market development and network externalities[19] are significant variables. The size of the country is defined as its GDP share in total world GDP and the market capitalisation of the domestic stock exchange is used as a proxy for the development of financial markets. Network externalities are being examined by including a lag of the dependent variable as explanatory variable in each regression.

2.3   Consequences of issuing an international currency

2.3.1   Advantages

The implications of being able to issue an internationally used currency are disputed. Dobson & Masson (2008) state that the ability to borrow and dominate trade in your own currency shifts risk to foreign investors and traders. These risks were predominantly evident during the Asian Financial Crisis that started in 1997, in which many Asian countries suffered from experiencing large foreign dept and a depreciating currency at the same time. Throughout these turbulent years there was an ongoing debate in the region about installing some sort of a regional currency to stabilize exchange rates and improve monetary integration.

This problem faced by countries that do not issue an international currency is often referred to as 'Original Sin'. Eichengreen & Hausmann (1999) define Original Sin as "A situation in which the domestic currency cannot be used to borrow abroad or to borrow long term at fixed interest rates, even domestically". This makes the domestic dept composition very risky. Furthermore, they state that financial instability is unavoidable because all domestic investments will have either a currency mismatch or a maturity mismatch. Assuming that there will be a counter party to hedge the currency risk would be the same as assuming a country is able to borrow abroad in its own currency. Finally, the greater the willingness of foreigners to lend and of residents to leave their money in their home country deepens domestic financial markets, making them less vulnerable to unforeseen financial shocks.

Warnock & Warnock (2006) come up with another important advantage. A country gains from issuing an international currency by lower borrowing cost and seigniorage. They estimate that East Asian purchasers of U.S. government bonds might have lowered long term interest rates to be paid by the U.S. by as much as 60 basis points. Thereby, they indirectly had an attribution to the wealth of the U.S. government. They quantify the impact were all else to remain the same. Consequently they state

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[19] Persistence is used as proxy for network externalities, reflected by a lagged dependent variable

that a factor like what they call "the power of the Fed" could somewhat alleviate the impact on U.S. interest rates. If the FED qualifies the level of long rates as undesirable, they could step in and buy Treasury securities, thereby undoing any potential effect.

Cline (2007) contributes to the discussion by saying that the U.S. was able to consistently yield a higher return on their investments overseas than it has had paid on its dept. The willingness of mainly the Asian countries' central banks to finance the current account deficit seems to be narrowly related to the position of the dollar as the leading reserve currency.

The third advantage relates to the residents of the issuing country. Being able to deal in your own currency is a lot more convenient for a country's exporters, importers, borrowers and lenders. As with the global use of the English language, many Americans tend to see the global use of the dollar as a natural everlasting advantage.

Kannan (2008) goes a step further by stating that this even operates through prices. If the use of a currency in international trade increases, the residents of the corresponding country profit through an increase in the purchasing power of their currency both at home and abroad. When the domestic currency is more widely used, its value in terms of the quantity of goods that can be purchased for a unit of the currency increases. It should be noted that the paper makes one important assumption as it assumes that monetary authorities do not accommodate the higher external demand in such a way that domestic price levels do not change. Even then the same takes place on an international level, resulting in a lower price for imports. The author finds that when more foreign exporters accept the domestic currency, this leads to a greater number of goods traded and a lower price per contract.

2.3.2   Disadvantages

Next to the previously mentioned extensive advantages, possessing an international currency also comes with some shortcomings. International use makes monetary policy of a country's central bank less effective in controlling domestic activity and balancing inflation. For Germany and Japan this effectively explains why the authorities discouraged the reserve currency status in the past. Currencies pegged to the dollar in the post-war period made it increasingly difficult for the U.S. to use the exchange rate as a tool to regulate the balance of payments. This is one of the reasons why it is unclear if China would encourage reserve currency use as it eradicates restriction on capital flows. (Dobson & Masson, 2008)

An additional inconvenience is the fact that seigniorage has negative implications as well. Increasing popularity may cause an inflow of capital and thereby letting the currency to appreciate. A more expensive currency can have a negative effect on the exports of a country and possibly diminishing its competitive position. This is another factor that influences China's current position.

At last a country can encounter negative effects through larger fluctuations in the demand for the currency. This potentially elevates the volatility of the exchange rate, which could be an undesirable

outcome since it negatively affects the confidence level. Chinn & Frankel (2005) mention that even though the two are related, this variability of demand is more likely to come from an increase in the degree of capital mobility than from the status of the currency. Although central banks may be concerned that they are less able to control the money stock, this problem will be less evident if the central bank does not intervene in the exchange market.

3.   Determinants for the international use of a currency

3.1   Possible determinants

3.1.1   Proxy for international use of a currency

When analysing the determinants of international currencies, this paper focuses on the reserve currency holdings of central banks for mainly two reasons. First, quarterly data on foreign exchange reserves is available for all the major currencies over the past ten years. The sizes of the other functions introduced in Table I are exceptionally difficult to quantify and therefore less suitable to analyse. The second reason is that reserve currency holdings are a superior indicator to measure the global importance of a currency. Unlike the other two functions a currency has on the official level, the share of a currency in worldwide central bank reserves changes gradually. This makes it a particularly appropriate variable to analyse the key determinants.

The critical requirement for a currency to play an important international role as a reserve currency is plausibly full convertibility. Though this is an important starting condition, it certainly isn't a guarantee. Its international use will eventually be determined by the underlying market forces. The following three subsections discuss the most important determinants that are often listed in academic research and subsequently used in this paper.[20]

The data used in this paper is mainly obtained from the International Monetary Fund (IMF) and the Organisation for Economic Co-operation and Development (OECD). This section will only briefly discuss the variables that were used and why these possibly are an important determinant. For a more detailed description of the data, its sources and the composition of the variables that are described in this section, see Appendix A.

3.1.2   Size of the economy

International currencies are in general linked to large economies and countries with a well developed and open financial system. A currency that is backed by a country or region with a large share in international output and trade has a logical advantage. On the other hand, for small countries it may be difficult to create efficient and competitive markets in foreign exchange. Large scale trade activities create a large market in foreign exchange transactions, making it possible for a country to rely on its own currencies for settling transactions. Another not unimportant consequence is that a larger sized market often goes hand in hand with economies of scale and scope, thereby lowering transaction cost.

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[20] Some relevant references are: Chen & Peng (2007), Chinn & Frankel (2005), ECB (2008), Eichengreen & Mathieson (2000), Dobson et all (2008), Galati & Wooldridge (2006), Mundell (1998) and Lim (2006)

Especially vehicle currencies tend to belong to the larger and more prevailing economies in the world. (Lim, 2006). See Table II for a comparison between the countries.

Table II: Share of reserves holdings and size of determinants

	U.S.	U.K.	Euro area	Japan	Switzer -land	China	Date
Currency Share in foreign reserves (% of allocated)	64,6	4,6	25,5	3,1	0,15	N.A.	Q3 2008
Currency Share in foreign reserves (U.S dollar, bn.)	2.814	199	1.113	136	6	N.A.	Q3 2008
Size of economy and financial market							
GDP (U.S. dollar, bn.)	14.413	2.734	13.883	4.704	498	4.152	Q3 2008
GDP (PPP) (U.S. dollar, bn.)	13.972	2.184	10.776	4.068	310	8.611	Q3 2008
GDP (PPP) (% of world total)	20.3	3.23	16.1	6.2	0.45	11.7	Q3 2008
Foreign trade: Import + Export (U.S. dollar, bn.)	3.723	1.187	4.442	1.560	369	2.930	Q3 2008
Foreign trade (% of world total)	10,9	3,5	13,0	4,8	1,1	8,6	Q3 2008
Stock market cap. (U.S. dollar, bn.)	16.157	2.565	6.361	3.334	999	2.163	Q3 2008
Stock market cap. to GDP ratio	1.12	0.94	0.46	0.71	2.00	0.52	Q3 2008
Stock market cap. (% of WFE total)	37,3	5,9	14,7	7,7	2,2	5,0	Q3 2008
Monetary stability							
10-year average inflation	2,83	2,81	2,20	-0,15	1,08	1,76	1999- 2008
Exchange rate volatility[21]	4.02	4.56	4.53	5.26	4.85	4.04	1999- 2008
Annual appreciation of exchange rate (% against SDR)	-0.84	-2.25	1.19	2.05	2.16	1.10	1999- 2008

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[21] Exchange rate volatility is the annualized standard deviation of monthly percentage change of the exchange rate against SDR over the 10-year period

The euro is now the home currency for 16 European countries, altogether having much more economic power than the countries individually. This creates much more potential for the euro as there used to be for all prior currencies like the French franc and the Dutch guilder. Despite the growing size of the euro area, the U.S. is still the largest when size is measured by GDP. If size is measured by the total export plus total import (trade), the euro area is already ahead of the United States and growing fast the last decade. This indicates the important role the euro countries play in international trade flows. China is after Japan the fourth largest in terms of GDP, but already the third largest when GDP is measured based on purchasing power parity (PPP) exchange rates or in terms of trade.

