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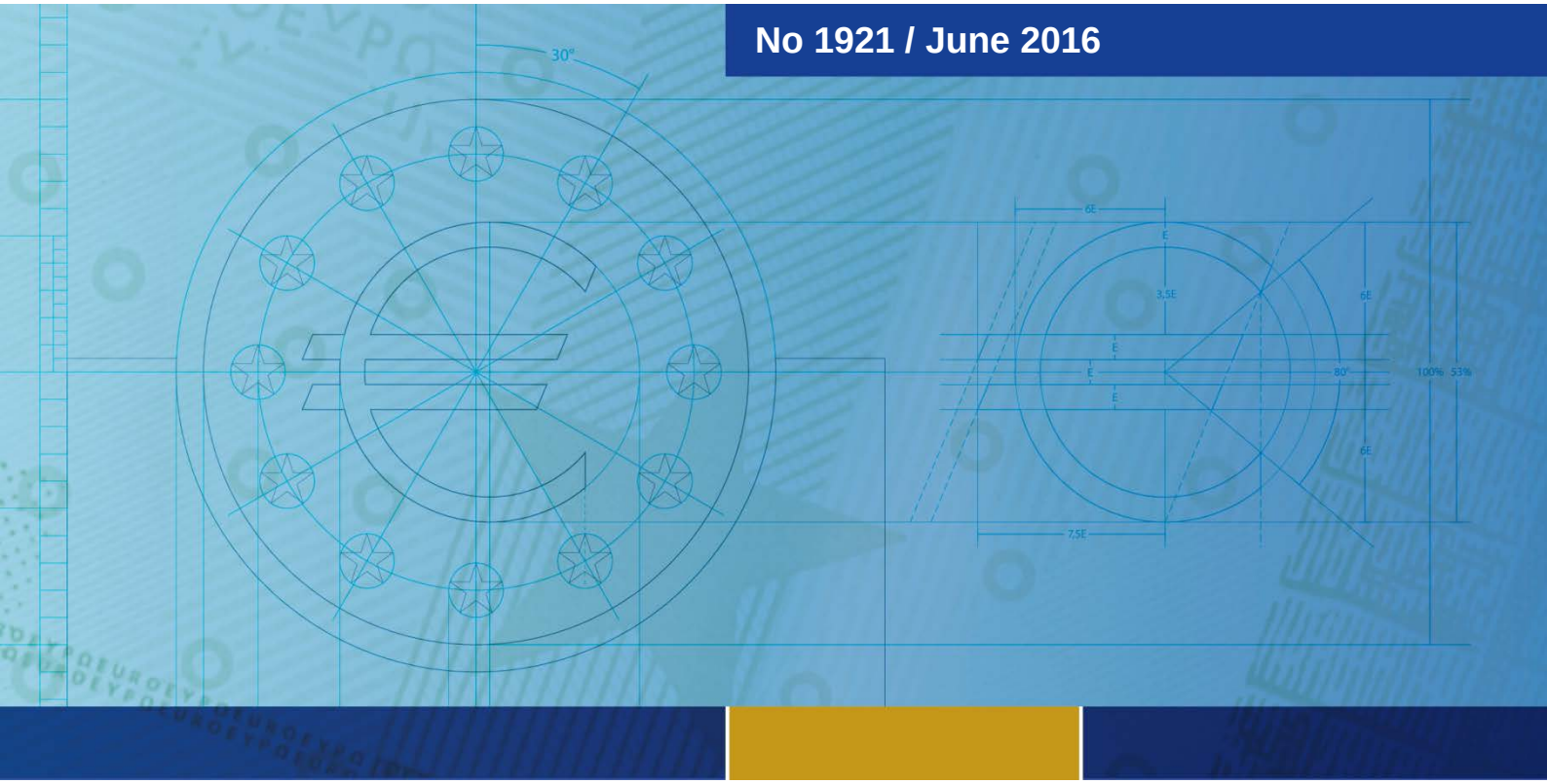
The real exchange rate and economic growth: revisiting the case using external instruments



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Abstract

We investigate the impact of movements in the real exchange rate on economic growth based on five-year average data for a panel of over 150 countries in the post Bretton Woods period. Unlike previous literature, we use external instruments to deal with possible reverse causality from growth to the real exchange rate. Our country-specific instruments are (i) global capital flows interacted with individual countries' financial openness and (ii) the growth rate of official reserves. We find that a real appreciation (depreciation) reduces (raises) significantly annual real GDP growth, more than in previous estimates in the literature. However, our results confirm this effect only for developing countries and for pegs.

Keywords: Real exchange rate, economic growth, instrumental variables, panel data.

JEL: F31, F43.

Non-technical summary

This paper takes another look at the effect of the real exchange rate on economic growth per capita from a medium term perspective, which is a question still unsettled in the literature following previous work by Rodrik (2008) and others. Its main contribution to the literature is in the identification strategy based on instrumental variables (IV). We aim at identifying exogenous movements in the real exchange rate, notably movements that are not driven by country-specific growth shocks, such as productivity shocks. We estimate the effect of real exchange rate movements on growth on a large panel of close to 150 countries over a sample of five-year periods from 1970 to 2010.

The paper uncovers three main results:

- Our identification strategy finds a strong and statistically significant positive (negative) effect of real depreciation (appreciation) on real per capita growth over five-year average periods. The effect is visible in developing countries and pegs, and is not significant or wrongly signed in advanced countries and floats.
- The effects appear to be approximately symmetric between appreciations and depreciations, although large depreciations appear to have a stronger impact than large appreciations on average.
- The effects that we estimate through the IV approach are much larger than previous comparable results in the literature.

Our overall conclusion is that the real exchange rate does matter for growth in developing economies, but substantially less so in advanced ones, which confirms and strengthens the conclusions of Rodrik (2008).

It should also be pointed out that our results suggest that using the exchange rate as a policy lever could be beneficial only in the early stages of economic development, while it becomes irrelevant in the long term as countries become richer. Moreover, it is not evident what type of exchange rate regime a developing country should adopt to maintain a relatively weak exchange rate in order to foster growth. By pegging their currency, for example, countries may temporarily benefit from devaluations but pay a price in terms of slower growth in case of appreciations of the base currency. Our results are therefore more relevant to understand the reasons why governments may pay attention to exchange rates, rather than a prescription for targeting exchange rates in developing countries.

1 Introduction

Exchange rates and the choice of the exchange rate regime retain a centre stage in the post-crisis environment especially for emerging economies (Klein and Shambaugh 2010; Rose 2011; Ghosh et al. 2014). In particular, there is a significant divide between policy-makers and economists regarding the impact of foreign exchange policies on growth. Whereas laymen and politicians are often intimately convinced that a lower exchange rate will spur growth; economists are generally sceptical that the relative price of two currencies may be a fundamental driver of growth over the long-run. For most economists, the exchange rate is an endogenous variable, whose contribution to growth may be difficult to disentangle. As a matter of fact, the question on whether engineering an exchange rate undervaluation helps medium-term growth is still surprisingly unsettled in the literature. Finding an answer to this question would have far-reaching implications for the design of exchange rate regimes and the international monetary system more broadly.

The key question of this paper is whether maintaining a relatively weak (nominal and real) exchange rate, such as through some form of sterilised intervention, or intervention coupled with capital controls, or any policy which has the same effect as a net subsidy to the tradable sector, impacts on economic growth in a lasting manner. Unlike Ghosh et al. (2014) and the previous literature therein quoted, we do not focus on crisis episodes in particular, nor on financial stability and economic risks. The focus is narrowly on headline per capita real GDP growth, because this is what ultimately national policy-makers are mostly concerned about.

