Sustained Exchange Rate Misalignemnt and Economic Development

(Preliminary version; please do not circulate)

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Abstract

We provide evidence that sustained real exchange rate (RER) misaligments have medium-run effects on economic development: positive over GDP *per capita* and capital stock in the case of undervaluation, and negative on capital stock in the case of overvaluation. Moreover, a large set of structural parameters are tested, pointing to structural changes during these episodes: undervaluations increase investments and the share of intermediate and capital goods imported, and decrease consumption, wage-share, the services sector and consumption goods imported; while overvaluations cause a reduction on investment and on the manufacturing sector, and an increase the share of commodities and natural-resources on exports. We also find evidence that these effects are heterogenous by income level. By analyzing sustained misalignments, the paper avoid capturing short-term shocks and focus on RER changes that affect expectations, which tends to be an important component on structural transformations. The main empirical strategies are propensity score reweighting and event-by-event analyzes, which are adopted aiming at addressing important endogeneity issues in the literature.

JEL codes: F43, F31, O47

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1 Introducion

The effect of real exchange rate (RER) misalignments on economic growth and capital accumulation have been the subject of several research efforts in recent years. While the literature

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has generally found a positive effect of real exchange rate undervaluation on growth, and the inverse for overvaluations, there are exceptions and relevant methodological criticism.

We explore the question from a different and novel angle. Employing panel data covering 124 countries over the period from 1950 to 2019, we apply a set of criteria to identify episodes of sustained RER misalignments (both undervaluations and overvaluations). We then investigate the subsequent consequences for output, capital stock growth and other important macroeconomic variables over extended periods of time. As discussed later, there are several advantages to this approach.

We find that persistent real exchange rate misalignments can have significant long-term consequences. Our baseline estimation imply that a country that went through an undervaluation episode achieves about 6 percent higher GDP per capita and capital stock within 14 years than a similar country that did not have the same experience. An overvaluation episode, on the other hand, is associated with a 5 percent smaller capital stock 14 years after the begining of the episode. Moreover, the effects are heterogenous among income levels: the positive effects on GDP take place only on low and high income countries, with the final effect after 14 years surpassing 10 percent in both cases; positive effects on capital stock, however, are only seem on low income countries. Another finding of the paper is that this heterogeneity relies on the degree of volatility of the misalignments episodes.

Analyzing the effects of such episodes on structural characteristics also highlight relevant consequences of RER misaligments. In general, undervaluation episodes promote an increase in the share of exports and a decrease in the consumption one; a reduction in the wage-share and the relative size of the services sector; an increase in investment, particularly in machinery; and a rebalancing of imports away from consumption goods and towards intermediate and capital goods. Overvaluation episodes have a negative effect on investment, particularly on physical structures; is a associated with an increase in the consumption share; increase the share of commodities and natural-resources on the exports, while reduces the share of both low and tech manufactures; relatively increase the services sector (in employment terms) and decrease the manufacturing one; and also shift imports towards capital and consumption goods and against intermediate ones.

Causal estimations, as the ones intended in the paper, face well-known challenges. Those tend to be even more severe on macroeconomic settings when the degree of endogeneity of the independent variable are either hard to define or arguably high. One central problem to estimate the causal effects of real exchange rate misalignments is that economies that go through such episodes might be different than countries that do not have such episodes in unobserved characteristics that also affect variables of interest. Consequently, cross-country regressions tend to be biased. A tentative solution for this problem is the use of country fixed effects on difference-in-difference or panel estimates. However, a second important challenge is that misalignment episodes might be preceded by movements on macro variables that we are interested, such as GDP and trade balance. In a setting of difference-in-difference or panel data, this implies a violation of the parallel-trends assumption, which, if ignored, also generate biased estimates.

Given the failure of the literature to deal with these important issues and the nonexistence, to the best of our knowledge, of an ideal method to deal with these cases, our empirical strategy is to use multiple approaches, each with its own advantages and limitations, to estimate the causal effects of RER misaligment on economic development. Our baseline approach is a semiparametric treatment effects (IPWRA) in which the 'treatment' is the occurance of an episode. It is a semiparametric method as it does require a model for the selection into episodes of misaligment, but does not impose a parametric model for the dynamics of the dependent variable.

Our second approach is based on event-specific estimations: each episode is analyzed individually and with 'clean' controls. This method allows us to observe the total distribution of effects instead of its average. Moreover, stacked event-by-event regressions can be used to estimate the average effect, in order to compare - qualitatively, given the different selection of controls - with the baseline approach.

Thirdly, we also perform a dynamic linear estimation with country fixed effects and autoregressive dynamics. For a number of reasons, among them the lack of confidence that the effects are linear, we perform this estimation only for GDP and do not attribute it much weight for our conclusions, although the effects are close to the ones achieved with the non-linear methods. The method, however, is also relevant to base the use of four lags of the variable of interest to control for pre-treatment effects, a procedure that we use in the othe approaches. Lastly, and as a robustness exercise, we also perform a type of synthetic differences-in-differences.

We believe, thus, that the effort to address issues that bias causality estimations for the effect of real exchange misaligment is an important contribution of the paper to this highly debated topic, and can help shed light on the reasons for conflicting results in the literature.

As mentioned earlier, we use formal criteria to distinguish sustained misalignments, which then constitute our treatment. This approach we believe is superior in several respects to earlier work. First, on a practical note, the concept of an equilibrium real exchange rate level is not well-defined in the literature (Demir and Razmi (2021)) so that focusing on significant and sustained deviations rather than annual or short-period movements helps minimize mismeasurement issues. Second, our approach helps mitigate the confounding effect of changes in macroeconomic variables that are purely due to recovery from a one-time large RER change, such as one following a currency crisis.

Third, an important reason to isolate and focus on sustained misalignments is the issue of the permanence of price signals. Bénassy-Quéré et al. (2021) find that, in contrast to the asymmetry assumption typically made in macroeconomics, tariffs have a significantly stronger impact on exports than real exchange rate changes.[1] Based on product level data for 110 countries over 1989-2013, they find that a one percent depreciation reduces imports by around 0.5 percent in current dollars, whereas an increase in import tariffs by 1 percentage point reduces imports by around 1.4 percent. As the literature recognizes, this may partly be because tariff changes are seen as more permanent indicators of policy than real exchange rate changes. In the presence of fixed costs, imperfect information, and time inconsistency issues, exporters and importers are more likely to change suppliers and pass-through levels in response to changes that are perceived as longer-lasting.

Focusing on long-lasting RER movements are likely to give us a better idea of the effects of relative price movements on various slow-moving macro aggregates such as the level of the capital stock, the composition of GDP in terms of its components, and the structure of the economy. This is especially true for processes such as saving, investment, and consumption, that have a significant forward-looking component. Expectations about the stability of the future path of exchange rate and monetary policy, for example, would influence investment and saving decisions. Finally, in addition to a forward-looking component, the process of expectation formation itself is also likely to have a backward-looking component. A few years of consistent misalignment in one direction or the other, therefore, is likely to influence expectations about the future. This again would be expected to affect macroeconomic behavior in a manner more significant than that induced by brief misalignments.

[1] See also see e.g., Fitzgerald and Haller (2018) Fontagné et al. (2018), for country level firm studies. The macroeconomic assumption mentioned in the main text is related to the well-known Lerner symmetry: a currency devaluation is equivalent to an export subsidy combined with an import tariff

At a broader level, the focus on sustained price signals can be motivated by the debate in development economics about the relative roles of history and expectations.[CITATIONS HERE] In a world where differential returns between sectors – say due to learning externalities - generate multiple equilibria, the equilibrium that an economy settles at is likely to be a function of history. On the other hand, as emphasized by a body of literature, self-fulfilling expectations could become a key determinant once one considers forward-looking behavior. (Krugman (1987), Matsuyama (1991), **Kaneda**). This is because resource movements are costly, and hence gradual and forward-looking expectations would incorporate the discounted trade-off between current and future costs and benefits. This, in turn, means that expectations about future returns assume a key role in determining whether or not resources start moving between sectors. Combine this with the presence of externalities and it becomes easy to see that any relative price change that subsidizes resource movements would have to be perceived as durable enough to make the shift worthwhile for a critical mass of economic actors. Policy duration for infant industry protection, Kaneda (2003) demonstrates in a dynamic set-up, is a crucial component of policy design aimed at achieving a "good" equilibrium. In our case, the relevant relative price signal is that coming from the real exchange rate, the resource movement can be seen as occurring between tradable and non-tradable sectors, and consistent with large parts of the literature, the manufacturing sector, which is largely tradable, can be seen as the sector with greater learning and other Marshallian externalities.

Our paper can be related to several strands of existing literature. Most directly, it contributes to the body of work analyzing the relationship between real exchange rate misalignment and growth. Employing an AK-type endogenous growth framework, Rodrik (2008) argues that the tradable sector in developing economies is characterized by market failures to a greater degree than the rest of the economy, and that this creates room for real undervaluation to counter the distortion. Razmi et al. (2012) emphasize productivity increases based on shifting of resources (including Lewisian surplus labor, **Lewis, 1954**) from traditional to modern/industrial sectors. If the tradable sector is the relatively modern part of the economy, and represents the locus of productivity growth, then raising the profit rate through undervaluation boosts aggregate employment and productivity. Other contributions, such as Rapetti (2013), Ros (2015), **and (. . .)** credit the tradable sector with providing opportunities for learning-by-doing and other Marshallian externalities. Korinek and Serven (2016) consider a set-up in which the externality originates, in an AK-type model, from learning by investing in the tradable sector. The first-order short-run outcome of real undervaluation is to generate static welfare losses. Over time, however, the second-best subsidy provided to the tradable sector moves private returns on capital closer to the social returns and results in dynamic. Under certain conditions, the inter-temporal trade-off between static losses and dynamic gains results in a net welfare gain from undervaluation. Levy-Yeyati et al. (2013) emphasize the distributional effects of real undervaluations. The shift in income away from wages, they argue, could boost saving and enable financially constrained tradable goods firms to invest more through larger supply of internal funds and/or through lower cost of capital and greater credit availability.

