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Burden Sharing and Exchange-Rate Misalignments within the Group of Twenty

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**BURDEN SHARING AND EXCHANGE-RATE MISALIGNMENTS
WITHIN THE GROUP OF TWENTY**

SUMMARY

The deepening US current account deficit has been one of the most striking features of the late 1990s and early 2000s. It has gone along with a diversification of its financing out of industrial countries towards emerging ones. On the other hand, rising foreign direct investment to developing Asia has led to the building-up of huge foreign exchange reserves in this region. Consequently, the debate on exchange-rate misalignments has been increasingly focused on emerging countries, with a peak during the Boca Raton (Florida) meeting of G7 finance ministers, in February 2004, where more flexibility in exchange rates was advocated, in a context where many emerging countries *de facto* run fixed pegs against the dollar. The G7 however may not be best place to call for more flexibility in exchange rates, as none of the large emerging countries belong to it. The G-20 might be better suited for such an aim, as argued by Bergsten (2004).

Building on this background, this paper provides real exchange rate benchmarks for the G-20. The methodology developed by Alberola *et al.* (2002) and Alberola (2003) is used to estimate equilibrium exchange rates based on a stock-flow model of the equilibrium exchange rate.

The real exchange rate is jointly determined by the external and internal balances. External balance is defined as a situation in which the current account is consistent with desired capital outflows or inflows, the latter being determined by the difference between the net foreign asset position and its unobserved desired level. The internal balance is driven by the Balassa-Samuelson effect. Therefore, the real exchange rate depends on the NFA and on a proxy of relative productivity.

Real effective equilibrium rates are estimated using a panel cointegration approach on 15 of the G-20 currencies (all but Russia and Saudi Arabia, eurozone countries being grouped into a single currency). Then, the full set of bilateral misalignments is derived on the basis of effective misalignments. By definition, only $n-1$ independent bilateral rates can be derived from a set of n effective rates. We turn out the solution of adding an $n+1^{\text{th}}$ currency standing for the rest of the world, as this solution would imply G-20 countries transferring the burden of overall adjustment to third countries. Keeping the analysis within G-20 boundaries implies that one of the G-20 currencies be taken as the numeraire, which means that the effective misalignment for this country needs to be dropped in the calculation of bilateral misalignments. Using various alternative numeraires, we however show the diagnosis of bilateral misalignments to be robust for most currencies.

Such diagnosis however relies on the assumption of simultaneous adjustment of all G-20 currencies, while the early 2000 debate came to grief over the problem of the inflexibility

of some G-20 currencies. The last step of the paper quantifies the impact of such lack of adjustment on bilateral misalignments for other currencies.

On the whole, the analysis suggests that the dollar/euro exchange rate would have been close to equilibrium in 2003, had the yuan and other Asian currencies been revalued to their own equilibrium level. We also show that the lack of adjustment in Asia tended to magnify the dollar over-valuation in 2001, and to a lesser extent in 2003. However, this effect is less general than might be believed, because the lack of appreciation of Asian currencies also helped the euro to reach its equilibrium level in effective terms. And in the case of Japan, the lack of adjusters reduces the amount of yen/dollar misalignment because the yen is found to be close to equilibrium in effective terms in 2001.

ABSTRACT

We present equilibrium effective exchange rates for a set of industrial as well as developing countries, based on a methodology close to that used by Alberola *et al.* (2002), where the real exchange rate is jointly determined by external balance as well as internal balance. We then calculate equilibrium bilateral exchange rates against the US dollar. Finally, we investigate the size of bilateral misalignments depending on the number of flexible currencies within the G-20. To derive the full set of bilateral misalignments, we turn out the solution of adding an $n+1^{\text{th}}$ currency standing for the rest of the world, as this would imply G-20 countries transferring the burden of overall adjustment to third countries. Using various alternative numeraires, we show the diagnosis of bilateral misalignments to be robust for most currencies. The lack of adjustment in some countries is shown to have an ambiguous effect on the adjustments beared by flexible currencies.

JEL Classification: F32, F33, F36

Key Words: Equilibrium exchange rate, international macro-economic imbalances, Group of the Twenty

LE PARTAGE DES AJUSTEMENTS DE CHANGE AU SEIN DU G20

RÉSUMÉ

L'aggravation du déficit courant américain est l'une des caractéristiques les plus marquantes de la fin des années 1990 et du début des années 2000. Elle s'est accompagnée d'une diversification de son financement, des pays industriels vers les pays émergents. D'autre part, la hausse de l'investissement direct vers les pays en développement d'Asie a conduit à l'accumulation d'énormes réserves de change dans la région. La question des désajustements de change s'est alors concentrée davantage sur les pays émergents, le point culminant du débat ayant été atteint lorsque les ministres des finances du G7, réunis à Boca Raton (Floride) en février 2004, ont réclamé davantage de flexibilité des changes, alors que les devises de nombreux pays émergents sont *de facto* en change fixe par rapport au dollar. Le G7 n'est cependant pas la meilleure tribune pour réclamer une telle flexibilité, dans la mesure où aucun des grands pays émergents n'y appartient. Comme le suggère Bergsten (2004), le G20 pourrait être mieux adapté à un tel objectif.

Dans ce cadre, le présent travail propose une mesure des taux de change d'équilibre pour le G20. On utilise la méthode développée par Alberola *et al.* (2002) et Alberola (2003) à partir d'un modèle stock-flux du taux de change d'équilibre.

Le taux de change réel est déterminé simultanément par les équilibres interne et externe. L'équilibre externe est défini par la cohérence du solde courant avec les flux de capitaux désirés, ces derniers étant déterminés par la différence entre la position extérieure nette et son niveau désiré, non observable. L'équilibre interne est déterminé par l'effet Balassa-Samuelson. Le taux de change réel dépend donc des actifs extérieurs nets et d'une variable de productivité relative.

Les taux de change effectifs réels d'équilibre sont estimés à l'aide des techniques de cointégration de panel pour 15 des monnaies du G20 (on exclut la Russie et l'Arabie Saoudite, les pays de l'UEM étant considérés comme un seul groupe). Les distorsions bilatérales de change sont ensuite déduites des désajustements effectifs. Par définition, il n'existe que $n-1$ taux de change bilatéraux indépendants dans un échantillon de n taux de change effectifs. On exclut la solution consistant à ajouter une $n+1^{\text{ème}}$ monnaie, correspondant au reste du monde, car cette solution impliquerait que les pays du G20 transfèrent le fardeau de l'ajustement global sur les pays tiers. Pour limiter l'analyse au G20, il faut que l'une des monnaies de ce groupe soit utilisée comme numéraire, ce qui suppose que la distorsion de change éventuelle de ce pays soit exclue pour le calcul des désajustements bilatéraux de change. L'utilisation de différents numéraires montre que le diagnostic portant sur les désajustements bilatéraux est robuste pour la plupart des monnaies.

Cette conclusion repose cependant sur l'hypothèse d'un ajustement simultané de toutes les monnaies du G20, alors même que le débat du début des années 2000 achoppait sur le

problème du manque de flexibilité de certaines des monnaies du G20. La dernière étape de cet article quantifie l'impact d'un tel défaut d'ajustement sur les distorsions bilatérales des autres monnaies.

Dans l'ensemble, l'analyse suggère que le taux de change dollar/euro aurait été proche de l'équilibre en 2003, si le yuan et les autres monnaies asiatiques avaient été réévalués, et ramenés à leur valeur d'équilibre de long terme. On montre également que le défaut d'ajustement en Asie a eu pour conséquence d'aggraver la surévaluation du dollar en 2001, et dans une moindre mesure en 2003. Cependant, cet effet est moins général qu'on pourrait le penser, car le défaut d'appréciation des monnaies asiatiques a également permis à l'euro d'atteindre son niveau d'équilibre en termes effectifs. Et, dans le cas du Japon, le nombre limité de pays assurant l'ajustement réduit l'ampleur du désajustement du taux de change yen/dollar, car le yen se trouve proche de son niveau d'équilibre en termes effectifs en 2001.

RÉSUMÉ COURT

On propose une mesure du taux de change effectif d'équilibre pour un ensemble de pays industriels et émergents. La méthode est fondée sur celle d'Alberola *et al.* (2002), où le taux de change réel est déterminé simultanément par les équilibres interne et externe. Les taux de change d'équilibre réels bilatéraux par rapport au dollar en sont déduits. Enfin, on analyse l'ampleur des distorsions bilatérales en fonction du nombre de monnaies flexibles au sein du G20. Pour déterminer l'ensemble des distorsions bilatérales, on exclut la solution consistant à admettre une $n+1^{\text{ième}}$ monnaie, correspondant au reste du monde, puisque cela impliquerait que les pays du G20 transfèrent le fardeau de l'ajustement global aux pays tiers. L'utilisation de différents numéraires permet de montrer que le diagnostic de désajustement bilatéral est robuste pour la plupart des monnaies. Le défaut de flexibilité de certains pays a un effet ambigu sur l'ajustement supporté par les monnaies flexibles.