Our work is related to a body of literature trying to measure the link between exchange rate undervaluation and growth (see Eichengreen 2008 for a review). In particular, our benchmark is Rodrik (2008) who evaluates this nexus on a database of 188 countries and 11 five-year periods ranging from 1950 to 2004. Based on a measure of undervaluation where real exchange rates are adjusted for the Balassa-Samuelson effect, Rodrik finds that, at least for developing countries, an undervalued real exchange rate predicts stronger growth. The motivation for this finding is that tradable economic activities are special in developing countries as tradables suffer disproportionately from the institutional and market failures that keep countries poor. In Rodrik's view, a sustained real depreciation increases the relative profitability of investing in tradables and acts in a second-best

fashion to alleviate the economic costs of these distortions.

One major concern surrounding this analysis is whether the real exchange rate may be treated as an *exogenous* policy instrument. Country-specific shocks, such as productivity shocks, may impact on the real exchange rate leading to reverse causality. The argument is well known and is made forcefully by Woodford (2008) in his discussion of Rodrik (2008). One argument in defense of OLS regressions of economic growth on the real exchange rate is that the direction of the possible reverse causality, i.e. a *positive* link between growth and real exchange rate appreciation, plays against finding negative and significant coefficients for the impact of exchange rates on growth. However, the direction of the endogeneity bias is not really clear a priori. A positive correlation between growth and real exchange rate appreciation may result from the Balassa Samuelson effect, but the opposite correlation holds after monetary policy and technology shocks in standard open economy DSGE models.[1] In addition, even if it could be safely argued that the reverse causality plays against finding a negative relationship between growth and the real exchange rate, it may still be inappropriate to treat the variation in the real exchange rate as exogenous (Woodford 2008; Nouira and Sekkat 2012). For example, the reverse causality problem could affect the size of the estimated coefficients, even if the signs are not affected. Finally, the evidence on undervaluation and growth is unclear when one considers the undervaluation episodes in isolation, as pointed out by Nouira and Sekkat (2012), which suggests some degree of asymmetry.

The main purpose and contribution to the literature of our paper is to address the problem of reverse causality between exchange rates and growth by applying instrumental variables estimates. In addition, we provide some robustness analysis of the results by Rodrik (2008), including observations for the most recent period covering the global financial crisis and limiting ourselves to the post Bretton Woods period.

In this paper we follow an instrumental variables approach to try and quantify the effect of exogenous real exchange rate fluctuations on economic growth. One key variable in our instrumentation strategy is capital flows. There is a significant degree of evidence in the literature that capital flows are (i) largely driven by global factors[2] and (ii) associated

[1] Intuitively, a positive technology shock at home should increase domestic output and at the same time make production cheaper at home than abroad, leading to a real depreciation. This creates a positive correlation between growth and *depreciation*, not appreciation.

[2] Forbes and Warnock (2012) and Rey (2015) claim that global capital flows are mainly associated

with real appreciation of the currencies of countries receiving (more) capital flows. We argue that a rise in capital flows *due to global (push) factors* acts, as far as the real exchange rate is concerned, as the mirror image of a policy of sterilised intervention since its main effect is a rise in the real exchange rate irrespective of local fundamentals, in particular country specific growth shocks (e.g. country specific productivity shocks). As a matter of fact, foreign exchange intervention aiming at maintaining a relatively weak exchange rate is often a reaction to, real or perceived, undue appreciation due to excessive capital inflows and fear of the Dutch disease.[3]

Sa et al. (2013) look at the effects, at a business cycle frequency, of capital inflow shocks in a panel VAR. They find these shocks to have a significant and positive effect on real house prices, real credit to the private sector, and real residential investment. They also find the shock, in line with our intuition, to appreciate the real exchange rate. For this reason, in our growth regressions we control for country-specific net capital inflows, to ensure that our instrument does not influence economic growth through a direct effect via credit availability. Unlike Sa et al. (2013), however, our perspective is beyond the business cycle frequency and therefore our results are not directly comparable to theirs.

Indeed, we look at low frequency, five-year average, data in (mainly) the post Bretton Woods period, i.e. starting from the early 1970s. This more recent sample period (compared with Rodrik 2008) is in our view more representative of the current configuration of the international monetary system (also taking into account the much lower capital mobility before the 1970s). With this broad objective in mind, we regress real GDP growth per capita on countries' real exchange rate, controlling for time and country fixed effects, and instrumenting the real exchange rate with a measure of global capital flows interacted with a variable measuring countries' sensitivity to such flows: *de jure* financial openness. We also use the growth rate of official reserves (a good proxy for exchange rate interventions during the 5-year period) as an additional instrument and as a robustness check.

The main result of our study is that once we address the simultaneity problem with

with changes in global risk.

[3]Recent foreign exchange interventions in Brazil and Switzerland have been motivated by the authorities more or less in these terms. Fernandez Arias and Levy Yeyati (2012) also note that *"one could interpret leaning-against-appreciation policies during expansions as the countercyclical prudential response to procyclical capital flows and real exchange rates"*. Lartey (2008) finds, however, that the Dutch disease can be prevent by floating exchange rates and following a standard inflation targeting strategy.

our instrumentation approach we are able to identify a strong and statistically significant negative effect of real appreciation on real per capita growth over five-year average periods. The effect is stronger for developing economies and in countries pegging their currency, while it is not significant in advanced economies and those floating their currency (though especially for the latter it is difficult to say because our instruments are weaker for floating currencies). The effects of the real exchange rate appear to be approximately symmetric between appreciations and depreciations. Another noteworthy result is that, quantitatively, the effects that we estimate through the instrumental variables (IV) approach are significantly larger than previous comparable results in the literature such as Rodrik (2008) and Aghion et al. (2009). We conclude that the exchange rate does matter for economic growth in developing economies, which broadly confirms and strengthens the conclusions of Rodrik (2008).

The paper is organised as follows. Section 2 provides a short literature survey on the nexus between exchange rates and growth, which can also help in understanding our position in the literature. Section 3 describes the data, and Section 4 the empirical model. Results are in Section 5. Section 6 concludes.

2 Literature on real exchange rates and economic growth

Before moving to the empirical analysis it is useful to review the literature on the nexus between real exchange rates and economic growth, both theoretical and empirical. Eichengreen (2008) offers an excellent review of the debate, including the role of exchange rate regimes and exchange rate volatility.[4] Here, therefore, we focus on more recent studies and those closer to the obejective of this paper.

There is a relatively large body of literature suggesting a correlation between the real exchange rate and GDP growth. As long as productivity is higher in the traded goods sector, countries have an incentive to maintain the relative price of traded goods high

[4]Indeed, our paper is also related to the literature on the role of the exchange rate regime for growth (Levy-Yeyati and Sturzengger 2002; see Petreski 2009 for a survey). Recently, Rose (2014) emphasised that the exchange rate regime was not an important determinant of growth during the global financial crisis episode. Moreover, our paper is also related to the literature on the role of exchange rates as shock absorbers or sources of shocks (Farrant and Peersman 2006).

enough to make it attractive to shift resources into their production. In Aizenman and Lee (2010), Benigno et al. (2015) and McLeod and Mileva (2011) there are learning by doing effects external to the individual firm in the traded goods sector, therefore a weak real exchange rate is needed to support the production of tradables. In these models, an exchange rate undervaluation acts like a subsidy to the (more efficient) tradables sector.