3.1.3 Financial development

Size also matters concerning the development and dept of financial markets. As mentioned before openness and the absence of controls are both crucial, but to attain the international currency status it's also important to have deep and well developed capital markets. Large and liquid secondary markets allow central banks and investors to liquidate or acquire big positions in the currency without the fear of losing capital (Cooper, 1997).

Lim (2006) states that a well-developed and large financial center attributes to the attractiveness of a currency and comes up with two more explanations. First, they offer a wide range of supplementary services useful to international investors wanting to borrow or invest in the domestic currency or those that want to hedge their foreign currency positions. Second, they have a bigger change to attract business from countries where financial markets are less developed. This sometimes makes it for market participants less expensive to invest abroad after buying an international currency first, rather than to directly invest with the domestic currency as means of payment.

It is rather difficult to find a proxy for these properties that is obtainable for all the financial centers. This paper makes use of the capitalization of a countries' stock market divided by global aggregate stock market capitalization and a countries' stock market capitalization relative to its GDP. The latter may capture the effect of having an important global financial center as London or New York, which results in a ratio that is almost twice as high for the U.S. and the U.K as for the euro area and Japan. Switzerland has the highest ratio of all with a stock market capitalization that is double the country's GDP. (See Table 2)

Furthermore, the authors state that the relationship between the different measures of size and the share of a currency in international central bank reserves is likely to be nonlinear[22]. As a nonlinear alternative, a currency's share is also calculated by using logistic transformation[23]. To further underline this relationship, figures IV and Figure V compare both methods for GDP at PPP rates and figures VI and VII do the same for trade. Especially figures IV and V show a clearly non linear

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[22] Currency shares are bounded between 0 and 1. As not all variables are constrained in a similar way, one way of taking this into account is logistic transformation

[23] Logistic = log(share/(1-share))

relationship. The data points representing the currencies in figure IV show that there must be a sharp upward curve somewhere in the middle of the graph.

Figure IV: Percentage share vs. GDP (PPP)
Q1 1999 – Q3 2008
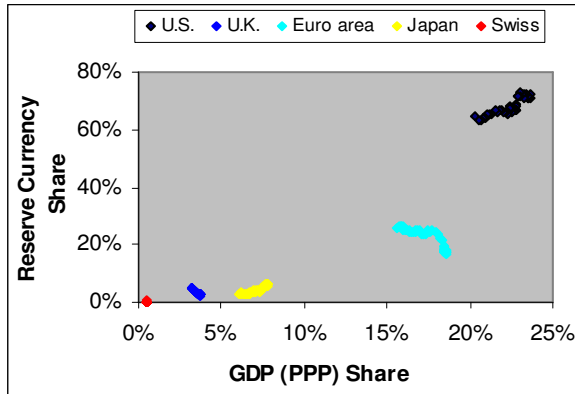
Figure V: Logistic share vs. GDP (PPP)
Q1 1999 – Q3 2008
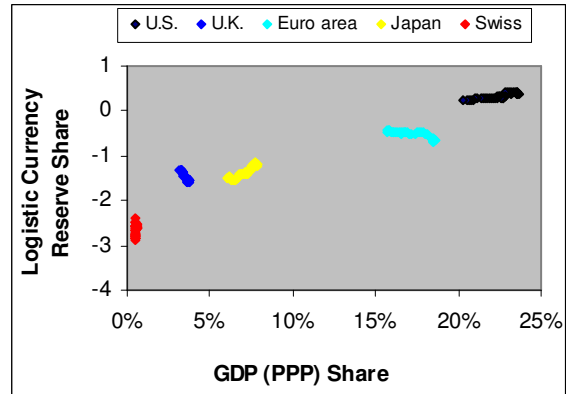
Figure VI: Percentage share vs. trade
Q1 1999 – Q3 2008
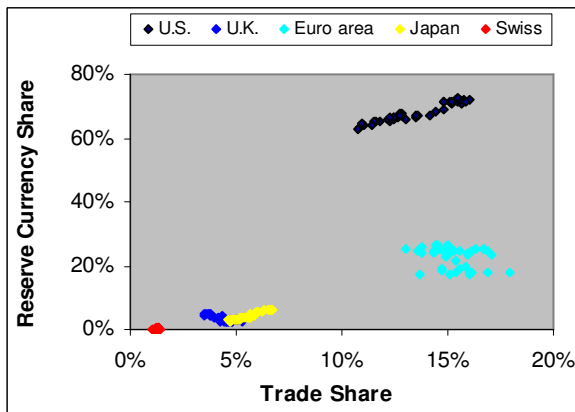
Figure VII: Logistic share vs. trade
Q1 1999 – Q3 2008
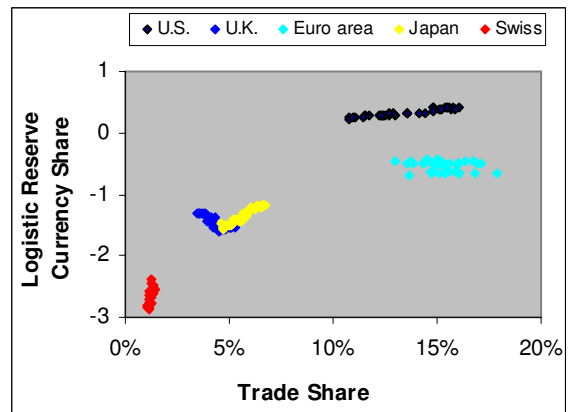
Figure VIII: Percentage share vs. market cap.
Q1 1999 – Q3 2008
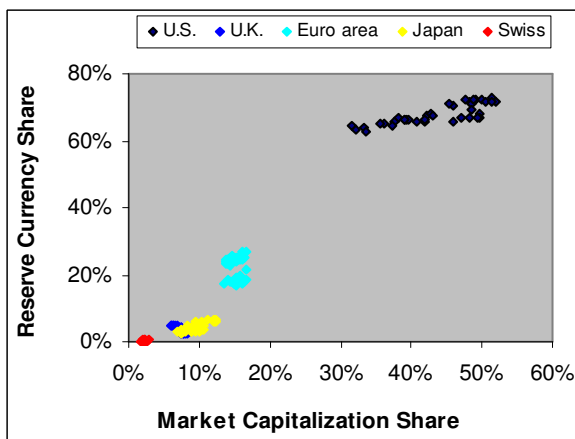
Figure IX: Percentage share vs. market cap.
Q1 1999 – Q3 2008
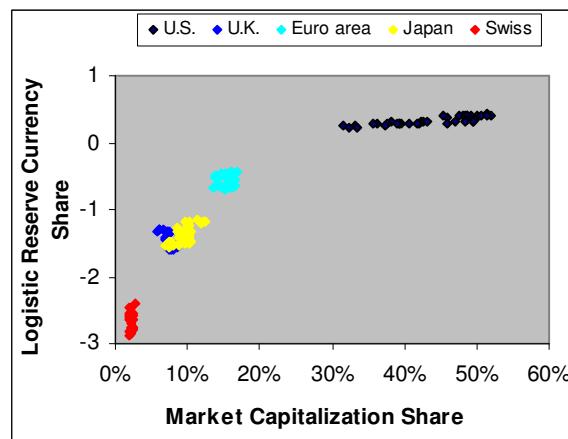
An exception is the market capitalization of a countries' financial market. Figures VIII and IX indicate that a linear relation might be the best guess in this case. It will be interesting to see whether this can be confirmed by the different regressions in the next section. Other variables that are not presented in the paper show in general the same qualitative results a GDP (PPP) and trade.

3.1.4   Stability and value of a currency

For an international currency that is used as a unit of account or as a store of value, another important quality is confidence in its purchasing power. If a currency plays an important role as a store of value, it will be held by many different institutions and people. Investors are exposed to the currency by holding international bonds, multinational firms are exposed with their working balances and central banks hold various currencies as reserves. Therefore, a currency that has stable value in terms of goods and services and that is not suffering from very high inflation will be preferred. Currencies that lack those features will bare higher holding risk and a declining purchasing power. Obviously those elements will have a negative effect on amount of assets that investors are holding in the particular currency.