While earlier empirical studies mainly explored the relationship between real overvaluation and output growth, and generally found a negative relationship, a series of more recent contributions has looked at the flip side, and found a positive relationship between real undervaluation and growth. (see, for example, Hausmann et al. (2005), Gala (2007), Prasad et al. (2007), Rodrik (2008), Miao and M. A. Berg (2010), Di Nino et al. (2011), A. Berg et al. (2012), Rapetti et al. (2012), Levy-Yeyati et al. (2013), and Habib et al. (2017), although there are exceptions, such as Schröder (2013), who finds that the relationship disappears once one controls for heterogeneity across countries. The positive relationship between undervaluation and growth seems to hold particularly for developing countries. Rapetti (2020) and Demir and Razmi (2021) provide exhaustive surveys of the relevant literature.

None of the empirical literature cited above looks at the effect of sustained real misalignments. For the reasons discussed earlier, this is a significant gap. There are however other recent studies that deploy formal criteria to identify episodes of sustained changes in one or another macroeconomic variable and attempt to understand the causal factors preceding them as well as sometimes the consequences following them. For example, Hausmann et al. (2005) explore the preceding correlates of episodes of economic growth, Freund and Pierola (2012) explore surges of manufactured exports while Cerra and Woldemichael (2017) study correlates of export accelerations in general, Libman et al. (2019) investigate investment episodes, Benigno et al. (2015) consider periods of sustained large capital inflows, and Bista and Sheridan (2021) take an econometric look at trade variables preceding episodes of growth takeoffs. In terms of approach, our paper is related to this strand of literature.

Our findings about the effect of sustained real exchange rate misalignments shed light on the relationship between trade aggregates and relative price changes. There, of course, is a vast literature that addresses this question [**cite a review survey**]. As discussed earlier, recent papers have found that trade responses to tariffs are more elastic than those to exchange rate changes. To the best of our knowledge, ours is the first paper that employs formal criteria to identify episodes of sustained and stable misalignments. By focusing on sustained signals we hope to address headlong the complications posed by the presence of beachhead effects (Baldwin and Krugman (1989) Krugman and Baldwin], 1989), fixed costs of exporting (Dutt et al. (2013) Dutt,2013), J-curve related delays, and the trade-induced entry and exit caused by the presence of heterogeneous firms in international trade [Melitz (2003)].

This paper also contributes to a large literature on the correlates of structural change and evolution. One thread of this strand of work, starting with Corden and Neary (1982), analyzes the "Dutch disease" aspect of real exchange rate misalignments. A natural resource discovery or terms of trade shock that leads to increased spending on non-tradables and subsequently to real overvaluation, could crowd out other tradable sectors such as manufacturing, and lead to de-industrialization. A more recent strand of literature in this spirit finds some evidence for premature de-industrialization in developing countries with the services sector expanding at the expense of industries (Rodrik (2016)). On the flip side, real undervaluations have been found by some studies to lead to diversification of economic structures, export diversification along intensive and extensive margins, greater tradable sector employment, and spurts of manufacturing export growth.[2].

Besides this introduction, the paper has a section in which the methods and results are presented and a final section of conclusion.

2 Empirical Section

2.1 Episodes

The episodes are found using data from the Penn World Table 10.0. The first step is to calculate a measure of real exchange rate misalignment. Following the standard procedure in the literature (Rodrik (2008); Rapetti et al. (2012)), we begin by computing the equilibrium real exchange rate, which takes into account that the law of one price is not expected to hold for non-tradables. In practical terms, this is done by adjusting the real exchange rate (RER) for the Balassa-Samuelson effect, regressing RER on real GDP per capita at national prices

[2]See Krugman (1987) who develops a Ricardian framework with a continuum of goods and shows how, in the presence of learning externalities and international spillovers, a temporary real devaluation can help achieve permanent diversification. For empirical treatments, see Freund and Pierola (2012), McMillan and Rodrik (2011), and Goya (2020). Guzman et al. (2018) survey these issues in comprehensive detail.

(RGDPCH):

$$lnRER_{it} = \alpha + \beta lnRGDPCH_{it} + f_t + \epsilon_{it} \quad (1)$$

where i and t are country and time indexes, respectively, f_t accounts for time fixed effects, and ϵ_{it} is the error term. We obtain an estimate of $\hat{\beta} = -0.19$, with a t-statistic of 51.3. The sign of the coefficient is in line with the Balassa-Samuelson prediction. Finally, we define the undervaluation index (UNDERVAL) as the ratio of actual to BS-adjusted real exchange rates: $UNDERVAL_{it} = RER_{it}/R\hat{E}R_{it}$. Defined in index form, UNDERVAL is comparable across countries and over time; when it exceeds unity, the domestic currency is undervalued in real terms (i.e., domestic goods are cheap in international dollar terms).

As our baseline window period is of 7 years, we compute the rolling geometric mean of this misalignment index. Having these results, we use three criteria to define sustained undervaluation (overvaluation) episodes:

1. *Size*: a devaluation (overvaluation) of at least 10% compared to the juxtaposed window;[3]

2. *Volatility*: the window must have a standard deviation of less than 10% above the average of the episodes that comply with criteria (i) - 0.17 for the undervaluation episodes and 0.12 for the overvaluation ones;

In case multiple episodes are found within the same 7 year window, a criteria to choose the more accurate beginning of it is added: the year with the strongest devaluation (compared to the previous year) is considered the beginning of an episode.

We find 189 undervaluation and 238 overvaluation episodes.[4] Countries are grouped in three sets based on their classification at the World Bank (low, low-middle, high-middle, high income) and their GDP per capita: for each year, the bottom half of countries with less income per capita at the low-middle income group is aggregated to the low income, and the upper half to the middle income one.

[3]For instance, in the case of undervaluation: if the average misalignment is 10% higher (exchange rate is more undervalued) in the period 2000-2006 than it was in the period 1999-1999.

[4]Very small countries, with less than 1 million in population at any year, were excluded from the sample. Countries with extreme RER misaligment were alo excluded: Turkmenistan, Kyrgyztan, Azerbaijan, Iraq, and Vietnam.

Table 1: Profile of episodes

Region			***Income***			***Time***		
	Under	Over		Under	Over		Under	Over
EAP	33	27	*Low*	91	92	*1950-1959*	5	11
ECA	32	74	*Middle*	61	83	*1960-1969*	20	24
LAC	37	38	*High*	37	55	*1970-1979*	37	48
MENA	23	13				*1980-1989*	43	44
NA	4	5				*1990-1999*	49	57
SA	11	5				*2000-2009*	35	47
SSA	49	69						

EAP = East Asia and Pacific; ECA = Europe and Central Asia; LAC = Latin America and Caribbean; MENA = Middle East and North Africa; NA = North America; SA = South Asia; SSA = Sub-Saharan Africa.

Figure 1: Averages of selected variables around undervaluation episodes - GDP in growth rates, others in %

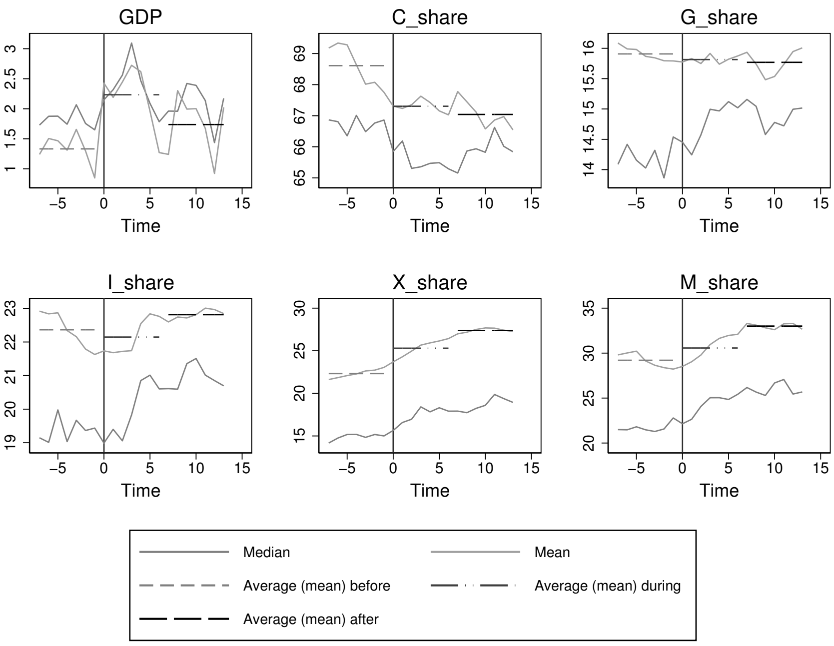
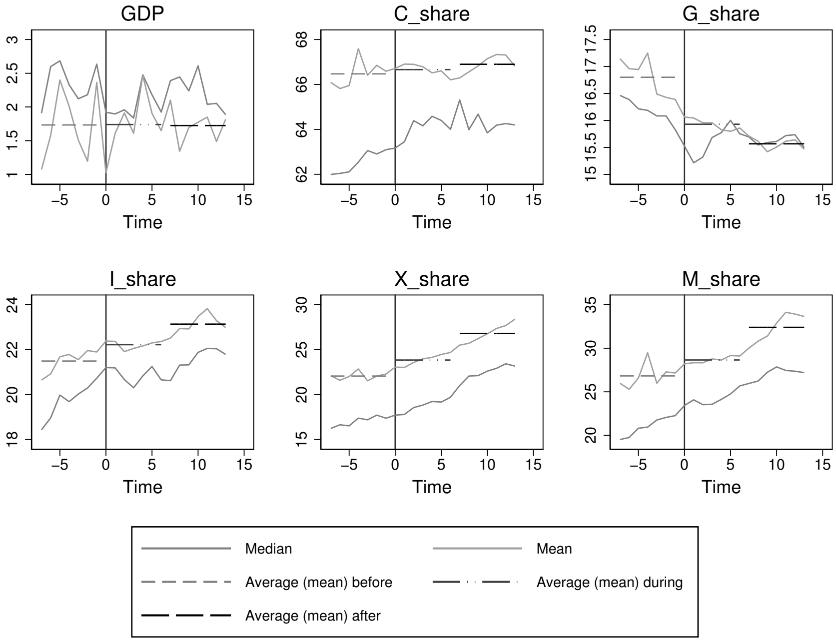


