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ON THE INCLUSION OF THE CHINESE RENMINBI IN THE SDR BASKET

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NON-TECHNICAL SUMMARY

In the context of ongoing discussions on the reform of the international monetary system, and as a consequence of the 2007-09 financial crisis that has once again highlighted the importance of international liquidity provision, the Special Drawing Right (SDR) has received renewed interest. In particular, the Governor of the People's Bank of China made a vibrant call for a revival of the SDR in March 2009, and in April 2010 the finance ministers and central bankers of the G20 decided to work on a "criteria-based path to broaden the composition of the SDR". In fact, the initiative targets the inclusion of the Chinese currency in the SDR basket, along with the US dollar, the euro, the yen and the pound.

Although China has become a prominent economic power (and the first exporting country for goods and services), this condition is not enough for its currency to be included in the SDR basket. The renminbi would need to become "freely usable", when it is hardly convertible and very far from playing an important part in foreign exchange markets. The challenge then is to examine whether this condition of "free usability" could be revised (at least for a limited period) and, above all, what would be the advantages.

Here we analyse the pros and cons of including the RMB in the SDR against the criterion of stability of the basket – stability of both its composition and its value. Indeed, stability is a key condition for the SDR to be attractive as a unit of account and as a reserve currency. Following the IMF methodology, we recalculate the weights of the different currencies of the basket and propose projections at the 2050 horizon. We compare these weights whether the RMB is included or not in the basket. Then, based on basic assumptions concerning the volatility of bilateral exchange rates and the level of equilibrium exchange rates, we assess the impact of RMB inclusion on the volatility of the basket, in the short run as in the long term.

Our results suggest that, had the renminbi be included in the SDR basket during the 1990s and 2000s, its weight would have been limited (less than ten percent). However, under basic assumptions concerning the future evolution of global trade and the distribution of foreign-exchange reserves, the renminbi could become the first or second currency of the basket by 2040. Hence, waiting too much before including the RMB in the basket (because it is not yet freely usable) would incur the risk of a significant discontinuity in the SDR behavior when the inclusion is eventually decided. The principle of a stable composition also argues against a wide broadening of the basket since including smaller countries would encounter the risk of having to revise the composition of the basket regularly to account for changes in country rankings.

The impact of RMB inclusion on SDR volatility will crucially depend on China's exchange-rate regime: assuming the RMB is pegged to the dollar, the volatility of the SDR vis-à-vis the euro and the pound would rise very significantly over the next decades, whereas it would be reduced against the US dollar, the renminbi and a number of third currencies. Conversely, should the yuan be allowed to float, the impact on the volatility of the SDR would be much more limited. Similarly, including the yuan while it is significantly under-valued would weaken the value of the SDR. These results are strong arguments in favor of postponing RMB inclusion until it is made more flexible and has adjusted somewhat towards equilibrium. However, it should be kept in mind that waiting too much would introduce a discontinuity on the behavior of the SDR because the new currency would immediately be attributed a large weight. Additionally, having the yuan in the SDR would counterbalance a depreciating trend of the SDR in real effective terms related to the Balassa-Samuelson and to cumulated deficits in the United States, as the US dollar represents 42 percent of the basket. Indeed, China is likely to experience strong real exchange-rate appreciation in the future in relation to the Balassa-Samuelson effect and/or to current account adjustment. This feature could raise the attractiveness of the SDR as a store of value. Meanwhile, we show that net debtors would not suffer from a large increase in the SDR interest rate.

On the whole, our results suggest that the question of the free usability requirement may be revised if the main objective is to raise the attractiveness of the SDR as a unit of account and as a store of value. Should the renminbi be included in the basket, it might reduce the indirect liquidity of the SDR as the yuan is not yet widely traded on foreign exchange market (both on-shore and off-shore). However, even though it is not widely traded, market expectations of an appreciation will temporary raise the demand for the Chinese currency, hence central banks may find it relatively easy to sell this currency. In our view, including the RMB in the SDR relatively rapidly would bring advantages in terms of stability of the composition and of the value of the basket, especially if China's exchange rate regime is made more flexible. This issue of flexibility is de facto more important than that of free usability to make the SDR more stable, at least in the short and medium run.

ABSTRACT

We study the impact of a broadening of the SDR basket to the Chinese currency on the composition and volatility of the basket. Although, in the past, RMB inclusion would have had almost negligible impact due to its limited weight, a much more significant impact can be expected in the next decades, and more so if the Chinese currency is pegged to the US dollar. If the objective is to reinforce the attractiveness of the SDR as a unit of account and a store of value through more stability, then a broadening of the SDR to the RMB could be appropriate, provided some flexibility is introduced in the Chinese exchange-rate regime. This issue of flexibility is de facto more important than that of "free usability" to make the SDR more stable, at least in the short and medium run.

JEL Classification: F31, F33.
Key Words: SDR, renminbi, international monetary system, foreign exchange volatility

L'ELARGISSEMENT DU MANIER DTS A LA MONNAIE CHINOISE

RESUME NON TECHNIQUE

Dans le cadre des discussions sur la réforme du système monétaire international, et suite à la crise financière de 2007-2009 qui a replacé au devant de la scène la question de la fourniture de la liquidité internationale, le Droit de Tirage Spécial (DTS) a connu un net regain d'intérêt. En particulier le Gouverneur de la banque centrale chinoise a livré, en mars 2009, un vibrant plaidoyer en faveur du DTS. Les ministres des finances et banquiers centraux du G20 se sont ensuite engagés, en avril 2011, à travailler sur un « sentier d'élargissement du DTS fondé sur des critères » Il s'agit en fait d'envisager l'inclusion de la monnaie chinoise dans le panier DTS, aux côtés du dollar, de l'euro, du yen et de la livre Sterling.

Si la Chine est sans conteste devenue une puissance de premier plan (et le premier pays exportateur mondial de biens), cela ne suffit pas pour que sa monnaie soit intégrée dans le panier DTS. Il faudrait que le renminbi devienne « librement utilisable », alors qu'il n'est même pas convertible et encore très loin d'occuper une place significative dans les transactions internationales. L'enjeu dès lors est d'examiner si cette condition peut être révisée (au moins pour une période déterminée) et, surtout, quels en seraient les avantages.

Nous examinons ici les avantages et inconvénients d'une inclusion du renminbi dans le panier DTS au regard du critère de stabilité du panier – stabilité de sa composition et de sa valeur. En effet, la stabilité du panier est une condition clé de l'attrait du DTS comme unité de compte et réserve de valeur. Suivant la méthode du FMI, nous reconstituons le poids des différentes monnaies composant le panier sur le passé et proposons des projections à l'horizon 2050. Nous comparons ces poids selon que le renminbi est ou non inclus dans le panier. A partir de ces différents poids, d'hypothèses sur la volatilité des monnaies deux à deux et les taux de change réels d'équilibre, nous évaluons l'impact de l'inclusion du renminbi sur la volatilité et la valeur du panier.

Nos résultats suggèrent que, si la monnaie chinoise avait été comprise dans le DTS en 1990, son impact sur le comportement du panier aurait été très limité en raison du faible poids du renminbi (moins de 10%). Cependant, sous quelques hypothèses simples concernant l'évolution future du commerce mondial et la composition des réserves de change, le renminbi pourrait devenir, à l'horizon 2040, la deuxième, voire la première monnaie du panier. Ainsi, attendre trop longtemps avant d'inclure le RMB (parce cette monnaie n'est pas « librement utilisable ») fait courir le risque d'une discontinuité lorsque le panier sera finalement élargi. Par contre, le principe d'une composition stable du panier milite contre l'inclusion d'autres monnaies, car leur liste risquerait de devoir être révisée périodiquement en fonction de l'évolution des rangs des différents pays.

L'impact de l'inclusion du RMB dans le DTS dépendra, de manière déterminante, du régime de change chinois : avec un RMB ancré sur le dollar, la volatilité du panier par rapport à

l'euro ou à la livre Sterling augmenterait considérablement au cours des décennies à venir, tandis que le DTS serait stabilisé par rapport au dollar, au renminbi et à un certain nombre de monnaies hors DTS. A l'inverse, un régime de change flexible limiterait très fortement l'impact de l'inclusion du renminbi dans le panier. De la même manière, l'inclusion d'un renminbi fortement sous-évalué affaiblirait la valeur du DTS. Ces arguments suggèrent de ne pas faire entrer le RMB dans le panier avant que la Chine n'ait flexibilisé son régime de change et réduit la sous-évaluation de sa monnaie. Cependant, il faut conserver à l'esprit qu'en attendant trop longtemps, on risque d'introduire une discontinuité au moment de l'élargissement du panier. Par ailleurs, l'inclusion du RMB dans le DTS pourrait compenser une tendance du panier à la dépréciation en termes effectifs réels, en lien avec l'effet Balassa-Samuelson et l'accumulation de déficits extérieurs aux Etats-Unis, le dollar représentant 42% du panier actuel. De manière symétrique, le potentiel d'appréciation du RMB est important, toujours en termes effectifs réels. Cet aspect pourrait renforcer l'attrait du DTS comme réserve de valeur. Simultanément, nous montrons que les pays débiteurs nets ne devraient pas souffrir d'une trop forte augmentation du taux d'intérêt du panier.

Au total, notre analyse suggère qu'il pourrait être justifié de revoir la condition de « libre usage » de la monnaie chinoise, si l'objectif premier de l'élargissement du panier est de renforcer son attrait comme unité de compte et réserve de valeur. Pour sûr, l'inclusion d'un RMB seulement partiellement convertible réduirait la liquidité indirecte du DTS. Cependant, même si le marché du renminbi (on-shore et off-shore) est encore limité, les anticipations d'appréciation de cette monnaie sont telles qu'une banque centrale n'aurait probablement pas de difficulté à trouver des acquéreurs. Nous concluons qu'un élargissement relativement rapide du DTS à la monnaie chinoise apporterait des avantages en termes de stabilité du panier (composition et valeur), pourvu qu'une certaine flexibilité soit introduite dans le régime de change. Cette question du régime de change est plus importante, au regard de l'objectif de stabilité, que celle du « libre usage » de la monnaie chinoise, au moins à court et moyen terme.

RESUME COURT

Nous étudions l'impact d'un élargissement du panier DTS à la monnaie chinoise sur la composition et la volatilité du panier, à court et long terme. Dans les décennies à venir, l'inclusion du RMB devrait avoir un impact considérable, surtout si la monnaie chinoise demeure ancrée sur le dollar. Si l'objectif est de renforcer l'attrait du DTS en tant qu'unité de compte et de réserve de valeur en le rendant plus stable, alors un élargissement au RMB relativement rapide serait adéquat, pourvu qu'une certaine flexibilité soit introduite dans le régime de change chinoise. Cette question de la flexibilité paraît plus importante, au regard de l'objectif de stabilité du DTS, que la contrainte de « libre usage » de la monnaie retenue jusqu'à présent comme critère clé de participation au panier.

Classification JEL : F31, F33.
Mots-clefs : DTS, renminbi, système monétaire international, volatilité des taux de change.

ON THE INCLUSION OF THE CHINESE RENMINBI IN THE SDR BASKET

Agnès Bénassy-Quéré[1] and Damien Capelle[2]

1. INTRODUCTION

The Special Drawing Right (SDR) was created in 1969 in order to supplement gold and the US dollar as international reserve assets, whose supply at that time was considered inadequate relative to the sharp expansion of world trade and capital flows. In 1978, IMF member states further decided to make the SDR "the main reserve asset of the international monetary system". Yet, in 2011, the SDR still accounted for less than 5 percent of total global reserves.[3]

The 2007-2009 financial crisis has revived the debate on the international monetary system (IMS). Although its direct responsibility in the crisis remains disputed, the IMS is generally believed that the IMS had an indirect contribution through extensive appetite for US assets and subsequent low interest rates in the United States during the period prior to the crisis. During the crisis, the IMS performed relatively well thanks to generous bilateral swap lines extended especially by the Federal Reserve. However this source of liquidity provision in times of crisis is discretionary and its importance may decline in the future, in line with the declining weight of the United States in the global economy (see Angeloni et al., 2011). Multilateral and regional facilities were developed during the crisis, but they are still viewed as imperfect substitutes for self-insurance through reserve accumulation at the national level. In this context, several authors (see, e.g., Stiglitz, 2009, Julius, 2010, Palais-Royal Initiative, 2011, Qiao and Xu, 2011) have called for a revival of the SDR or of alternative global quasi-currency schemes as the pillar of international liquidity management. This issue has been intensively discussed within the G20 under French presidency. Although no consensus could be found on a far-reaching overhaul of the SDR framework, a first step was taken in this direction in April 2011 in Washington, when G20 Finance ministers and central bankers agreed to work on a "criteria-based path to broaden the composition of the SDR".[4] This process was linked to a broader discussion about the role of emerging economies in the IMS and the need to take into account their growing role in the world economy. More specifically, the G20 was taking stock of the fact that China had become the first exporter country in the world, the share in global trade being one of the criteria for inclusion of the currency in the SDR. More politically, such discussion arose while there was mounting pressure on China to revise its exchange-rate and capital-flow regime: joining the selective club of SDR basket

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We are grateful to Olivier Jonglez for introducing us to the subtleties of SDR weighing, and to Gunther Capelle-Blancard for carefully reading an early draft. All errors and insufficiencies remain ours.