Over the past ten years the Japanese yen is the currency with the highest average volatility and the U.S. dollar with the lowest, although differences are small (Table 2). When looking at inflation the picture looks different. Between 1999 and 2008 the U.S. and the U.K. had an average yearly inflation of around 2.8%, while in Japan prices declined with an average of 0.15% per year. It will be interesting to see whether these conditions have a significant influence on the reserve holdings of central banks and if these effects differ from previous research. Not least because the situation is totally different from the situation in the decades before the introduction of the euro, when in numerous countries inflation was well above 5% and sometimes even above 10% during many years. In the United States, the decade between 1973 through 1982 was the most inflationary in modern history. At the end of this decade the cost of living had more than doubled (Graham, 2006). What is striking is that countries with the lowest average 10 year inflation saw their currency appreciate and countries with high inflation experienced depreciating currencies. Where the yen appreciated, pound sterling and the U.S. dollar depreciated.

In addition to volatility and inflation, this paper will look at is the appreciation of a currency with reference to the SDR of the IMF. A strong currency that appreciates relative to other currencies might be favorable to use as part of foreign exchange reserves. As mentioned before, for a more detailed description and composition of the variables used, see appendix A.

3.1.5   Network externalities

As for more things in life, when more people are using a certain currency it becomes increasingly valuable too all users. Software becomes more popular as a larger amount of people are using the same

program and a certain language becomes more interesting to study as a greater number of people are able to speak it. For this, the reason is not necessarily the fact that it is the best software program on the market or the easiest language to learn. To some extend this phenomenon can be translated to the presence of key currencies.[24] There is a strong inertial bias which indicates that whatever currency is used the past, is in favor of being used in the future. Once a currency becomes a vehicle currency and is used in a broad international spectrum, it becomes more attractive to different users.

An increasing network implies a bigger number of counterparties for a trade, thus increases the odds for a favorable match and a quick deal. This develops into a self-reinforcing cycle when more people join the network, attracted by the increased liquidity in the market (Lim, 2006). On the supply side of the deal there are advantages of an expanding network and market size as well. Average costs are reduced with scale as more users lead to lower costs per unit. In addition, a larger market size is likely to lessen the average waiting time between matching all the sell- and buy orders. This allows market-making institutions to hold smaller inventories for the same amount of transactions, thereby reducing overall cost. (Krugman, 1980)

As mentioned before a currency's share in total currency reserves is measured as a percentage of total allocated currency reserves as well as by using logistic transformation. There is another reason that this might be a good approximation apart from the ones brought forward in footnote number 20 and Figure IV to Figure VII, that were presented in the previous section. The presence of network externalities and economies of scale namely suggests that measures of international currency use may not be linear in its determinants. Or as Chinn and Frankel (2005) state, "network externalities would predict a tipping phenomenon". This means that in case a currency exceeds another leading reserve currency, the growth rate of the surpassing currency would accelerate and the switch would occur speedily. Eichengreen (2005) has a critical note on these findings and concludes that positive network effects will possibly be weakened in the future as innovation in technologies and changing market structures create a different environment as there was in the past.

3.2 Methodology

3.2.4   Data

This paper focuses on the period after the introduction of the euro in January 1999. Quarterly data is used from first quarter of 1999 up to the third quarter of 2008. The sample period is partly dictated by the data break induced by the prologue of the euro. Another reason is that quarterly reported data in the IMF's COFER database only goes back to the first quarter of 1999. As a result the panel database consists of 39 observations for each currency and 195 in total.

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[24] Persaud (2004) gave the following description of this analogy: "Windows is the dollar of operating systems"

In 2005 the IMF changed the way of reporting reserve data and corrected all statistics extending back to 1995. Another important improvement apart from increasing the data's frequency is the way how unreported data is treated. Where the IMF used to estimate the reserve holdings of central banks that did not want to report their data, they now place these reserves under the separate category 'unallocated'. As this paper analyses a currency's share in total *allocated reserves*, this potentially increased the accuracy and reliability of the data compared to earlier estimates.

The variables that are being used in this paper as determinants of reserve currencies are (... GDP, GDP at purchasing power exchange rates, market capitalization of the stock market, market capitalization divided by GDP, total trade, volatility of the exchange rate, appreciation of the currency, inflation and a lag of the dependent variable). As mentioned before, for a more detailed description of the data and its sources, see appendix A.

The regressions in this paper will exploit value shares of exchange reserves. Consequently, the current exchange rate does not only appear on the left hand side of the equation when foreign reserves are measured, but in some occasions also on the right hand side. This is for example the case when valuing GDP in U.S. dollars. In their paper, Chinn & Frankel (2005) mention this does not necessarily induce the appearance of an econometric problem as endogeneity or simultaneity. Furthermore, the exchange rate does not always appear directly on the right hand side. Regressions also use the long run trend appreciation and GDP measured at purchasing power parity exchange rates.

The number of lags is determined by a coefficient that was first used by Schwarz (1978). When the optimal lag structure is implemented, this minimizes the Schwarz statistic. This coefficient is found by running a grid search on the lag structure, beginning with one lag. The results indicate that a lag of one quarter is the best choice and this is subsequently implemented in the model as independent variable.

To guarantee the model is valid and there is no need to use more lags, it is necessary to make sure there is no autocorrelation left in the residuals. None of the traditional measures as the Durban Watson statistic and the Breusch-Godfrey tests can be applied to dynamic panel data. Therefore, a manual test has to be conducted. First a residual series of the regression is made and this series is regressed on its lag (-1). Secondly, a Wald test is conducted. Under the null hypothesis that the original idiosyncratic errors are uncorrelated, the residuals from this equation should have an autocorrelation coefficient of minus 0.5. As this hypothesis is not rejected at the 5% level, the estimated coefficients are unbiased and consistent when using ordinary least squares (OLS). (Arellano & Bond, 1991)

3.2.5 Panel structure

A panel data set contains repeated observations over the same units, collected over a number of periods. By using repeated observations on the same units it's possible to specify and estimate more complicated and realistic models than a single cross-section or a single time-series would do. (Verbeek, 2000). Other names for panel data are pooled data, combination of time series and cross

section data, and longitudinal data. When the equation contains a lagged dependent variable as an explanatory variable as in this paper, the model is called a dynamic- or autoregressive model.

Baltagi (1994) defines panel data as "the pooling of observations on a cross-section of households, countries, firms, etc. over several time periods". He names several benefits and limitations of using panel data. Panel data gives more informative data, more variability, more degrees of freedom, more efficiency and makes is possible to test more complicated models compared to a simple time series or cross section study. Besides, panel data are better to study the dynamics of adjustment and are therefore well suited to investigate the duration of economic states and the speed of the adjustments. The limitations refer mainly to the use of panel data after conducting a survey and are primarily data problems as nonresponse and measurement errors.

The use of panel data has become more and more popular in international studies. According to Hsiao (2005) there are at least three reasons that contribute to this geometric growth. (i) the availability of data, (ii) greater capacity for modeling the complexity of human behavior and (iii) challenging methodology. He concludes by stating that "although panel data offer many advantages, they are not panacea".

Table III presents an example of a two dimensional panel structure. Only a selection of the individual characteristics is displayed. Because each country is observed every year, the data set is called a balanced panel structure. Table III shows just three quarters for two countries, whereas the entire data set contains five countries over 39 quarters.

Table III: Example of a panel data set

	Quarter	Reserve share of the currency	GDP share in world total	Trade share in world total
Euro area	Q1 1999	0.18	0.20	0.14
Euro area	Q2 1999 …	0.18	0.21	0.14
Euro area	Q3 2008	0.26	0.23	0.13
United States	Q1 1999	0.71	0.29	0.15
United States	Q2 1999 …	0.72	0.29	0.15
United States	Q3 2008	0.65	0.24	0.11
Source: IMF, OECD				

A regression of panel data differs from a regular time-series or cross-section in that it has a double subscript on its variables instead of a single. All variables are indexed with an *i* for the country (*i=1,…, N*) and a *t* for the time period (*t=1,…, N).* The standard linear regression model for panel data can be written as:

$$y_{it} = \beta_0 + x'_{it}\beta + \varepsilon_{it} \qquad i = 1, …, N; \quad t = 1, …, T$$

Where x_{it} is a K-dimensional vector of explanatory variables, *i* denotes the cross-section dimension while *t* denotes the time-series dimension. N is the number of countries and T stands for the number of observations for country *i*. The model imposes that the intercept and the slope coefficients are identical for all countries and time periods. The error term varies over countries and captures all unobservable factors that affect y_{it}. Because panel data sets vary over the time dimension as well as over the individual dimension, estimators based on panel data are even with identical sample sizes typically more accurate than from other sources. To estimate this model by OLS, the usual conditions apply to achieve unbiasedness, efficiency and efficiency.[25]

The two authors previously mentioned in this subsection and many others suggest using a country specific-fixed effect-model. However, as Chamberlain (1980) and Greene (2004) amongst others discuss, the maximum likelihood estimator (MLE) is inconsistent and biased in a country-specific fixed-effects model. As N tends to infinity for a fixed T, the quantity of fixed-effects, for *i* = 1, …, N, increases with the sample size N. Consequently, an incidental-parameter problem arises. Although MLE would be consistent if T tends to infinity, this paper has a small T, consisting of only 39 individual observations. In this case fixed-effects can not be estimated consistently and will therefore not be applied.