In Rodrik (2008), a weak real exchange rate compensates for institutional weaknesses and market failures (e.g. knowledge spillovers, credit market imperfections, etc.) which lead to underinvestment in the traded goods sector in developing countries. In Di Nino at al. (2011), nominal depreciation has persistent real effects on output growth in a model with Bertrand competition and increasing returns to scale. A different channel is proposed by Glüzmann et al. (2012) where a weak exchange rate leads to higher saving and investment through lower labour costs and income re-distribution. By shifting resources from consumers to financially-constrained firms, real devaluation boosts savings and investment.

Most empirical work tends to confirm a positive relation between weak real exchange rates and growth. Dollar (1992) shows that overvaluation harms growth, whereas Razin and Collins (1997) and Aguirre and Calderon (2005) find that large over- and under-valuation hurt growth, while modest undervaluation enhances growth. Similarly, Hausmann et al. (2005) demonstrate that rapid growth accelerations are often correlated with real exchange rate depreciations. Rodrik (2008) finds that the growth acceleration takes place, on average, after ten years of steady increase in undervaluation in developing countries. Di Nino et al. (2011) also conclude that there is a positive relationship between undervaluation and economic growth for a panel dataset covering the period 1861-2011. In addition, the authors show that undervaluation supported growth by increasing exports, especially from high-productivity sectors, in Italy in 1861-2011. Kappler et al. (2011) identify 25 episodes of large nominal and real appreciations in a sample of 128 countries of developing and advanced economies between 1960 and 2008. They find that the effects on output are limited. The negative effect on the level of output is only 1 percent after six years, and results are statistically insignificant. More at a business cycle frequency, Farrant and Peersman (2006) show that pure real exchange rate shocks (i.e. separated from the effect of monetary policy) have a substantial contemporaneous impact on output (exchange rate shocks are identified through sign restrictions in a VAR setting). Finally,

Glüzmann et al. (2012) find that undervaluation does not affect the tradable sector, but does lead to greater domestic savings and investment, as well as employment, in developing countries. On the other hand, Nouira and Sekkat (2012) find no evidence that undervaluation promotes growth for developing countries, after excluding overvaluation episodes.[5]

In the literature, the problem of reverse causality between the exchange rate and growth is usually tackled with the use of GMM. To our knowledge, the only exception is the work by Bussiere et al. (2015) who use a propensity score matching approach - controlling whether real exchange rate appreciations are accompanied by a productivity boom or a surge in capital inflows - to deal with the endogeneity of real exchange rates. They find that while growth is boosted in countries experiencing an appreciation together with a productivity boom, it is reduced when accompanied by a surge in capital inflows (though the combined effect of appreciation and capital inflows is statistically insignificant). While the main purpose of our paper and theirs is similar, there are several important differences between their work and ours. First, we consider the impact of appreciation from a lower frequency perspective (five-year averages), while their focus is on the annual frequency. Our paper therefore speaks to the literature on the role of exchange rates for growth, while the focus of Bussiere et al. is more on the business cycle dimension. Second, we use instrumental variables, while they use propensity score matching, which are different methods with their own pros and cons.[6] Third, we look at both exchange rate appreciations and depreciations, while they only investigate appreciation episodes.

3 Data

Our sample goes from 1970 to 2010 (post Bretton Woods) divided into non-overlapping 5-year periods, where variables are mostly 5-year averages of annual data. We use a large country coverage, as in Rodrik (2008), i.e. up to 150 countries.

[5] A few papers focus on the link between real exchange rates and *Total Factor Productivity (TFP) growth*. Fuentes et al. (2006) show that real undervaluation increased TFP growth in Chile in 1960-2005. McLeod and Mileva (2011) find that real depreciation raises TFP growth in a panel of 58 developing countries, but the relationship is non-linear: after a certain point, more depreciation leads to slower TFP growth.

[6] For example, the propensity score method assumes that all potential confounders are observed and included, while instrumental variables do not make this assumption. On the other hand, instruments may be weak or invalid.

Main variables. Our main dependent variable is per capita GDP growth (PPP GDP from Penn World Tables 7.1, henceforth PWT 7.1). For the real exchange rate, we focus on the bilateral rate with the USD (PPP/XRAT from PWT 7.1) rather than the real effective exchange rate, due to data availability reasons. In the robustness analysis, we also use the real (CPI deflated) effective exchange rate computed by the IMF. A higher level of the exchange rate measures denotes an appreciation of the domestic currency in real terms. In addition, we substitute the real bilateral exchange rate against the US dollar with a simple measure of its *overvaluation*, measured as the log deviation of the actual rate from equilibrium. As a proxy of the exchange rate fundamental value, similarly to Rodrik (2008), we regress the real exchange rate against the per capita GDP to account for the Balassa-Samuelson effect, including country and time-fixed effects.

Instruments. To instrument for the real exchange rate (see next section) we interact world capital flows, the sum of total foreign liabilities from the IMF IFS with measures of countries' sensitivity to them, namely de jure financial openness, proxied by the Chinn-Ito (2006) index, which is in turn based on the IMF Annual Report on Exchange Arrangements and Exchange Restrictions.[7] We also use the growth rate of foreign exchange reserves, obtained from the IMF IFS statistics.

Control variables. We include a number of control variables for economic growth, while we show only the statistically significant ones, namely the level of per capita GDP at the beginning of each five-year period (PWT 7.1), inflation (WDI), the saving rate (WDI), and trade openness defined as the sum of exports and imports over GDP (PWT 7.1).[8] For the short term interest rate, we use the main central bank policy rate (when available) or short-term market (mainly interbank) interest rates. We also include country-specific net capital inflows as a share of GDP, from the IMF IFS statistics.[9]

Exchange rate regime. We use the exchange rate regime classification of Reinhart and Rogoff (2004) to distinguish between countries with a fixed exchange rate and those

[7] We also used alternative measures of sensitivity to capital flows (de facto financial openness, and financial development proxied by the private credit to GDP ratio) and obtained results that are consistent with those reported. These additional results are not reported for brevity but are available from the authors.

[8] We included additional control variables, such as different measures of education and schooling or government expenditure, but these were not statistically significant.

[9] Results using gross inflows are very similar to those with net inflows as controls, reflecting the fact that gross and net inflows are highly positively correlated.

floating. Fixed exchange rates include all countries/years in the categories 1 and 2 of the coarse classification of Reinhart and Rogoff (2004), i.e. those with a currency board, a peg or a crawling band narrower than -/+2%. The remaining countries/years are considered as floaters. Notably, according to this criterion, euro area countries are all classified as peggers after 1999.

Advanced economies. We distinguished advanced economies from the rest of the sample using the IMF classification of advanced economies, as reported in the 1970s when our sample begins. The results are robust to the choice of alternative definitions.[10]

Net foreign currency exposure. We consider separately countries with a positive or negative net foreign currency position, using the updated database of Benetrix et al. (2015), although we do not report results for brevity.

Table 1 describes the sources of the data, and *Table 2* reports summary statistics. Note that the sample of available observations for the real bilateral exchange rate is twice as large as for the real effective exchange rate.