[3] See COFER data from the International Monetary Fund.

[4] See final communiqué available at www.g20.utoronto.ca/2011/2011-finance-110415-en.html.

currencies could be viewed as a reward from opening up its financial account and introducing more flexibility in its exchange-rate regime.

As already mentioned, the SDR is a multilateral instrument of liquidity provision. However it is also a store of value and a unit of account (see IMF, 2011). For it to be attractive for both functions, the value of the basket needs to be relatively stable. This requirement has indeed been key in the decisions taken on its composition since the launch of the SDR. In this paper, we study the implications of including the renminbi in the SDR basket, focusing on the stability of the basket. Section 2 provides a short reminder on the SDR. In Section 3, we discuss the motivation and feasibility of including the RMB in the SDR. Section 4 details the valuation method of the basket and applies it successively to the present basket and to an alternative basket that would include the renminbi. Section 5 studies the implications of including the renminbi in the SDR basket for the stability of the SDR. Section 6 explores the impact of including the renminbi on the SDR interest rate. Section 7 concludes.

2. A BRIEF REMINDER ON THE SDR

The SDR was created in 1969 after several years of international discussions within the « Group of Ten », a group composed of the finance ministers and central bankers of the ten largest economies at that time (see Solomon, 1996). In the late 1960s, growing expectations of a US dollar devaluation (reinforced by the Vietnam war) had considerably reduced the attractiveness of the dollar as a reserve currency. However gold was in limited supply. To circumvent the shortage of stable reserve assets, in a context of booming international trade, it was decided to create a multilateral vehicle – the SDR – whose value would rely (initially) on gold but availability would depend neither on gold discoveries nor on the US balance of payments; rather on allocation decisions taken by the IMF Board of Governors.

2.1. The SDR as a unit of account

Initially defined as equivalent to 0.888671 grams of fine gold and thus equivalent to one dollar, the value of SDR was redefined as a basket of 16 currencies in 1974 (those of the 16 IMF members responsible each for at least one percent of world trade), following the breakdown of the Bretton Woods system and the subsequent removal to any reference to gold. In 1981, the number of currencies in the basket was reduced to five (US dollar, yen, pound sterling, Deutschemark, French franc) in order to simplify the valuation of the SDR and to make it more attractive. In 1999, the French franc and the Deutschemark were replaced by the euro, thus bringing the number of currencies down to four. In 2000, the IMF Board decided that only "freely usable" currencies should be included in the SDR, the concept of "free usability" being defined in the articles of agreement of the Fund (we come back to this point in the next section). Since then, the selection criteria have remained unchanged:

> "*The value of the special drawing right shall be determined on the basis of the four currencies issued by Fund members, or by monetary unions that include Fund members (monetary unions), whose exports of goods and services during the five-year period ending*

12 months before the effective date of this decision or any subsequent revision had the largest value, and which have been determined by the Fund to be freely usable currencies in accordance with Article XXX(f) of the Fund's Articles of Agreement. In the case of a monetary union, the determination of the values of exports of goods and services of the union shall exclude the trade of goods and services among members that are part of the union."[5]

The value of the SDR in terms of the dollar is calculated daily by the Fund as a weighted average of the market values in terms of the dollar of each of the four currencies.

2.2. The SDR as a reserve asset

As already mentioned, a major objective given to the SDR was to supplement gold and the dollar as reserve assets. Allocations have occurred on three occasions: in 1970-1972 (9.3 SDR bn), in 1978-1981 (12.1 SDR bn), and in 2009 (161.2 SDR bn). The allotment of the SDRs to participants relies on their quota shares in the IMF.

The SDR is not a currency. It is potentially a claim on the freely usable currencies of IMF members. The mechanism runs as follows: (1) the IMF decides a general allocation of SDRs. (2) The SDRs are distributed among IMF members depending on their quota shares. (3) SDRs carry a weekly-determined interest rate that is based on "a weighted average of representative interest rates on short-term debt in the money markets of the SDR basket currencies".[6] The same interest rate applies to the SDR as a holding and as a liability. Hence, there is no net interest to be paid or received before SDRs are actually used. (4) Through the designation or the voluntary mechanism, participants with a balance-of-payment deficit may exchange their SDRs for a freely usable currency in order to be able to cope with their obligations. (5) If a country holds less SDRs than it was allocated, a net interest has to be paid to the IMF. Conversely, a country that holds more SDRs than allocated receives a net interest from the Fund which acts as a clearing house.

Because it is an average of the interest rates of four advanced economies, the interest rate applied to SDR debtors is relatively low compared to what emerging and developing countries generally serve on their short-term debts. Additionally, SDR allocations are independent from the balance of payments of key-currency countries and provide a financial safety net to countries that have not accumulated foreign-exchange reserves. Finally, the SDR scheme is equivalent to pooled foreign-exchange reserves, which in principle reduces the needs for reserve accumulation at the national level and its related costs.[7]

The IMF ensures that the claims on freely usable currencies can be exercised based on the designation mechanism (strong external position members are designated to purchase SDRs

[5] Decision No. 12281-(00/98) G/S October 11, 2000. Quoted in IMF (2005).

[6] See SDR factsheet, http://www.imf.org/external/np/exr/facts/sdr.htm.

[7] For a review of the distinctive features of the SDR, see Clark and Polak (2002).

from members with weak external positions) and through voluntary arrangements. Yet, the procedure for general allocations is cumbersome. The standard procedure is that the IMF Managing Director makes a proposal at least six months before the expected date; then, the Executive Board and the Board of Governors must approve it, successively, by a majority of 85%. On the demand side, there is reluctance to hold reserves that cannot be traded directly on a market and do not benefit from the usual range of hedging instruments. Moreover, it is easy to reproduce the SDR basket through appropriate holdings of the four currencies of the basket, hence to combine the stability of the basket with the readiness-for-use of the reserves.

3. THE RMB IN THE SDR: IS IT DESIRABLE? FEASIBLE?

Before simulating the impact of including the renminbi in the SDR, we need to understand the motivation for and feasibility of such broadening of the basket, given IMF rules.

3.1 The rationale for including the RMB in the SDR basket

Following Angeloni et al. (2011), we can explore the why question along three standard normative axes: efficiency, stability and equity.

Efficiency. The original purpose of the SDR in 1969 was to supplement the US dollar as a source of international liquidity. Including the renminbi in the SDR would strengthen the legitimacy of the SDR as a reserve asset since it would be consistent with the world economic structure and the role the People's Bank of China has started to play as a liquidity provider through the development of bilateral swap lines with foreign central banks. Furthermore, the inclusion of the RMB in the SDR and the associated reduced volatility of the SDR against the RMB would work as an incentive for the PBoC to provide dollars in exchange for SDRs on a voluntary basis, which would reduce its dollar exposure (although the potential for diversification through SDR holdings would remain limited unless there are more active allocations in the future). Hence, including the RMB in the SDR could contribute to enhancing the international financial safety net.

Stability. Offering China a way to diversify its reserves with little market impact and without the use of a controversial substitution account would be an achievement in terms of stability. However, to the extent that the RMB stays more or less pegged to the USD, having the RMB in the SDR would, all things being equal, raise the volatility of the basket against currencies that are not de jure or de facto pegged to the dollar. This could reduce the incentive for the corresponding countries to use the SDR both as a reserve asset and as a unit of account. It could even increase the incentive to peg currencies to the dollar around the world and accumulate dollars as a liquid proxy of the SDR. Conversely, having the five major international currencies in the SDR could be conducive to creating a G5 monetary group for consultation on exchange-rate and monetary issues.[8]

[8] See Bénassy-Quéré and Pisani-Ferry (2011).

Equity. Including the RMB in the SDR can be viewed as a way of having China take more responsibility in the functioning of the global monetary system and to encourage it to "speed up the RMB reforms in order to conform with the other basket currencies".[9] However it would also be a way to allow international investors to take long positions in the Chinese currency even before the latter is made convertible. This could encourage rather than discourage reserve accumulation (in the form of SDRs). More importantly, it would amount to socializing the exchange-rate risk. Assume, for instance, that when allowed to float, the RMB appreciates against the other currencies of the SDR basket. Then, any country holding SDRs will be able to convert them into key currencies at an inflated exchange rate, the loss being borne by the central bank that makes the swap. Although the impact would be limited, including the RMB in the SDR could also increase the interest rate of the basket, with detrimental implications for debtor countries.

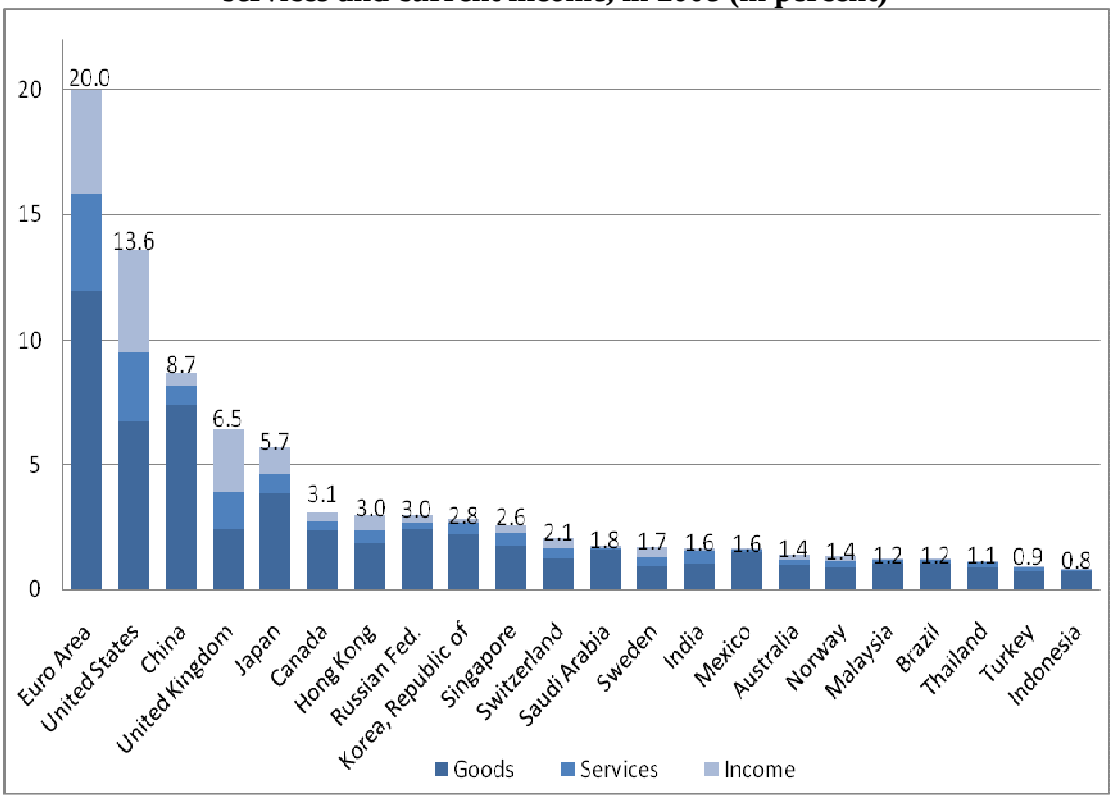
3.2. The feasibility of RMB inclusion in the SDR

The selection of the currencies included in the SDR is not carved in stone and it has changed a number of times in the last 50 years, as already mentioned. Any change must be approved by the IMF Executive Board with an 85 percent majority. The valuation method, including the weight of the different currencies, is reviewed every five years by the Executive Board, at the 70 percent majority.

As illustrated in Figure 1, China has become the first exporting country (second exporting monetary area) in terms of goods. When adding services and current income, it ranks second as a country and third as a currency area. Hence China passes the first test to see its currency included in the SDR basket.

[9] See Newnham, Chong and Wang (2011).

Figure 1. Share of various countries or currency areas in world exports of goods, services and current income, in 2008 (in percent)



Source : own calculations based on IMF (IFS) data.

The question then is that of "free usability" of the Chinese currency. The concept of free usability relies on the IMF XXX[th] Article of Agreement:

> "*A freely usable currency means a member's currency that the Fund judges, in fact, (i) widely used to make payments for international transactions, and (ii) is widely traded in the principal exchange markets*." (IMF Articles of Agreements, XXX (f)).

This concept was operationalized by the IMF staff in 1977. Accordingly, a "freely usable" currency is a currency that is:

- Widely used to make payments for international transactions, based on "the extent to which trade in goods and services is paid for in that currency, as well as on the relative volume of capital transactions denominated in that currency".[10] In practice, the indicators used are the share of a member's exports of goods and services in global trade, and the share of its currency in the denomination of official reserve holdings.