Classification *JEL* : F32, F33, F36

Mots-clefs : Taux de change d'équilibre, déséquilibres courants mondiaux, G20

**BURDEN SHARING AND EXCHANGE-RATE MISALIGNMENTS WITHIN THE
GROUP OF TWENTY[§]**

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1. INTRODUCTION

Major changes in external imbalances have occurred in the world since the late 1990s. The most acknowledged one has been the growing size of the US current account deficit. This movement has been compensated for with rising surpluses in East Asia, in Russia and in the Middle East, and with the vanishing of the aggregate deficit of Latin America. In 2003, individual imbalances grew to -4.9% of GDP in the United States, -6% in Australia, +10% in Taiwan, +11% in Hong Kong, +8.9% in Russia, and +12.9% in Saudi Arabia. Hence, the mirror of US imbalances has increasingly been located in emerging-market countries.

Another feature of the past decade has been the rise of foreign direct investment to developing Asia, and the subsequent build-up of foreign exchange reserves in this region. Indeed, Chinese official reserves have become the second largest in the world (after Japan), with 12.5% of world reserves at end-December 2003, compared with only 6.4% of world reserves at end-December 1996.¹

Consistently, emerging-market countries have been increasingly included in the debate on exchange-rate misalignments. This concern was manifest in the Boca Raton (Florida) statement of Group of Seven finance ministers on February 6-7 2004: “*In this context, we emphasize that more flexibility in exchange rates is desirable for major countries or economic areas that lack such flexibility to promote smooth and widespread adjustments in the international financial system, based on market mechanisms*”.²

This statement was not followed by action in Asian countries – especially China – that have continued *de facto* or *de jure* to run fixed pegs on the US dollar despite current account surpluses and capital inflows. However, the G-7 was perhaps not the best group to issue such a statement, because none of these countries belongs to it. As Bergsten (2004) has argued, the right group would instead be the Group of Twenty (G-20), which was created in 1999 to “promote cooperation to achieve stable and sustainable growth that benefits to all”. As far as persistent exchange-rate misalignments could be the source of a misallocation of

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¹ We are grateful to Bronka Rzepkowski for providing us with these data, calculated using International Monetary Fund and national sources.

² This quotation can be found at <http://www.g7.utoronto.ca/finance/fm040207.htm>.

resources, this should be an issue discussed in G-20 meetings. Hence, Bergsten argues that “*the G-20 should gradually but steadily succeed the G-7 as the informal steering committee for the world economy in addressing topics such as these, for reasons of both effectiveness and political legitimacy*”.³

Following this view, one is left with the difficult problem of providing exchange-rate benchmarks for the G-20 countries. In this paper, we present equilibrium effective exchange rates for a set of industrial as well as developing countries, based on a methodology close to that used by Alberola *et al.* (2002) and Alberola (2003), where the real exchange rate is jointly determined by external balance as well as internal balance. We then calculate equilibrium bilateral exchange rates against the US dollar. Finally, we investigate the size of bilateral misalignments depending on the number of flexible currencies within the G-20.

2. REAL EFFECTIVE EXCHANGE RATES FOR THE G-20

Research on real equilibrium exchange rates has followed two main avenues. The first was launched by John Williamson (1983): the fundamental equilibrium exchange rate (FEER) is defined as the real exchange rate that allows both internal and external equilibrium. Internal equilibrium can be defined using the concept of the nonaccelerating inflation rate of unemployment. External equilibrium is more difficult to operationalize because it corresponds to a “sustainable” current account surplus or deficit. In practice, it is necessary to define a current account target for each country. This method has been widely applied (see, in particular, Wren Lewis and Driver, 1998). Its main advantage is that the methodology is transparent and openly normative. Its main drawback is that it relies on price elasticities of trade that are difficult to estimate, and on current account targets that can be seen as *ad hoc* assumptions. In addition, as Ronald MacDonald (1997) puts it, “*the FEER approach per se does not embody a theory of exchange rate determination. Nonetheless, there is the implicit assumption that the actual real effective exchange rate, q , will converge over time to the FEER*” (p. 7).

The second research avenue relies on observed long-run relationships between the real exchange rate and its determinants. This approach has been proposed by MacDonald (1997) and Clark and MacDonald (1998). The behavioral equilibrium exchange rate (BEER) contains no assessment on the sustainability of the exchange-rate path. It is an equilibrium rate only in the sense that the observed real exchange rate tends to come back to the BEER after a shock, in the sense of the cointegration literature. The misalignment is the difference between the actual exchange rate and the exchange rate provided by the permanent part of the model, which can incorporate a wide array of theories of exchange-rate determination.

A number of researchers have developed approaches of the equilibrium exchange rate that fall in between the FEER and the BEER. This is the case for instance of the natural real exchange rate approach (NATREX) introduced by Jerome Stein (1994). As in the FEER approach, the NATREX is the exchange rate that permits the attainment of both internal

³ Fred Bergsten (2004), p. 5. See also O’Neill and Hormats (2004).

and external equilibrium. However, the current account is modeled as the result of saving and investment behavior, as in a BEER approach. Because consumption is a positive function of the net foreign asset position (through a wealth effect), it is possible to derive the equilibrium exchange rate by holding the ratio of net foreign assets to GDP constant in the long run. The NATREX also depends on productivity, which drives investment in the short run but growth and savings in the long run.

Detken *et al.* (2002), among others, have applied the NATREX methodology to the euro equilibrium exchange rate. The model developed by Faruquee *et al.* (1999) also falls in between the two approaches, in that the current account target is determined by econometric estimation of savings and investment behavior rather than a sustainability calculation.

Finally, a Balassa-Samuelson effect can be introduced either in the FEER or in the BEER, by assuming the existence of two sectors in the economy. The external equilibrium requirement then only applies to the tradable sector, whereas internal equilibrium must include a long-run productivity drift on top of short- to medium-run demand effects.⁴

Here we follow a methodology close to that used by Alberola *et al.* (2002) and Alberola (2003), where the real exchange rate is jointly determined by external balance as well as internal balance. The real exchange rate is defined as the relative price of foreign currencies; hence, it rises when the domestic currency depreciates in real terms. The price index at home and abroad is the geometric average of the price indices of the tradable sector and of the non-tradable sector. Assuming the share of each sector is the same across countries, the real exchange rate can be written as the geometric average of the foreign-to-domestic relative price in the tradable sector and of the “internal” real exchange rate, that is, the ratio of domestic nontradable-to-tradable relative price to foreign nontradable-to-tradable relative price.

The equilibrium relative price in the tradable sector is defined as the one that allows the current account to reach a level that is consistent with desired capital outflows or inflows, the latter being proportional to the discrepancy between the desired and observed levels of the net foreign asset (NFA) position.

The equilibrium internal real exchange rate stems from a Balassa-Samuelson effect; that is, the relative price of domestic non-tradable goods rises when productivity in the tradable sector rises relative to world productivity.

This very simple model leads to the following testable relationship:

$$q_t = f(nfa_t, relp_t) \quad (1)$$

where q_t denotes the real effective exchange rate, nfa_t is the net foreign asset position, and $relp_t$ stands for relative productivity in the tradable sector compared to the non-tradable sector, as a ratio of foreign relative productivity. We expect q_t to fall (the real exchange rate to appreciate) when the NFA position rises, because a lower trade account is needed to reach a given current account due to higher interest receipts, and because desired capital

⁴ See, for instance, Edwards (1989). Egert (2003) provides a recent review of equilibrium exchange rate estimations for transition countries, which generally include a Balassa-Samuelson effect.

outflows are likely to diminish when the NFA position rises. The real exchange rate is also expected to appreciate when $relp_t$ rises, because this leads to a price increase in the non-tradable sector, which experiences wage increases without productivity gains.

We consider fifteen currencies corresponding to Argentina, Australia, Brazil, Canada, China, the United Kingdom, Indonesia, India, Japan, South Korea, Mexico, Turkey, the United States, South Africa and the eurozone⁵. Data are annual and cover the period 1980 to 2001. The (log of) the real effective exchange rate for each country is calculated as a weighted average of real bilateral exchange rates, with consumer price indices⁶. The weights rely on the average geographic distribution of imports and exports of goods and services during the period 1999-2001. We do not want to use the “rest of the world” as a residual that would implicitly participate in the correction of G-20 imbalances, despite its own balance of payments pattern. Introducing the rest of the world as a residual would be especially misleading given the world imbalance⁷, and it is beyond the scope of G-20 meetings⁸. Hence, trade weights here are normalized to sum to 1.