(Tables 1-2 here)

4 The empirical model

Our empirical model is specified as follows:

$$\Delta y_{it} = \alpha_i + \lambda_t + \beta RER_{it} + \delta R_{it} + \zeta z_{it-1} + \varepsilon_{it} \quad (1)$$

where y is real GDP growth per capita, RER is the log bilateral real exchange rate against the USD, R is the nominal short term interest rate, and z is a vector of controls (lagged GDP per capita, inflation, saving ratio, trade openness, net capital inflows) that are common in the growth literature. We include the domestic interest rate to control for the fact that domestic monetary policy may influence the real exchange rate and economic growth. The coefficient of interest in this regression is β. To address the problem of reverse causality, we instrument RER using instruments defined as follows,

$$x_{it} = FLOWS_t * \eta_{i,t-1}$$

[10] For instance, we also used a threshold of 6,000 international dollars as in Rodrik (2008) to distinguish between advanced and developing economies or the mean of the per capita GDP in our sample, which corresponds to around 9,500 international (PPP converted) dollars per person (at 2005 constant prices).

where $\eta_{i,t-1}$ is a measure of the currency i's vulnerability to global capital flows ($FLOWS_t$), based on the country's de jure financial openness, lagged one period to mitigate the risk of reverse causality.[11]

We argue that gyrations in world capital flows should be largely independent of each country's fundamentals, i.e. represent a push factor for most or all countries.[12] They should therefore represent a source of variation in real exchange rates in countries that are more exposed to them, i.e the countries that are more financially open at time t. This is the core of our identification approach. One important caveat is that shifts in capital flows may affect economic growth directly, for example by changing credit availability conditions as emphasised for example in Sa et al. (2013). To the extent that this is the case in practice, this would make the instrument invalid because it would influence income growth directly. For this reason, in our regressions we also control for net capital inflows.[13]

In order to cross check the robustness of the results we also use another instrument, namely the growth rate of foreign exchange reserves, a proxy for countries' exchange rate interventions. The relevance of this instrument is supported by a recent study by Blanchard et al. (2015) who find that larger foreign exchange intervention leads to less exchange rate appreciation in response to gross capital inflows.

Note that per capita real GDP growth is expressed in percentages, and the real exchange rate is in logs. Therefore, the coefficient of interest β can be interpreted as the effect on *average* real output growth over a five year period resulting from a real appreciation by 100% (a higher value of RER denotes a real appreciation). Also note that we include RER in levels, given that it is clearly stationary at the frequency we use in this paper.

We estimate the model (1) for the whole sample of countries and periods as well as for different subsets of countries: advanced and developing countries; pegs and floats; and exchange rate appreciations vs. depreciations.[14]

[11] Our main instrument is therefore a so-called Bartik instrument; see Bartik (1991).

[12] The United States may be an exception and for this reason it is excluded from the sample.

[13] Note that in Sa et al. (2013) capital inflow shocks are positive for growth. Here we argue for the opposite channel: a capital inflow shock appreciates the real exchange rate, and we want to test is this appreciation *reduces* growth.

[14] We also split countries according to whether they have *negative or positive net foreign asset positions*, using the data of Lane and Shambaugh (2010) and Benetrix et al. (2015) (not reported for brevity). It can

5 Results

Before describing the results in detail, it is useful to give a summary of the main findings. Our main result is that once we address reverse causality by applying instrumental variables we uncover a strong and statistically significant positive (negative) effect of real depreciation (appreciation) on real per capita growth over five-year average periods. The effect is stronger for developing countries (rather than advanced) and for pegs (rather than floats). On the other hand, the effects appear to be approximately symmetric between appreciations and depreciations. Finally, the effects that we estimate through the IV approach are much larger than previous comparable results in the literature. Hence, our conclusion is that the exchange rate does matter for growth, especially in developing economies, which broadly confirms and strengthens the conclusions of Rodrik (2008).

5.1 OLS

Table 3 reports OLS estimates of equation (1) similar to Rodrik (2008), although the sample period as well as the dependent variable are different. OLS results may not be informative, in the light of what was earlier discussed about reverse causality, but they may still be interesting as a benchmark. Overall, and in contrast with Rodrik (2008), we find no statistically significant impact of the real exchange rate on real per capita GDP growth in our OLS regressions. We also find some interesting results beyond our main question of interest. Net capital inflows are strongly and positively associated with real GDP growth; the coefficient for initial GDP per capita level is statistically significant and negative; inflation has a negative and statistically significant impact on growth; and the coefficients for the saving ratio and trade openness are positive, all as expected.

(Table 3 here)

be expected that, *ceteris paribus*, countries with a positive net foreign currency position derive valuation gains from a depreciation which may boost their growth rate, for example through wealth effects or due to less binding financing constraints. On the contrary, following a depreciation, countries with a negative net foreign currency position experience valuation losses and have to face negative balance sheet effects which could hamper growth. While this is indeed what we find in this regression, i.e. the coefficient on the real exchange rate is much larger in countries with a positive net foreign currency position, the effect of the foreign currency position is surprisingly large and deserves further investigation. As far as we are aware, this is the first time that the net foreign currency position is found to have a bearing on the growth effects of exchange rate movements, especially at low frequency.

5.2 First stage results

We report our first stage regression in *Table 4*, where the dependent variable is the real bilateral exchange rate with the US dollar. Our instruments are significant and with the expected sign both individually and when included jointly. An expansion of world capital flows leads to an appreciation of the real exchange rate in more financially open countries, while an accumulation of foreign exchange reserves depreciates the real exchange rate, in line with our identification story. We also find that the initial real per capita level of GDP and net capital inflows are positively associated with a more appreciated real exchange rate.

(Table 4 here)

5.3 Baseline IV

Are the results of OLS regressions in *Table 3* influenced by reverse causality? To test this hypothesis, in *Table 5* we report our baseline IV results, using the specification that was introduced in Section 4. For the baseline exercise we use both instruments together. In this case, we find relatively strong evidence that, for the whole sample, the real exchange rate negatively and significantly affects real per capita GDP growth. The size of the coefficient is large and economically significant. A 10% real depreciation (appreciation) leads to 1% higher (lower) real GDP growth per year in the baseline. The effect is even larger for non-advanced countries (in line with results in Rodrik 2008), where a 10% depreciation (appreciation) leads to a rise (fall) in economic growth by almost 1.5%. The effect for advanced countries is also negative but smaller and not statistically significant. Note that we test that these coefficients are significant when taking into account the possibility that instruments are weak, using an application of the conditional likelihood ratio test of Moreira (2003). In all cases but two, the J test does not reject the null of valid instruments at the 10 per cent confidence level.

We also find that the significant impact of the real exchange rate on economic growth only prevails for pegs, but not for floats. Note that if depreciation fosters growth mainly through a reallocation from non-tradables to tradables, then the exchange rate regime should not matter, since this mechanism should be at play irrespective of the source of the exchange rate movement. On the other hand, exchange rates may deviate from

fundamentals more in pegs than in floats; notably pegs may entail the possibility of being locked into an overvalued level that hampers growth. It is therefore not implausible that the effect of the real exchange rate on growth is stronger in pegs, at least because we can better observe such effects. Importantly, however, our evidence is stronger for pegs probably just because we have far more pegs than floats in our sample (indeed most smaller countries peg their currency) and our instruments are significantly weaker for floats.[15] Therefore, our evidence on pegs vs. floats should be interpreted with caution.