3.3 Results

3.1.1 **Determinants for all five currencies**

The linear model will be used as a starting point but it can literally not be the model that best fits the data. Table IV reports the results of regressions of currency shares as percentage against all the variables presented in the previous sections. In all six regressions the lagged variable is highly significant which underlines the presence of partial adjustment and network externalities. The coefficient for this lagged endogenous variable is very high and lies between 0.988 and 0.993. The coefficients reflect the very slow adjustment rate of currency reserves to changes in the different variables. Just about 1.2% to 0.7% of the adjustment to the long run is approximated to occur in a single quarter. The adjusted R^2 is in all cases very high and above 0.99 mainly due to the same lagged variable that is included and logically predicts a major part of the next observation.

Column (1) shows the outcome of a basic regression specification. Surprisingly, the variable GDP turns out to have an insignificant coefficient. This is in contrast with Chinn and Frankel (2005), Eichengreen (1997) and Chen & Peng (2007) amongst others, who do find a significant positive

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[25] Identical to Chinn and Frankel (2005), seemingly unrelated regression (SUR) panel estimation gives qualitatively similar results. According to the authors there is an obvious reason to expect correlation in the error terms. When added, shares sum up to almost one (the small difference is due to the category "Other currencies") and an upward disturbance in one currency should be reflected by negative disturbances on average across the other currencies. Only the simple panel estimates are reported since the results are practically similar.

coefficient for GDP.[26] To correct for the growing influence of other major economies as China and India that do not issue a major reserve currency but do have an increasing influence on world GDP, the variable was also measured as percentage of only the five countries that correspond to one of the five dominant reserve currencies. The changing share in world GDP of other, predominantly Asian countries could have contributed to the observed difference in the significance of the GDP coefficient. This resulted in a slightly smaller coefficient as in column (1) with a considerable lower standard error, but the outcome still wasn't significant.

Table IV: Panel regression including all currencies with percentage share

Dependent variable: Share
Sample: Q1 1999 – Q3 2008

	1	2	3	4	5	6
GDP	0.0129 (0.0085)					
GDP (PPP)		**0.0268 (0.0101)**	**0.0268 (0.0100)**	**0.0267 (0.0101)**	**0.0259 (0.0101)**	
Inflation difference	**0.0010 (0.0003)**	**0.0009 (0.0004)**	**0.0008 (0.0004)**	**0.0008 (0.0004)**	**0.0008 (0.0004)**	0.0006 (0.0004)
Appreciation			0.1513 (0.1046)	0.1494 (0.1087)	0.1566 (0.1066)	0.1247 (0.1059)
Volatility (σ)	0.0488 (0.0836)	0.0454 (0.0817)	0.0541 (0.0817)	0.0524 (0.0859)	0.0557 (0.0821)	0.0405 (0.0819)
Market capitalization				0.0009 (0.0141)		
Market to GDP ratio					0.0005 (0.0018)	
Trade						**0.0230 (0.0103)**
Share lag (-1)	**0.9908 (0.0038)**	**0.9879 (0.0039)**	**0.9884 (0.0035)**	**0.9890 (0.0093)**	**0.9884 (0.0035)**	**0.9929 (0.0024)**
N	190	190	190	190	190	190
Adj. R^2	0.99	0.99	0.99	0.99	0.99	0.99

Figures in bold are significant at the 5% level

In the next four columns the variable GDP measured at market rates is replaced by GDP measured at purchasing power parity exchange rates. The later does have a significant positive coefficient, meaning that an increase in relative income level in terms of purchasing power of a country has a positive influence on the share of a currency in international foreign exchange reserves. A possible reason for the difference between these two variables is the less volatile procession of GDP at PPP rates, which might result in a lower level of noise in the regression. The coefficient is higher for GDP (PPP) because the shares of the five concerning countries are substantially lower when measured at purchasing power exchange rates. As the price level in upcoming markets as China and India is lower, they see their relative share increasing at the cost of the five countries that issue a major reserve currency.

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[26] Although these authors use a significance level of 10% instead of the 5% used in this paper, GDP presented in column (1) is also insignificant if the first level is used

The coefficient of the lagged dependent variable is in all cases lower than one and therefore gives a pattern of exponentially declining impacts as time goes on. Given the coefficient of 0.027 for GDP (PPP) and an adjustment rate of 1.2% (1 – 0.988) per quarter, a one percent increase in the share of GDP (PPP) would result in a 2.23% increase of the corresponding currency in global reserves held by central banks (0.0267 / (1 – 0.988)). It takes around 14 years before only half of this effect would be realized. A reason for the considerably higher coefficient compared to the papers discussed in the previous section might be the use of PPP exchange rates in stead of market rates. This results in shares that are smaller for the five countries that correspond to one of the reserve currencies.

Another major difference compared to the papers discussed in the section 2.2 is not that the variable inflation is significant but that it enters the equation with a positive coefficient. Inflation is generally considered to have a negative effect on a currencies status as a reserve currency as it corrodes the currency's long term value. Section 3.1.3 already gives a small conversion considering this issue and mentions the big difference in inflation level between the decades before the introduction of the euro (start of the examined sample) and the ten years following. During these years Japan for example experienced a yearly average deflation of 0.15%, while at the same time it sees its share of GDP at PPP rates decline with 25% from just over 8% to 6% of world total. If a regression for all countries as well as one excluding Japan is made which only contains the variable inflation, the result is significant for all five with a coefficient close to the ones in Table IV but is not significant for the one excluding Japan. Therefore Japan seems to have a big contribution to the results presented in Table IV. GDP (PPP) and inflation have a positive correlation in this sample, not only for all five countries but as well when Japan is excluded. Baig (2003) amongst others has shown that deflation was one of the reasons for the long trend of declining or staggering GDP in Japan since the early 1990s, often called 'the lost decade'. They concluded that deflation, however mild imposed significant cost on the Japanese economy as a whole.

In column (6), GDP at PPP rates is replaced as a measure of size by the variable trade. The coefficient is positive and significant designating a positive effect of the volume of total import and export on the global importance of the domestic currency. Chinn and Frankel (2005) find the same positive effect and see their inflation variable turning insignificant as well if GDP is replaced by trade. This paper follows their interpretation, as they mention that GDP is a more standard criterion for size in literature of international currencies and they see no reason to replace it.

Other papers like Lizondo & Mathieson (1988) and Flandreau & Jobst (2005) who study previous data, also find a significant positive contribution for trade flows to a currency's international role. Using trade and GDP (PPP) both as indicator for size in the same regression leaves unrealistic results as the coefficient for the variable GDP (PPP) turns negative. Table VI shows the correlation between the different variables and the very high correlation between trade and GDP (PPP) is a possible explanation for this puzzling effect.

Contrary to Chinn and Frankel (2005) no significant relation was found between a currency's share in international reserves and the volatility of the exchange rate. Alternatively, the volatility of the real exchange rate was used as an explanatory variable, showing an insignificant relation as well. Neither can we see an effect from an increase or decrease in the total capitalization of a country's stock market, where Chen and Peng (2007) do find positive significant coefficient. Chinn and Frankel (2005) state that their results contained unexpected negative relation for this variable in some regressions. Column (4) of Table V shows the same unexpected sign. As mentioned for GDP one of the reasons might be the growing importance of countries not issuing a reserve currency. The ratio against the world total is again replaced by the share of all five corresponding stock markets aggregated. To envision, the share of the U.S. stock market capitalization in world total declined from 49% to 35%, but only from 58% to 52% when calculated in the alternate way. Similar to the GDP ratio there are no changes in the significance or sign of the stock market variable. Excluding GDP at PPP rates and using market capitalization as the only measure of size does not make a difference.