Figure 2: Averages of selected variables around overvaluation episodes - GDP in growth rates, others in %



2.2 Linear Estimations

A common way to estimate the effects of such episodes is the use of a dynamic model (for instance, see Acemoglu et al. (2019) for democratization episodes). Formally, we have:

$$y_{ct} = \beta E_{ct} + \sum_{j=1}^{d} \gamma y_{ct-j} + \alpha_c + \theta_t + \epsilon_{ct} \tag{2}$$

with y being the variable of interest, E the dummy for the episode, α is the country fixed effects, and θ the year fixed effects. Finally, the addition of d lags of the variable of interest might be important to eliminate the residual serial correlation in the error term and to remove potential pre-treatment trends in the dependent variable. [5]

In these types of models, the long-run effect of the episode is determined by its contemporaneous effect and the serial persistence of the variable of interest. We think this is a too strong assumption, and see no reason to expect the effect of a real economic misalignemnt to be linear. Thus, the effects estimations given by the models of this section are not taken as our benchamark ones - although the results do roughly converge with the semi-parametric estima-

[5]This is related to the usual assumption made with linear dynamic panel models: $[\epsilon_{ct}|y_{ct-1}, ..., y_{ct_0}, E_{ct}, ..., E_{ct_0}, \theta_t$, and α_c for all c and $t \geq$ t$_0$]. That is, it is assumed that the episode and the past dynamics of the variable of interest are uncorrelated to current and future shocks and that the error terms is serially uncorrelated.

tions presented next. However, these estimations are particularly important to test the capacity of different lags to control for pre-treatment trends and eliminate residual correlation, which will be important for the other methods used.

This form of estimating dynamic panels (henceforth *Within*, following Acemoglu et al. (2019)) might be affected by the well known Nickell bias, which emerges from the use both individual fixed effects and autoregressive dynamics. We thus test a GMM estimator developed by Arellano and Bond (1991) (henceforth AAB), which produces consistent estimates of the dynamic panel model. The results are presented in tables 2 and 3. In the first four estimations of each model, we simple test different lags of GDP; in the last estimation - (5) and (10) - we control for variables that are (empirically) significant for the probability of episode occurrence and (theoretically) related to the GDP performance.[6]

A first, and most important given the limitations of assuming a linear effect in this case as indicated above, piece of information that can be obtained in the tables is the number of lags that should be used to control for both pre-episode trend in the variable of interest and to eliminate any residual serial correlation in the error term. This evaluation is made by i) the test for serial correlation in the residuals, which might indicate a lack of lags - AR2 test -; ii) and the p-values (including jointly) for the lags. At table 2, we can see that 4 lags are jointly significant in both *within* and AAB estimations, while the addition of two more lags are non-significant. Looking at the AR2 test, it can also be seen that with the use of four lags the serial correlation in the error terms is eliminated. These are strong results in favor of the use of four lags as controls. In the case of overvaluation episodes, presented in table 3, the results are weaker: the correlation in the error is not completely eliminated with the use of four lags, although four lags are again jointly significant while the addition of more lags are not. Taking into account these two results, though, controlling again for four lags seems to be the best option. Moreover, as indicated in appendix B, after controlling for four lags, the correlation between episodes and transitory movements in the variables disapppears.

Secondly, and given the limitations indicated, the estimations also give us a first approximation of the effect of real exchange rate misalignment on long-term GDP growth. We will focus in the estimations controlling for four lags of the dependable variables, which will be our baseline for the rest of the paper. In the case of undervaluation episodes, the *within* estimations indicate a long-run positive effect of 33.3% without other controls and 20.4% with other controls, with

[6] See table ??.

only the former being barely statistically significant at 10%. The AAB estimations give smaller and non statistically significant results, 15.6% and 10.8%, without and with extra controls. In the case of overvaluation episodes (table 3), the long-run estimated effects range from -27.4% (with extra controls) to -42.6% (without extra controls), both highly significant statistically. The AAB estimations are again smaller: -12.7% without extra controls and -6.4% with them - statistically significant at 10% and 5%, respectively.

We are interested in variables that indicate structural change in the economies during the episodes examined; however, to present all variables would require an unfeasible amount of space. We will focus, thus, in presenting the effects on GDP and capital stock, and indicating variables that have a statistically significant change and that are consistent in the different methods used in the section 'Structural Change'. In the case of linear models, as indicated, our focus is less on the estimated effects and more in the information about pre-trend and serial residual correlation, and thus only the effect on GDP is presented.

2.3 Semi-parametric Estimation

Our baseline results are achieved using a semiparametric method, the "Inverse-probability weighted regression adjusment" estimator, IPWRA (Imbens and Wooldridge (2009); Wooldridge (2007)). The method is not "fully" parametric in the sense that we do not specify a parametric process for the variables of interest, however, it still requires the specification of a model for either the probability of the occurance of an episode or the conditional expectation of future values of the variables of interest amoung countries that did not went through an episode. The choice of the IPWRA estimator takes into account the fact that it is 'doubly robust', that is, it is sufficient that one of the two models specified is valid for the estimator to be consistent.[7]

Briefly put, the method can be understood as a combination of local projections (Jordà (2005)) with propensity-score methods to construct counterfactuals. A probit model is used to estimate the likelihood of a country experiencing an episode; these probabilities are then used to weight observations in the control group. Subsequently, the counterfactual outcome is estimated using a linear regression method with the donors and their respective weights. We are, thus, constructing a counterfactual that is as similar to our treated units as possible (given the variables included in the probit), and our estimations correspond to the "treatment effects

[7] Some of the recent literature that has been using this method for macro and international economics research and that influenced our use is, for instance, Angrist and Kuersteiner (2011), Jordà and Taylor (2016), and Girardi et al. (2020).

Table 2: Effects of undervaluation on GDP (log points) - Linear estimations

			Within					*AAB*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Undervaluation episode	0.006	0.008	0.008	0.008	0.008	0.006	0.008	0.011	0.010	0.010
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.009)	(0.008)	(0.008)	(0.008)	(0.009)
log y first lag	0.982	1.236	1.189	1.190	1.158	0.930	1.147	1.104	1.101	1.072
	(0.005)	(0.047)	(0.036)	(0.041)	(0.040)	(0.017)	(0.056)	(0.044)	(0.048)	(0.051)
log y second lag		-0.259	-0.157	-0.176	-0.150		-0.221	-0.136	-0.157	-0.135
		(0.045)	(0.027)	(0.026)	(0.024)		(0.047)	(0.024)	(0.023)	(0.021)
log y fourth lag			-0.046	-0.051	-0.046			-0.037	-0.041	-0.040
			(0.013)	(0.026)	(0.014)			(0.014)	(0.027)	(0.015)
log y sixth lag				0.024					0.037	
				(0.027)					(0.031)	
p-value lag 1 to last (up to 4)		[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]
p-value lag 2 to last			[0.001]	[0.000]	[0.003]			[0.036]	[0.066]	[0.024]
p-value lag 4 to last				[0.649]					[0.436]	
Long-run effect of (under) episode)	0.318	0.367	0.333	0.306	0.204	0.082	0.109	0.156	0.128	0.108
	(0.300)	(0.232)	(0.204)	(0.211)	(0.154)	(0.137)	(0.121)	(0.110)	(0.094)	(0.099)
Persistence of y process	0.982	0.977	0.975	0.975	0.963	0.930	0.926	0.926	0.920	0.906
	(0.005)	(0.005)	(0.005)	(0.004)	(0.007)	(0.017)	(0.015)	(0.013)	(0.017)	(0.016)
AR2 test p-value						0.11	0.49	0.03	0.89	0.01
Observations	6039	5915	5667	5419	4768	5726	5602	5354	5106	4466
Countries in sample	124	124	124	124	119	124	124	124	124	118

Table 3: Effects of overvaluation on GDP (log points) - Linear estimations

			Within					*AAB*		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Overvaluation episode	-0.007	-0.009	-0.010	-0.010	-0.009	-0.003	-0.006	-0.009	-0.008	-0.008
	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
log y first lag	0.982	1.219	1.182	1.182	1.150	0.930	1.093	1.081	1.082	1.010
	(0.004)	(0.045)	(0.037)	(0.040)	(0.039)	(0.024)	(0.052)	(0.047)	(0.050)	(0.050)
log y second lag		-0.241	-0.158	-0.177	-0.152		-0.171	-0.135	-0.157	-0.130
		(0.043)	(0.032)	(0.033)	(0.030)		(0.038)	(0.032)	(0.034)	(0.027)
log y fourth lag			-0.050	-0.036	-0.053			-0.023	-0.022	-0.032
			(0.017)	(0.036)	(0.018)			(0.019)	(0.033)	(0.018)
log y sixth lag				0.016					0.047	
				(0.029)					(0.037)	
p-value lag 1 to last (up to 4)		[0.000]	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]	[0.000]	[0.000]
p-value lag 2 to last			[0.011]	[0.001]	[0.008]			[0.474]	[0.148]	[0.114]
p-value lag 4 to last				[0.730]					[0.446]	
Long-run effect of (over) episode)	-0.400	-0.405	-0.426	-0.464	-0.274	-0.042	-0.082	-0.127	-0.120	-0.064
	(0.233)	(0.162)	(0.143)	(0.142)	(0.096)	(0.062)	(0.058)	(0.069)	(0.081)	(0.032)
Persistence of y process	0.982	0.979	0.978	0.978	0.966	0.930	0.921	0.930	0.931	0.873
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.024)	(0.023)	(0.021)	(0.031)	(0.028)
AR2 test p-value						0.13	0.68	0.30	0.40	0.24
Observations	5787	5663	5415	5167	4474	5432	5308	5060	4812	4123
Countries in sample	124	124	124	124	119	124	124	124	124	118

on the treated".