The NFA position is obtained from the Lane and Milesi-Ferretti database⁹. The stock data are updated using current accounts for 2000 and 2001. We use the ratio of the NFA position to GDP. Finally, relative productivity is proxied by the ratio of the consumer price index (CPI) to the producer price index (PPI), denoted rpi_t in logarithms¹⁰. This widely used approximation stems from the idea that non-tradable goods are included in the CPI but not (or not much) in the PPI. Therefore, the Balassa-Samuelson effect, which passes productivity growth differentials to the relative price of non-tradable to tradable goods, should be caught through this variable.

The euro nominal exchange rate before 1999 is calculated as a weighted average of the twelve eurozone members. The weights used are the share of each country in GDP at current exchange rates for each year of the sample. The same calculation is performed for price levels. The NFA position is taken from the European Commission (net international investment position) from 1998. Before 1997, the variable is obtained by subtracting the current account of the eurozone aggregate (source: Eurostat).

Panel unit root and cointegration tests were performed using the various methodologies proposed in the literature. The series are found to be integrated of order 1 and cointegrated in panel (see Appendix A). Table 1 reports the cointegration vector obtained either with ordinary least squares (OLS) or the fully-modified OLS method (FM-OLS) introduced by Phillips and Hansen (see, for instance, Pedroni 1996 or Kao and Chiang 2000). The two

⁵ Hence, our sample covers all G-20 countries except Russia and Saudi Arabia; France, Germany and Italy are grouped into the euro area.

⁶ Nominal exchange rates are taken from the IMF, *International Financial Statistics* database, except the Chinese rate, which is taken from World Bank (1994) in order to include the non-official exchange rate before 1994. The consumer price indices are from the World Bank *World Development Indicators*. For Argentina and Brazil, bilateral real exchange rates are taken from the CEPII-CHELEM database.

⁷ Summing world current accounts tends to produce a world deficit.

⁸ This is true in the same way as China’s misalignment is out of the scope of G-7 meetings.

⁹ This database can be found at <http://www.tcd.ie/iis/plane/data.html>.

¹⁰ PPIs are taken from the IMF *International Financial Statistics*. For Argentina, Brazil and Turkey, wholesale prices from national sources are used.

variables are significant and correctly signed: a rise in the NFA position or in the CPI/PPI ratio leads to a real exchange rate appreciation. Moreover, the value of the parameter associated with rpi is close to -1 , as expected.

Table 1. Cointegration vector obtained with either ordinary least squares (OLS) or fully modified OLS (FM-OLS) estimation in a panel context with fixed effects

Variable	OLS	FM-OLS
q	1	1
nfa	-0.4323 (-3.80)	-0.6398 (-6.28)
rpi	-0.8755 (-9.08)	-0.9349 (-10.61)

Note: t-statistics are given in parentheses.

Using a unique panel equation for calculating equilibrium exchange rates relies on the very strong assumption that the same behavior applies to all countries. However, country-by-country estimates would be of poor econometric significance because there are only 22 observations per country. More important, the estimation period may not be representative of long-term behavior in some countries. For instance, the “desired” net foreign asset position may in fact have moved in emerging-market countries, following capital liberalization or structural reforms. This could well have led to a positive relationship between nfa and q (a fall in the NFA position being concomitant to exchange-rate appreciation). In a similar way, price liberalization may have polluted the relationship between rpi and q . Such specific behaviors in some countries in the past may have little to say about the future.

In addition, for world consistency, it is not possible to say that a rise in the NFA position leads to opposite exchange rate reactions in two different countries, just because the NFA of one country should be reflected in the NFAs of its partners. For all these reasons, we believe that working on a single, panel equation is more appropriate for deriving a set of consistent equilibrium exchange rates.¹¹

In Figures 1, the real equilibrium exchange rate calculated with the FM-OLS panel estimation is compared with the observed rate in each of the 15 countries. By construction, the average of both series over the whole 1980-2001 period is the same. This is due to the fact that the residuals of the estimation have a zero average. Hence, it is implicitly assumed that the real effective exchange rate was at its equilibrium level, on average, over this period. The misalignments observed at any point of time are conditional on this assumption.

For the whole period 1980-2001, the equilibrium real exchange rate appears relatively stable in Canada, Mexico, the United States, and South Africa. The result obtained for the USA may appear puzzling. It stems from the offsetting effects of a fall in the net foreign asset position (which depreciates the equilibrium exchange rate) and of a rise in the CPI/PPI ratio (which induces an appreciation), especially in the second half of the period.

¹¹ Further discussion of “in sample” versus “out-of-sample” estimations of equilibrium exchange rates can be found in Egert, Lahrière-Révil and Lommatzsch (2004).

Consistent with common wisdom, the USD appears over-valued from 1983 to 1986. It is undervalued from 1988 to 1995, and overvalued again from 1997 to 2001. The Mexican peso also appears to be over-valued at the end of the period, whereas the Canadian dollar is under-valued due to a sharp depreciation from 1996 to 2001.

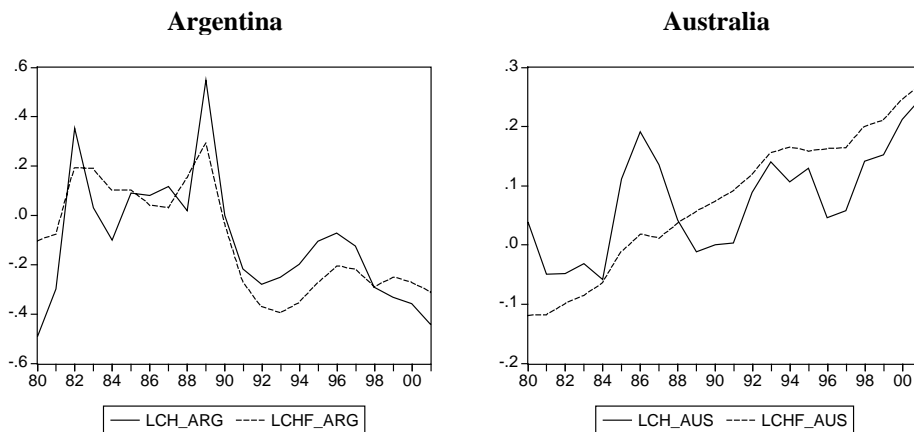
Conversely, the real equilibrium exchange rate tends to appreciate during the period in Argentina, China, Japan, south Korea, Turkey and the eurozone. This movement stems from rising NFA in the eurozone, from a rising CPI/PPI ratio in Argentina and Turkey, and from both effects in China, Japan and Korea.

Finally, the depreciation of the equilibrium exchange rate during the period is sizeable in Australia, the UK, India and Indonesia. In all cases the CPI/PPI ratio declines over the period. In all cases but the UK (where a hump shape is observed), the NFA position also declines over the period.

The case of Brazil is particular in that, except in 1989-1990, the equilibrium exchange rate seems to closely follow the observed exchange rate. This movement mimics the CPI/PPI fluctuations, which are much larger than in other countries. The results for Brazil should be handled with care.

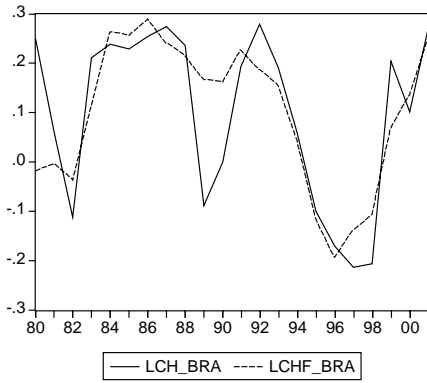
Figures 1. Real equilibrium exchange rates calculated using FM-OLS.

Plain line = observed real effective exchange rate; dotted line = equilibrium real effective exchange rate; rise = depreciation¹²

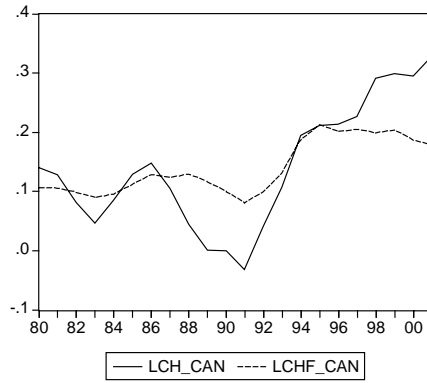


¹² ARG = Argentine, AUS = Australia, BRA = Brazil, CAN = Canada, CHN = China, GBR = United Kingdom, IDN = Indonesia, IND = India, JPN = Japan, KOR = Korea, MEX = Mexico, TUR = Turkey, USA = USA, ZAF = South Africa, ZZM = Eurozone.