Table V: Panel regression including all currencies with logistic share

Dependent variable: Logistic Share
Sample: Q1 1999 – Q3 2008

	1	2	3	4	5	6
GDP	0.0332 (0.0986)					
GDP (PPP)		0.1054 (0.1034)	0.1052 (0.1037)	0.1486 (0.1076)	0.0992 (0.1035)	
Inflation difference	**0.0061 (0.0028)**	**0.0062 (0.0024)**	**0.0061 (0.0025)**	**0.0066 (0.0024)**	**0.0058 (0.0025)**	**0.0058 (0.0024)**
Appreciation			0.1135 (0.6811)	-0.0708 (0.6910)	0.2898 (0.6907)	-0.1478 (0.6990)
Volatility (σ)	-0.6163 (0.6122)	-0.7909 (0.6159)	-0.7813 (0.6217)	-0.8438 (0.6199)	-0.9038 (0.6126)	-0.9038 (0.6126)
Market capitalization				-0.0515 (0.0357)		
Market to GDP ratio					0.0167 (0.1184)	
Trade						0.1699 (0.1068)
Logistic lag (-1)	**0.9927 (0.0119)**	**0.9873 (0.0097)**	**0.9874 (0.0097)**	**0.9945 (0.0121)**	**0.9883 0.0097**	**0.9873 (0.0067)**
N	190	190	190	190	190	190
Adj. R^2	0.99	0.99	0.99	0.99	0.99	0.99

Figures in bold are significant at the 5% level

Table VI: Correlation between different measures of size

	GDP (PPP)	Trade	Market cap
GDP (PPP)	1	0.95	0.87
Trade	0.95	1	0.70
Market cap	0.87	0.70	1

After the linear estimation, Table V shows the results of the same six regressions but this time with the logistic share as dependent variable. According to figures IV to VII this might fit the data better as the linear approximation. The results in Table V do not seem to support this presumption. GDP is not significant both at market rates and at purchasing power rates. The only significant variable apart from the lagged dependent variable is inflation, showing again a positive coefficient. Figure IV to Figure VII show especially for GDP at PPP exchange rates a clear indication of the presence of a logistic relationship with a currencies share in central bank reserves. It's therefore worth the effort to take a closer look and find a possible explanation that will be discussed in the next section.

A final point of notice is the fact that the last year of the dataset will be remembered as one of the most turbulent years in financial history. In 2008 financial markets collapsed, especially in the second half of the year and volatility was on levels that were not being seen for a long time. One can argue that these changing circumstances have had dramatic effect on financial data as the stock market capitalization and GDP of the different countries. The same regressions that were presented in Table IV and Table V have also been conducted excluding the year 2008. In general the results were similar and therefore there was no reason to exclude the final year of the sample and lose the related data. The main reason for the identical results might be the fact that the paper makes use of relative differences instead of individual changes. Instead of using a country's GDP measured in absolute numbers or percentages, the share of a country's GDP in total world GDP is used. These relative changes were less pronounced due to the global scale of the financial unrest.

3.1.2   Determinants excluding the Swiss franc

Most literature that makes use of data from the decades before the prelude of the euro use the Swiss franc as one of the main international reserve currencies is their econometric research. There was an obvious motive for this, as the share of the Swiss franc in international central banks reserves once exceeded the 2% level in the early 1980s. During the investigated period of this paper, from the first quarter of 1999 to the third quarter of 2008, the share of the Swiss franc fluctuates between 0.4% and 0.1%. Next to being a very small reserve currency, the Swiss franc is responsible for a relatively large part of the noise in different regressions. Therefore the results seem to be particularly sensitive for the inclusion of the Swiss franc. This might be the cause that a variable as GDP which is a significant and important factor in earlier papers is not significant in regressions wherefore the logistic share is applied as dependent variable.

For these two reasons, the regressions made for all five currencies in Table IV and Table V are repeated without the Swiss franc. The disadvantage of losing one country is the loss of data, declining from 195 to 156 observations. The results are presented in Table VI and Table VII. Based on the number of significant variables it can be concluded that dropping the Swiss franc leaves us with fewer but cleaner data.

Table VI represents the linear approximation and does not indicate a big difference in the results with or without the Swiss currency. Inflation is not always joined by a significant coefficient and the speed of adjustment, measured by the lagged variable of reserve currency shares points towards a faster progress to the long run adjustment level. The coefficient for the variable GDP (PPP) is somewhat higher and still significant. When Switzerland is included this coefficient is around 0.027, without Switzerland this number increases to almost 0.04. A one percent increase in world GDP (PPP) share now results in a increase of around 2.5% (0.04 / (1 – 0.984)) in foreign exchange reserve share for the corresponding currency. The adjustment speed is a little faster as when the Swiss franc is included and the half-life for this faster rate of adjustment is a little more than 10 years.

A possible explanation is the relative high price level in Switzerland which results in a bigger relative difference between GDP and GDP at PPP rates. For the U.S. the share in world aggregate for GDP in the third quarter of 2008 is 24% and this number declines to 20% if purchasing power exchange rates are being used instead. The share of Switzerland on the other hand goes down from 0.83% to 0.45% and therefore shows a much higher relative difference.

The variable trade in column (6) is now insignificant at the 5% level although the coefficient still lies in between the significance range of the 10% level. The coefficient shows a somewhat stronger effect of a country's share in international trade on the share of the domestic currency in international foreign exchange reserves. Again the variable inflation does not enter the regression with a significant coefficient but in Figure VII this occurs more frequently compared to Figure V.

Table VII: Panel regression excluding the Swiss franc with percentage share

Dependent variable: Share
Sample: Q1 1999 – Q3 2008

	1	2	3	4	5	6
GDP	0.0164 (0.0158)					
GDP (PPP)		**0.0399 (0.0163)**	**0.0381 (0.0164)**	**0.0456 (0.0192)**	**0.0384 (0.0165)**	
Inflation difference	**0.0010 (0.0005)**	**0.0010 (0.0004)**	0.0009 (0.0004)	**0.0010 (0.0005)**	0.0009 (0.0004)	0.0006 (0.0004)
Appreciation			0.1598 (0.1298)	0.1822 (0.1334)	0.1594 (0.1302)	0.1329 (0.1341)
Volatility (σ)	0.0624 (0.1957)	-0.0732 (0.1915)	-0.0646 (0.1913)	-0.1006 (0.1976)	-0.0686 (0.1948)	-0.0110 (0.1955)
Market capitalization				0.0149 (0.0110)		
Market to GDP ratio					-0.0003 (0.0028)	
Trade						0.0278 (0.0164)
Share lag (-1)	**0.9897 (0.0064)**	**0.9843 (0.0052)**	**0.9853 (0.0052)**	**0.9744 (0.0155)**	**0.9852 (0.0053)**	**0.9923 (0.0032)**
N	152	152	152	152	152	152
Adj. R^2	0.99	0.99	0.99	0.99	0.99	0.99
Figures in bold are significant at the 5% level						

Table VIII excludes the Swiss franc as well and gives the results when the logistic transformation of a currency's share is used as dependent variable analogue to Table VI. It now becomes clear that Switzerland does make an important difference as the amount of significant variables increase dramatically. Not only inflation and GDP (PPP) are both highly significant, the variable that represents the appreciation of a currency against the special drawing rights of the IMF now enters the regression with a positive and significant coefficient as well. Another dissimilarity is the lagged variable, which has the lowest coefficient of all four tables. The adjustment rate towards the long run changes now lies between just over 5% and 3.5% on a quarterly basis for the regressions that include the variable GDP (PPP).

Table VIII: Panel regression excluding the Swiss franc with logistic share

Dependent variable: Logistic Share
Sample: Q1 1999 – Q3 2008

	1	2	3	4	5	6
GDP	0.1372 (0.1219)					
GDP (PPP)		**0.2723 (0.0992)**	**0.2896 (0.0978)**	**0.3662 (0.1134)**	**0.2880 (0.0983)**	
Inflation difference	**0.0080 (0.0025)**	**0.0074 (0.0016)**	**0.0070 (0.0016)**	**0.0077 (0.0017)**	**0.0070 (0.0016)**	**0.0052 (0.0015)**
Appreciation			**1.1067 (0.4512)**	**1.3486 0.4857**	**1.1067 (0.4527)**	0.8427 (0.4725)
Volatility (σ)	-0.1000 (0.6483)	-0.5751 (0.6395)	-0.6831 (0.6304)	-0.5441 (0.6375)	-0.6595 (0.6387)	-0.3894 (0.6794)
Market capitalization				0.0501 (0.0378)		
Market to GDP ratio					0.0026 (0.0099)	
Trade						0.1139 (0.0744)
Logistic lag (-1)	**0.9752 (0.0173)**	**0.9650 (0.0110)**	**0.9638 (0.0108)**	**0.9461 (0.0172)**	**0.9640 0.0109**	**0.9874 (0.0097)**
N	152	152	152	152	152	152
Adj. R^2	0.99	0.99	0.99	0.99	0.99	0.99
Figures in bold are significant at the 5% level						

The variable that is constructed as the ratio of a country's stock market capitalization divided by its GDP is in accordance with the previous three tables insignificant. As mentioned in the previous section it is hard to find a variable that simulates the broadness and development of a country's financial market. Other reasons might be the fact that it is hard to compare financial markets of the different countries. Where Japan and the euro area have an average ratio of around 0.7 over the course of the sample period, for the U.S. and the U.K. the average is 1.4. A larger ratio does not necessarily indicate the existence of more well developed financial system. The size of the public sector, which is larger in the euro area and Japan, plays a role as well.