The main assumption made with the use of this method is that the selection into an episode can be modeled as a function of observables, so that by taking into account those observables, the potential future values of the variables of interest for those countries that go through an episode are not different than for those countries that do not. That amounts to the "selection on observables" assumption. To have confidence that this assumption holds, one has to chose appropriate observables; that is, to control by variables that affect both the probability of an episode and the potential outcome of the variable of interest. Given that we have a set of 37 variables of interest, and that we also want to test the effects of episodes of both undervaluation and overvaluation for each of the four income groups (besides the general effect), we have a total of 370 different estimations. Our choice of the variables to construct the counterfactuals follows, thus, a trade-off between more precise specifications (that comes with the cost of lack of clarity given the limited space to present the justification) and completely horizontal ones (that although being simpler and explicit, has the obvious drawback of given us less confidence in making the "selection on observables" assumption).

We follow, thus, two procedures to give us some flexibility while avoiding the risk of excess subjectivity or lack of clarity. First, we determine the number of lags to control for pre-treatment trends, being these lagged values of the variables of interest the observables in the linear regression adjustment part of the estimations. We make two exercises to chose the most adequate number of lags to be used in all estimations. The first is the dynamic linear models presented in the previous section. Following the results presented in the previous subsection, we use four lags of the variables of interest and year fixed effects in our baseline specification.

Secondly, we determine which variables to use in the propensity-score model. In this case, we allow a greater flexibility both because it seems hard to argue that the determinants are the same in all cases (undervaluation episodes in poor countries and overvaluation in high income ones, for instance) and because we only have 10 different cases to examine. Thus, for each of the five categories of income (general, low, low-middle, high-middle, high) and for episodes of under and overvaluation, we test the relevance of up to 4 lags of four variables that are theoretically relevant to episodes and the potential outcome: GDP, real exchange rate misalignment (Mis), trade balance (% of GDP) (TB), and terms of trade (TOT); finally, we also include a dummy for capital control (CC). [8] The variables were included if significant individually or jointly at

[8] We use the measure suggested by Ilzetzki et al. (2019) given that it covers most of the period and countries

10%. The results can be seem at appendix B. The list of variables to be used in the propensity scores of our estimations in each cases is in the table ??.

Table 4: Variables used on IPRA estimations

	Overvaluation	*Undervaluation*
General	TOT (4), Mis (4), TB (4), CC	GDP (4), Mis (4), TB (4), CC
Low Inc.	GDP (4), Mis (4), TB (4), CC, TOT (4)	GDP (4), Mis (4), TB (4)
Middle Inc.	GDP (4), Mis (4), TB (4)	Mis (4), CC
High Inc.	GDP (4), Mis (4), TB (4), CC	GDP (4), Mis (4), TB (4), TOT (4), CC

All variables are used in four lags, except the dummy for capital control for the year of the begining of the episode.

More formally, after calculating the weights based on the variables for each of the 10 cases and attributing it for each control unit, the estimation has the following form:

$$\Delta X_{i,t+s} = \alpha_t^s + \beta^s E_{i,t} + \sum_{j=1}^{4} \theta X_{i,t-j} + \epsilon_{i,t+s} \tag{3}$$

where α_t^s are year dummies. All growth variables of interest are in log terms, so that $\Delta X_{i,t+s}$ gives the approximate percentage change in the variable of interest between the average of four years before the start of the episode and $t + s$.[9] The variables that are shares are not in log terms, and the effect of size X should be read as an increase or decrease of X percentage points. The option to use the average of four years before the episode instead of the year immediately before it follows from (i) the understanding that these episodes follow strict criteria but are not "natural experiments" with a sharp change in the real exchange rate, so that in some particular cases historical knowledge suggest that the beginning of the analysis would be a couple of years before or after, and (ii), related to this, the objetive of avoiding giving to much weight to one specific year.

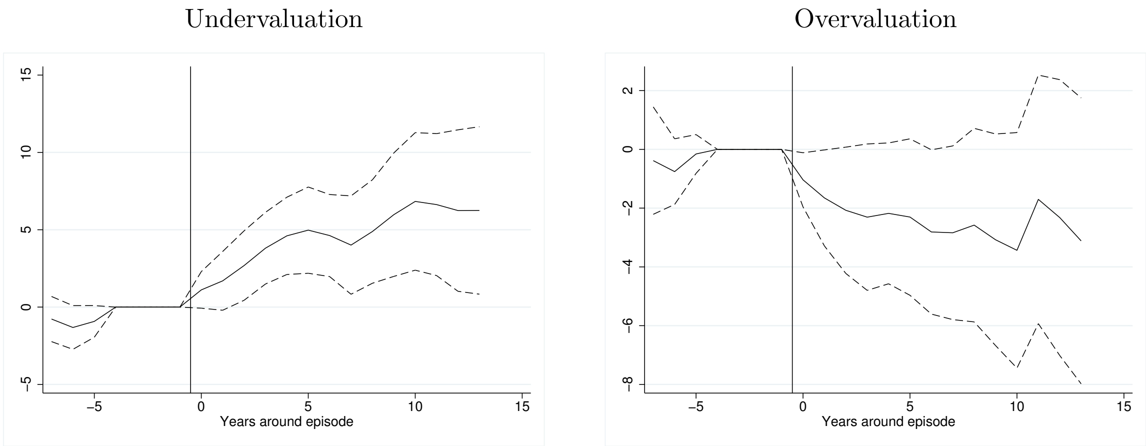
Figure 3 indicates that undervaluation episodes generate, on average, a long run increase on GDP per capita of more than 6%; while overvaluations produce a reduction of about 2.5% that is non-significant on the long-run. The result for capital stock (figure 4) is even more stark, with a devaluation episode causing an increase in the capital stock of more than 6% (and possibly

that we use. Other indexes often used, such as the Chinn-Ito one, comprehend a smaller time frame.

[9] We implemented all estimators in this section with Stata *teffects* command and computed standard errors by using 50 bootstrap samples in which we clustered the data at the country level.

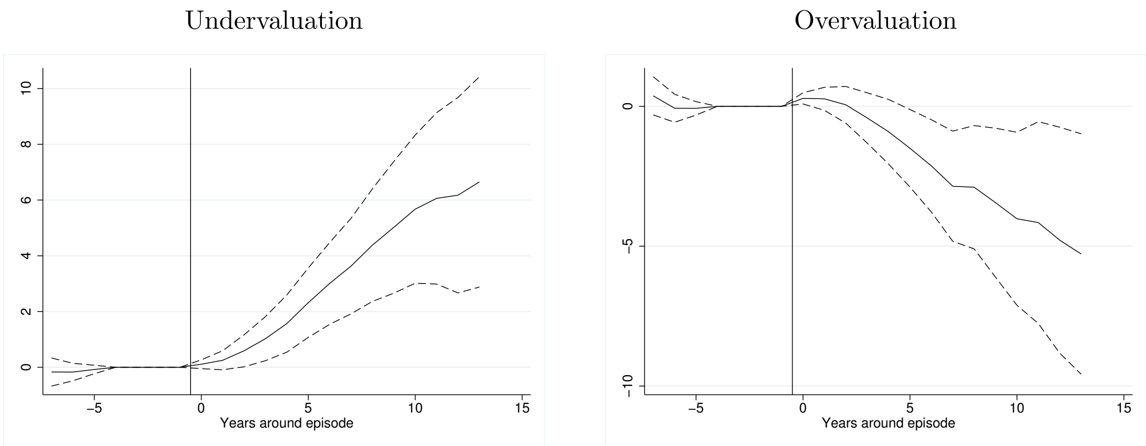
more as there is no clear tendency of stabilization after the 14 years observed here), while an overvaluation reduces in 4% by the end of the observable window.

Figure 3: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP.



The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

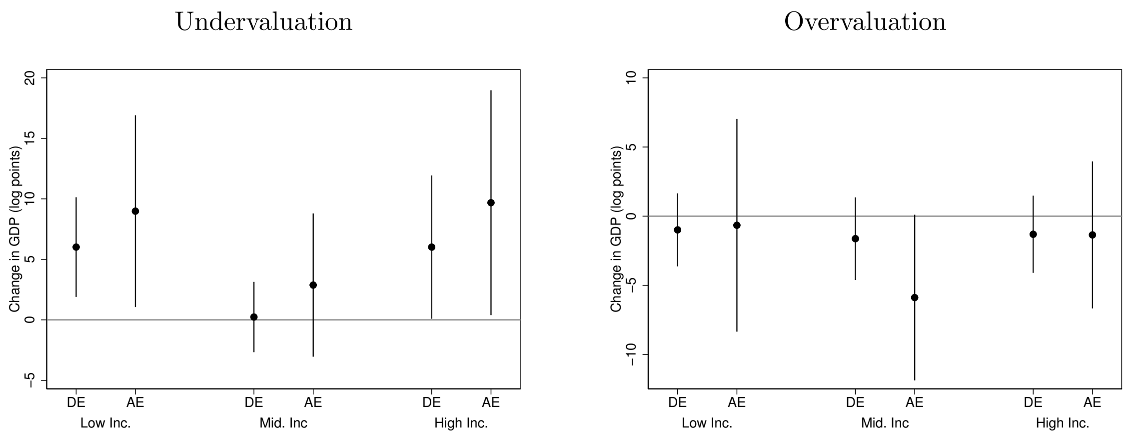
Figure 4: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock.