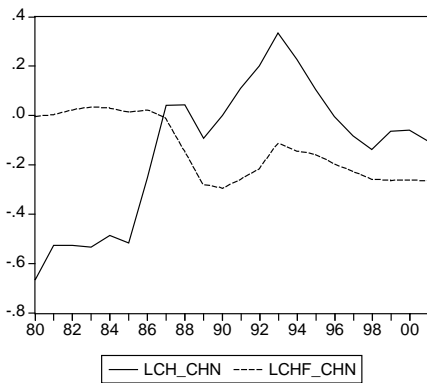
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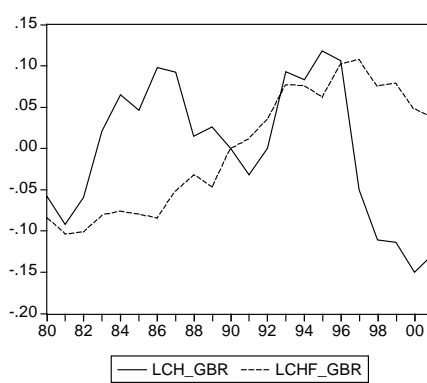
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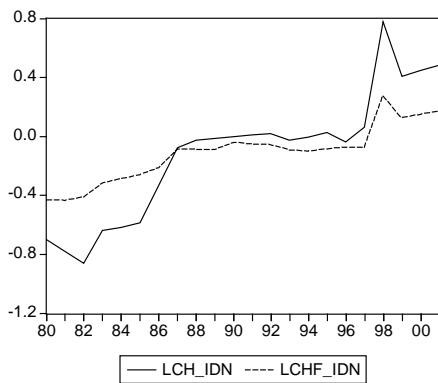
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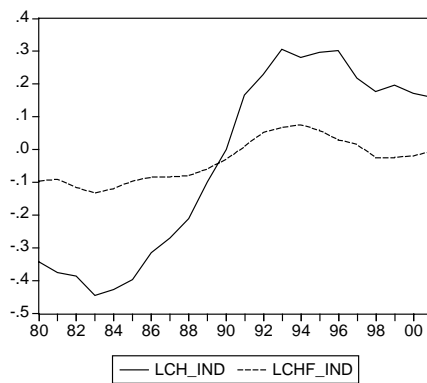
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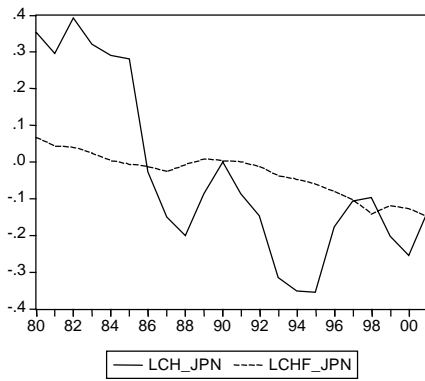


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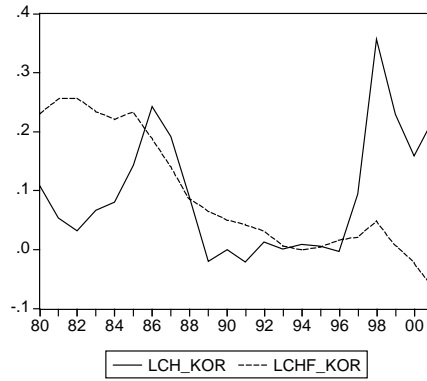


Burden Sharing and Exchange-Rate Misalignments within the Group of Twenty

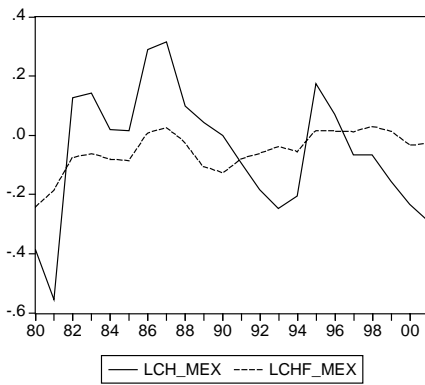
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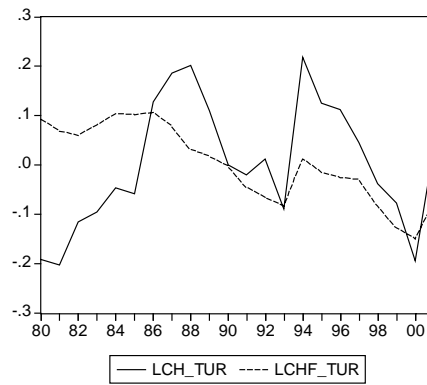
South Korea



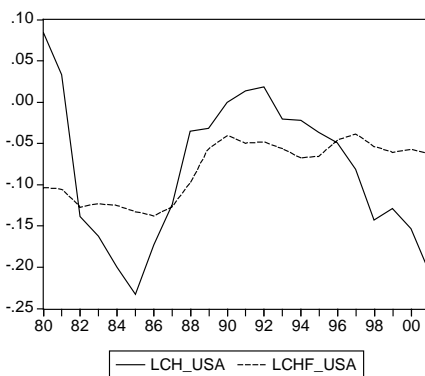
Mexico



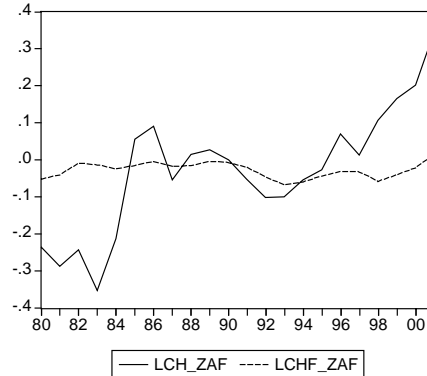
Turkey



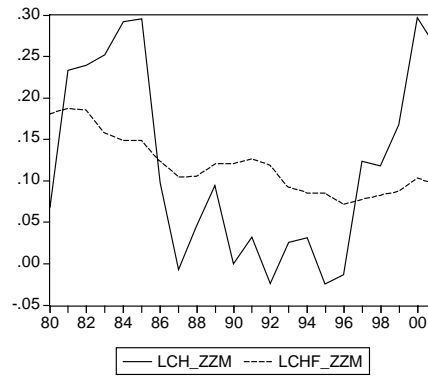
United States



South Africa



Eurozone



Source : author's calculations

The misalignments obtained for 2001 are summarized in Table 2. There is a symmetry between, on the one hand, the overvaluation of the US dollar (14%) and of the pound sterling (17%), and on the other hand, the undervaluation of the euro (17%), the Canadian dollar (15%), the Chinese yuan (16%) and the Indian rupee (16%). The table shows a very large under-valuation in Indonesia and South Korea, whereas the yen appears close to equilibrium in 2001.

Table 2. REER misalignments in 2001

Overvalued currencies		Undervalued currencies	
Argentina	-13.0%	Brazil	2.2%
Australia	-2.3%	Canada	15.1%
UK	-16.6%	China	16.2%
Mexico	-26.2%	Indonesia	31.4%
USA	-14.2%	India	16.4%
		Japan	1.3%
		Korea	28.2%
		Turkey	11.2%
		South Africa	33.1%
		Euro area	16.8%

Source: author's calculations

As noted by Alberola *et al.* (1999) among others, the results for effective equilibrium exchange rates, although interesting, are uninformative as regards the equilibrium position between pairs of countries. This problem has become especially topical since the end of the 1990s, with Asian countries coming back to *de facto* pegs on the US dollar. Hence, we now proceed to the calculation of equilibrium bilateral exchange rates.

3. EQUILIBRIUM BILATERAL EXCHANGE RATES

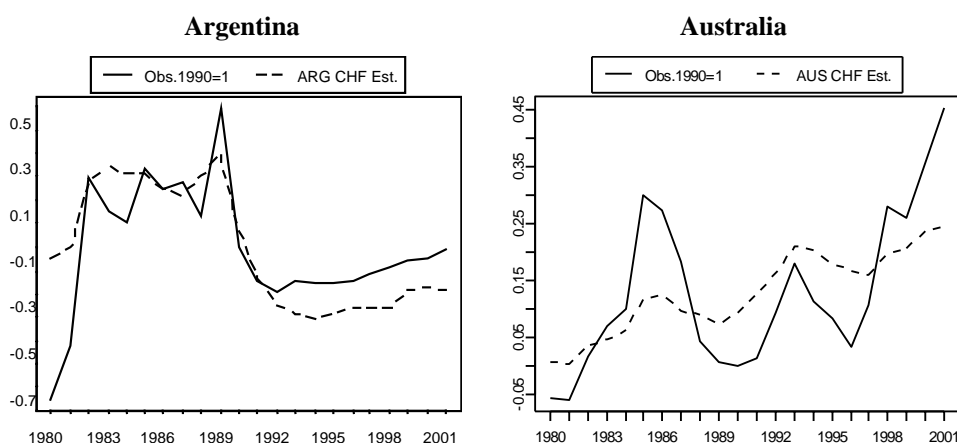
The methodology for deriving bilateral exchange rates basically consists in multiplying the vector of effective rates by the inverted matrix of the weights (see Appendix B). When necessary, the vector of bilateral rates against the numeraire is ultimately converted into exchange rates against the US dollar.