The fact that the regressions in Table VIII contain the most significant variables suggests the existence of the tipping phenomenon, described in section 2.2.3. As much as four variables are significant in a

single regression. Although there are only four different countries in the data set and the smallest country is excluded, results still provide evidence for a nonlinear relation. As discussed in section 2.2, numerous authors as Cohen (1971), Eichengreen (1997), Eichengreen & Mathieson (2006), Chinn & Frankel (2005) found evidence as well for the slow evolvement of reserve currency shares regardless of bigger changes in the broader financial environment. This might play a role in the speed at which the renminbi is able to gain terrain in the international playing field. The potential implications for the Chinese currency will be discussed in more detail in the next section.

As mentioned earlier Eichengreen & Mathieson (2006) found what they called "striking stability over time, not just of the currency composition of reserves but also of its principal determinants: trade flows, financial flows and currency pegs". After this section it can be concluded that even though this paper uses different variables and another sample period, this statement can not literally hold. With the notation that 'striking stability over time' is a subjective expression.

The fourth variable that turns out to be significant when Switzerland is excluded and the logistic transformation of a currency's share is used is appreciation. This variable is significant in three out of the four regressions in which it is included. Appreciation is only not significant when GDP (PPP) is replaced by the variable trade. The same phenomenon could be seen in previous tables for the variable inflation, which became insignificant when the measure of size was changed accordingly. The correlation between total trade and the appreciation of a currency is only 0.07. Correlation is therefore not a likely explanation this time.

Appreciation is measured by constructing a two year moving average of a currency's monthly appreciation against the SDR and thereby signifies its relative value change. A currency that on average depreciated over the past 24 months will therefore have a negative value in the related quarter. The ECB (2008) and Chinn and Frankel (2005) found the same affect as they found a negative coefficient for the depreciation trend of a currency. Although they used a long term trend of 20 years and excluded the Japanese yen, their coefficient has a comparable magnitude. It would be interesting to see whether this is still the case since the introduction of the euro but the lack of data is a problem there. Using the appreciation of the German mark relative to the SDR as a proxy for the euro will be less suitable over a time frame that's as long as 20 years.

4 Prospects for the renminbi

4.1 *Potential size of the renminbi in foreign exchange reserves*

The outcome of the previous section reveals that several factors had an important influence on the currency composition of foreign exchange reserves. In this section, these variables will be translated to the current situation in China. By monitoring China regarding the significant variables that were extracted from the currently four dominant reserve currencies, a statement can be made about the potential of the Chinese renminbi.

As mentioned before, it is hard to find a variable that represent the liquidity of a candidate's financial center. Chinn and Frankel (2005) and in an earlier stage Tavlas (1990) stated that although the representing variables did not enter with statistical significance, the development of the financial center is one of the key determinants. They admit this fact as a shortcoming of their model and the same is true for this paper. This factor will not be discussed in more detail but while concluding about the potential of the renminbi it can not be neglected.[27]

One other precautionary point is the reliability of Chinese macro economic data. The days are over that the Chinese presented their fourth quarter GDP results before the end of the current year. But still there are doubts about the very low volatility in the Chinese GDP growth and other economic indicators since the major reforms in 1978. In 2006 Goldman Sachs tried to get a better insight in the Chinese data and found some signs of irregularities. They figured that it is sometimes hard to compare economic data as the sample of companies or goods is subject to strong growth and changes dramatically. Furthermore they state that monthly data is more reliable than data that is presented only yearly or quarterly, as the estimates for GDP. Data with a lower reporting frequency are more influenced by changes that do not have an economic background. (Goldman Sachs, 2006)

GDP (PPP)

With reference to GDP measured at purchasing power exchange rates, China has been one of the fastest growing countries in the world for several consecutive decades. From 1999 to 2008 the GDP (PPP) of China increased by a staggering 194%, which is no less than 11.4% on an annual basis. For the euro area the growth number over this period was only 4.3%. For China it seems to be a big difference which variable is used to analyze its relative size. Measured at PPP exchange rates its share in world total is already as big as 12%, when measuring at market exchange rates this number is just 7%. GDP (PPP) is a significant variable in this paper and the potential of the renminbi will therefore be judged using this measure of size.
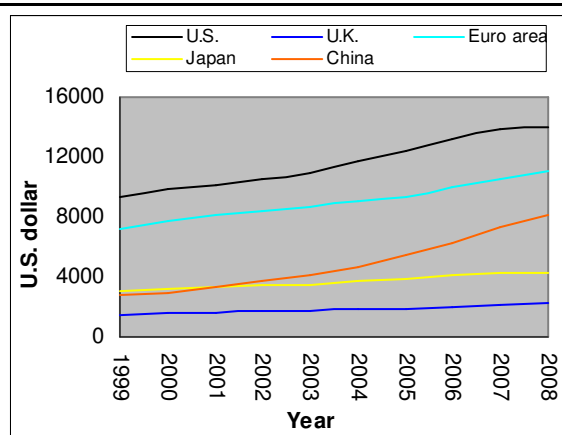
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[27] Tavlas (1990) gives a detailed description on the importance of open, broad and deep financial markets as determinant of international currencies

Besides the statistical significance, Dobson & Masson (2008) indicate that it gives a better representation of the Chinese situation with respect to its production of goods and services and for international income comparisons. Figure X and XI show the development of the GDP (PPP) for the different countries. Only yearly data are available for China, therefore all data presented in these figures are on a yearly basis.

Holz (2008) estimates China's future GDP (PPP) by extrapolating the average annual growth between 1978 and 2005 and by assuming a 3% annual appreciation of the Chinese currency. He finds that China's GDP (PPP) will exceed that of the United States by as early as 2015. China already exceeded the U.S. in terms of exports and is only just behind the euro area. If size, as in this paper, is measured by the country's share in total export plus total import, China ranks third but is approximately twice the size of Japan. Based on these numbers, the potential share of the renminbi could after the adjustment period be considerably larger as the present share of the pound sterling and the Japanese yen, which are as big as 4.6% and 3.1 %.

Figure X: Comparison of absolute GDP (PPP) 1999 – 2008 **Figure XI: Comparison of GDP (PPP) share 1999 – 2008**
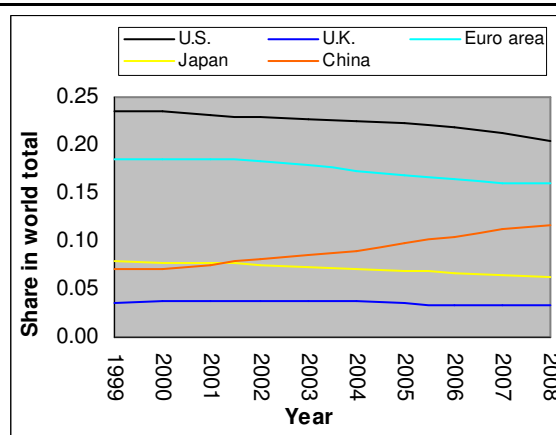
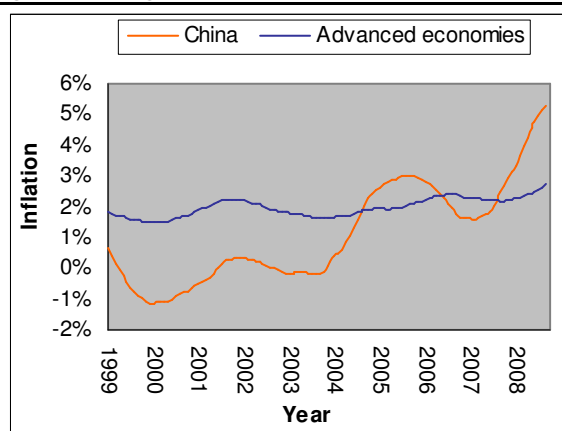

Source: Economist Intelligence Unit

Inflation

In the mid 1990s inflation was one of the major problems in China. Year on year inflation even exceeded the 20% level in the second half of 1995. The previous section showed a positive significant coefficient for inflation as explanatory variable. It should be noted that the maximum difference between one of the inflation of one of the five countries and the inflation of the IMF's advanced economies was Japan in the third quarter of 2001. The difference was only as large as 2.97%. Although the coefficient indicates a positive relation between the share of a reserve currency and inflation it is comprehensible that high inflation or even hyperinflation will not be a positive signal of a reliable and stable currency. Caution is needed as Chinn and Frankel (2005) found a negative coefficient for a period with far higher average global inflation levels. Therefore the Chinese inflation

at the end of 2008 of a little over 5% as is shown in Figure XII might be a desirable level that at least would not negatively influence the international reserve currency status of the renminbi.