The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

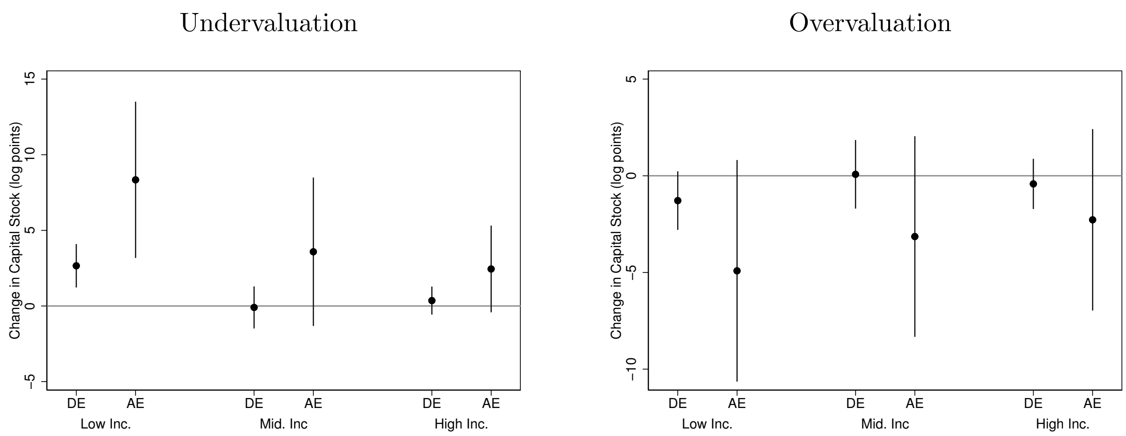
The effects are significantly heterogenous among income groups. Figure 5 indicates that both low and high income countries have positive, lasting effects of undervaluation episodes, while middle-income countries do not. Interestingly, only low income countries have a significant increase in their capital stock in the medium-run (figure 6); this might indicate that while such episodes help low income countries in actually change its development path, in the case of rich countries, the effects might be related to a temporary boost after some negative shock. In the case of overvaluation, the effects are statistically non-different than zero for both GDP and capital stock, although the coefficients tend to be negative.

Figure 5: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 6: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of K - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

2.4 Case-by-case analysis

Our second method is to estimate separated effects for each of the episodes, in contrast to the baseline model of an average effect across all the undervaluation e overvaluation episodes. This method gives us two sets of information that complement our baseline results: i) it can be evaluated if the general results are driven by specific cases, indicating the frequency with it the qualitative average results hold; and ii) each episode, containing the 'treated country' and clean controls, can be stacked in order to calculate common treatment effects that can also serve as a robustness check for the baseline case.

First, we create specific datasets for each episode containing the treated country[10] and 'clean' controls, understood as other countries that i) did not experienced undervaluation or overvaluation episodes within a 8-year window around the episode that we are examining (s = -3, ..., 11)[11]; ii) have data for the variable of interest for all those years; and iii) have a similar GDP per capita (the ten countries with the closest GDP per capita that comply with the previous criteria). We also test the short-term effects (a 12-years window (s=-5, ..., 7)[12]).

2.4.1 Event-by-event - individual effects

For each of the datasets we calculate a regular diff-in-diff estimation, still controlling for heterogeneity in the pre-treatment period, which can be formally presented as:

$$X_{i,t} = \beta E_{i,t} + \alpha_t + \gamma_i + \sum_{j=1}^{4} \theta X_{i,t-j} + \epsilon_{i,t} \tag{4}$$

To calculate the standard errors, we follow the procedure proposed by Ferman and Pinto (2019) which is appropriate when estimating with only one treated unit.[13] Figures 7 and 8 are illustrations of the distribution of the results for each under and overvaluation cases.[14]

[10] A country can have multiple episodes in different years; for each episode a new dataset is created.

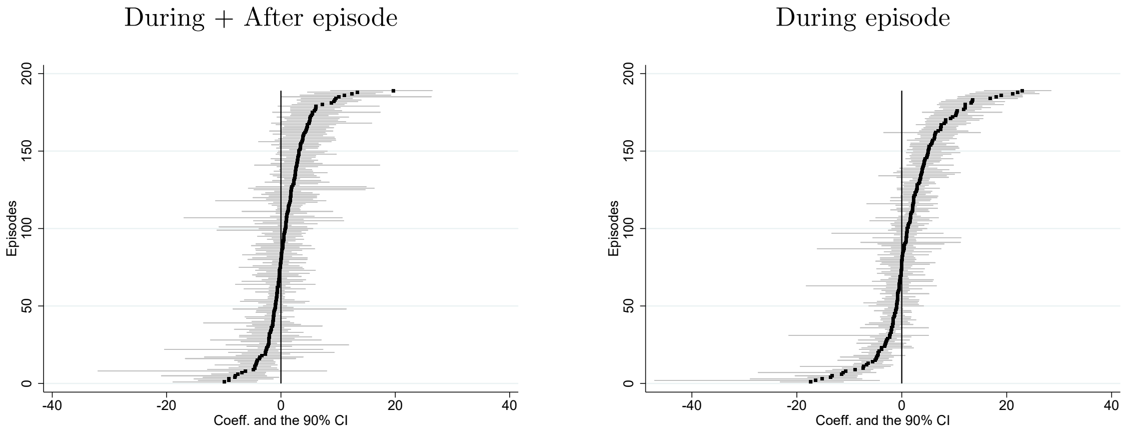
[11] The option for a window that is smaller than the total 21 years of interest is justified by the fact that if the later frame is used, too few controls remain in each episode.

[12] The pre-treatment is also reduced in order to incorporate episodes of variables that have more limited data availability, such as employment by sector

[13] Their procedure can also be used to control for heteroskedasticity; this, however, is not a relevant issue given our dataset with the same number of observations for each country.

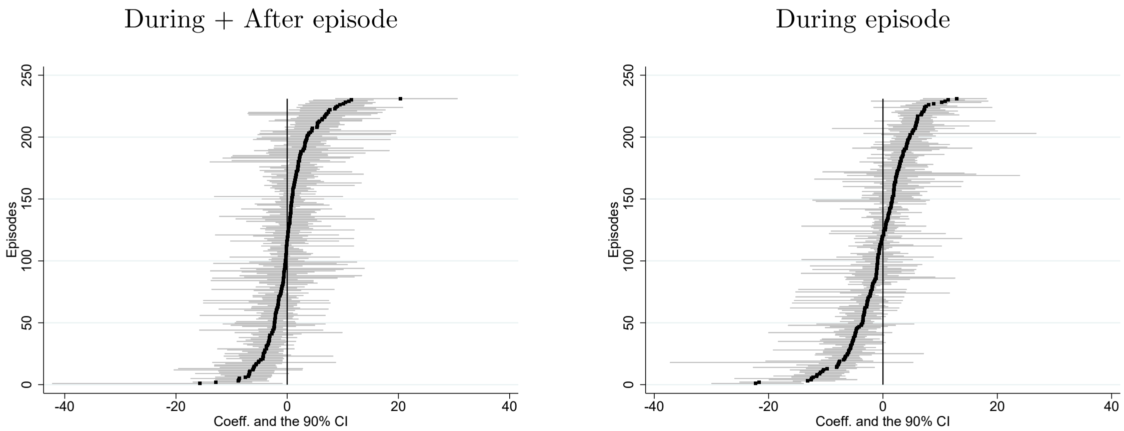
[14] For a similar use and presentation of results, see Cengiz et al. (2019)

Figure 7: Case-by-case estimates for the average effect of an undervaluation episode on log of GDP *per capita*



Black dots are the coeficientes for each of the episodes and the gray area is the 95 percent confidence interval.

Figure 8: Case-by-case diff-in-diff for the effect of an overvaluation episode on the log of GDP *per capita*



Black dots are the coeficientes for each of the episodes and the gray area is the 95 percent confidence interval.

2.4.2 Event-by-event - aggregate effects

The second use of the event-by-event datasets is to stack each event in a wide format[15] and estimate a common, average treatment effect which can be directly compared to our baseline estimation (for methodological references see, for instance, Sun and Abraham (2020), Callaway and Sant'Anna (2020), and Cengiz et al. (2019) appendix D). The comparison should be made particularly in qualitative terms, and not quantitative ones, given that the controls for the estimations with the IPWRA and 'Case-by-case' (CBC henceforth) methods are deliberately

[15]Meaning that each episode-specific dataset contains one observation for each country (for each year) - one treated country and the 10 controls that follow the 3 criteria indicated above for that particular episode.

different, chosen to estimate the most accuratly the direction of the effect in each case. The specification used in this section has the advantage of using more strict controls and tends to be less biased in the presence of heterogeneous treatment effects.