Finally, note that our results are robust to using the real effective exchange rate as measured by the IMF (column (6)) and a proxy for the real exchange rate overvaluation, based on a simple estimate of the equilibrium value that accounts for the Balassa-Samuelson effect as also done by Rodrik (2008) (column (7)). Results for other variables included in the regression are very similar to the OLS estimates, as expected.

(Table 5 here)

5.4 Robustness

Table 6 contains a robustness analysis of the baseline results according to whether countries are advanced or developing, using different classification methods. Irrespective of the definition, we find that the effects are stronger and more significant in developing countries, and in particular in developing countries which also peg, in line with Rodrik (2008). This may suggest that the effect of real exchange rate appreciation or depreciation may reflect the influence of low productivity growth in the non-tradable sector due to poor institutions, which is more likely to prevail in developing countries.

Further robustness analysis is included in *Table 7*, which brings additional insights. In columns (2)-(3), we use only one instrument at the time in exactly identified regressions. The results are very much in line with the baseline in column (1). Finally, in the last column of the table we test whether our results are driven to a large extent by the global

[15] An additional caveat is that any exchange rate classification regime is subject to a significant measurement error (Rose 2011). We also run our baseline regression for pegs using only one instrument at the time (not reported for brevity). This is done in order to check if the growth impact of the real exchange rate growth rate is stronger when the growth in foreign reserves is used as an instrument, i.e. when the real exchange rate movement is the result of deliberate policy action. We find, however, no major difference in results depending on the instrument used; in fact the growth impact is larger when using the other instrument.

financial crisis, i.e. the five-year period between 2006 and 2010. When excluding this observation we find that the coefficient remains negative and significant, but its size is somewhat reduced compared with the baseline.

In *Table 8* we focus on the difference between appreciations and depreciations, i.e. on the possible asymmetry of the relationship. There does not seem to be a significant difference between appreciations and depreciations, though they are borderline statistically significant when included individually and the effect of depreciations is somewhat larger. It is also interesting that the effect seems to be stronger for depreciations in pegging economies rather than appreciations in countries pegging their currency, although in this case results are not statistically significant. In columns (5) and (6) we exclude large depreciations (currency crises) and large appreciations, by trimming the left or the right tail at the 5th percentile of the distribution of real exchange rate log-changes. The exclusion of large depreciations leads to a small reduction in the size (in absolute terms) of the coefficient for the real exchange rate, which instead increases when excluding large appreciations. This suggests that large depreciations are more important than large appreciations for growth. Importantly, our baseline result regarding the impact of the real exchange rate on growth is not driven by outliers, as we show in column (7) where we exclude both large appreciations and large depreciations.

In *Table 9* we use two-step system GMM estimates with small sample correction, where the real exchange rate is instrumented, in the first differences equation, with its second lag level. We find results that are in line with the baseline results qualitatively, but point to a smaller effect of the real exchange rate, around one third of the baseline estimate. Moreover, in the case of advanced economies, there is a positive relationship between the real exchange rate and growth. The GMM results of Table 9 are close to estimates in previous papers, namely Rodrik (2008) and Aghion et al. (2009). It is evident that our IV estimates point to a much larger effect of the real exchange rate on growth than estimated via GMM regressions (see *Table 10*). This suggests that lagged explanatory variables may not necessarily be good instruments to deal with reverse causality. Notably, Reed (2015) and Bellemare et al. (2015) show that lag identification depends on the assumption that the unobserved confounding variable is not serially correlated but the lagged endogenous variable is, which is unlikely.

It is plausible that our higher estimates relative to the GMM results are due to the

sharper identification owing to the use of exogenous instruments. Our instrumentation strategy can also be criticized – for example in the cases in which the first stage F statistic points to weak instruments. However, for each regression we have reported tests showing if the coefficient on the endogenous real exchange rate is significant in the presence of weak instruments.

(Tables 6-10 here)

6 Conclusions

In this paper we take another look at the effect of the real exchange rate on economic growth per capita from a medium term perspective, an issue which is still unsettled in the literature. Our main contribution to the literature is in the identification strategy based on instrumental variables. We aim at identifying exogenous movements in the real exchange rate, notably movements that are not driven by country-specific growth shocks (for example, productivity shocks). We estimate a large panel of close to 150 countries over a sample of five-year periods from 1970 to 2010.

Our main results can be summarised in three points. First, our identification strategy uncovers a strong and statistically significant positive (negative) effect of real depreciation (appreciation) on real per capita growth over five-year average periods. Second, the effect is visible in developing countries and pegs, and is not significant or wrongly signed in advanced countries and floats, where our instruments are also weaker. On the other hand, the effects appear to be approximately symmetric between appreciations and depreciations, although large depreciations appear to have a stronger impact than large appreciations on average. Finally, the effects that we estimate through the IV approach are much larger than previous comparable results in the literature, which suggests that our identification leads to sharper results. Hence, our overall conclusion is that the exchange rates does matter for growth in developing economies, but substantially less so in advanced ones, which confirms and strengthens the conclusions of Rodrik (2008).

It should be noted that our paper contains a careful empirical analysis of the effects of *exogenous* changes in the real exchange rate on per capita GDP growth from a medium term perspective, but is subject, like any analysis, to caveats and limitations. Most important, it has relatively little to say on the transmission channels. Future research

may want to focus on disentangling the effect on the most important component of output (e.g. tradables and non-tradables), and to distinguish the contributions of productivity and of production inputs (capital and labour). Such analysis will unavoidably face more data limitations than we do in this paper, but is nevertheless essential to shed some light on the way exchange rates influence countries' economic performance over time.

Finally, an additional caveat concerns the policy implications of our work. First, the results suggest that using the exchange rate as a policy lever could be beneficial only in the early stages of economic development, while it becomes irrelevant in the long term as countries get richer. Financial development could be one of the factors making the exchange rate unimportant for growth (Aghion et al. 2009). Second, it is not evident what type of exchange rate regime a developing country should adopt to maintain a relatively weak exchange rate in order to foster growth. By pegging their currency - a popular choice among small open developing economies - the countries accept to follow the vagaries of another's country currency, benefitting from devaluations but paying a price in terms of slower growth in case of appreciations. Levy-Yeyati and Sturzenegger (2003) find that less flexible exchange rate regimes are associated with slower growth in developing countries. Our evidence suggests instead that, if anything, it would be important to choose to peg at the right time, because over time even pegging countries do not control their real exchange rate. Our results are therefore more relevant to understand the reasons why governments may pay attention to exchange rates, rather than a prescription for targeting exchange rates in developing countries.