Appreciation

The discussion of this variable is a little more complicated regarding the Chinese present-day situation of the exchange rate regime. Ever since the introduction of the new and second renminbi in 1955, the exchange rate has been pegged to the U.S. dollar. Presently, the preferred band wide of the Chinese currency with respect to the dollar is 0.5%. Despite its peg, it has been revalued several times in recent history. China's economy gradually opened in the 1980s and at that time the renminbi was devalued to increase the competitiveness of Chinese exporters. Figure XIII shows that the exchange rate against the U.S dollar depreciated from a high of 1.50 to a record low of 8.42 by 1994. In July 2005 the peg against the U.S. dollar was lifted and replaced by a peg against a basket of foreign currencies, which also included other Asian currencies as the South Korean won, the Thai bath and the Singapore dollar. The basket is still largely dominated by the U.S. dollar and the renminbi fluctuates around 6.83 per U.S. dollar since July 2008, which could implicitly mean a re-pegging of the Chinese currency to the U.S. dollar.[28]

Figure XII : Inflation comparison **Q1 1999 – Q3 2008**	**Figure XIII: Renminbi per U.S. dollar** **January 1981 – December 2008**
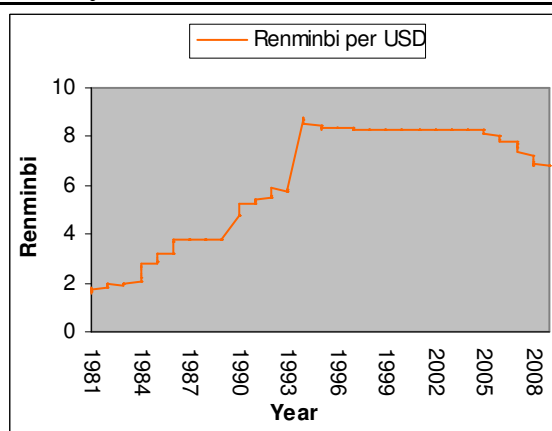
Source: IMF	Source: Federal Reserve Bank of New York

The IMF estimated that, by purchasing power parity, the value of the United States dollar was equivalent to 3.798 renminbi in 2008, indicating a substantial undervaluation of the Chinese currency.[29] Even though the short term effect might be limited due to the peg, the fundamental undervaluation can have an appreciating effect in the coming decades. In a paper on the relative

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[28] Source: People's Bank of China

[29] Source: IMF, *World Economic Outlook Database,* April 2009. According to an IMF summary of the 24-member board discussion on July 8th, 2009, the term "substantially undervalued was used again". Many directors urged further strengthening of the renminbi

valuation of the renminbi, Wang Xiaofeng & Soofi (2007) conclude that an increase in foreign exchange reserves and an increase in national income may have a profound impact on the future value of the renminbi. They state that based on those findings and on the current Chinese policy of moving the currency towards full convertibility, a large revaluation might be redundant.

In addition Cheung, Chinn & Fujii (2007) estimate that once sampling uncertainty and serially correlated errors on inferences regarding the extent of currency misalignment are accounted for, there is little statistical evidence for the undervaluation of the renminbi. They conclude that it does not mean there is no undervaluation in accordance with the well-known result that it is rather difficult to model exchange rates in general.

Network externalities

On the short term this will be the most important factor to keep the role of the renminbi as a reserve currency limited if China were to further liberalize financial markets and accept full convertibility of its currency. The existence of network externalities seems to be one of the most influential factors regarding the procession of reserve currencies and predicts the existence of a tipping phenomenon, as discussed in section 2.2.3. It took the dollar almost half a century to gain a dominant position over the pound sterling after the U.S. already outpaced the United Kingdom on an economic level. Nevertheless the results of section 3.3 indicate that the renminbi might not have to wait so long this time and will reach the status of major reserve currency at a faster pace.

4.2 Additional issues

This section will address some factors that might have influence on the future status of the renminbi as a reserve currency that are not related to the economic situation in China. The first point relates to the SDR as a possible alternative for reserve currencies that are issued by a single country or region. Ekpenyong (2007) is one of the authors that state that the SDR is likely to become an acceptable reserve currency in the future.

But is that likely to happen soon? A problem for the success of the SDR would be the limited amount of traders. If it would solely be used as a reserve currency, only central banks and no private investors would be trading the SDR. Therefore the market of SDRs would never be able to compete on the level of liquidity with one of the other currencies and it would take many years for its money markets to get liquid enough to become a widely used reserve currency.[30] Yet, they took a small step as the IMF approved to boost liquidity by allocating $250 billion worth of special drawing rights, a resource that hasn't been used in 30 years.[31] Nevertheless, even with this injection, SDRs would still constitute less

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[30] Statement from: The Economist, July 9th, 2009, Juan small step
[31] Source: Ibtimes, July 20th, 2009: *IMF Approves $250 billion SDR allocation to boost global liquidity*

than 5% of the world's foreign currency reserves. So far there are simply too few of them in circulation to be a realistic alternative that could detriment the renminbi.[32]

Another important factor is whether and in which respect the Chinese government wants the renminbi to become an international reserve currency. As mentioned in section 2.3.2, there are not only advantages, but issuing an international currency also comes with some shortcomings. Eichengreen (2004) concludes that compared to all costs and risks, the arguments against moving toward a more flexible exchange rate and more widely used currency are unconvincing. On the other hand Chinn & Frankel (2005) argue that China might follow the path of Germany and Japan and will be reluctant to internationalize the renminbi as they worry about the implications. Japan was already the world's second economy for a long time when the use of the yen was still limited due to the tight regulations that were imposed by the Japanese government.

It will be interesting to see what decisions are being made in the future and if the Chinese are in favor of a globally used renminbi. Apart from China's wishes and doubts, another compelling point is the question if the rest of the world is willing to hold reserves issued by a country with a one party system. Other nations might see the current political system as an extra source of risk. Dobson & Masson (2008) mention that doubts whether China's political regime will ever be completely market friendly are likely to dampen the renminbi's future prospects. Therefore it will possibly not be able to play the role that corresponds to the importance of its economy and financial markets.

The final factor that will be discussed is the extensive size of Chinese assets that are denominated in U.S. dollars. Obviously China will not be interested in seeing the value of the dollar decline due to their economic and political actions. China is the largest foreign holder of dollar denominated assets with an estimated total of $1.45 trillion[33] at the start of 2009, which is 66% of their total foreign exchange reserves. The Economist (2009) writes that any attempt of China to diversify out of the greenback would risk triggering a plunge in the currency, the so called "dollar trap". They add that a more flexible exchange rate and an internationalization of the renminbi would incur a loss on existing reserves but will stem future losses.

4.3 Recent movements towards internationalization

For any currency full convertibility is a requisite to reach the status of being a widely accepted international reserve currency. There are no signs that there will be a move in that direction shortly and if so, it will take many years of preparation for the Chinese government to fulfill this requirement. Although we might have to wait many years or maybe even decades to behold this development, there certainly are noticeable recent improvements that sustain the international status of the renminbi and that encourage its use outside mainland China.

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[32] Source: Financial Times, july 19th, 2009, *Chatter about ne w global currency is overblown*
[33] Source: IMF; UBS, includes U.S. Treasuries, U.S. agencies and other U.S. assets

July 6th, 2009 might have been a starting point for the next level of the renminbi's use in international trade and finance. That day the Chinese government selected five cities under which Shanghai, which were allowed to settle their transaction with Hong Kong, Macau and member countries of Association of Southeast Asian Nations in renminbis. To finance and facilitate such trade, foreign banks will be able to buy or borrow renminbi from Chinese mainland lenders. The settlement program will be limited to companies with good credit and the People's Bank of China (Chinese central bank) will control and monitor the risks associated with the settlement plan.

Although Chinese firms will be willing to settle their trades in renminbi, foreign investors will be more careful. As there is no well developed forward market for the renminbi yet, it is hard to manage the associated currency risk.[34] In a reaction from the central bank, Deputy Governor Su Ning stated that using the renminbi as settlement currency will in fact help companies to manage their currency risk because it's a relatively stable currency. A strategist from the world's biggest foreign exchange trader, the Swiss bank UBS AG gave the following comment: "This is a first step on the long road towards the ultimate goal of making the yuan a global reserve currency".[35] He further mentions that this first step is probably going to take more than five years.