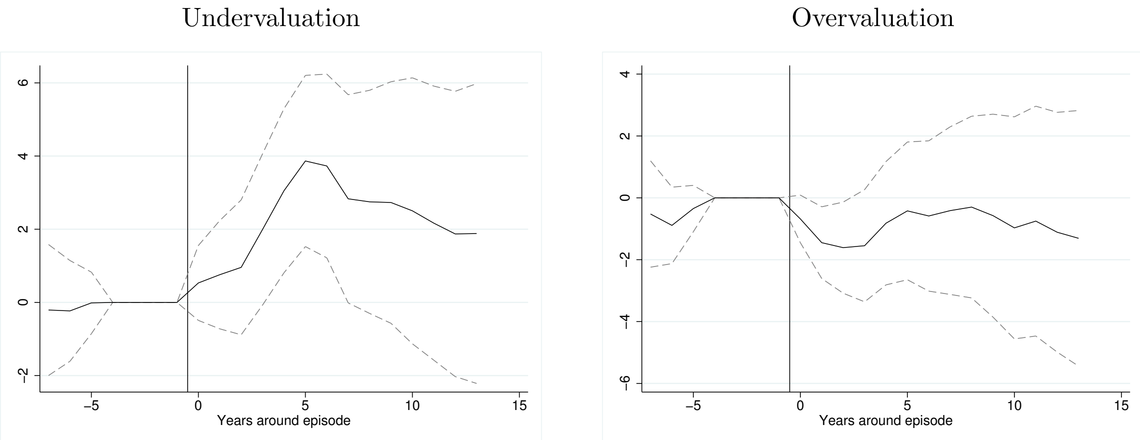
Having stacked the datasets, we have a very similar regression equation to the one used in the baseline case:

$$\Delta X_{i,t+s} = +\beta^s E_{i,t} + \sum_{j=1}^{4} \theta X_{i,t-j} + \mu_e + \epsilon_{i,t+s} \tag{5}$$

the main difference being the term μ_e which is a dummy for each episode.[16]

The general effects are qualitatively similar, although smaller (figures 9 and 10). The results by income level are also very similar (figures 11 and 12): undervalations episodes have lasting positive effects on GDP per capita of low and high income groups, while in terms of capital stock, only the former seems to benefit. Results are also very close to the baseline estimations in the case of overvaluations, the only difference is the negative effect over the capital stock on high income countries.

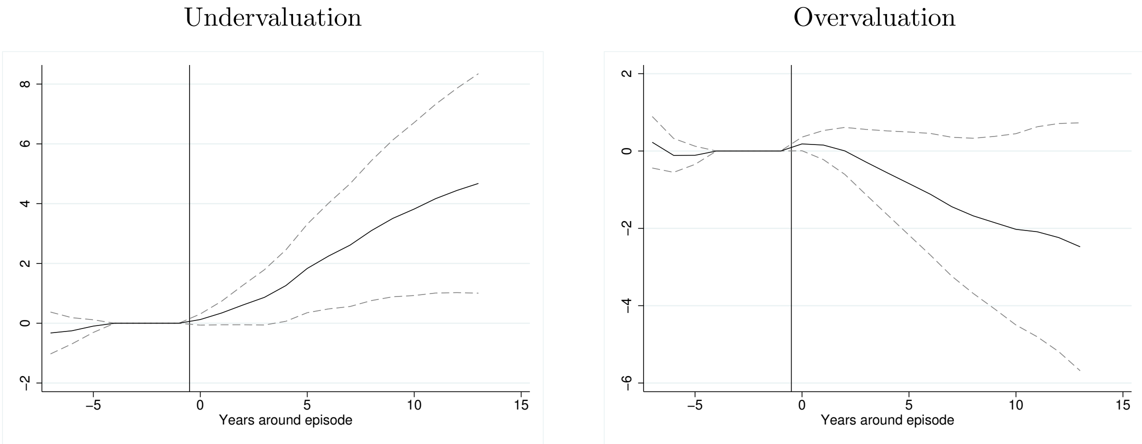
Figure 9: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP



The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

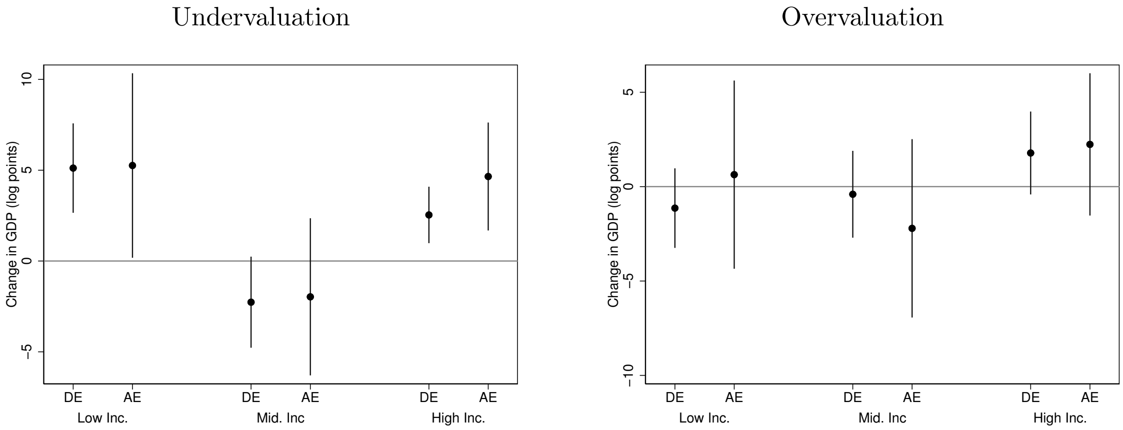
[16] We do not need country fixed effects given that our outcomes are in differences (with respect to the four year average before the episode), and we also do not need year fixed effects given that we aligned the episodes by event-time; however, ommitted variables can be relevant in determining the outcome *between* episodes.

Figure 10: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital stock.



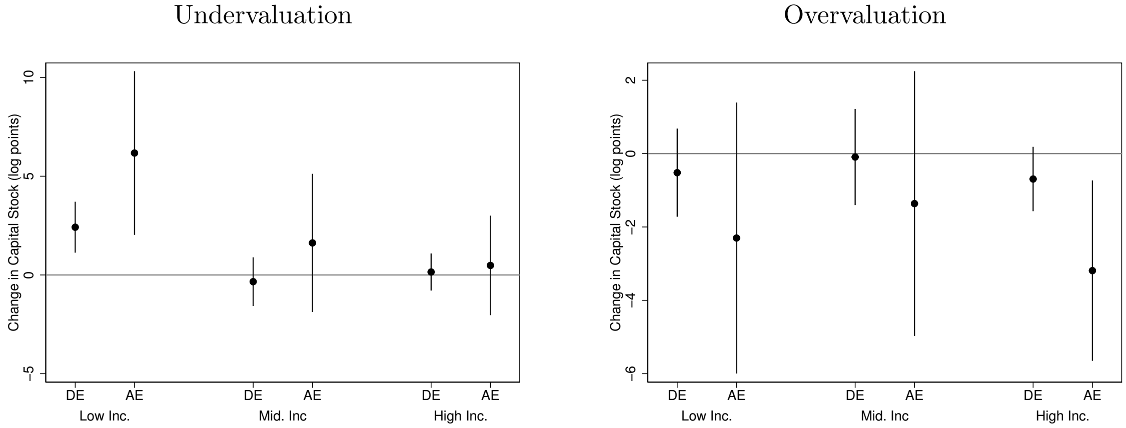
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 11: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 12: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of K - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

2.5 Structural Changes

Tables ?? to ?? indicate the most relevant variables affected by the episodes of under and overvaluation. The variables presented are those that are statistically significant in the IPWRA or CBC estimations, as long as it does not present contradictory signals (positive and significant using IPWRA and significantly negative in the CBC estimation, for instance). It is important to remember here that we are interested more in the qualitative result (the direction of the effect) than in its quantitative counterpart (the size of the effect); this priority is explicit when we opt to use different criteria to clean controls depending on the flexibility the method of estimation allows.

The most general effects of undervaluation episodes are: increase in exports, decrease in the wage-share, decrease of the services sector (both VA and employment), increase in investments (particularly in machines), a decrease in the share of consumption goods in the imports basket, while the shares of intermediate and capital goods increase. There is also some evidence, although weaker, that industrial employment increases and the share of high-tech goods in the export basket decrease, probably following an increase in the total volume of low-tech exports. In the case of overvaluations: investments tend to decrease (particularly in structures (plants, buildings, etc.), consumption (as a share of GDP) tends to increase, exports become more concentrated in commodities and manufactures related to natural resources, and less in low and high-tech manufactures, while imports become more concentrated in consumption and capital goods and less in intermediate goods. There is also evidence of a positive effect on services (particularly in employment) and a negative in manufactures (VA).

2.6 Robustness and Extensions

2.6.1 Synthetic control

A third method that can be used to create controls for the estimations is synthetic controls (Abadie (2021), Born et al. (2019)). The advantage over the previous methods is that we can create a control that is not only similar to the treated country in terms of income or characteristics associated with the probability of treatment, but also other structural elements. As is also well know, this method is very sensitive to the variables used[17]. Having this in mind, and the fact that more specific variables that we use in the other estimations methods tend to have less data points, we opted to focus on the estimation of only the GDP and capital stock with this method, and as a form of checking the results obtained before.[18]

As performed in the case-by-case analysis, we create a synthetic control for each episode, and them the data is stacked to calculate the average effect (for applications of similar synthetic difference in differences methods see, for instance, Dube and Zipperer (2015) and Arkhangelsky et al. (2019)). The variables used to create the control are GDP and capital stock per capita, trade openess, and investment share. To construct the synthetic control, these variables are used from time -7 to time -4 (in reference to time 0, when the episode begins), in order to avoid capturing any pre-treatment effects; the estimation is them the same as the one in the stacked case of the case-by-case analysis, controlling for 4 lags of the dependent variable. The idea is, thus, to create a synthetic control that is structurally similar to the treated unit, while keep controlling for four lags in order to control for pre-treatment effects.