[10] See IMF (2010), p. 17.

- "Widely traded in the principal foreign exchange markets […] based on the volume of transactions, the existence of forward market, the spread between buying and selling quotations denominated in that currency."[11] In practice, tradability is assessed through the share of each currency in international banking liabilities, international debt securities and global foreign exchange market turnover. The underlying idea is that each currency of the basket has broad and deep foreign-exchange market, including for hedging products (see Box 1).

In its latest review in 2010, the Executive Board considered that, although China was now part of the four largest exporting zones in the world, the "freely usable" criterion was not met yet for the RMB. However, it decided to keep the matter under close review, thereby potentially paving the way for the RMB to be included during the next review in 2015. In 2011, the IMF was tasked with reviewing the criterion of free usability. One possibility could be to downplay the criterion of "free usability" (since the "free usability" of the pound and the yen is not fully exploited currently in the SDR arrangement), thus accepting a non-freely usable renminbi in the basket during a transition period. Another possibility could be to make clear the purpose of the requirement (see Box 1), to review the indicators guiding the free-usability assessment and to take into account the growing demand for RMB by private agents, which could in practice make it easy for central banks to sell this currency. In any case, the idea would be to assess the impact of RMB inclusion on the attractiveness of the SDR as a unit of account and as a store of value. Some degree of financial account convertibility should be achieved (attractiveness of the SDR as a store-of-value), together with some flexibility of the exchange rate (so that the inclusion of a new currency does not increase the volatility of the basket).

In brief, the door has been half-opened towards the inclusion of the renminbi in the SDR basket, in spite of the still limited cross-border dissemination of this currency (only 0.06% of international bonds and notes at end-2009, and 0.1% of total global foreign exchange market turnover during the 2007-2010 period[12]). But the door is still half-closed given the far-reaching structural changes that could be needed in terms of financial opening up, exchange-rate flexibilization and institutional change.

[11] See IMF (2010), p. 17.

[12] See BIS International Debt Securities Statistics, tables 13A and 13B, and BIS *Triennnial Central Bank Survey of Foreign Exchange and Derivatives Market Activity*, 2010.

Box 1. The rationale for the free usability requirement

The concept of freely usable currencies was first established to ensure that the IMF could use all currencies held in its operations. The link with the SDR was only established in 2000. The criteria used to assess which currency is freely usable have not been explicitly revisited since the late 1970s.

As already mentioned, SDRs are not traded on markets. They can only be sold to and bought by central banks against freely usable currencies. Central banks whose countries display a balance-of-payment deficit must be able to exchange their SDRs for a freely usable currency in order to intervene on markets and face their obligations. Hence, free usability is an insurance for the countries in balance-of-payment deficit that they will be able to use SDRs to finance their deficit, despite the lack of direct marketability of the basket.

In fact, two levels of liquidity should be distinguished for the SDR. The "direct liquidity" between the SDR and the freely usable currencies is not a true problem as the IMF ensures that every member can effectively get foreign currencies against SDRs through the designation and voluntary mechanisms. In turn, the "indirect liquidity" between the freely usable currencies and other currencies on foreign exchange markets is a true problem as there is no administrative insurance, which justifies the free usability requirement.

Is the shallowness and the narrowness of Chinese financial markets and the lack of trade of renminbi on foreign-exchange markets a strong obstacle to the free usability of the Chinese currency? Following the above reasoning, including a non-freely usable currency could reduce the indirect liquidity of the SDR basket. However, even though it is not widely traded, market expectations of an appreciation will temporary raise the demand for the Chinese currency, hence central banks may find it relatively easy to sell this currency. Moreover, the indicators for the freely usable requirement take into account outstanding amounts rather than flows, hence they overlook the growing role of RMB. Finally, there may be little need for more free usable currencies in the SDR since already SDR holders tend to favor only two of the four existing freely usable currencies. These are significant arguments in favor of reviewing again the relevant criteria of free usability.

If we posit that the inclusion of the RMB in the SDR is a possibility, then a difficult question is that of the number of currencies in the basket. As already mentioned, in 2000 it was decided that only the currencies of the four largest exporters should be included in the SDR. Consistently**,** the Japanese yen or the British pound (depending on the evolution their respective exports) would need to be dropped if the Chinese renminbi was to be included. However, keeping the yen and the pound in the basket would be consistent with the objective of stability of the composition of the basket, as Japan and the UK should remain the 4^{th} and 5^{th} largest exporters. Furthermore, London remains a major financial center, so the UK is better ranked in terms of capital flows than in terms of exports. Considering the rising role of financial transactions in the global economy, it could be justified to modify the decision of

2000, keep the pound and the yen in the basket and raise the number of currencies from four to five.

The next question then is why not including more currencies in the basket. Based on countries shares in trade and current income (Figure 1), possible candidates could be the Canadian dollar, the HK dollar, the Russian rubble, the Korean won, the SGP dollar, and possibly other currencies, all being convertible, unlike the renminbi. However the potential of development of these currencies is clearly more limited than that of the renminbi. Furthermore, including smaller countries in the basket would encounter the risk of having to revise the composition of the basket regularly to account for changes in country rankings. Finally, the choice on the number of currencies results from a trade-off between efficiency (which requires a limited number of currencies to reduce hedging costs) and stability of the value of the basket (which favors including more currencies to the extent that they are uncorrelated with the currencies already in the basket). The currencies mentioned above generally display high correlation with the US dollar, which reduces their attractiveness to stabilize the SDR. In the following, we consider a broadening of the SDR basket to the renminbi only.

4. OLD AND NEW SDR

In this section, we rely on the IMF methodology to calculate the value of a "new" SDR basket that would include the renminbi on the top of existing currencies.

4.1 Valuation methodology

The methodology used by the IMF to calculate the weight of each currency in the basket and the subsequent value of the SDR is detailed in IMF (2010). The weight of currency *i* in the basket reviewed in year *T*, $w_{i,T}$,is based on average exports of goods and services and currency-denomination of official reserves over the five years preceding year *T*, as a percentage of the corresponding averages summed up over the *N* currencies of the basket:

$$w_{i,T} = \frac{\sum_{t=T-6}^{T-1}\left(X_{i,t} + R_{i,t}\right)}{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}\left(X_{i,t} + R_{i,t}\right)} \quad (1)$$

where $X_{i,t}$ is the value of exports of goods and services (including current-income credit) in year *t*, and $R_{i,t}$ is the value of the balances in currency *i* held by the monetary authorities of

other Member states at the end of year *t*. Then, currency weights are converted in "currency amounts" in SDR as follows:[13]

$$\alpha_{i,T} = \frac{w_{i,T} E^{\$}_{SDR,Q4(T)}}{E^{\$}_{i,Q4(T)}} = w_{i,T} E^{i}_{SDR,Q4(T)} \qquad (2)$$

where $E^{i}_{j,Q4(T)}$ is the exchange rate between *i* and *j* (units of currency *i* in one unit of currency *j*) in the last quarter of year T. The value of the SDR in terms of the US dollar can then be recovered for any time *t* until the next basket review:

$$E^{\$}_{SDR,t}(T) = \sum_{i=1}^{N} \alpha_{i,T} E^{\$}_{i,t} \qquad (3)$$

Based on this methodology and on data from IMF IFS and COFER (also from the European Central Bank for the Euro Area during the 1995-1999 period), we have tried to recover the official SDR basket from 1991 to 2006. The results are reported in Table 1 (first two lines for each currency). The official and recalculated baskets look very similar, except for some discrepancies for the pound and the dollar: the dollar weight tends to be undervalued by our calculations, and that of the pound overvalued. In order to pinpoint the causes of the gap, we have compared the data used by the IMF (when available) with our own data. The gaps can partly be explained by revisions of the data over time and by discretionary rounding decisions.[14]

[13] The exact formula is

$$\alpha_{i,T} = \frac{w_{i,T} E^{\$}_{SDR,Q4(T)}}{E^{\$}_{i,Q4(T)}} \times \frac{E^{\$}_{SDR,Dec31(T)}}{\sum_{j=1}^{N} \left(\frac{w_{j,T} E^{\$}_{SDR,Q4(T)}}{E^{\$}_{j,Q4(T)}} \right) E^{\$}_{j,Dec31(T)}} = \frac{w_{i,T}}{E^{\$}_{i,Q4(T)}} \times \frac{E^{\$}_{SDR,Dec31(T)}}{\sum_{j=1}^{N} \left(\frac{w_{j,T}}{E^{\$}_{j,Q4(T)}} \right) E^{\$}_{j,Dec31(T)}}.$$

The second part of the formula ensures that the value of the SDR in terms of the US dollar calculated on December 31 on the basis of the new basket will be the same as that actually prevailing on that day.

[14] In the reviews of 1990, 1995 and 2005, the Board decided to give to the dollar a residual percentage point.

Table 1. Official and recalculated SDR weights, in percent*

Review year (T)	1990	1995	1998	2000	2005	2010
Applying to (H)	1991-1996	1996-1998	1999-2000	2001-2005	2006-2010	2011-2015
Dollar						
Official	40	39	39	45	44	41.9
Recalculated	39	38	37	44	44	41.9
Recal. with RMB	39.6	38.5	38.5	44.0	41.2	37.6
Deutschemark						
Official	21	21	-	-	-	-
Recalculated	21	21	-	-	-	-
Recal. with RMB	20.6	20.5	-	-	-	-
French franc						
Official	11	11	-	-	-	-
Recalculated	11	11	-	-	-	-
Recal. with RMB	10.6	10.5	-	-	-	-
Euro						
Official	-	-	32	29	34	37.4
Recalculated	-	-	33	31	34	37.4
Recal. with RMB	-	-	31.0	28.0	31.8	33.4
Yen						
Official	17	18	18	15	11	9.4
Recalculated	17	18	18	14	11	9.4
Recal. with RMB	16.6	17.5	17.5	14.0	10.4	8.4
British pound						
Official	11	11	11	11	11	11.3
Recalculated	12	12	12	11	11	11.3
Recal. with RMB	10.6	10.5	10.5	10.0	10.4	10.1
Renminbi						
Official	-	-	-	-	-	-
Recalculated	-	-	-	-	-	-
Recal. with RMB	2.0	2.5	2.5	4.0	6.2	10.5
TOTAL						
Official	100	100	100	100	100	100
Recalculated	100	100	100	100	100	100
Recal. with RMB	100	100	100	100	100	100

*Consistently with IMF's methodology, the shares are rounded up to the nearest whole percentage point before 2010. For the 2010 review, the shares are rounded up to one decimal. When including the RMB in the basket (last lines for each currency), we round up all shares to one decimal.

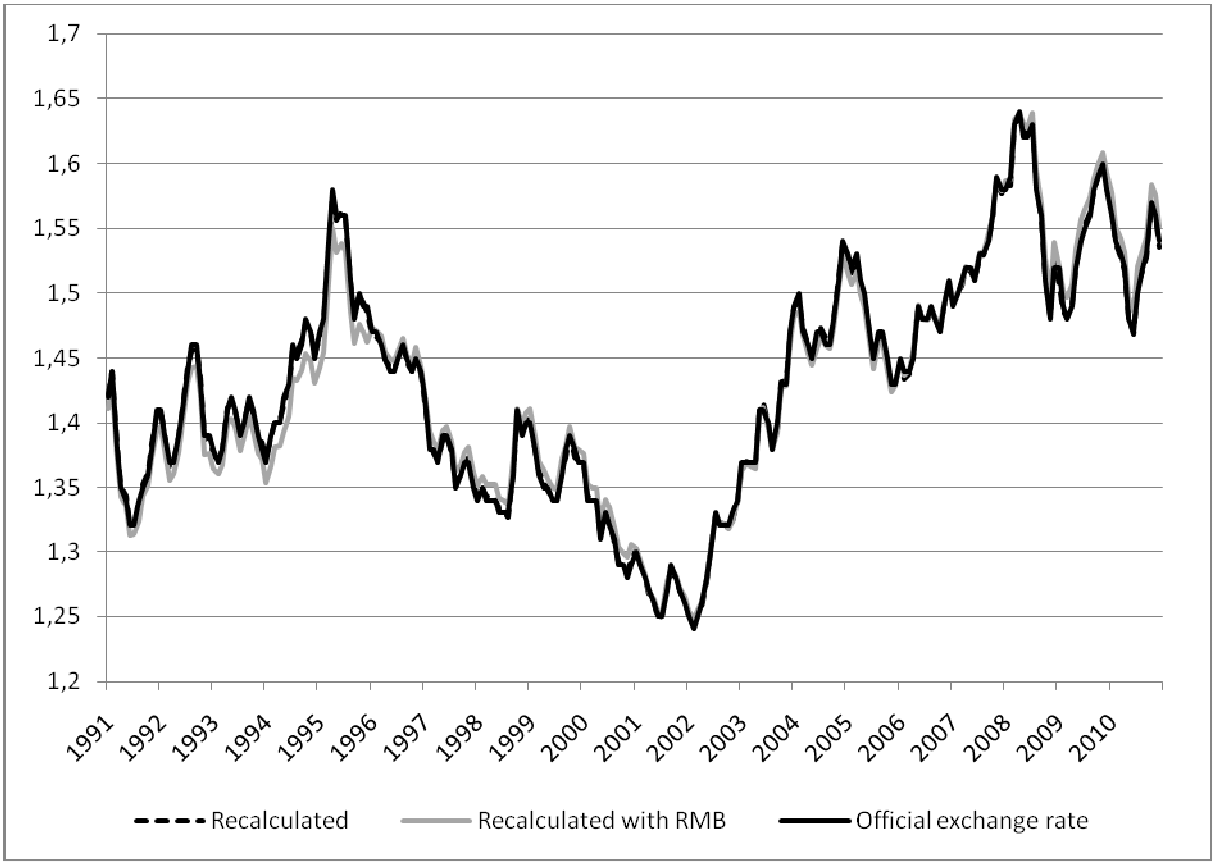
Source: authors' calculations based on IMF data.