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Table 1. Data description

Variable	Description	Source
Real per capita GDP	PPP Converted GDP Per Capita (Chain Series), at 2005 constant prices.	PWT
Real exchange rate (RER) vs. USD	Purchasing Power Parity (PPP) over GDP in national currency units per USD divided by nominal exchange rate versus USD (XRAT). An increase indicates appreciation of national currency.	PWT
Overvaluation of RER vs. USD	Log deviation of the bilateral real exchange rate against the USD from equilibrium. As a proxy of the exchange rate fundamental value, the real exchange rate is regressed against the per capita GDP to account for the Balassa-Samuelson effect, including country and time-fixed effects.	PWT and own calculations
CPI-based Real Effective Exchange Rate (REER)	Index. An increase indicates an appreciation of the national currency.	IMF IFS
Inflation	Consumer price index (2005 = 100).	PWT
Trade openness	Total trade, exports plus imports, at current prices, as % of GDP.	PWT
Saving ratio	Gross national income less total consumption, plus net transfers, as % of GDP.	WDI
Monetary policy rate	Rate (number of countries): discount rate (110); refinancing, repo or other rate (12), money market rate (22); interbank 3-month rate (4); Treasury bill rate (16).	IMF IFS, GFD, Haver and national sources
Net capital inflows	Total financial liabilities minus total financial assets, excluding foreign exchange reserves, as % of GDP	IMF IFS
Foreign exchange reserves	Growth rate of official foreign exchange reserves in USD	IMF IFS
World capital flows	Sum of financial account liabilities (USD, current prices).	IMF IFS
De jure index of capital account openness	Chinn-Ito index based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions.	Chinn and Ito (2006)

Sources. International Monetary Fund International Financial Statistics (IMF IFS) and World Economic Outlook (WEO). Penn World Tables 7.1 (PWT). World Bank World Development Indicators (WDI). Global Financial Data (GFD). Haver. Chinn, M. D. and H Ito (2006)."What Matters for Financial Development? Capital Controls, Institutions, and Interactions," Journal of Development Economics, 81, 1, 163-192 (October).

Table 2. Summary statistics

	(1) Obs.	(2) Mean	(3) Std. Dev.	(4) Min	(5) Max
Real per capita GDP growth (%)	1,369	1.696	4.154	-27.12	40.62
Real exchange rate vs. USD (log)	1,380	4.079	0.490	2.137	9.103
CPI-based REER (log)	728	4.735	0.520	3.367	11.58
Overvaluation of RER vs. USD (log)	1,380	0.000	0.470	-2.045	5.017
Monetary policy rate (%)	1,027	21.26	165.4	0.100	4,781
Net capital inflows to GDP (%)	1,067	3.041	8.638	-55.29	135.0
Initial GDP per capita level (log)	1,354	8.379	1.283	5.179	11.31
Inflation (%)	1,091	13.70	28.25	-4.841	344.5
Saving ratio (% of GDP)	1,225	17.16	16.33	-87.91	82.19
Trade openness (% of GDP)	1,380	81.13	47.82	1.954	410.2
World capital flows to GDP (ratio)	1,488	2.145	1.026	1.276	4.246
De jure capital account openness (index)	1,179	-0.0113	1.487	-1.864	2.439
Growth in foreign exchange reserves (%)	1,199	13.07	25.42	-148.8	266.8

Table 3. OLS estimates

Dependent variable: Real per capita GDP growth

	(1) Baseline	(2) Advanced	(3) Excluding advanced	(4) Pegs	(5) Floats	(6) REER	(7) Overval. RER
Real exchange rate (RER) vs. USD	-0.177	0.972	0.208	-1.037	1.086		
	(0.475)	(1.880)	(0.546)	(0.735)	(0.918)		
Real effective exchange rate (REER)						0.057	
						(0.526)	
Overvaluation of RER vs. USD							-0.665
							(0.476)
De jure financial openness (t-1)	0.217*	-0.156	0.371**	0.221	0.324	0.238*	0.273*
	(0.128)	(0.207)	(0.154)	(0.143)	(0.341)	(0.127)	(0.156)
Monetary policy rate	0.001***	-0.071	0.001***	-0.024	0.001***	0.001***	0.001***
	(0.000)	(0.041)	(0.000)	(0.026)	(0.000)	(0.000)	(0.000)
Net capital inflows to GDP	0.158***	-0.017	0.169***	0.174***	0.013	0.158***	0.188***
	(0.041)	(0.055)	(0.040)	(0.038)	(0.071)	(0.041)	(0.047)
Initial GDP per capita level	-5.793***	-11.063***	-5.420***	-5.692***	-5.989***	-5.756***	-7.139***
	(0.660)	(1.565)	(0.633)	(0.853)	(1.292)	(0.642)	(0.894)
Inflation	-0.022***	0.014	-0.019***	0.007	-0.026***	-0.023***	-0.018***
	(0.006)	(0.060)	(0.005)	(0.036)	(0.007)	(0.006)	(0.005)
Saving ratio	0.151***	0.191***	0.142***	0.157***	0.070*	0.150***	0.163***
	(0.036)	(0.059)	(0.036)	(0.042)	(0.042)	(0.036)	(0.038)
Trade openness	0.030***	0.024	0.030***	0.031***	0.061***	0.029***	0.039***
	(0.007)	(0.016)	(0.008)	(0.009)	(0.016)	(0.007)	(0.008)
Observations	742	158	584	492	204	742	526
Countries	146	23	123	129	70	146	97
R2	0.438	0.685	0.459	0.488	0.383	0.440	0.524

Notes. The table reports OLS estimates with robust standard errors clustered by country, including time and country fixed-effects. The sample period is 1970-2010, using non-overlapping 5-year averages. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level. See Table 1 for a description of the variables.

Table 4. First stage regressions, OLS

Dependent variable: Bilateral real exchange rate vs. the USD

	(1)	(2)	(3)
De jure financial openness (t-1)	0.031*	0.038**	0.027*
	(0.016)	(0.017)	(0.016)
Monetary policy rate	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Net capital inflows to GDP	0.002*	0.002*	0.002**
	(0.001)	(0.001)	(0.001)
Initial GDP per capita level	0.265***	0.240***	0.238***
	(0.073)	(0.074)	(0.074)
Inflation	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Saving ratio	-0.002	-0.001	-0.001
	(0.002)	(0.002)	(0.002)
Trade openness	-0.003**	-0.003**	-0.003**
	(0.001)	(0.001)	(0.001)
World capital flows*De jure financial openness (t-1)	0.022**		0.021**
	(0.009)		(0.008)
Growth in foreign exchange reserves		-0.001***	-0.001***
		(0.000)	(0.000)
Observations	742	737	737
Countries	146	146	146
R2	0.302	0.305	0.313

Notes. The table reports OLS estimates with robust standard errors clustered by country. The sample period is 1970-2010, using non-overlapping 5-year averages. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level. The model includes time dummies and country fixed effects. See Table 1 for a description of the variables.

Table 5. IV estimates

Dependent variable: Real per capita GDP growth

	(1) Baseline	(2) Advanced	(3) Excluding advanced	(4) Pegs	(5) Floats	(6) REER	(7) Overval. RER
Real exchange rate (RER) vs. USD	-11.712***	-7.094	-14.743**	-12.239***	8.104		
	(4.008)	(15.551)	(6.972)	(4.275)	(10.100)		
Real effective exchange rate (REER)						-9.721**	
						(4.941)	
Overvaluation of RER vs. USD							-11.222***
							(3.691)
De jure financial openness (t-1)	0.693***	0.200	0.538**	0.647**	-0.141	0.759**	0.664***
	(0.240)	(0.698)	(0.270)	(0.278)	(0.735)	(0.308)	(0.224)
Monetary policy rate	0.000	-0.046	0.000	-0.025	0.002	0.000	0.000
	(0.001)	(0.082)	(0.001)	(0.050)	(0.001)	(0.001)	(0.001)
Net capital inflows to GDP	0.174***	0.010	0.188***	0.188***	-0.028	0.191***	0.168***
	(0.033)	(0.074)	(0.036)	(0.030)	(0.098)	(0.041)	(0.032)
Initial GDP per capita level	-2.716*	-8.641	-2.375	-2.389	-8.996**	-5.252***	-4.405***
	(1.392)	(5.318)	(1.789)	(1.607)	(4.571)	(1.248)	(0.923)
Inflation	-0.034***	-0.058	-0.036**	-0.049	-0.033***	-0.021*	-0.032***
	(0.013)	(0.149)	(0.017)	(0.070)	(0.012)	(0.012)	(0.012)
Saving ratio	0.129***	0.219***	0.125***	0.156***	0.142	0.132***	0.123***
	(0.033)	(0.083)	(0.036)	(0.037)	(0.105)	(0.036)	(0.032)
Trade openness	0.000	0.015	-0.011	0.004	0.112	0.017	0.001
	(0.014)	(0.025)	(0.023)	(0.016)	(0.074)	(0.015)	(0.014)
Observations	731	158	573	471	177	522	731
Countries	140	23	117	109	46	94	140
F first stage	9.478	0.539	4.101	11.74	0.548	3.841	10.35
J test (p-value)	0.822	0.171	0.288	0.096	0.822	0.064	0.830
CLR test H_0: β=0 (p-value)	0.000	0.360	0.004	0.001	0.346	0.005	0.000