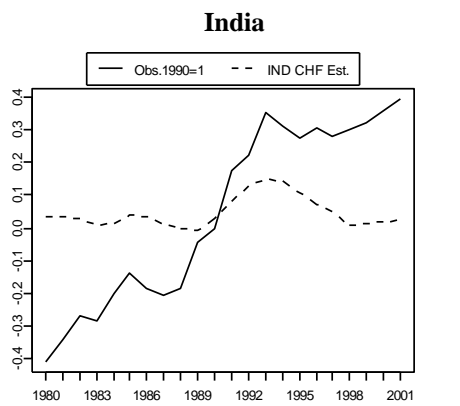
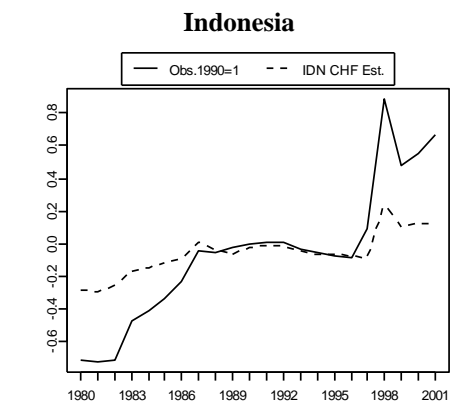
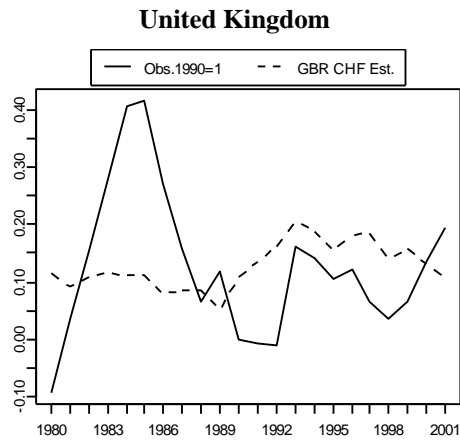
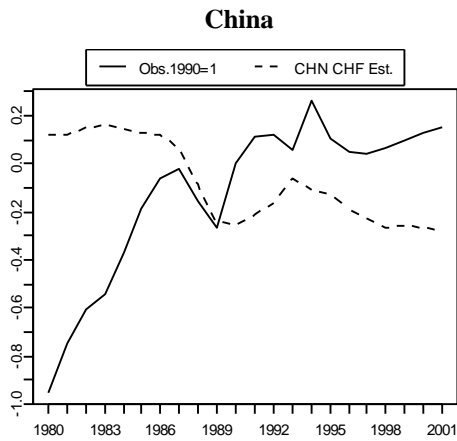
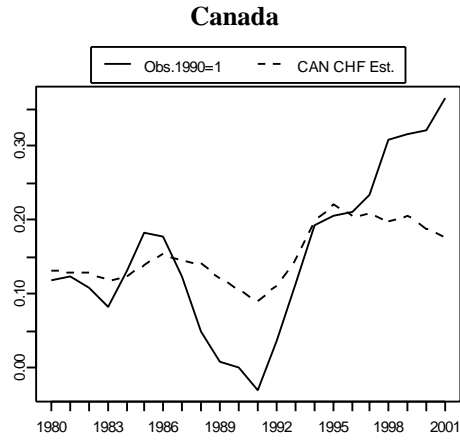
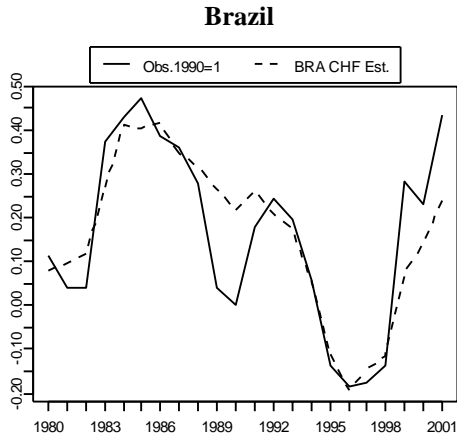
Because we work in a closed, G-20 framework, there is no “rest of the world”. Hence, each of the 15 effective exchange rates is a weighted average of 14 bilateral rates. This means that, when moving to bilateral rates, one of the 15 currencies must be selected as the numeraire. In the derivation of bilateral rates, the misalignment in effective terms for this currency will not be accounted for. Hence, the choice of the numeraire is of high importance. In the following, we successively use different numeraires and compare the results.

3.1. The dollar as the numeraire

Here we calculate equilibrium bilateral exchange rates against the dollar when taking the dollar as the numeraire. It should be kept in mind that this amounts to neglecting the misalignment of the effective rate of the dollar in the calculation. The results are displayed in Figures 2. Contrasting to effective rates, there is no equality between average equilibrium and average observed bilateral rates. For instance, one currency can be systematically under-valued against the USD (provided it is systematically over-valued against another currency). However, in practice, the shape of equilibrium bilateral rates against the USD is generally close to that of the effective rate. The UK is an exception, with a stable equilibrium rate against the USD despite the depreciating trend in effective terms.

Figures 2. Equilibrium bilateral exchange rates against the dollar, 1980-2001
 (Plain line = observed real exchange rate; dotted line = equilibrium real exchange rate;
 rise = depreciation)





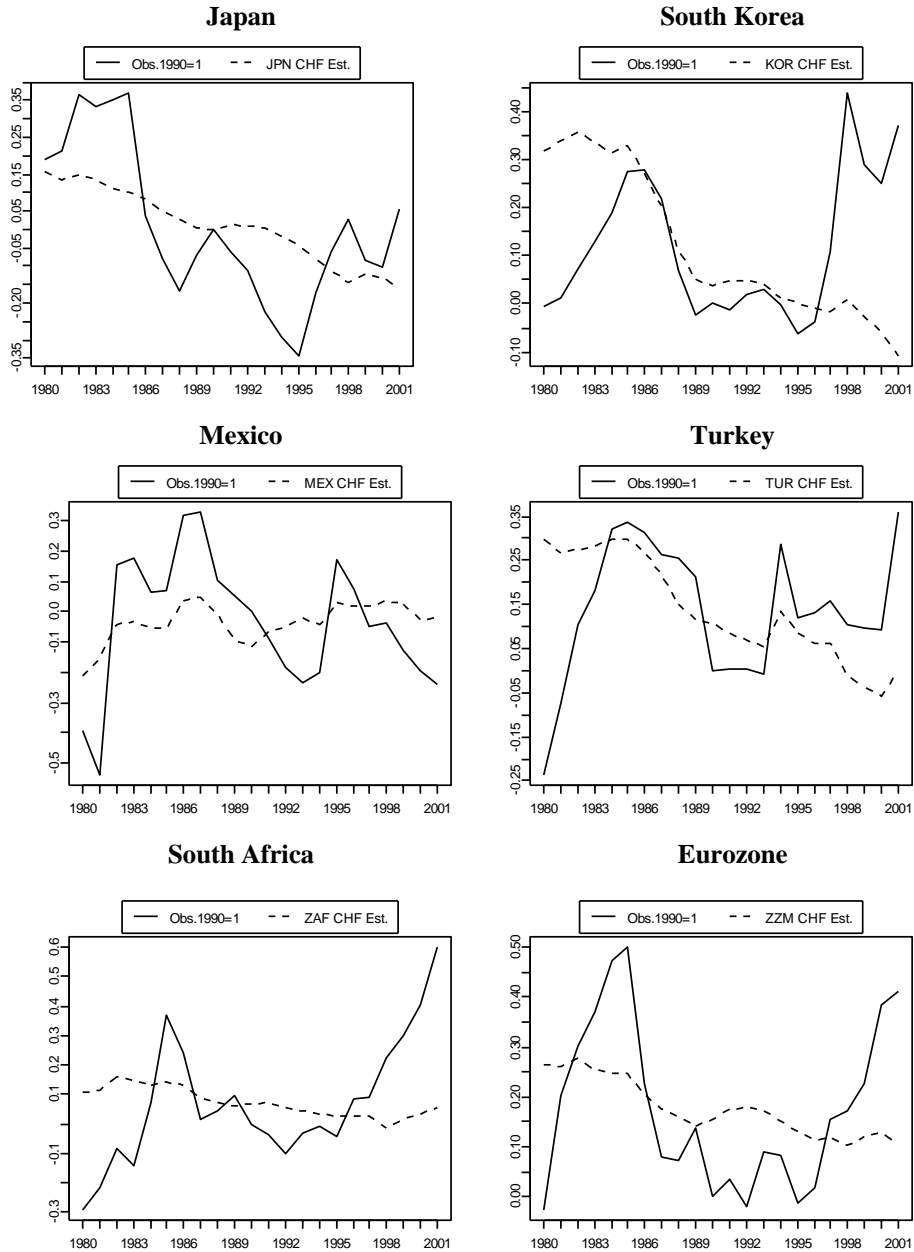


Table 3 reports the bilateral misalignments in 2001. All currencies but the Mexican peso appear under-valued against the USD, which means that the USD is overvalued against all currencies but the peso. We then calculate the bilateral real exchange rate variations between 2001 and 2003 to obtain an estimate of misalignments in 2003, provided the equilibrium exchange rate stayed at its 2001 level. Given its strong appreciation between