4.2 Including Renminbi in the basket

We now assume that the renminbi has been included in the SDR, and we recalculate the basket accordingly based on the above methodology. The data for China come from the IFS database, and we have assumed that the value of reserve holdings in renminbi is negligible over the 1991-2010 period. The results are reported for each currency in the last lines of Table 1. The share of the renminbi is very small during the 1990s but it starts picking up in the 2000s to reach two digits for the 2010 review based on data over 2005-09.

We can then derive the value of the SDR in terms of dollars based on our recalculated basket with and without the RMB and on Equation (3), and compare these calculations with the official exchange rate of the SDR against the dollar. The results are depicted in Figure 2. The three lines are hardly distinguishable, which suggests that including the renminbi in the SDR would not have made a big difference over the past, given the limited weight of the Chinese currency in the basket.

Figure 2. Official and recalculated $/SDR nominal exchange rates (monthly data)



Source : IMF and own calculations.

4.3 An SDR for the next decades

As already mentioned, the share of the RMB in the basket only reaches two digits in the review of 2010. From negligible, the Chinese currency may become important in the next decades. We now turn to a prospective exercise based on long-run projections for exports and reserve holdings. Equation (1) can be decomposed as follows:

$$w_{i,T} = \frac{\sum_{t=T-6}^{T-1}\left(X_{i,t}+R_{i,t}\right)}{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}\left(X_{i,t}+R_{i,t}\right)} = \frac{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}X_{i,t}}{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}\left(X_{i,t}+R_{i,t}\right)} \times \frac{\sum_{t=T-6}^{T-1}X_{i,t}}{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}X_{i,t}} + \frac{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}R_{i,t}}{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}\left(X_{i,t}+R_{i,t}\right)} \times \frac{\sum_{t=T-6}^{T-1}R_{i,t}}{\sum_{i=1}^{N}\sum_{t=T-6}^{T-1}R_{i,t}}$$

or

$$w_{i,T} = \frac{X_T}{X_T+R_T}x_{i,T} + \frac{R_T}{R_T+X_T}r_{i,T} \qquad (4)$$

where X_T (resp. R_T) denotes the sum of average exports (resp. reserves) for our four or five countries-zones (resp. currencies), over the five-year period preceding the year of the review T, and $x_{i,T}$ (resp. $r_{i,T}$) denotes the ratio of average exports (resp. reserves) of country or zone (resp. currency) i over X_T (resp. R_T), for the same period.

For the four (or five) countries as a whole, we assume a constant ratio of reserves to exports:[15]

$$\frac{R}{R+X} = \text{constant}$$

As for the share of country i in total exports, we rely on projections at the 2050 horizon drawn from the MIRAGE model[16] and themselves relying on Fouré et al. (2010). The current income credit component of x_i, is absent from MIRAGE's projections. It is projected by multiplying exports of goods and services by an average income credit-to-export ratio observed in each country over the 2005-2010 period. As for official reserves, we rely on two alternative scenarios:

- A conservative scenario (S1): From 2010 to 2050, the currency composition of official reserves remains the same, at the global level, as observed during the 2010 review (hence over the 2005-2009 period): $r_{i,T} = r_{i,2010}$ for T = 2011 to 2050.

[15] Hence we consider that the rise in this ratio observed for 20 years comes to an end.

[16] See www.cepii.fr/anglaisgraph/models/mirage.htm.

- A multipolar scenario (S2): At the 2050 horizon, the currency composition of official reserves matches the country distribution of GDPs across the four or five SDR countries:[17]

$$r_{i,2050} = \frac{R_{i,2050}}{\sum_{i=1}^{N} R_{i,2050}} = \frac{GDP_{i,2050}}{\sum_{i=1}^{N} GDP_{i,2050}} \quad (5)$$

  From 2011 to 2050, we assume a linear adjustment of $r_{i,T}$ to $r_{i,2050}$.

The projection results are reported in Table 2. They should be considered only as illustrative given the heroic assumptions on which they rely.

Without the RMB in the SDR basket, the shares of the four currencies are roughly stable over the four decades. In S2, there is a slight rebalancing from the dollar to the other three currencies due to the increase in their shares in official reserves.

Currency shares are no longer stable over time when the renminbi is included in the basket. The fall is especially dramatic for the euro and the pound. Under the conservative scenario (S1), the renminbi reaps a 30 percent share at the 2050 horizon, against 35 percent for the dollar and 23 percent for the euro. Under the multipolar scenario (S2), the renminbi already accounts for 32 percent of the basket in the 2035 review. In both scenarios, Table 2 evidences the building up of a tripolar monetary system, albeit at different horizons. In the following, we use the conservative scenario (S1).

[17] We align the currency composition of reserves to the distribution of GDPs rather than exports due to higher correlation observed over the past. GDP projections are taken from Fouré et al. (2010). GDPs in volume are augmented with a Balassa-Samuelson effect to account for the evolution of relative prices.

Table 2. SDR weights over the next decades, in percent

	Review year T	2010	2015	2020	2025	2030	2035	2040	2045	2050
	Applying to:	2011-15	2016-20	2021-25	2026-30	2031-35	2036-	2041-	2046-50	2051-55
	Dollar									
S1	Without RMB	41.9	42.5	42.9	43.3	44.0	44.5	45.2	45.7	46.2
	With RMB	37.6	38.3	37.9	37.2	36.7	36.2	35.7	35.3	35.0
S2	Without RMB	41.9	41.6	41.5	41.2	41.1	41.1	41	40.9	40.8
	With RMB	37.6	37.2	35.2	33,1	30.9	28.9	26.9	25,1	23.2
	Euro									
S1	Without RMB	37.4	37.8	37.4	37.0	36.5	36.0	35.5	35.1	34.8
	With RMB	33.4	32.2	30.8	29.4	27.8	26.3	25.1	24.1	23.3
S2	Without RMB	37.4	38.3	38.1	38.1	37.9	37.6	37.5	37.4	37.3
	With RMB	33.4	32.4	30.7	28.8	26.9	25.1	23.5	22.1	21.0
	Yen									
S1	Without RMB	9.4	9.3	9.4	9.5	9.5	9.6	9.6	9.6	9.5
	With RMB	8.4	7.7	7.5	7.2	6.9	6.6	6.3	6.1	6.0
S2	Without RMB	9.4	9.7	10.0	10.3	10.7	11	11.3	11.5	11.7
	With RMB	8.4	8	7.8	7.6	7.4	7.1	6.9	6.7	6.6
	British pound									
S1	Without RMB	11.3	10.4	10.3	10.2	10.0	9.9	9.7	9.6	9.5
	With RMB	10.1	8.7	8.3	7.8	7.3	6.9	6.5	6.2	6.0
S2	Without RMB	11.3	10.4	10.4	10.4	10.3	10.3	10.2	10.2	10.2
	With RMB	10.1	8.6	8.2	7.7	7.2	6.7	6.3	6	5.7
	Renminbi									
S1	Without RMB	-	-	-	-	-	-	-	-	-
	With RMB	10.5	13.1	15.5	18.4	21.3	24	26.4	28.3	29.9
S2	Without RMB	-	-	-	-	-	-	-	-	-
	With RMB	10.5	13.8	18.1	22.8	27.6	32.2	36.4	40.1	43.5
	TOTAL									
S1	Without RMB	100	100	100	100	100	100	100	100	100
	With RMB	100	100	100	100	100	100	100	100	100
S2	Without RMB	100	100	100	100	100	100	100	100	100
	With RMB	100	100	100	100	100	100	100	100	100

Source : IMF and own calculations

5 IMPLICATIONS FOR THE STABILITY OF THE SDR

One guiding principle for reconsidering the composition of the SDR is the stability of the basket in terms of the major currencies. Two concepts are successively studied: short-run volatility, and exchange-ratemisalignments.

5.1 Short-term volatility

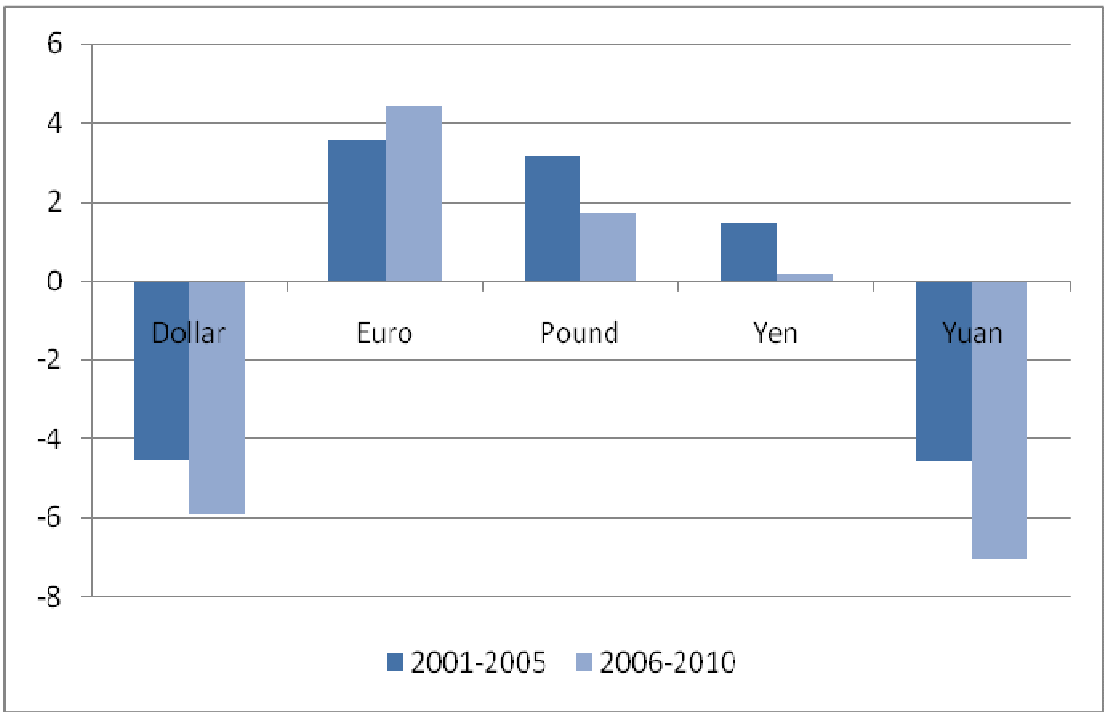
Short-term volatility is measured here as the standard deviation of monthly exchange-rate variations over each five-year period following each review period:[18]

$$SD_{i,H} = \sqrt{\frac{1}{59}\sum_{t=h+1}^{h+60}\left(\frac{E_{i,t}^{SDR} - E_{i,t-1}^{SDR}}{E_{i,t-1}^{SDR}} - \bar{g}_{i,H}^{SDR}\right)^2} \qquad \text{where} \qquad \bar{g}_{i,H}^{SDR} = \frac{1}{59}\sum_{t=h+1}^{h+60}\left(\frac{E_{i,t}^{SDR} - E_{i,t-1}^{SDR}}{E_{i,t-1}^{SDR}}\right) \quad (6)$$

Figure 3 shows the change in volatility when moving from a four- to a five-currency SDR, i.e. when including the renminbi in the basket, over 2001-05 and 2006-10. All exchange rates against the SDR are calculated based on the currency weights reported inTtable 1 ("recalculated" and "recal. with RMB" lines). The results are consistent in the two periods: including the yuan in the SDR basket reduces the volatility of the SDR against the dollar and the yuan itself, raises its volatility against the euro and the pound, and leaves the volatility against the yen roughly unchanged. The peg of the yuan on the dollar explains these results. The impact of the renminbi inclusion on the volatility of the SDR against the euro and the pound however remains limited – less than ten percent - due to the limited weight of the Chinese currency in the basket (4 and 6 percent in the first and second five-year periods, respectively).

[18] The results are qualitatively unchanged with other measures of short-term exchange-rate volatility.