We present in figure 13 an example of a single country-episode in order to ilustrate the method. We present the effect of the undervaluation on Korea in 1961.

[17] See, for instance, Ferman, Pinto, and Possebom (2020).

[18] Maybe cite, however, that the vast majority of the estimations for the other variables are consistent with the results previooulsy obtained.

Table 5: Average results - all countries

UNDERVALUATION	IPWRA		CBC		CBC - Freq. (%)	
	During	Post	During	Post	Positive	Negative
X	8.875*	12.246*	5.411*	6.053	64.2	35.8
I	3.252	6.025	2.757	2.774	63.8	36.2
X_share	0.961*	0.714	0.882+	0.592	62.8	37.2
C_share	-0.548	-1.547+	-0.331	-0.120	39.6	60.4
M_share	0.373	-0.956	0.125	0.531	62.8	37.2
Serv	-1.251*	-0.674	-0.837+	-1.342*	39.4	60.6
Serv_emp	-0.607	-1.018	-0.036	-0.446	33.3	66.7
Ind_emp	0.133	1.073+	0.204	0.498	40	60
wage_share	-0.964*	-0.503	-1.099*	-1.041*	24.2	75.8
I_Mach	7.108*	11.683+	5.643+	4.838	77.1	22.9
shareconsgoodsM	-0.828*	-0.605	-0.818*	-0.325	50	50
shareintgoodsM	1.265*	1.033+	0.417	-0.235	33.3	66.7
shareKgoodsM	0.030	-0.030	0.398	0.585*	83.3	16.7
sharehightech	-0.287	-0.394	-0.790*	-1.860*	33.3	66.7

Robust standard errors in parentheses
* p<0.05, + p<0.1

[H]

OVERVALUATION	IPWRA		CBC		CBC - Freq. (%)	
	During	Post	During	Post	Positive	Negative
I_Struc	-4.315	-11.932*	0.591	-0.388	52.3	47.7
I_share	-0.742*	-0.666	-0.116	-0.044	45.2	54.8
G_share	0.087	-0.178	-0.412*	-0.839*	44.6	55.4
C_share	0.531	0.663	1.379*	2.217*	47.8	52.2
sharecomm	1.307+	1.660	2.102*	3.030*	61.1	38.9
sharelowtech	-1.450*	-2.243*	-1.822*	-3.941*	13.8	86.2
sharenatres	0.577	1.618+	-0.119	0.636	71.8	28.2
sharehightech	-0.569	-2.140	-0.329	-1.065*	28	72
sharemediumtech	0.006	0.289	0.168	0.379	64.1	35.9
shareKgoodsM	0.258	0.383	0.569*	0.906*	72.2	27.8
shareintgoodsM	-0.625	-0.480	-2.244*	-2.078*	34.2	65.8
shareconsgoodsM	0.371	0.355	1.362*	1.056*	59.4	40.6
Serv_emp	0.480+	1.579*	0.310	0.574	70	30
Man	-0.046	0.040	-0.522*	-0.771+	42.9	57.1

Table 6: Average results - Low income countries

UNDERVALUATION							
	IPWRA		**CBC**		**CBC - Freq.**		
	During	**Post**	**During**	**Post**	**Cases**	**Positive (%)**	**Negative (%)**
I_Struc	6.841	15.344*	1.897	13.274	18	77.8	22.2
I_Other	21.559*	43.887*	13.186	32.568+	14	71.4	28.6
I_TraEq	15.596*	21.429	9.620	2.699	21	71.4	28.6
I_Mach	13.374*	19.625*	18.990*	20.911*	24	95.8	4.2
C_share	-1.529+	-2.194	-0.825	0.129	25	36	64
sharenesM	-0.761*	-1.216*	-0.591	-0.818	6	16.7	83.3
wage_share	-0.553	-0.629	-0.834+	-0.734	10	20	80
Serv	-0.817	-0.400	-1.247+	-2.754*	18	38.9	61.1
Ind_emp	0.927	2.552	0.889*	2.006*	6	66.7	33.3
shareKgoodsM	-0.419	0.000	0.482	0.229	10	90	10
sharemediumtech	0.500	1.886	-0.246	-0.618	11	63.6	36.4
sharenatres	0.684	3.137	0.390	0.685	15	60	40
Serv_emp	-0.708	-0.928	0.323	-0.470	4	25	75

Robust standard errors in parentheses
* p<0.05, + p<0.1

OVERVALUATION							
	IPWRA		**CBC**		**CBC - Freq.**		
	During	**Post**	**During**	**Post**	**Cases**	**Positive (%)**	**Negative (%)**
C_share	1.832*	3.672*	1.690*	3.479*	30	46.7	53.3
G_share	-0.765*	-0.857*	-1.141*	-1.494*	33	36.4	63.6
I_share	-0.954	-1.653+	-0.649	-1.291+	21	47.6	52.4
eci	-11.280*	-7.155	-8.500*	-11.800*	22	31.8	68.2
shareKgoodsM	1.302+	1.137	1.102+	1.426+	7	85.7	14.3
shareintgoodsM	-0.680	-0.525	-2.216*	-1.975+	10	30	70

Table 7: Average results - Middle income countries

UNDERVALUATION							
	IPWRA		**CBC**		**CBC - Freq.**		
	During	**Post**	**During**	**Post**	**Cases**	**Positive (%)**	**Negative (%)**
I_TraEq	-15.697*	5.203	-14.858	-3.548	8	37.5	62.5
eci	-4.822	-11.168+	0.007	-0.034	18	33.3	66.7
I_Struc	-10.191*	-10.240	-9.113+	-8.507	8	25	75
wage_share	-1.263+	-0.648	-1.457*	-1.141	9	55.6	44.4
sharehightech	-0.930*	-2.059*	-0.897*	-3.307*	6	33.3	66.7
I_Mach	-4.135	2.542	-5.149	-3.401	8	37.5	62.5
shareintgoodsM	0.343	-1.794	0.379	-1.136	11	18.2	81.8
shareconsgoodsM	-0.054	1.097	-0.573	0.603	15	66.7	33.3
Agr	0.200	0.499	0.503	0.426	6	83.3	16.7
hhi	1.923	2.899	0.000	0.018	11	63.6	36.4

Robust standard errors in parentheses
* p<0.05, + p<0.1

OVERVALUATION							
	IPWRA		**CBC**		**CBC - Freq.**		
	During	**Post**	**During**	**Post**	**Cases**	**Positive (%)**	**Negative (%)**
wage_share	0.731*	0.202	0.694*	0.462	19	63.2	36.8
Man	-0.368	-1.432*	-0.244	-0.635	15	40	60
I_Struc	-4.398	-15.266+	0.669	0.918	11	45.5	54.5
shareintgoodsM	-0.500	0.284	-2.710*	-1.983+	14	35.7	64.3
shareconsgoodsM	0.422	0.409	1.516*	1.098+	11	63.6	36.4
sharelowtech	-0.599	-1.923	-1.384*	-4.018*	9	33.3	66.7
hhi	0.386	1.971	0.024+	0.054*	13	69.2	30.8

Table 8: Average results - High income countries

UNDERVALUATION							
	IPWRA		**CBC**		**CBC - Freq.**		
	During	**Post**	**During**	**Post**	**Cases**	**Positive (%)**	**Negative (%)**
I	3.624	13.117+	-0.422	1.182	6	66.7	33.3
wage_share	-1.274*	-0.737	-1.073*	-1.204*	14	7.1	92.9
shareintgoodsM	1.480*	0.028	0.186	-0.325	5	60	40
shareconsgoodsM	-0.943*	-0.293	-1.235*	-1.357*	8	0	100
sharemediumtech	-1.725+	-1.026	-1.888*	-2.566*	8	12.5	87.5
C_share	-0.996+	-2.379*	-1.031*	-3.077*	10	20	80
shareKgoodsM	-0.503	-0.400	0.276	0.967*	10	90	10
sharecomm	1.447	0.756	2.966*	2.871*	7	71.4	28.6
sharehightech	-0.086	-0.169	-1.087+	-0.839	5	20	80
I_Mach	-4.782	-8.943	-8.475*	-16.711*	2	50	50

Robust standard errors in parentheses
* p<0.05, + p<0.1

OVERVALUATION							
	IPWRA		**CBC**		**CBC - Freq.**		
	During	**Post**	**During**	**Post**	**Cases**	**Positive (%)**	**Negative (%)**
Serv	0.884*	0.657+	2.457*	2.497*	3	100	0
wage_share	0.345*	-0.438	0.387*	-0.423	15	46.7	53.3
I_TraEq	-12.332	-25.491*	-3.103	-8.861	9	11.1	88.9
I_Struc	-7.469	-20.608*	4.775	-3.854	6	50	50
sharemediumtech	-0.983	-2.630*	0.352	0.022	18	44.4	55.6
G_share	0.832*	1.155+	0.578+	0.835+	4	100	0
I_share	-0.882	-1.284*	-0.193	-0.562	13	30.8	69.2
shareintgoodsM	-0.971	-1.111	-1.718*	-2.121*	14	35.7	64.3
shareconsgoodsM	0.819	0.509	2.008*	1.618*	11	63.6	36.4
sharecomm	1.359	2.889	1.797*	3.850*	14	85.7	14.3
sharelowtech	-0.346	-0.192	-2.447*	-4.251*	14	0	100
I_Other	-9.675	-18.464	-9.060+	-16.805+	13	30.8	69.2