2001 and 2003, the euro appears undervalued by only 7.6% in 2003 compared with 30.5% in 2001. Canada, Indonesia, and South Korea also reduce their amount of under-valuation. The British pound switches from undervaluation in 2001 to overvaluation in 2003, whereas the under-valuation of the yen remains stable at about 22%. The large under-valuation of the Chinese currency (44.0%) was slightly larger still in 2003 (47.3%), given the peg on the dollar and low inflation differential between China and the United States over this period. Finally, the case of Argentina is puzzling, with a huge under-valuation due to the fall of the currency after the crisis. The hypothesis of a constant equilibrium exchange rate between 2001 and 2003 is likely to be violated in this country, invalidating the 2003 estimated misalignment.

Table 3. Bilateral misalignments against the USD in 2001 and 2003
(in %, numeraire = US dollar)

Country or region	Misalignment in 2001	Real exchange variation between 2001 and 2003	Misalignment in 2003 based on 2001 equilibrium rate
Argentina	17.8	74.7	92.5
Australia	21.0	-24.5	-3.5
Brazil	19.2	8.3	27.4
Canada	19.0	-11.2	7.8
China	44.0	3.3	47.3
UK	8.8	-13.3	-4.4
Indonesia	54.6	-31.7	22.9
India	37.6	-5.5	32.0
Japan	21.8	0.3	22.1
Korea	48.0	-10.4	37.5
Mexico	-22.0	8.9	-13.1
Turkey	36.3	-35.6	0.7
South Africa	54.9	-22.9	32.0
Euro	30.5	-22.9	7.6

Note: A positive sign denotes an undervaluation

Source: authors' calculations

3.2. Alternative numeraires

As was argued above, the effective misalignment of the numeraire currency is not taken into account in the derivation of bilateral misalignments. This means that using the US dollar as the numeraire may lead to misleading results, because the dollar appears overvalued in effective terms in 2001 (Table 2).

To quantify this problem, we calculated two additional sets of equilibrium bilateral rates. The first one uses the euro as the numeraire. The second one uses the Turkish lira. Turkey is the country with the smallest share in the trade of its other G-20 partners (and it also appeared close to equilibrium in 2003; see table 3). Hence, not accounting for Turkish misalignments is unlikely to have a major distortionary impact on other bilateral rates. For the sake of comparability, all bilateral rates are ultimately converted into bilateral rates

against the US dollar using the corresponding equilibrium dollar/euro or dollar/lira exchange rate. In fact, the misalignments obtained with the euro and with the Turkish lira as the numeraire are very close to each other. Hence, Table 4 only reports the misalignments with the euro as the numeraire in 2001 and 2003 (along with the results already presented in Table 3).

When the euro is used as the numeraire, the dollar/euro rate appears at equilibrium in 2003, whereas a slight under-valuation of the euro remains in 2003 when the dollar is used as the numeraire. This difference can be related to the fact that the amount of euro under-valuation in effective terms in 2001 is lower than the amount of dollar over-valuation (Table 2); hence, neglecting euro undervaluation in effective terms leads to lower euro undervaluation against the dollar than when the dollar's effective over-valuation is neglected.

Another reason for this difference is the fact that the (normalized) share of the US in eurozone trade (28.9%) is higher than the share of the eurozone in US trade (19.3%). Hence, a smaller adjustment in the dollar/euro exchange rate is needed to reach the equilibrium effective rate of the euro than the equilibrium effective rate of the dollar. For other countries, the difference between the two calculations is quite small.

Table 4. Bilateral misalignments against the USD in 2001 and 2003 (in %)

Country or region	Misalignment in 2001		Real exchange variation between 2001 and 2003	Misalignment in 2003 based on 2001 equilibrium rate	
	Dollar as numeraire	Euro as numeraire		Dollar as numeraire	Euro as numeraire
Argentina	17.8	12.8	74.7	92.5	87.5
Australia	21.0	17.3	-24.5	-3.5	-7.2
Brazil	19.2	15.1	8.3	27.4	23.4
Canada	19.0	18.1	-11.2	7.8	6.9
China	44.0	40.8	3.3	47.3	44.1
UK	8.8	2.6	-13.3	-4.4	-10.7
Indonesia	54.6	51.1	-31.7	22.9	19.4
India	37.6	33.2	-5.5	32.0	27.6
Japan	21.8	18.8	0.3	22.1	19.1
Korea	48.0	44.9	-10.4	37.5	34.5
Mexico	-22.0	-22.7	8.9	-13.1	-13.9
Turkey	36.3	29.6	-35.6	0.7	-6.0
South Africa	54.9	49.6	-22.9	32.0	26.7
Euro	30.5	22.0	-22.9	7.6	-0.9

Note: a positive sign denotes an under-valuation.

Source: authors' calculations

4. THE NUMBER OF ADJUSTEES

As was stressed at the start of this paper, one central argument in the debate on exchange rate misalignments is the fact that the lack of adjustment in some countries may magnify

the burden of the adjustment for other countries. Indeed, the equilibrium bilateral exchange rate calculations proposed in the previous section implicitly assume that all exchange rates adjust simultaneously. In this section, we try to quantify the impact of some countries refraining from letting their real exchange rate adjust.

To this end, several sets of equilibrium bilateral exchange rates are calculated depending on the number of currencies that are flexible. Equilibrium bilateral rates are calculated in the same way as in the previous section. However, the country that does not allow for exchange rate adjustment is removed from the calculations: its effective real exchange rate does not participate in the correction of imbalances; remaining bilateral exchange rates adjust to move remaining effective exchange rates to their equilibrium values. Five scenarios are compared:

- S0 is the benchmark scenario where all currencies adjust;
- S1: all currencies but the yuan adjust;
- S2: the currencies of emerging-market Asian countries (China, India, Indonesia, South Korea) do not adjust;
- S3: Asian currencies (China, India, Indonesia, Korea, Japan) do not adjust;
- S4: only G-7 currencies (US dollar, Canadian dollar, euro, yen, pound sterling) adjust.

As in the previous section, we proceed by inverting the system of equilibrium effective rates. **We assume that non-adjusters have fixed exchange rates against the USD.** As is detailed in Appendix B, when the USD is used as the numeraire, this amounts to removing both the rows and the columns corresponding to non-adjusters, which means that their effective misalignment is no longer taken into account in the calculation, and that their bilateral rates against the numeraire (the USD) are fixed.

When the euro is used as the numeraire, the bilateral rates to be held constant are not bilateral rates against the numeraire (e_i) but bilateral rates against the USD ($e_i - e_D$). For instance, the yuan/euro rate (e_Y) moves exactly like the dollar/euro rate (e_D). Once again, the rows and columns corresponding to non-adjusters must be removed. But now, the corresponding weights must be transferred to the USD column (see Appendix B).

The impact of the lack of adjusters on remaining misalignments is ambiguous. Suppose, for instance, that the yuan is fixed against the USD. When depreciating towards equilibrium, the dollar must depreciate more against the euro because it does not depreciate against the yuan. To put the same point a different way, the euro has to appreciate more against the dollar if the yuan does not adjust. However, if the problem were that the dollar was undervalued, the euro would need to depreciate less against the USD when the yuan appreciates with the dollar. In general, then, the impact of the lack of adjusters is an empirical question.

The results for the G-7 currencies with the two alternative numeraires are displayed in Table 5. Consistent with the above reasoning, the overvaluation of the dollar against the euro is larger when some adjusters are lacking if the euro is taken as the numeraire, but smaller if the dollar is taken as numeraire. The latter result comes from the fact that the euro is undervalued in effective terms: if the yuan does not appreciate, then the needed

appreciation of the euro against the USD (which is taken as the numeraire) is smaller because there is no depreciation against the yuan.