Figure 3. Change in volatility when including the RMB in the SDR (percentage change compared to the volatility against the present SDR basket, over each period)



Source: own calculations.

The impact of RMB inclusion in the basket on third currencies is reported in Appendix A. Strikingly, RMB inclusion reduces the volatility of the SDR basket against all third currencies under review. Not surprisingly, the more the currency is pegged on the US dollar (hence also de facto on the RMB), the stronger the volatility is reduced.

We now discuss the possible impact of RMB inclusion on the volatility of the basket in the next coming decades, based on the weighting projections of Section 4 and on a number of assumptions concerning the volatility of the Chinese currency We denote by $g^{i}_{SDR,t}$ the exchange-rate variation (in percent) of currency *i* against the SDR between the t-1th and the t^{th} month of the *H* five-year period and drop the *H* and *T* subscripts for clarity:

$$g^{i}_{SDR,t} = \frac{E^{i}_{SDR,t} - E^{i}_{SDR,t-1}}{E^{i}_{SDR,t-1}} = \frac{\sum_{j=1}^{N} \alpha_j (E^{i}_{j,t} - E^{i}_{j,t-1})}{\sum_{j=1}^{N} \alpha_j E^{i}_{j,t-1}} \qquad (7)$$

where $\alpha_{j,}$ is the currency amount of currency *j*. Equation (7) can be re-written as:

$$g^{i}_{SDR,t} = \frac{\sum_{j=1}^{N} \alpha_j E^{i}_{j,t-1}\left(\frac{E^{i}_{j,t} - E^{i}_{j,t-1}}{E^{i}_{j,t-1}}\right)}{\sum_{j=1}^{N} \alpha_{j,T} E^{i}_{j,t-1}} \approx \frac{\sum_{j=1}^{N} \alpha_j E^{i}_{j,1Jan}\left(\frac{E^{i}_{j,t} - E^{i}_{j,t-1}}{E^{i}_{j,t-1}}\right)}{\sum_{j=1}^{N} \alpha_j E^{i}_{j,1Jan}} \quad (8)$$

where $E^{i}_{j,1Jan}$ is the exchange rate of currency *j* in terms of currency *i* on the first day of the period considered (*H*). Noting that $\alpha_j E^{i}_{j,1Jan} = w_j E^{j}_{SDR,1Jan} E^{i}_{j,1Jan} = w_j E^{i}_{SDR,1Jan}$, we get:

$$g^{i}_{SDR,t} \approx \frac{\sum_{j=1}^{N} w_j E^{i}_{SDR,1Jan}\left(\frac{E^{i}_{j,t} - E^{i}_{j,t-1}}{E^{i}_{j,t-1}}\right)}{\sum_{j=1}^{N} w_j E^{i}_{SDR,1Jan}} = \sum_{j=1}^{N} w_j \left(\frac{E^{i}_{j,t} - E^{i}_{j,t-1}}{E^{i}_{j,t-1}}\right) = \sum_{j=1}^{N} w_j g^{i}_{j,t} \quad (9)$$

From Equation (9) we can derive the variance of each currency *i* against the SDR, over period *H*:

$$Var(g^{i}_{SDR})_H = Var\left(\sum_{j=1}^{N} w_{j,H} g^{i}_{j}\right)_H = \sum_{j=1}^{N} w^2_{j,H} Var(g^{i}_{j})_H + 2 \sum_{1 \le j < j' \le N} w_{j,H} w_{j',H} Cov(g^{i}_{j}; g^{i}_{j'})_H \quad (10)$$

where *Cov* denotes the covariance. From Equation (10), we finally get our measure of short-term exchange-rate volatility.

We investigate two alternative, polar scenarios based on observed variances and covariances over the 1999-2009 period:

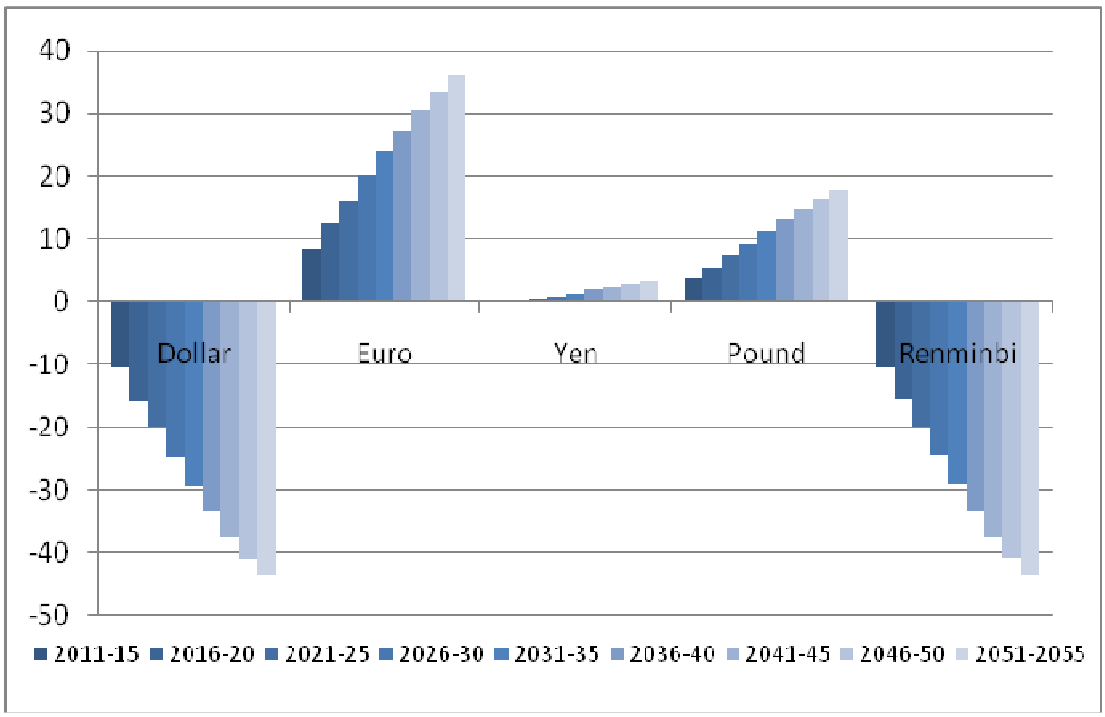
- *Peg*: the renminbi is supposed to be pegged to the dollar. Its volatility against the dollar is zero; that against the others currencies is equal to that of the dollar against the same currency; finally, all covariances involving the RMB/USD exchange rate are zero and each covariance involving the RMB/i exchange rates is equal to the corresponding covariance involving the USD/i exchange rate.
- *Float*: the renminbi is assumed to float freely. Its variance against each currency *i* is assumed identical to the average variance of the three other currencies against the same currency *i*; and the covariances of each RMB/i exchange rate are assumed to be averages of the two covariances of j/i, with j≠RMB, i. [19]

[19] Hence, for each period *H*, we have:

The variance-covariance matrices used in both scenarios are reported in Appendix B, together with the observed variance-covariance matrix over 1999-2009.

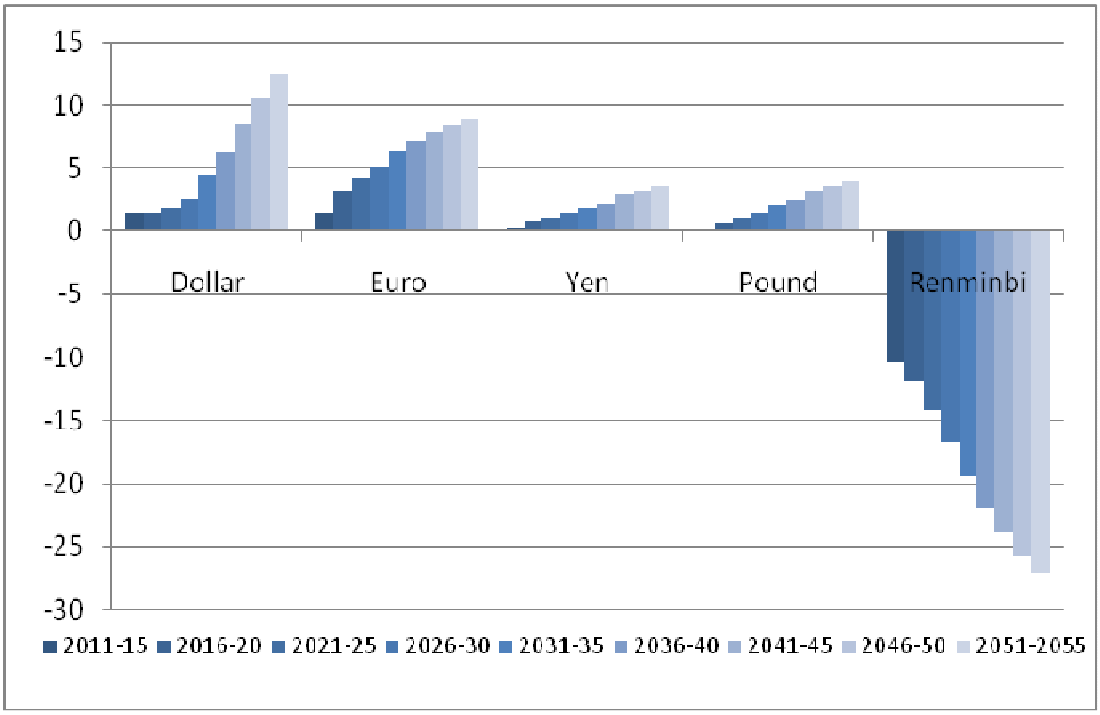
Figure 4 shows the change in volatility in the future when moving from a four to a five-currency SDR, i.e. from including the renminbi in the basket, using the weights given by Table 2. For each scenario (1, 2), we compare the volatility of the SDR basket vis-à-vis the five currencies with and without the renminbi.

Figure 4 Change in volatility when including the renminbi in the SDR in each scenario (in percent)
Scenario 1: pegged renminbi



$Var(g^i_{RMB})_H = \frac{1}{3}\sum_{j=1}^{3} Var(g^i_j)_{1999-2009}$, $Cov(g^i_{RMB}, g^i_j)_H = \frac{1}{2}\sum_{\substack{j'=1 \\ j' \neq j}}^{2} Cov(g^i_{j'}, g^i_j)_{1999-2009}$ and $Cov(g^{RMB}_j, g^{RMB}_{j'})_H = \frac{1}{8}\left(\sum_{k=1}^{3}\sum_{k'=1}^{3} Cov(g^k_j, g^{k'}_{j'})_{1999-2009} - Var(g^{j'}_j)_{1999-2009}\right)$. The float assumptions are based on the observation that free floating currencies display surprisingly stable monthly volatility across currencies and across time (see Mussa, 2000).

Scenario 2: floating renminbi



Source : own calculations.

When the renminbi is supposed to stay pegged to the US dollar (scenario 1), the results are similar qualitatively as those depicted in Figure 3 for the 2006-10 period: including the Chinese currency in the basket reduces the volatility of the SDR against both the dollar and the renminbi, raises the volatility of the SDR against the euro and the pound and leaves that against the yen roughly unchanged. Not surprisingly, the impact of RMB inclusion increases over time, in line with the rising weight of the Chinese currency in the basket. For instance, over the 2026-30 period, RMB inclusion raises the volatility of the SDR against the euro by 20 percent, against less than 5 percent over 2006-10.

If the renminbi is allowed to float, and given our assumptions concerning its volatility against the other currencies of the basket, its inclusion in the SDR raises the volatility of the latter against every currency but the RMB itself. However, the magnification of volatility is now much more limited than in scenario 1. For instance, over the 2026-30 period, the volatility of the SDR against the euro is increased by only 5 percent. Like in the previous case, though, the magnification of volatility increases along the rise in the weight of the RMB in the basket.

Three conclusions may be drawn from this analysis. First, as long as many currencies are de jure or de facto pegged to the dollar and the RMB itself is pegged to the US currency, the inclusion of the RMB in the SDR basket mechanically reduces the volatility of the latter against many currencies, including the RMB and the dollar themselves. Second, the impact, on the volatility of the SDR, of introducing the RMB in it, is limited in the short run but much

more important 10 or 15 years ahead. Third, including the RMB in the basket has much more benign impact on the volatility of the latter if the RMB is no longer pegged on the dollar. On the whole, SDR broadening would reduce the volatility of the basket against many currencies, with the major exceptions of the euro and the pound. Waiting until the RMB is made more flexible would have ambiguous effect on volatility: on the one hand, a floating RMB would have less impact on the volatility of the basket; on the other hand, waiting more would imply a higher weight by the time of RMB inclusion.[20]

5.2. Misalignments

A desirable feature of the SDR basket is also long-run stability: the SDR should not display a trend of appreciation or depreciation against the main currencies of the international monetary system. One way to study this second aspect of stability is to analyse possible misalignments of the SDR, misalignments being defined as deviations of the exchange rate from its equilibrium level. Measuring misalignments requires a model of the equilibrium exchange rate. Here, we successively rely on purchasing power parity (PPP) and on a Balassa-Samuelson benchmark.[21]

a. Deviations from PPP

By definition, the PPP exchange rate is the nominal exchange rate that would equalize the purchasing power of one unit of a currency in two different countries. Let *P* denote the general price level in the home economy and *P** the price level in the foreign economy. The PPP exchange rate is given by *PPP = P*/P*: when the price level rises in the foreign country compared to the home country, the home currency must appreciate (*PPP* must rise) so as to compensate for the inflation differential. Along these lines, we can define the PPP exchange rate of the SDR against currency *i* as a function of the nominal and the real exchange rates:

$$PPP^{i}_{SDR,t} = \frac{E^{i}_{SDR,t}}{RER^{i}_{SDR,t}} \qquad (11)$$

where RER^{i}_{SDR} is the real exchange rate of the SDR against currency *i*.[22] The misalignment of the i/SDR exchange rate relative to PPP at time *t* can then be defined as:

[20] Such discontinuity could possibly be avoided by changing the weighting methodology, e.g. by including FX turnover in the weighing scheme, see Newham et al. (2011).