Notes. The table reports the IV estimates with robust standard errors clustered by country, including time and country fixed-effects. The real exchange rate is instrumented by two variables: (i) world capital flows multiplied by the *de jure* (Chinn-Ito) index of capital account liberalisation at time t-1, and (ii) the growth rate of foreign exchange reserves. Advanced economies are identified at the beginning of the sample according to the IMF classification. Pegs and floats are identified according to the Reinhart-Rogoff (2004) classification of exchange rate regimes. F first stage shows the Kleibergen-Paap rk Wald F statistic to test for the relevance of the instruments. The J test is the *weak-instrument* robust version of the test for the validity of the instruments, under the null hypothesis that the instrumental variables are uncorrelated with the error term. The CLR test is an application of the Moreira (2003) conditional likelihood-ratio test for the statistical significance of the main (beta) coefficient associated with the real exchange in the presence of potentially weak instruments. The sample period is 1970-2010, using non-overlapping 5-year averages. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level. See Table 1 for a description of the variables.

Table 6. IV estimates: advanced vs. developing economies

Dependent variable: Real per capita GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Advanced	Developing	Developing & Peg	Developing & Float	Advanced	Developing	Developing & Peg	Developing & Float
Threshold for per capita GDP:	above $9,500	below $9,500			above $6,000	below $6,000		
Real exchange rate (RER) vs. USD	-8.033	-19.836*	-16.601**	12.211	-13.125	-16.776**	-15.112**	11.487
	(13.498)	(10.539)	(6.936)	(8.998)	(14.502)	(8.152)	(6.417)	(7.216)
De jure financial openness (t-1)	0.657	0.354	0.388	0.246	0.859	-0.002	-0.232	0.553
	(0.654)	(0.352)	(0.359)	(0.642)	(0.647)	(0.370)	(0.383)	(0.621)
Monetary policy rate	0.015	0.000	-0.008	0.002*	0.001	-0.022	-0.330***	0.029*
	(0.034)	(0.001)	(0.042)	(0.001)	(0.001)	(0.026)	(0.095)	(0.016)
Net capital inflows to GDP	0.111***	0.226***	0.208***	-0.064	0.129***	0.195***	0.183***	-0.029
	(0.030)	(0.047)	(0.035)	(0.261)	(0.025)	(0.052)	(0.037)	(0.182)
Initial GDP per capita level	-4.919	-2.676	-2.629	-7.869**	-4.391	-2.820*	-1.010	-5.374*
	(3.749)	(2.119)	(1.815)	(3.615)	(4.650)	(1.653)	(1.858)	(2.950)
Inflation	-0.063	-0.040*	0.018	-0.047**	-0.038	-0.002	0.115*	-0.091**
	(0.139)	(0.021)	(0.084)	(0.024)	(0.031)	(0.033)	(0.069)	(0.039)
Saving ratio	0.097**	0.144***	0.176***	0.199	0.092	0.166***	0.149***	0.170
	(0.049)	(0.041)	(0.042)	(0.131)	(0.056)	(0.040)	(0.041)	(0.114)
Trade openness	0.016	-0.018	0.002	0.221	0.005	-0.014	0.018	0.230*
	(0.033)	(0.036)	(0.023)	(0.137)	(0.035)	(0.037)	(0.023)	(0.140)
Observations	266	465	299	104	340	375	237	82
Countries	48	92	72	29	68	77	58	25
F first stage	1.593	2.184	4.633	1.399	1.155	2.982	4.962	2.120
J test (p-value)	0.191	0.332	0.121	0.125	0.720	0.916	0.990	0.786
CLR test H_0: β=0 (p-value)	0.472	0.002	0.007	0.096	0.308	0.006	0.014	0.132

Notes. The table reports the IV estimates with robust standard errors clustered by country, including time and country fixed-effects. The real exchange rate is instrumented by two variables: (i) world capital flows multiplied by the *de jure* (Chinn-Ito) index of capital account liberalisation at time t-1, and (ii) the growth rate of foreign exchange reserves. Advanced economies are distinguished from developing economies according to two different thresholds in the per capita GDP (in USD at PPP): (i) the average value across all countries in the sample (USD 9,500) and (ii) the threshold used by Rodrik, 2008 (USD 6,000). Pegs and floats are identified according to the Reinhart-Rogoff (2004) classification of exchange rate regimes. F first stage shows the Kleibergen-Paap rk Wald F statistic to test for the relevance of the instruments. The J test is the *weak-instrument* robust version of the test for the validity of the instruments, under the null hypothesis that the instrumental variables are uncorrelated with the error term. The CLR test is an application of the Moreira (2003) conditional likelihood-ratio test for the statistical significance of the main (beta) coefficient associated with the real exchange in the presence of potentially weak instruments. The sample period is 1970-2010, using non-overlapping 5-year averages. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level. See Table 1 for a description of the variables.

Table 7. Robustness of IV estimates

Dependent variable: Real per capita GDP growth

	(1)	(2)	(3)	(4)
	Baseline	One IV: World capital flows*Kaopen	One IV: Reserves growth	1970-2005
Real exchange rate (RER) vs. USD	-11.712***	-9.603*	-12.376**	-6.940*
	(4.008)	(5.389)	(5.400)	(3.598)
De jure financial openness (t-1)	0.693***	0.618**	0.721**	0.577**
	(0.240)	(0.270)	(0.291)	(0.227)
Monetary policy rate	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Net capital inflows to GDP	0.174***	0.171***	0.175***	0.197***
	(0.033)	(0.032)	(0.034)	(0.031)
Initial GDP per capita level	-2.716*	-3.283**	-2.540	-4.562***
	(1.392)	(1.673)	(1.692)	(1.197)
Inflation	-0.034***	-0.031**	-0.034**	-0.021***
	(0.013)	(0.012)	(0.014)	(0.008)
Saving ratio	0.129***	0.133***	0.128***	0.147***
	(0.033)	(0.033)	(0.033)	(0.035)
Trade openness	0.000	0.006	-0.001	0.010
	(0.014)	(0.016)	(0.018)	(0.014)
Observations	731	737	731	578
Countries	140	141	140	117
F first stage	9.478	7.938	11.33	7.926
J test (p-value)	0.822	.	.	0.067
CLR test H_0: β=0 (p-value)	0.000	.	.	0.034

Notes. With the exception of columns (2) and (3), the table reports the IV estimates where the real exchange rate is instrumented by two variables: (i) world capital flows multiplied by the *de jure* (Chinn-Ito) index of capital account liberalisation at time t-1, and (ii) the growth rate of foreign exchange reserves. Columns (4) and (5) distinguish the countries according to their international currency exposure (Net FX), as measured by Lane and Shambaugh (2012) and Benetrix et al. (2015). See Table 1 for a description of the variables and notes to Table 5 for the methodology and further details. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level.