Hence, the magnification or dampening effect of fewer adjusters depends on the numeraire chosen, i.e. on whether the analysis focuses on an over-valued currency (the USD) or on an undervalued one (the euro). However, the sensitivity of the dollar/euro misalignment to the lack of adjusters is weaker in the dampening case than in the magnification one, so that it is likely that fewer adjusters will magnify the needed dollar/euro adjustment. This feature can be related to the fact that, as mentioned above, bilateral trade between the eurozone and the USA is more important for the eurozone than it is for the US economy. Hence, what happens in the rest of the world impacts more on the dollar/euro misalignments when focusing on the US imbalance (with the euro as the numeraire) than on the eurozone imbalance (with the USD as the numeraire).

Table 5. Bilateral misalignments against the US dollar in the various scenarios (%)

Country or region	Scenario	Misalignment in 2001		Real exchange rate variation between 2001 and 2003	Misalignment in 2003	
		Numeraire = euro	Numeraire = US dollar		Numeraire = euro	Numeraire = US dollar
Canada	S0	18.1	19.0	-11.2	7.0	7.8
	S1	18.2	17.5	-11.2	7.0	6.3
	S2	18.2	17.6	-11.2	7.0	6.4
	S3	18.2	17.1	-11.2	7.0	5.9
	S4	18.2	17.9	-11.2	7.0	6.7
Euro	S0	22.0	30.5	-22.9	-0.9	7.6
	S1	32.4	24.9	-22.9	9.6	2.1
	S2	32.2	25.7	-22.9	9.3	2.8
	S3	38.4	24.0	-22.9	15.5	1.2
	S4	31.3	27.2	-22.9	8.5	4.3
UK	S0	2.6	8.9	-13.3	-10.7	-4.4
	S1	9.2	3.7	-13.3	-4.1	-9.6
	S2	9.0	4.4	-13.3	-4.2	-8.8
	S3	12.9	2.8	-13.3	-0.4	-10.5
	S4	8.7	5.8	-13.3	-4.6	-7.5
Japan	S0	18.8	21.8	0.3	19.1	22.1
	S1	16.1	14.0	0.3	16.4	14.3
	S2	16.4	14.9	0.3	16.6	15.2
	S4	16.5	15.6	0.3	16.7	15.8

Note: a positive sign denotes an under-valuation.

Source: author's calculations.

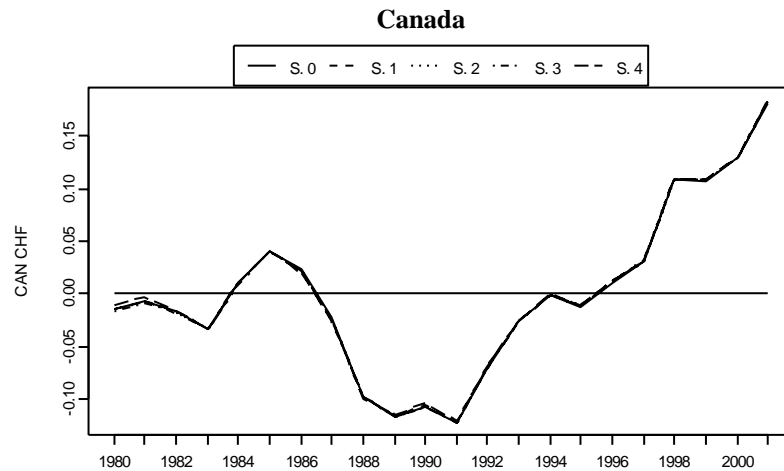
It has been argued above that the dollar/euro exchange rate was close to equilibrium in 2003. This corresponds to the baseline scenario (S0). The lack of adjustment from China and other Asian countries leads to a residual under-valuation of the euro that can be as large as 16% in the calculation with the euro as the numeraire if even the yen does not adjust. Interestingly, the bulk of this effect comes from China, because that is where

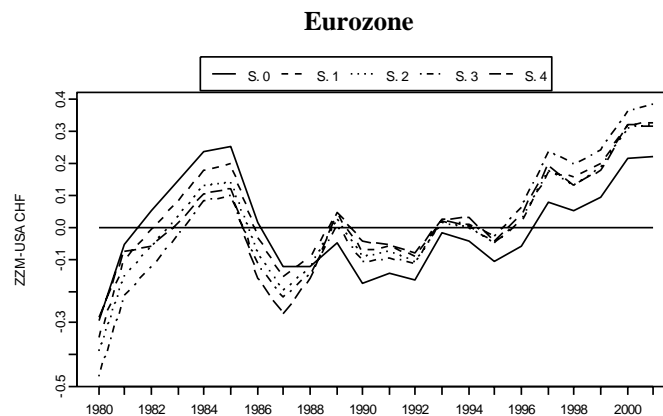
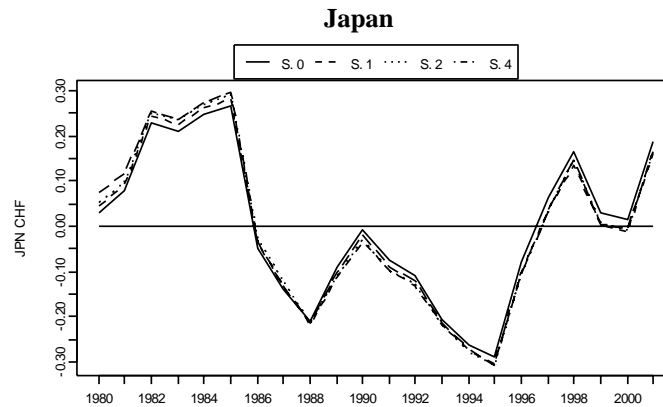
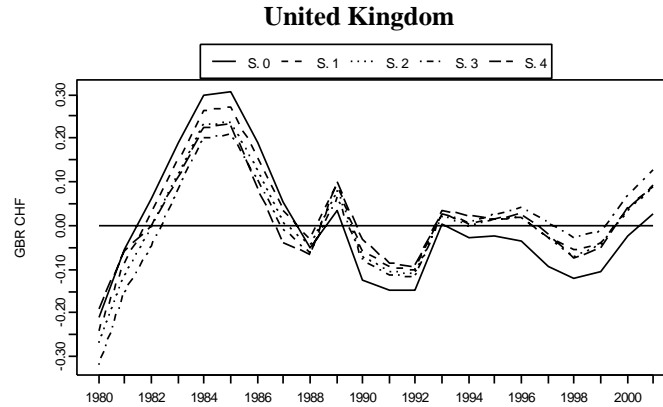
undervaluation was largest in 2003 (see Table 3). Indeed, scenarios S1 to S4 appear relatively close to each other in the second half of the period because they are dominated by the lack of adjustment in China. It is less the case in the 1990s where scenarios S1, S2 and S3 clearly fall in between S0 and S4 (see Figures 3).

Turning to other G-7 currencies, it is worth noting that with the euro as numeraire the lack of adjusters largely eliminates the over-valuation of the pound sterling against the USD found in the baseline scenario in 2003. In the case of Japan, the lack of appreciation in other Asian countries reduces the needed appreciation of the yen against the US dollar. This is because the effective exchange rate of the yen is close to equilibrium: if Asian currencies appreciate, then the yen needs to appreciate against the USD to keep the effective rate stable, but this is no longer necessary if Asian currencies do not appreciate. Finally, the impact of a reduced number of adjusters is negligible for Canada due to the overwhelming share of the US dollar in the effective exchange rates (81.7% in our normalized database), which leaves little room for an impact of other bilateral rates.

**Figures 3. Adjustment scenarios for selected Group of Seven currencies
(numeraire = euro)**

Bilateral misalignments against USD based on panel estimations
of equilibrium effective exchange rates





It has been found above that the lack of adjusters has an ambiguous impact on the equilibrium dollar/euro rate depending on the numeraire (euro versus dollar), but that the magnifying effect is likely to dominate. This point can be checked by using a third currency as the numeraire. One candidate is the Turkish lira because the share of Turkey in US and eurozone trade is small. Another candidate is the yen, which is the currency closest to its

equilibrium level (in effective terms) in 2001. The results (Table 6) confirm that having fewer adjusters tends to raise the bilateral dollar/euro misalignment. As expected, the difference across the scenarios is smaller when the yen or the Turkish lira is the numeraire. The difference across the scenarios is especially small when the yen is used as the numeraire. Hence, one should not exaggerate the “burden-sharing” argument according to which a lack of adjusters magnifies the dollar/euro misalignment.