China sees the importance of following a stage-by-stage path towards the internationalization of the domestic currency. It must harmonize the path of internal economic and financial reforms. Li (2006) states that China should work to strengthen regional economic cooperation and make full use of the status of Hong Kong in the process of realizing convertibility and facilitating regionalization of the renminbi. Hong Kong was the first outside the mainland to allow its banks to take deposits and issue debit- and credit cards in renminbi in 2003.

China's step to allow renminbi bond issuance in Hong Kong was another important milestone. One of the last to issue renminbi bonds in Hong Kong is the China Development Bank cooperation. The former government owned policy lender was converted into a commercial bank in 2008. In July 2009 the bank announced to offer its first renminbi denominated bonds since its conversion with a minimum size of one billion renminbi. Two years earlier the bank was the first financial institution from mainland China to issue renminbi bonds in Hong Kong.[36] At this time the issuance of renminbi bonds is still restricted to mainland financial institutions and mainland branches of Hong Kong financial institutions. Representatives from the Hong Kong monetary authority urged the Chinese government to open to markets to more investors[37]. Chen (2007) adds that Hong Kong provides the perfect testing ground for the use of the renminbi outside mainland China.

The third major recent development is the signing of multiple bilateral agreements between China and other important trading partners. Only for the year 2009, China signed RMB 650 billion ($95 billion) in currency swap agreements with six central banks; South Korea, Argentina, Hong Kong, Malaysia,

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[34] Source: The Economist, July 9th, 2009, Juan small step
[35] Source: Bloomberg, July 6th, 2009, Shanghai companies sign first yuan settlement deals
[36] Source: Xinhua, July 27th, 2009, CBS to issue its first RMB bond in Hong Kong after going commercial
[37] Source: Reuters, July 10th, 2009, HK urges China to relax rules on yuan business

Belarus and Indonesia. By signing these swap agreements China removes other currencies, largely the U.S. dollar, from the settlement and allows itself to receive renminbi for exported goods and services. Argentina's central bank said in a comment that: "The yuan is one of the currencies with the greatest potential and has a significant role to play in the current redesign of the international monetary system". Apart from diversifying away from the U.S. dollar, another advantage for the Chinese exporters is lower transaction costs as the domestic currency no longer has to be converted. [38]

Besides the positive comments and big ambitious plans for the future, one critical note has to be made. Most of the countries that signed the swap agreements haven't utilized them yet. So far the Chinese currency they receive has very little use to them besides financing trade with China. So a country like Indonesia cannot use these reserves for the purposes countries normally use foreign exchange reserves for, like defending its own currency on the exchange market.[39]

Altogether there are more and more signs that the Chinese government is willing to increase the global role of the domestic currency. Besides these measures it is unlikely that the authorities will accede major changes in the exchange rate regime. More thorough going changes may need to wait until the prelude of the next five year plan, for 2011 – 2015. After all, despite the major reforms of the recent decades, China is still a country with in essence a communist structure.

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[38] Source: Financial Times, March 31st, 2009, China and Argentina in currency swap
[39] Source: The Wall Street Journal, April 1st, 2009, Toward Swapping China's currency

5 Conclusion

This paper intends to verify and signify the relations between different economic variables and a currency's share in foreign exchange reserves of worldwide central banks. Evidence is found for a significant influence of a country's GDP measured at purchasing power exchange rates, inflation, the relative appreciation of the currency and network externalities. Although no evidence is found for the broadness and deepness of the financial markets of issuing countries, it cannot be ignored as an important factor. The fact that this quality is extremely difficult to quantify makes it a complicated factor to include in an empirical research. Regarding GDP measured at purchasing power exchange rates, a one percent increase in a country's share in world total results in an increase of around 2.5% in the share of foreign exchange reserves of the corresponding currency. Compared to the previous major changes in the reserve currency landscape, the adjustment rate has become faster. It takes a little over ten years before half of this effect would be realized.

Most previous papers that discussed the same topic did not have much interest in the difference between GDP at market exchange rates and GDP at purchasing power exchange rates. As this paper discusses the perspective of the Chinese domestic currency, the difference is of crucial importance. The share of the Chinese economy in world aggregate is far larger if signified by purchasing power. Another crucial difference is the way in which inflation contributes to the model. While inflation is usually considered to have a negative impact, this paper finds a positive coefficient. A likely explanation for this is the positive correlation between inflation and GDP over the past decade with Japan as a well known example. Inflation seems to have a positive effect as long as it is under a certain threshold. Other papers found a negative relation in times when inflation was considerably higher compared to the sample that is used in this paper.

It should be noted that the potential share of the Chinese renminbi is discussed without the limitation that is imposed by the current restrictive regulations and the possibly slow liberalization of the Chinese financial markets. Although this path may be long, China seems to have made its first steps towards the global acceptance of the renminbi and thereby making it a likely candidate for the list of major reserve currencies. Since July 2009, a selection of Chinese companies has been allowed to settle their transactions with a selection of nations in their renminbis instead of first converting to mainly U.S. dollars. Other notable improvements were the first issuance of renminbi bonds outside mainland China and the signing of several bilateral agreements about currency swaps.

Besides these constraints there are additional issues that might affect the future prospect of the Chinese currency. This paper discussed the IMF's SDR as potential alternative, which changes are limited so far due to the low liquidity. In addition, the willingness of China to create the ideal conditions for the renminbi as a reserve currency is disputed. Issuing such a currency not only brings advantages but will trigger shortcomings as well. The extensive size of Chinese asset denominated in U.S. dollars is one of the related factors.

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Appendix A

Data description and sources

Reserve currency holdings

Share of a currency in total allocated currency reserves of central banks worldwide at the end of each quarter. The share of a currency in total central bank reserves is calculated as a percentage as well as by logistic transformation. The IMF's COFER database distinguishes monetary authorities' claims on nonresidents denominated in U.S. dollar, euros, pounds sterling, Japanese yen and Swiss franc. Other currencies are bundled under the category 'other currencies'. Foreign exchange reserves in COFER consist of banknotes, bank deposits, treasury bills, short- and long-term government securities and other claims usable in the event of balance of payment needs. The claims do not include holdings of a currency by the issuing country. For instance, the U.S. dollar assets of the Federal Reserve are not foreign exchange reserves. Data is submitted to IMF on a voluntary basis by 140 member and non member countries; in witch all industrial countries are represented. The data presented are aggregated data, as the COFER data for individual countries are strictly confidential. (Source: IMF*, COFER*)

GDP

Ratio of GDP per country to GDP of world aggregate, measured in U.S. dollars (converted at official exchange rates). Annualized quarterly data that is seasonally adjusted is used. The data for China is not seasonally adjusted as this data is not available. (Source: IMF*, International Financial Statistics*; world GDP data from IMF*, World Economic Outlook*; GDP of the euro countries from Eurostat)

GDP (PPP)

Ratio of GDP per country to GDP of world aggregate at PPP exchange rates, measured in U.S. dollars (converted at official exchange rates). (Source: OECD, *Main Economic Outlook*)

Trade

Trade is defined as total imports plus total exports of each individual country divided by total import plus total export of world aggregate. Trade denotes a countries' portion in total international trade. (Source: IMF, *International Financial Statistics*)

Appreciation

The variable appreciation is calculated by making a two year moving average of the monthly appreciation of the currency against the IMF's SDR. The SDR is an international reserve asset created by the IMF in 1969. It is a basket, today containing the following four currencies; U.S. dollar (44%), euro (34%), Japanese yen (11%) and pound sterling (11%). The SDR is calculated daily as the sum of specific amounts of the four currencies valued in U.S. dollars. As a proxy for the euro exchange rate

for the period before 1999, the appreciation of the German mark relative to the SDR is taken (Source: IMF, *International Financial Statistics*)

Volatility

Volatility is calculated as the two year moving average of deviation of the log first difference of the monthly SDR exchange rate and the concerning currency. As a proxy for the euro exchange rate for the period before 1999, the volatility of the German mark to the SDR is taken. (Source: IMF, *International Financial Statistics*)

Stock market capitalization

Share of a countries' stock market capitalization in the total stock market capitalization of all members of the World Federation of Exchanges (WFE). For the total size of Euro Area stock markets, the initial 11 countries that introduced the euro are taken. (Source: WFE)

Stock market capitalization to GDP ratio

Market capitalization of a country's stock market denoted in U.S. dollars and divided by GDP in U.S. dollars. (WFE; IMF, *International Financial Statistics;* GDP of the euro countries from Eurostat*)*

Inflation

A two year monthly moving average of year on year inflation is made. Then the difference in inflation with the IMF advanced economies is used to construct the variable. (Source: IMF, *international financial statistics*; CPI data before 1997 for the Euro area is from the OECD, *Main Economic Indicators*)