[21] For a review of equilibrium exchange rate theories, see Bénassy-Quéré A., Béreau S. and Mignon V. (2010).

[22] $RER^{i}_{SDR,t} = RER^{i}_{\$,t} \sum_{j=1}^{N} w_j RER^{\$}_{j,t}$, with $RER^{\$}_{j,t} = \frac{E^{\$}_{j,t} P_j}{P_{\$}}$ Here we use yearly GDP price levels from the World Bank, from 1990 to 2009.

$$M^{i}_{SDR,t} = \frac{E^{i}_{SDR,t} - PPP^{i}_{SDR,t}}{PPP^{i}_{SDR,t}} \quad (12)$$

If $M^{i}_{SDR} > 0$, then the SDR is over-valued against currency *i* (currency *i* is undervalued). Figure 5 compares the misalignments obtained whether the RMB is included or not in the SDR.

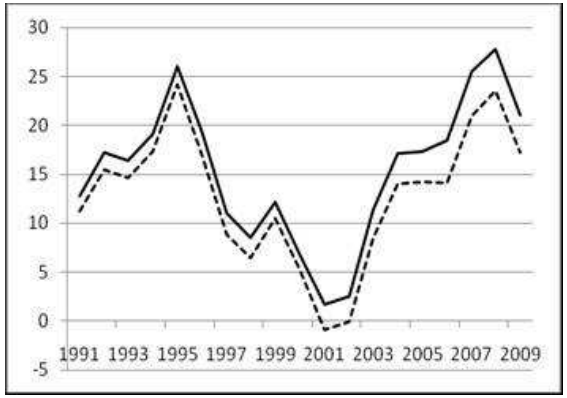
The renminbi and, to a lesser extent, the dollar and the pound are found undervalued against the SDR over the whole 1991-2009 period. The yen shifts from overvalued during the 1990s to under-valued in the 2000s. As for the euro, it is found largely overvalued since 2003.

Because it is largely undervalued against the SDR, including the RMB in the basket tends to weaken the value of the SDR, hence to make the other currencies more overvalued (euro) or less undervalued (dollar, pound, yen in the 2000s). However, due to its limited weight, the inclusion of the RMB in the SDR does not make a large difference. For 2009, for instance, the undervaluation of the dollar is reduced by less than 5 percent. However, should individual misalignments persist in the next decades, the impact of RMB inclusion would be magnified. As an illustration, Table 3 reports the misalignments against the SDR over the next decades based on bilateral misalignments observed in 2009 and the currency weights given by Table 2. The impact of RMB inclusion rises over time. Over the 2026-30 period, for instance, the over-valuation of the euro against the SDR increases by 8.4 pp, instead of 2.5 percent in 2009. Of course, there is no reason for the misalignments observed in 2009 to persist. However this analysis underlines a second trade-off concerning the timing of RMB inclusion: postponing it would allow for the RMB to move closer to PPP; but its misalignment would suddenly impact on the SDR at the time of its inclusion in the basket.

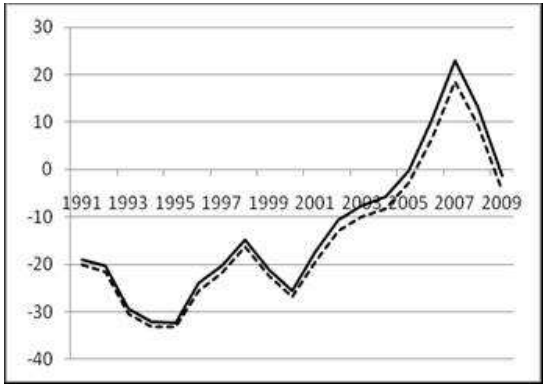
Figure 5. Misalignments relative to PPP, in percent

Solid line: RMB out of SDR; Dotted line: RMB in SDR

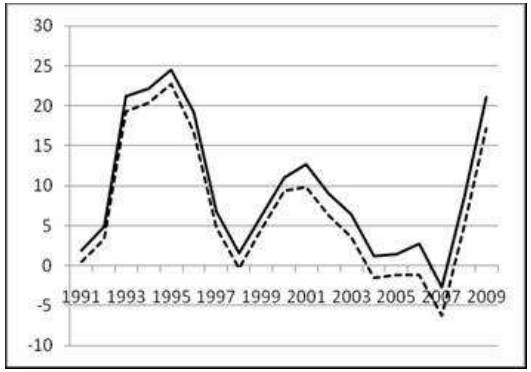
SDR against USD



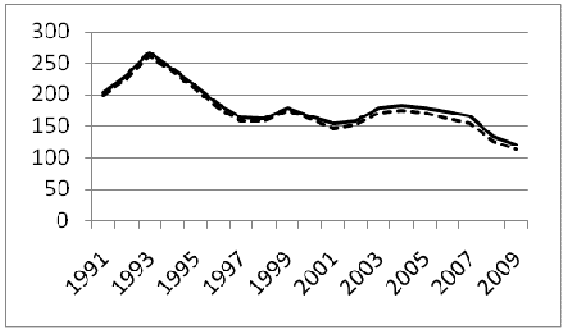
SDR against yen



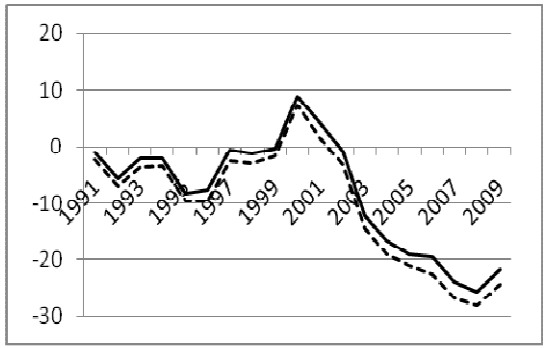
SDR against pound sterling



SDR against renminbi



SDR against deutschemark (through 1999) and then euro



Reading: a positive sign denotes an overvaluation of the SDR, hence an undervaluation of the currency.
Source: Authors' calculations based on World Bank data.

Table 3. Misalignments of the SDR relative to PPP based on 2009 bilateral misalignments (in percent)

		2009	2011-15	2016-20	2021-25	2026-30	2031-35	2036-40	2041-45	2046-50	2051-55
SDR/RMB	With RMB	113.8	110.5	106.9	103.7	99.5	95.4	91.4	88.3	85.6	83.4
	Without RMB	120.8	123.6	123.8	123.6	123.2	122.5	122.3	121.6	121.4	121.0
SDR/EUR	With RMB	-24.2	-25.4	-26.7	-27.8	-29.3	-30.8	-32.2	-33.3	-34.2	-35.0
	Without RMB	-21.7	-20.8	-20.7	-20.8	-20.9	-21.1	-21.2	-21.5	-21.6	-21.7
SDR/JPY	With RMB	-4.4	-5.8	-7.4	-8.9	-10.7	-12.6	-14.4	-15.8	-17.0	-18.0
	Without RMB	-1.2	0.0	0.1	0.0	-0.1	-0.4	-0.6	-0.9	-1.0	-1.1
SDR/GBP	With RMB	17.2	15.4	13.4	11.7	9.4	7.1	4.9	3.2	1.8	0.5
	Without RMB	21.1	22.6	22.7	22.6	22.4	22.0	21.9	21.5	21.4	21.2
SDR/USD	With RMB	17.2	15.5	13.5	11.7	9.4	7.2	5.0	3.2	1.8	0.6
	Without RMB	21.1	22.6	22.7	22.6	22.4	22.0	21.9	21.5	21.4	21.2

Reading: a positive figure points to an overvaluation of the SDR.
Source: own calculations.

b. Deviations from Balassa-Samuelson

Although an appropriate long-run benchmark for advanced economies, PPP hardly applies to an emerging country like China where productivity is still much lower than in advanced economies, justifying the exchange rate to be undervalued with regard to PPP (Balassa-Samuelson effect). Accordingly, the real exchange rate between currencies *i* and *j* at time t, $RER^{i}_{j,t}$, depends on the productivity differential which is generally proxied by the differential in GDP per capita in PPP, *GDPcap* :

$$\ln RER^{i}_{j,t} = c + a_i + b \ln \frac{GDPcap_{j,t}}{GDPcap_{i,t}} \qquad (13)$$

with $RER^{i}_{j,t} = \frac{E^{i}_{j,t} P_{j,t}}{P_{i,t}}$ and $b > 0$. We first perform a panel cointegration estimation of Equation (13) for 128 countries over the period 1980 to 2009. Real exchange rates are based on World Bank's PPP conversion factors, and are expressed against the dollar. As for GDP per capita in PPP, it is taken at constant international dollars of 2005. The unit root and cointegration tests are reported in Appendix C. We get $\hat{b} = 0.23$: a 10 percent increase in GDP per capita relative to the US involves a real exchange-rate appreciation of 2.3 percent against the dollar, other things equal. Then, we can recover the real equilibrium exchange rate of each country *i* against the SDR as follows:

$$\hat{RER}^{i}_{SDR,t} = \hat{RER}^{i}_{\$,t} \sum_{j=1}^{N} w_j \hat{RER}^{\$}_{j,t} \quad (14)$$

with $\hat{RER}^{i}_{\$,t} = e^{\hat{c}+\hat{a}_i+\hat{b}\ln\frac{GDPcap_{US,t}}{GDPcap_{i,t}}}$ and $\hat{RER}^{\$}_{j,t} = \frac{1}{\hat{RER}^{j}_{\$,t}}$.

Finally, the misalignment of the SDR/i exchange rate in terms of the Balassa-Samuelson benchmark can be defined as:

$$\hat{M}^{\,i}_{SDR,t} = \frac{RER^{i}_{SDR,t} - \hat{RER}^{i}_{SDR,t}}{\hat{RER}^{i}_{SDR,t}} \quad (15)$$

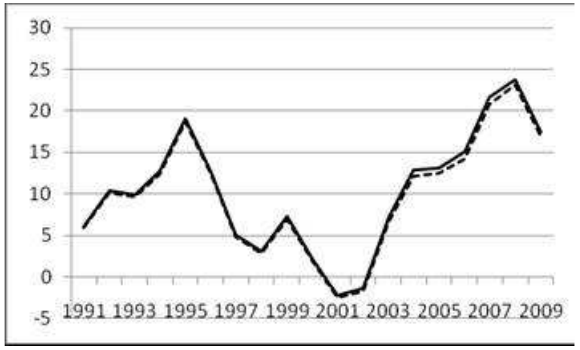
Figure 6 compares the misalignment obtained whether the RMB is included or not in the SDR basket. Strikingly, the inclusion of the RMB in the SDR basket now has negligible impact on calculated misalignments. This is because the misalignment of the RMB is much more limited with reference to a Balassa-Samuelson benchmark than in terms of PPP: including the RMB in the basket now has negligible impact on the equilibrium exchange rate of the SDR, hence on the misalignments.

This second view on misalignments mitigates the conclusion based on PPP and further suggests an important argument in favor of the inclusion of the RMB in the basket: to the extent that the value of the SDR should remain stable over the long run, it would be advisable to balance its composition between, on the one hand, the currencies of advanced economies, that are likely to depreciate in real effective terms over the long term, and that of a large, emerging country that is bound to appreciate in relation with the Balassa-Samuelson effect. This line of reasoning is strengthened when considering the cumulated deficits of the United States, one major counterpart being China's cumulated surpluses.