Table 8. Robustness of IV estimates: non-linearity

Dependent variable: Real per capita GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Appreciations	Depreciations	Appreciations & Peg	Depreciations & Peg	Excl. large depreciations	Excl. large appreciations	Excl. large appr. & depr.
Real exchange rate (RER) vs. USD	-5.197*	-7.839*	-3.573	-10.113	-8.815***	-13.001***	-10.000***
	(3.104)	(4.753)	(3.381)	(9.494)	(3.023)	(4.156)	(3.198)
De jure financial openness (t-1)	0.265	0.864***	0.130	1.199**	0.594***	0.760***	0.662***
	(0.206)	(0.277)	(0.228)	(0.493)	(0.195)	(0.242)	(0.202)
Monetary policy rate	-0.000	-0.009	0.001	-0.504*	0.000	0.000	0.000
	(0.001)	(0.011)	(0.025)	(0.276)	(0.001)	(0.001)	(0.001)
Net capital inflows to GDP	0.075**	0.069***	0.085**	0.070***	0.175***	0.156***	0.160***
	(0.036)	(0.021)	(0.040)	(0.023)	(0.033)	(0.029)	(0.029)
Initial GDP per capita level	-4.283***	-4.431***	-4.167***	-1.182	-3.636***	-2.416*	-3.289***
	(1.167)	(1.379)	(1.370)	(2.789)	(1.147)	(1.386)	(1.150)
Inflation	-0.025***	-0.023**	-0.016	0.100	-0.022**	-0.026**	-0.021**
	(0.009)	(0.011)	(0.094)	(0.113)	(0.009)	(0.012)	(0.009)
Saving ratio	0.096***	0.071	0.093***	0.058	0.141***	0.090***	0.107***
	(0.028)	(0.043)	(0.033)	(0.051)	(0.031)	(0.029)	(0.027)
Trade openness	0.006	0.028*	0.019	-0.003	0.007	0.006	0.009
	(0.012)	(0.015)	(0.013)	(0.029)	(0.012)	(0.014)	(0.011)
Observations	386	295	259	161	704	696	672
Countries	115	92	86	55	140	131	130
F first stage	17.00	4.567	12.99	1.268	13.15	9.532	11.93
J test (p-value)	0.654	0.908	0.013	0.115	0.991	0.393	0.536
CLR test H_0: β=0 (p-value)	0.072	0.058	0.153	0.214	0.001	0.000	0.000

Notes. The table reports the IV estimates where the real exchange rate is instrumented by two variables: (i) world capital flows multiplied by the *de jure* (Chinn-Ito) index of capital account liberalisation at time t-1, and (ii) the growth rate of foreign exchange reserves. The sample in column (5) (in column (6)) excludes the observations in the left (right) tail (5^{th} percentile) of the distribution of real exchange rate log-changes. Finally, in column (7), both tails of the distribution have been excluded from the sample. See Table 1 for a description of the variables and notes to Table 5 for the methodology and further details. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level.

Table 9. GMM estimates

Dependent variable: Real per capita GDP growth

	(1) Baseline	(2) Advanced	(3) Excluding advanced	(4) Pegs	(5) Floats	(6) REER	(7) Overval. RER	(8) 1970-2005
Real exchange rate (RER) vs. USD	-3.947**	11.941*	-3.659**	-5.974***	2.541			-1.846
	(1.776)	(5.843)	(1.796)	(2.049)	(1.973)			(1.632)
Real effective exchange rate (REER)						-3.834*		
						(2.308)		
Overvaluation of RER vs. USD							-3.938**	
							(1.740)	
De jure financial openness (t-1)	0.244	-0.436	0.075	0.111	-0.374	0.299	0.241	0.194
	(0.347)	(0.469)	(0.351)	(0.764)	(0.511)	(0.355)	(0.343)	(0.310)
Monetary policy rate	-0.000	-0.095	-0.000	0.005*	0.002**	-0.000	-0.000	-0.000
	(0.000)	(0.109)	(0.000)	(0.003)	(0.001)	(0.000)	(0.000)	(0.000)
Net capital inflows to GDP	0.188***	0.015	0.194***	0.180***	0.262***	0.203***	0.186***	0.204***
	(0.022)	(0.084)	(0.025)	(0.024)	(0.096)	(0.023)	(0.022)	(0.020)
Initial GDP per capita level	0.321	-10.501***	0.682	0.049	0.154	-0.633	-0.313	-0.095
	(0.617)	(3.434)	(0.741)	(0.856)	(0.895)	(0.479)	(0.505)	(0.495)
Inflation	-0.049***	0.030	-0.047***	-0.039*	-0.041***	-0.051***	-0.048***	-0.044***
	(0.010)	(0.134)	(0.010)	(0.022)	(0.014)	(0.013)	(0.010)	(0.008)
Saving ratio	0.235***	0.149	0.225***	0.221***	0.063	0.214***	0.232***	0.269***
	(0.040)	(0.167)	(0.039)	(0.046)	(0.131)	(0.046)	(0.039)	(0.045)
Trade openness	0.024	0.014	0.018	0.015	0.019	0.018	0.024	0.027*
	(0.018)	(0.013)	(0.019)	(0.017)	(0.018)	(0.013)	(0.018)	(0.016)
Observations	742	158	584	492	204	526	742	607
Countries	146	23	123	129	70	97	146	142
Instruments	24	24	24	24	24	24	24	23
Hansen test (p-value)	0.772	0.554	0.882	0.101	0.327	0.866	0.771	0.151

Notes. The table reports the two-step system-GMM estimates with the Windmeijer (2004) small sample correction, treating the real exchange rate as endogenous (instrumented with the second lag level in the first differences equation), the control variables as predetermined (instrumented with the first lag level) and time fixed effects as exogenous. The Hansen test checks the validity of the instruments, under the null hypothesis that the instrumental variables are uncorrelated with the error term. See Table 1 for a full description of the variables. ***,**,* indicate statistical significance at the 1, 5, 10 per cent level.

Table 10. Impact of depreciation on average annual growth (over 5-year period). Summary and benchmarking to other studies

Study Dependent variable (Sample)	Real exchange rate	Impact of 20% depreciation on growth	Method
Habib Mileva Stracca (2015) Real GDP per capita (1970-2010)	Bilateral vs. USD:		
	level	0.0%	OLS
	overvaluation	0.1%	OLS
	level	2.3%***	IV
	overvaluation	2.2%***	IV
	level	0.8%***	GMM
	overvaluation	0.8%***	GMM
Rodrik (2008) Real GDP per capita (1950-2004)	Bilateral vs. USD:		
	level	0.1% **	OLS
	overvaluation	0.3%***	OLS
	overvaluation	0.2%**	GMM
Aghion et al. (2009) Real GDP per worker (1960-2000)	Trade-weighted effective: overvaluation	0.2% **	GMM

***,**,* indicate statistical significance at the 1, 5, 10 per cent level.

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