Table 6. Bilateral misalignments against the USD in 2001 depending on the numeraire

Country or region	Scenario	Numeraire			
		euro	US dollar	Turkish lira	yen
Canada	S0	18.1	19.0	18.2	18.2
	S1	18.2	17.5	18.2	18.1
	S2	18.2	17.6	18.2	18.1
	S3	18.2	17.1	18.2	Na
	S4	18.2	17.9	18.2	18.2
Euro	S0	22.0	30.5	23.8	27.5
	S1	32.4	24.9	30.7	27.2
	S2	32.2	25.7	30.6	27.4
	S3	38.4	24.0	34.7	Na
	S4	31.3	27.2	30.2	28.1
UK	S0	2.6	8.9	2.9	6.0
	S1	9.2	3.7	8.8	5.9
	S2	9.0	4.4	8.8	6.1
	S3	12.9	2.8	12.2	Na
	S4	8.7	5.8	8.5	6.7
Japan	S0	18.8	21.8	18.9	Na
	S1	16.1	14.0	16.0	Na
	S2	16.4	14.9	16.3	Na
	S4	16.5	15.6	16.4	Na

n.a. = non available

Source: author's calculations.

5. CONCLUSIONS

In this paper, we have tried to produce a quantitative analysis of exchange-rate misalignments in a closed G-20 framework. The first step consists in estimating real effective equilibrium rates based on the same model through a panel cointegration approach on 15 of the G-20 currencies. This first step is useful in that it provides a quantification of misalignments for each country. However, the policy discussion needs to translate effective misalignments into bilateral misalignments. This is the second step, which consists in deriving the full set of bilateral misalignments on the basis of effective misalignments.

This second step is difficult, because only $n-1$ independent bilateral rates can be derived from a set of n effective rates. One solution is to add an n^{th} currency representing the rest of the world. However, this solution means that G-20 countries transfer to third countries the burden of overall adjustment. Keeping the analysis within G-20 boundaries implies choosing one of the G-20 currencies as the numeraire, which means that the effective misalignment of this currency will be dropped in the calculation of bilateral rates.

By using various alternative numeraires, we can show the diagnosis of bilateral misalignments to be robust for most currencies. However, such diagnosis assumes a simultaneous adjustment of all G-20 currencies. One main point of debate in the early 2000s has been the lack of adjustment of some G-20 currencies. The last step of this paper is to quantify the impact of such a lack of adjustment on bilateral misalignments for other currencies.

On the whole, the analysis suggests that the dollar/euro exchange rate would have been close to equilibrium, had the yuan and other Asian currencies been revalued to their own equilibrium level. We also show that the lack of adjustment in Asia tended to magnify the dollar's over-valuation in 2001, and to a lesser extent in 2003. However, this effect is less general than might be believed, because the lack of appreciation of Asian currencies also helps the euro to reach its equilibrium level in effective terms. And in the case of Japan, the lack of adjustment reduces the amount of the yen/dollar misalignment because the yen is found to be close to equilibrium in effective terms in 2001.

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Appendix A: Unit root and cointegration results

Panel unit root tests

Variable	LM	t-bar	LL	MW
q	-0.2575 (0.6016)	-0.6299 (0.2643)	-0.0882 (0.4648)	32.929 (0.3256)
nfa	0.8601 (0.1948)	-0.7863 (0.2158)	0.7692 (0.7791)	36.955 (0.1784)
rpi	1.0819 (0.1396)	-1.8343 (0.0333)*	-1.0167 (0.1546)	52.384 (0.0061)*

Note: p-values are given in parentheses. An asterisk indicates the rejection of the unit root null hypothesis at the 5% significance level (p-value less than 0.05). LM: Lagrange multiplier test (Im *et al.*, 1997); t-bar: group-mean t-bar test (Im, Pesaran and Shin, 1997); LL: Levin and Lin (1992) test; MW: Maddala and Wu (1999) test.

Pedroni panel cointegration tests

Panel cointegration tests: q=f(nfa,rpi)				Group mean cointegration tests: q=f(nfa,rpi)		
v test	rho test	non parametric t test	parametric t test	rho test	non parametric t test	parametric t test
2.9013*	-1.0187	-0.9223	-1.6543*	0.0204	-0.7972	-1.5402
(0.0018)	(0.1542)	(0.1782)	(0.0490)	(0.5081)	(0.2126)	(0.0617)

Note: p-values are given in parentheses. An asterisk indicates the rejection of the null hypothesis of no cointegration at the 5% significance level (p-value less than 0.05).

Appendix B: From effective to bilateral equilibrium exchange rates

The logarithm of the real effective exchange rate for country i , q_i , is the trade-weighted average of the log of bilateral exchange rates of country i against trade partners j :

$$q_i = \sum_j w_{ij} (e_i - e_j) = e_i - \sum_{j \neq i} w_{ij} e_j \quad (\text{B.1})$$

where e_i is the log of the bilateral exchange rate of country i against the numeraire currency, and w_{ij} denotes the share of country j in the trade of country i . Note that the sum of the weights is equal to 1, *i.e.* $\sum_j w_{ij} = 1$.

Let Q be the vector of the 15 equilibrium effective real exchange rates previously estimated, and let E the vector of the 15 equilibrium bilateral real exchange rates. As suggested by Alberola *et al.* (1999), it is possible to express Q , with the numeraire currency being the last element, in terms of E as follows:

$$Q = (I - W)E \quad (\text{B.2})$$

where W is the (15×15) trade matrix and I is the identity matrix of order 15.

Because $(I - W)$ contains only 14 independent exchange rates, it must be singular. To circumvent this problem, we have to eliminate the redundant multilateral exchange rate. To do so, we remove the row and the column corresponding to the numeraire currency, and the remaining 14 multilateral exchange rates are expressed relative to the numeraire.

We can write

$$Q^* = (I - W)^* E^* \quad (\text{B.3})$$

where the asterisk indicates that the row and column corresponding to the numeraire currency have been removed. The vector of equilibrium bilateral real exchange rates, denoted as E^* , is thus given by:

$$E^* = (I - W)^{* -1} Q^* \quad (\text{B.4})$$

Suppose that one country z keeps a fixed exchange rate against the numeraire. We have $e_z = 0$. According to equation B.1, we have

$$q_z = - \sum_{j \neq i} w_{zj} e_j \quad (\text{B.5})$$

The effective exchange rate of country z only reflects the exchange rates of third currencies against the numeraire. The effective exchange rates of other currencies q_i are also given by applying equation B.1:

$$q_i = e_i - \sum_{\substack{j \neq i \\ j \neq z}} w_{ij} e_j \quad (\text{B.6})$$

Hence the vector of flexible bilateral rates against the numeraire is obtained by inverting the system of 13 effective rates (14 currencies less currency i) \tilde{Q}^* in terms of the 13 floating bilateral rates \tilde{E}^* :

$$\tilde{E}^* = (\tilde{I} - \tilde{W})^{*-1} \tilde{Q}^* \quad (\text{B.7})$$

where a tilde (\sim) means that the row and column corresponding to the fixed currency have been removed. If more than one currency keeps a constant exchange rate against the numeraire, the same methodology applies with a reduced system size.

Now suppose that one country z fixes its exchange rate not against the numeraire, but against a third currency h . Hence we have $e_z - e_h = 0$. In this case, the effective rate of z is given by:

$$q_z = e_h - w_{zh}e_h - \sum_{\substack{j \neq z \\ j \neq h}} w_{zj} e_j \quad (\text{B.8})$$

The effective rates of other currencies are given by:

$$q_i = e_i - w_{iz}e_h - \sum_{\substack{j \neq i \\ j \neq z}} w_{ij} e_j \quad (\text{B.9})$$

The $w_{iz}e_h$ term comes from the fact that currency z is no longer fixed against the numeraire. For instance, a depreciation of currency h against the numeraire (rise in e_h) has not a one-for-one impact on the effective rate of h (q_h) because currency h does not depreciate against z .

The vector of bilateral rates is now given by the following 13x13 system:

$$\tilde{E}^* = (\mathbf{I} - \tilde{Y} - \tilde{W})^{*-1} \tilde{Q}^* \quad (\text{B.10})$$

where \tilde{Y} is a matrix with zeros everywhere but in a column containing the share of z in trade of each country in row (w_{iz}). This column is located in the same place as the column containing the share of h in the trade of each country (w_{ih}) in \tilde{W} :

$$\tilde{Y} = \begin{pmatrix} 0 & \dots & w_{1z} & 0 \\ 0 & & w_{2z} & 0 \\ \dots & \dots & \dots & \dots \\ 0 & & w_{13z} & 0 \end{pmatrix} \quad (\text{B.11})$$

This correction of the system amounts to considering an “ h monetary zone” which includes currency z and whose impact on each effective rate q_i depends on the sum of the cumulated

weights of h (w_{ih}) and of z (w_{iz}). The same methodology applies to more than one non-adjuster: the corresponding rows and columns are removed, and the weights are added to that of the anchor currency h in the trade matrix.

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