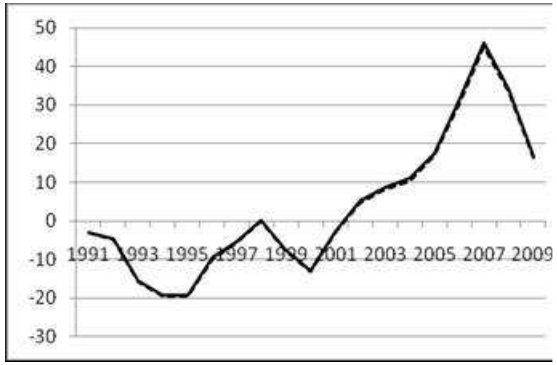
Figure 6. Misalignments relative to a Balassa-Samuelson benchmark, in percent

Solid line: RMB out of SDR; Dotted line: RMB in SDR

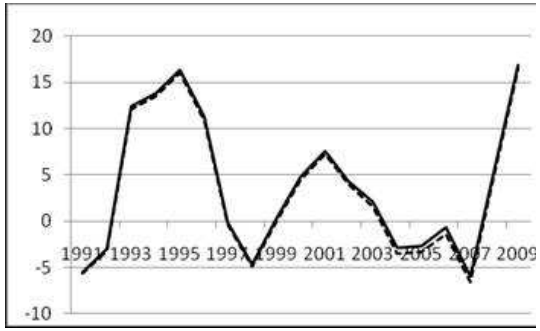
USD/SDR



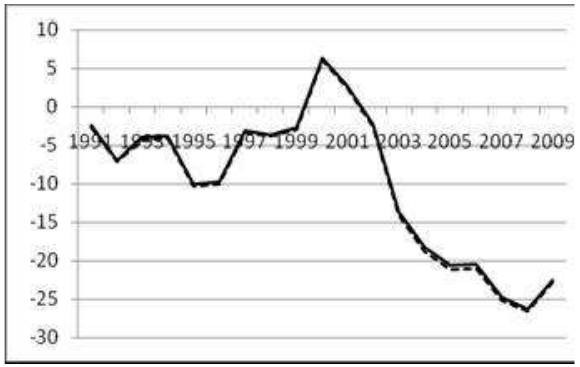
YEN/SDR



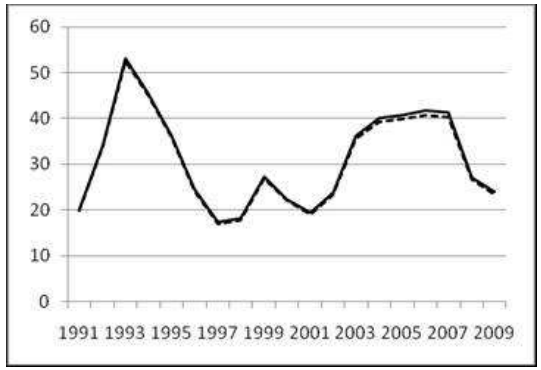
GPB/SDR



DM/SDR (through 1999) and then EUR/SDR



RMB/SDR



Reading: a positive figure points to an overvaluation of the SDR.
Source: own calculations

6. IMPLICATIONS FOR THE SDR INTEREST RATE

We finally investigate the impact of the inclusion of the RMB on the interest rate of the SDR, which is a weighted average of the 3-month benchmark interest rates of the basket currencies:

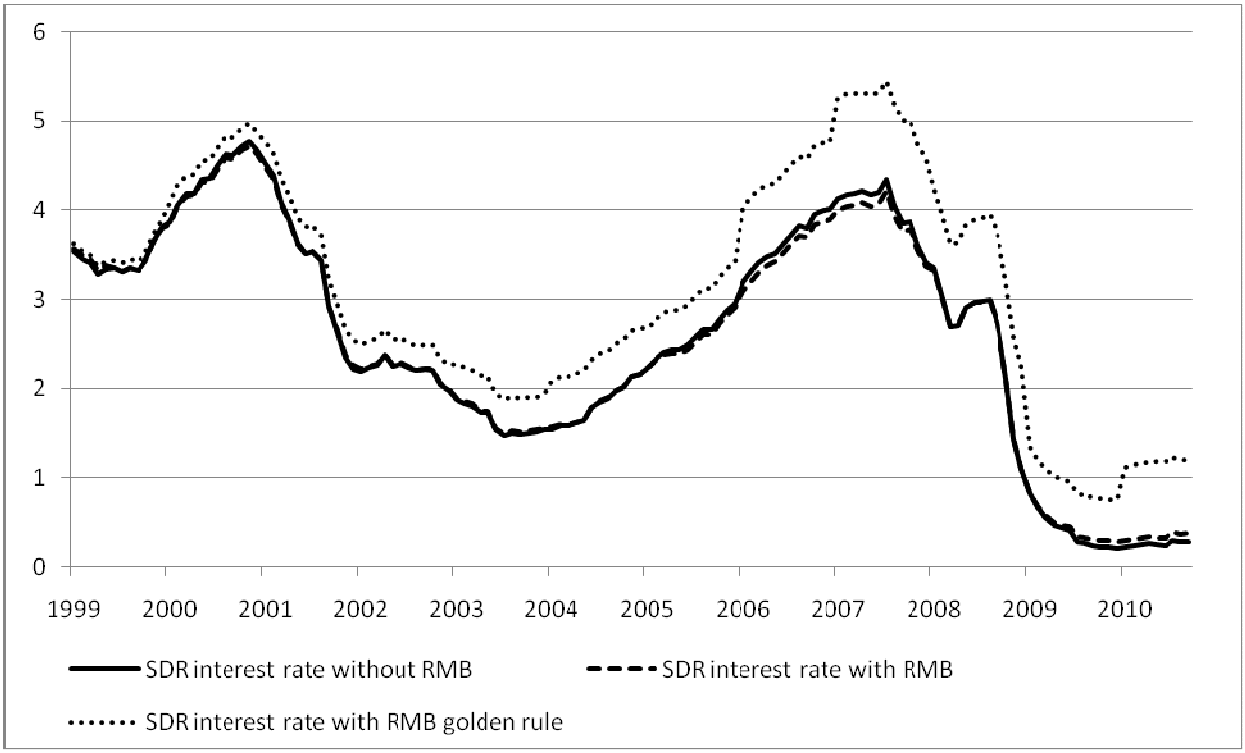
$$i_{SDR,t} = \sum_{j=1}^{N} \alpha_{j,T} E_{j,t}^{SDR} i_{j,t} \qquad (16)$$

where $\alpha_{j,T} E_{j,t}^{SDR}$ is the effective weight of currency *j* at date *t*, and $i_{j,t}$ is the short-term interest rate in country (or currency zone) *j*. We use Equation (16) to compare the SDR interest rate with and without the RMB in the basket. Three-month interest rates are taken from the IFS (IMF) for the United-States, the Euro area, Japan and the United-Kingdom. For China, we use the interest rate on three-month central-bank bills from Datastream.[23]

Figure 7 shows a very slight increase in the SDR interest rate when the RMB is included in the basket, and only in the very end of the period. It can be argued however that interest rates have been maintained artificially low in China thanks to capital controls and banking regulations. Indeed, monetary policy has been channeled largely through quantitative measures such as minimum reserve requirements and credit ceilings. Figure 7 shows what would happen to the SDR interest rate should the Chinese rate have been equal to the nominal GDP growth rate (golden rule). The impact of RMB inclusion in the SDR is more significant (one percentage point in 2010).

[23] We have supplemented the PBoC bill series available before 2003 with the discount rate/bank rate series from the IMF.

Figure 7. SDR Interest rate with and without the RMB (in percentage points)



Source : own calculations.

Like in the previous sections, it is possible to project the impact of the inclusion of the RMB on the interest rate depending on the weight of the RMB and on the gap between the RMB interest rate and the mean of the other interest rates. Denoting by i_{SDR}^{RMB} and i_{SDR} the SDR interest rate respectively with and without the RMB, and by w_j^{RMB} , w_j the corresponding currency weights, we have:

$$i_{SDR,t}^{RMB} = \sum_{j=1}^{5} w_j^{RMB} i_{j,t} \quad \text{and} \quad i_{SDR,t} = \sum_{j=1}^{4} w_j i_{j,t}$$

Therefore $$i_{SDR,t}^{RMB} - i_{SDR,t} = \sum_{j=1}^{4} (w_j^{RMB} - w_j) i_{j,t} + w_{RMB}^{RMB} i_{RMB,t} \qquad (21)$$

We first assume that, for each currency *j*, $i_{j,t}$ remains equal to its average level over the 2003-2009 period: $i_{j,t} = \bar{i}_{j,2003-09}$.[24] The results are reported in Table 4, line "+0". They evidence a negligible impact of RMB inclusion on the SDR interest rate, even when the weight of the RMB becomes large. The reason is that, over the 2003-09 period, the short run interest rate in China is found very close to the weighted average of the four SDR currencies. It can be argued that this situation of "repressed finance" is artificial: should the Chinese banking system be opened up and managed through price incentives rather than quantitative rules, the real interest rate would have to rise above zero in China. Consistently, we explore alternative scenarios where the Chinese interest rate is set 1, 3, 5 and 7 percentage points, successively above the average rate of the other four countries: $i_{RMB,t} = \bar{i}_{SDR,2003-09} + n$ with n=1;3;5;7. The results are reported in Table 4.

Table 4. Impact of the inclusion of RMB in the basket on the SDR interest rate (in percent)

		2011-15	2016-20	2021-25	2026-30	2031-35	2036-40	2041-45	2046-50	2051-55
w_{RMB}^{RMB}		10.5	13.1	15.5	18.4	21.3	24	26.4	28.3	29.9
$i_{RMB,t} - \bar{i}_{SDR,2003-2009}$ (percentage points)	+0	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
	+1	0.10	0.14	0.16	0.19	0.22	0.25	**0.28**	**0.29**	0.31
	+3	0.31	0.40	0.47	0.56	**0.65**	**0.73**	0.80	0.86	0.91
	+5	0.52	0.66	**0.78**	**0.92**	1.07	1.21	1.33	1.42	1.51
	+7	0.73	**0.92**	1.09	1.29	1.50	1.69	1.86	1.99	2.10

Source: own calculations.

Unless the Chinese interest rate becomes much higher than the other four, the inclusion of the RMB in the basket would still have little impact on the SDR interest rate. A hypothetical path of the gap between the Chinese interest rate and the average of the other four has been put in bold in Table 4: at the 2016 horizon, it is 7 pp above the average of the other SDR countries, consistent with nominal growth. Then, Chinese catch up and ageing process leads to a decline in nominal growth, bringing the interest rate towards those of advanced economies. Along this path, the impact of RMB inclusion on the SDR interest rate never reaches one percentage point.

[24] The period before 2003 is dropped so as to restrict the analysis to comparable series of interest rates. We have: $\bar{i}_{\$,2003-09} = 2.17\%, \bar{i}_{€,2003-09} = 2.31\%, \bar{i}_{£,2003-09} = 3.63\%, \bar{i}_{¥,2003-09} = 0.22\%, \bar{i}_{\text{RMB},2003-09} = 2.18\%$. The recalculated SDR interest rate without the RMB over the 2003-09 period is $\bar{i}_{SDR,2003-09} = 2.19\%$.

6. CONCLUDING REMARKS

In the perspective of the reform of the IMS, the inclusion of the renminbi in the SDR is mainly motivated by two objectives: enhancing the attractiveness of the SDR both as a reserve asset and as a unit of account, and strengthening international monetary cooperation. Regarding the first objective (the focus of this paper), the inclusion of the renminbi can be assessed according to the broad principles guiding SDR valuation decisions:[25] representativeness, and stability of the composition and value of the basket. Although tentative, our results suggest several conclusions:

First, the inclusion of the renminbi in the SDR would make the basket more representative of the structure of global trade thus improving the legitimacy of the basket. Although the renminbi is not yet widely used in current and financial transactions, it can be expected to meet this requirement in the medium run.

Second, had the renminbi be included in the SDR basket during the 1990s and 2000s, its weight would have been limited (less than ten percent). However, under basic assumptions concerning the future evolution of global trade and the distribution of foreign-exchange reserves, the renminbi could become the first or second currency of the basket by 2040. Hence, waiting too much before including the RMB in the basket (because it is not yet freely usable) would incur the risk of a significant discontinuity in the SDR behavior when the inclusion is eventually decided. The principle of the stability of the composition also argues against a wider broadening of the basket since the potential of development of the candidates is clearly more limited than that of the renminbi and since including smaller countries in the basket would encounter the risk of having to revise the composition of the basket regularly to account for changes in country rankings.

Third, the impact, of RMB inclusion on SDR volatility will crucially depend on China's exchange-rate regime: assuming the RMB is pegged to the dollar, the volatility of the SDR vis-à-vis the euro and the pound would rise very significantly over the next decades, whereas it would be reduced against the US dollar, the renminbi and a number of third currencies. Conversely, should the yuan be allowed to float, the impact on the volatility of the SDR would be much more limited. Similarly, including the yuan while it is significantly under-valued would weaken the value of the SDR. These results are strong arguments in favor of postponing RMB inclusion until it is more flexible and has adjusted somewhat towards equilibrium. However, it should be kept in mind that waiting too much would introduce a discontinuity on the behavior of the SDR because the new currency would immediately be attributed a large weight. Additionally, having the yuan in the SDR would counterbalance a depreciating trend of the SDR in real effective terms related to the Balassa-Samuelson and to cumulated deficits in the United States that represent 42 percent of the basket. Indeed, China is likely to experience strong real exchange-rate appreciation in the future in relation to the Balassa-Samuelson effect and/or to current account adjustment. This feature could raise the

[25] See IMF (2010) p. 5.

attractiveness of the SDR as a store of value. Meanwhile, net debtor countries would not suffer from a large increase in the SDR interest rate.

Finally, our results suggest that the question of the free usability requirement may be revised if the main objective is to raise the attractiveness of the SDR as a unit of account and as a store of value. Should the renminbi be included in the basket, it might reduce the indirect liquidity of the SDR as the yuan is not yet widely traded on foreign exchange market (both on-shore and off-shore). However, even though it is not widely traded, market expectations of an appreciation will temporary raise the demand for the Chinese currency, hence central banks may find it relatively easy to sell this currency. In our view, including the RMB in the SDR relatively rapidly would bring advantages in terms of representativeness and stability of the composition and of the value of the basket, especially if China's exchange rate regime is made more flexible. This issue of flexibility is de facto more important than that of free usability to make the SDR more stable, at least in the short and medium run.

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APPENDIX A.

Implications of RMB inclusion in the SDR for third currencies

Here we investigate the implication of including the RMB in the SDR basket for the volatility of the SDR in terms of ten currencies that do not belong to the basket: the Australian dollar, the Brazilian real, the Canadian dollar, the HongKong dollar, the Indian rupee, the Korean won, the Malaysian ringgit, the Mexican peso, the Russian ruble, the Saudi riyal, the Singaporean dollar and Swiss franc (i.e. the ten possible candidates according to Figure 1). We rely on the standard deviation of monthly exchange-rate variations. The results are reported in Table A.1. They suggest that the inclusion of the renminbi in the SDR would have reduced the volatility of the SDR basket against the various non-SDR currencies in the 1990s and 2000s. A first sight this is obvious as the inclusion of a new currency is a basket mechanically stabilizes the basket against non-member currencies. However, one must keep in mind the fact that the renminbi is highly correlated to the US dollar, therefore its inclusion could potentially destabilize the i/SDR exchange rate when *i* is not correlated to the US dollar. The table shows that those currencies closest to the US dollar (the HK dollar, and Saudi riyal) are those benefiting from the highest decline in volatility following RMB inclusion in the basket.

Table A.1. Change in the standard deviation of exchange rate variation after the inclusion of the renminbi, in percent

	1991-1995	1995-1998	1999-2000	2001-2005	2006-2010
Australian dollar	-1.1	-1.1	-0.7	-0.6	-1.0
Brazilian real	-	-1.7	0.0	-0.6	-0.7
Canadian dollar	-1.3	-2.0	-1.6	-1.6	-1.8
HK dollar	-1.8	-3.6	-3.9	-4.5	-6.0
Indian rupee	-0.3	-0.8	-1.8	-2.8	-2.4
Korean won	-1.8	-0.1	-0.4	-1.2	-1.1
Malaysian ringgit	-1.5	-0.7	-0.3	-4.5	-3.5
Mexican peso	-0.5	-0.3	-0.7	-1.4	-1.1
Russian rubble	-	-	-0.1	-2.8	-1.2
Saudi riyal	-1.8	-3.6	-3.9	-4.5	-6.3
Singaporean dollar	-1.6	-1.5	-0.7	-2.3	-3.3
Swiss franc	-0.6	-0.4	-0.2	-0.9	-1.9

Source: own calculations

APPENDIX B.

Variance-covariance matrices over the 1999-2009 period and in each scenario

Table B.1. The observed variance-covariance matrix over the 1999-2009 period

	$/€	£/€	¥ /€	RMB /€	¥/ $	$/£	RMB/$	¥/ £	RMB/£	¥/ RMB
$/€	**6.70**	2.19	4.50	6.53	-1.93	4.33	-0.17	2.29	4.33	-1.86
£/€	2.19	**3.34**	1.10	2.03	-1.00	-1.09	-0.11	-2.13	-1.30	-1.06
¥/€	4.50	1.10	**8.15**	4.51	3.74	3.34	-0.08	6.91	3.43	3.56
RMB/€	6.53	2.03	4.51	**6.54**	-1.84	4.41	-0.04	2.46	4.40	-1.88
¥ / $	-1.93	-1.00	3.74	-1.84	**5.77**	-0.92	0.07	4.67	-0.83	5.43
$/£	4.33	-1.09	3.34	4.41	-0.92	**5.48**	-0.04	4.37	5.55	-0.79
RMB/$	-0.17	-0.11	-0.08	-0.04	0.07	-0.04	**0.11**	0.03	0.06	-0.02
¥ / £	2.29	-2.13	6.91	2.46	4.67	4.37	0.03	**8.99**	4.67	4.55
RMB/£	4.33	-1.30	3.43	4.40	-0.83	5.55	0.06	4.67	**5.65**	-0.88
¥/	-1.86	-1.06	3.56	-1.88	5.43	-0.79	-0.02	4.55	-0.88	**5.50**

Source: own calculations based on Eurostat and Bank of England data.

Table B.2. The variance-covariance matrix under Scenario S1 (peg)

	$/€	£/€	¥ /€	RMB /€	¥/ $	$/£	RMB/$	¥/ £	RMB/£	¥/ RMB
$/€	**6.70**	2.19	4.50	6.70	-1.93	4.33	0.00	2.29	4.33	-1.93
£/€	2.19	**3.34**	1.10	2.19	-1.00	-1.09	0.00	-2.13	-1.09	-1.00
¥/€	4.50	1.10	**8.15**	4.50	3.74	3.34	0.00	6.91	3.34	3.74
RMB/€	6.70	2.19	4.50	**6.70**	-1.93	4.33	0.00	2.29	4.33	-1.86
¥ / $	-1.93	-1.00	3.74	-1.93	**5.77**	-0.92	0.00	4.67	-0.92	5.77
$/£	4.33	-1.09	3.34	4.33	-0.92	**5.48**	0.00	4.37	5.48	-0.92
RMB/$	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
¥ / £	2.29	-2.13	6.91	2.29	4.67	4.37	0.00	**8.99**	4.37	4.67
RMB/£	4.33	-1.09	3.34	4.33	-0.92	5.48	0.00	4.37	**5.48**	-0.83
¥/ RMB	-1.93	-1.00	3.74	-1.86	5.77	-0.92	0.00	4.67	-0.83	**5.77**

Source: own calculations.

Table B.3. The variance-covariance matrix under Scenario S2 (float)

	$/€	£/€	¥ /€	RMB /€	¥/ $	$/£	RMB/$	¥/ £	RMB/	¥/
$/€	**6.70**	2.19	4.50	3.34	-1.93	4.33	-3.13	2.29	-	-
£/€	2.19	**3.34**	1.10	1.65	1.00	-1.09	-	-2.13	-1.61	-
¥/€	4.50	1.10	**8.15**	2.80	3.74	3.34	-	6.91	-	5.32
RMB/	3.34	1.65	2.80	**6.06**	-	-	-1.56	-	1.30	1.69
¥ / $	-1.93	1.00	3.74	-	**5.77**	-0.92	1.43	4.67	-	4.20
$/£	4.33	-1.09	3.34	-	-0.92	**5.48**	-2.63	4.37	2.73	-
RMB/	-3.13	-	-	-1.56	1.43	-2.63	**5.98**	-	-0.64	-0.41
¥ / £	2.29	-2.13	6.91	-	4.67	4.37	-	**8.99**	3.25	5.79
RMB/	-	-1.61	-	1.30	-	2.73	-0.64	3.25	**5.93**	2.55
¥/	-	-	5.32	1.69	4.20	-	-0.41	5.79	2.55	**7.64**

Source: own calculations.

APPENDIX C.
Estimating the Balassa-Samuelson effect

We want to estimate the following, long-run relationhip:

$$\ln RER^{i}_{\$,t} = c + a_i + b \ln \frac{GDPcap_{US,t}}{GDPcap_{i,t}} + \eta_{i,t} \qquad \text{(C.1)}$$

$RER^{i}_{\$,t}$ is the real exchange rate of country *i* against the dollar in year *t* (relative price of US goods). We use the PPP conversion factor of the World Bank for GDP, over the observed nominal exchange rate. $GDPcap_{i,t}$ is the level of GDP per capita in PPP, in constant international dollars of 2005. The sample is composed of 128 countries over the period 1980 to 2009.

We first test for the stationarity of the series ($\ln RER_{\$}^{i}$ and $\ln GDPcap_{US}^{i}$ where $GDPcap_{US}^{i} = \frac{GDPcap_{US}}{GDPcap_i}$) by estimating the following equations:

$$\Delta \ln RER^{i}_{\$,t} = \varphi \ln RER^{i}_{\$,t} + \alpha + \beta t + \sum_{j=1}^{5} \gamma_j \Delta \ln RER^{i}_{\$,t-j} + \eta_{i,t} \qquad \text{(C.2)}$$

$$\Delta \ln GDPcap^{i}_{US,t} = \varphi \ln GDPcap^{i}_{US,t} + \alpha + \beta t + \sum_{j=1}^{4} \gamma_j \Delta \ln GDPcap^{i}_{US,t-j} + \eta_{i,t} \qquad \text{(C.3)}$$

The number of lags is selected based on the method proposed by Campbell and Perron. After setting a maximum number of lags (p), we estimate (C.2) and (C.3). If the last lag is not significantly different from 0 (at the 1% level), we estimate the relation with p-1 lags. We repeat this procedure until the coefficient on the last lag included in the relation is significant. The lag order is reported in Table C.1.

Table C.1. Lag order for unit root tests

Series	p_{max}
lnGDPcap	4
lnRER	5

Source: own calculations.

The results of the various panel root cointegration tests are reported in Tables C.2 and C.3. On the whole, we conclude that both series are I(1). We subsequently carry out the seven panel cointegration tests proposed by Pedroni (see Table C.4). At the 5% confidence level, five tests out of seven reject the null hypothesis of no cointegration. We thus conclude that the two

variables are cointegrated and estimate the cointegration vector with random effects.[26] The results are reported in Table C.5. The hypothesis of equality for the constants is rejected.

Table C.2. Panel unit root tests for the logarithm of the real exchange rate

Stationarity Tests LNRER		p=5		Akaike Info Criterion		Schwarz Info Criterion		Hannan-Quinn Criterion	
Levin, Lin Chu	Unit root (common)	10.1432	1.0000	-0.38998	0.3483	-0.05630	0.4776	-0.51325	0.3039
Breitung	Unit root (common)	3.64577	0.9999	2.12595	0.9832	1.08301	0.8606	0.99973	0.8413
ADF-Fisher	Unit root (individual)	134.801	0.4160	195.133	0.0004	156.162	0.0742	200.893	0.0002
PP-Fisher	Unit root (individual)	117.709	0.8084	116.544	0.8589	117.709	0.8084	120.436	0.7931

Source: own calculations.

Table C.3. Panel unit root tests for the logarithm of $GDPcap_{US}/GDPcap_i$

Stationarity Tests LNGDP		p=4		Akaike Info Criterion		Schwarz Info Criterion		Hannan-Quinn Criterion	
Levin, Lin Chu	Unit root (common)	9.59566	1.0000	3.17491	0.9993	3.39908	0.9997	3.86197	0.9999
Breitung	Unit root (common)	6.10547	1.0000	7.92039	1.0000	6.57328	1.0000	6.10052	1.0000
ADF-Fisher	Unit root(individual)	103.358	0.9691	157.946	0.0772	127.171	0.6493	157.556	0.0804
PP-Fisher	Unit root (individual)	73.8058	1.0000	71.3837	1.0000	69.7026	1.0000	69.6957	1.0000

Source: own calculations.

Table C.4. Panel cointegration tests

Stat name	H_0	H_1	Stat	p-value	5%	1%
Panel v-Statistic	No cointegration	Common AR coefs	-122.4262	1.0000	√	√
Panel rho-Statistic	No cointegration	Common AR coefs	-2.675203	0.0037	X	√
Panel PP-Statistic	No cointegration	Common AR coefs	-6.700647	0.0000	X	X
Panel ADF-Statistic	No cointegration	Common AR coefs	-7.606954	0.0000	X	X
Group rho-Statistic	No cointegration	Individual AR coefs	0.478826	0.6840	√	√
Group PP-Statistic	No cointegration	Individual AR coefs	-5.20037	0.0000	X	X
Group ADF-Statistic	No cointegration	Individual AR coefs	-4.663506	0.0000	X	X

Source: own calculations.

[26] Fixed effects are rejected by the Breush and Pagan Lagrangian multiplier test.

Table C.5. Estimation of the long-run relationship

Variable	Coefficient	Std Errod	t-Statistic	Prob
$\ln(gdpcapita_{US}/gdpcapita_i)$	0.2324	0.0128	18.1360	0.0000
Constant	-0.1306	0.0332	-3.9336	0.0001

Source: own calculations.

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