Figure 13: Effect of the undervaluation episode in Korea, 1961

Comparison between Korea and Synthetic control

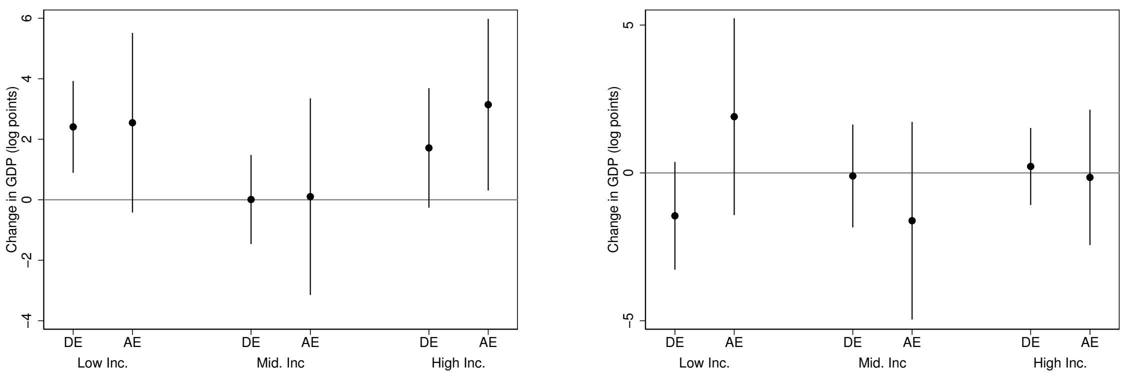
Simple local projection regression

As can be seen in figures 14 and 15, the main results also hold using this method. Both low and high income countries benefit from undervaluation periods in terms of GDP, although positive effects on capital are obtained only by low income countries. The effects of overvaluations are again statistically non-significant, but the estimation indicates that the effects tend to be slightly worse for middle-income countries.

Figure 14: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP (control created as a synthetic control) - average effect by income group

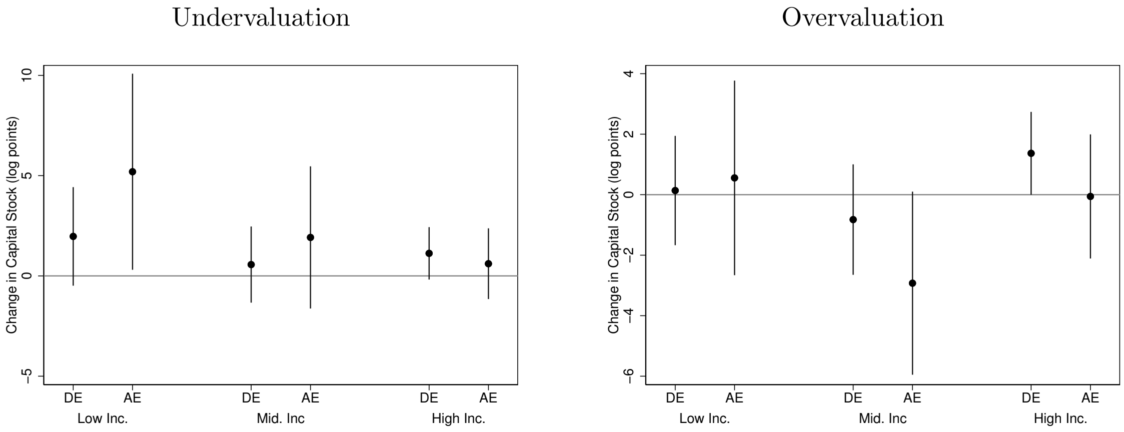
Undervaluation

Overvaluation



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 15: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital (control created as a synthetic control) - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

2.6.2 Commodity exports

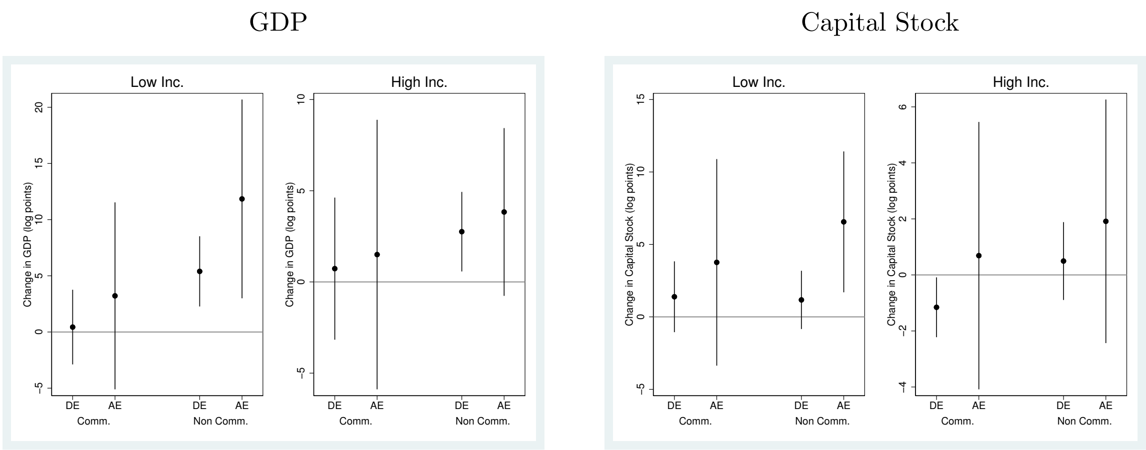
To check if the effect of real exchange rate misalignment is conditional on the type of exports a country is specialized, we analyze the effects depending on the share of commodities on exports. Given the large negative correlation between GDP and importance of commodities on the exports basket, we also sub-divide the groups of exports type between *low income* (those that have are low or low-middle income according to the World Bank classification) and *high income* (middle-high or high income according to the World Bank). Given this important correlation, and in order to have a more balanced sample, we adopt different thresholds in each income group. Low income countries are considered specialized in commodities exports if its share is larger than 50% (in the year of the begining of the episode); for high income countries, the threshold is 25%.

The results presented in this section follow are baseline method (IPWRA)[19]. Staked data (CBC) estimations can be found on appendix D.

Preliminary observation of the results indicate that non-commodity exports have a better result in face of an undervaluation, particularly within low income countries and in terms of GDP (less in terms of capital stock). In the case of overvaluation episodes, countries specialized in commodities export also tend to be more negatively affected.

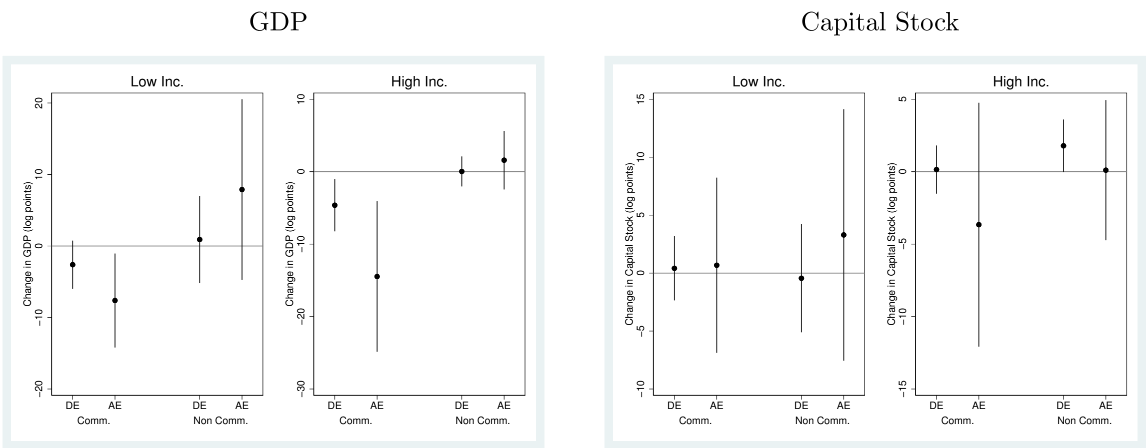
[19]For each of the estimations, the same procedure to find relevant variables to be used in the propensity-score are performed.

Figure 16: Semiparametric estimates of the over-time effects of real exchange rate undervaluation episodes - average effect by type of exports and income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 17: Semiparametric estimates of the over-time effects of real exchange rate overvaluation episodes - average effect by type of exports and income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

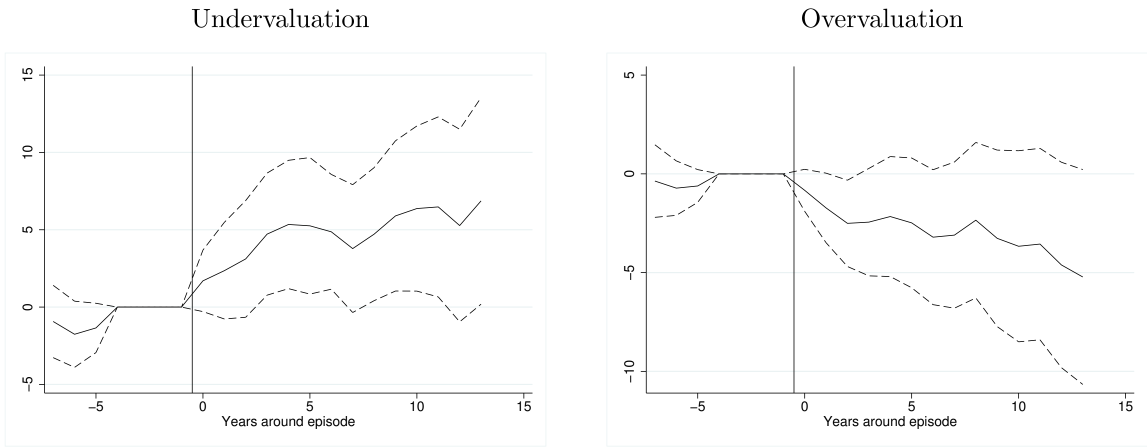
2.6.3 Criteria

Again, we present the estimates for our baseline method (IPWRA). Estimations using the CBC method can be found in appendix E.

More strict misalignment criteria

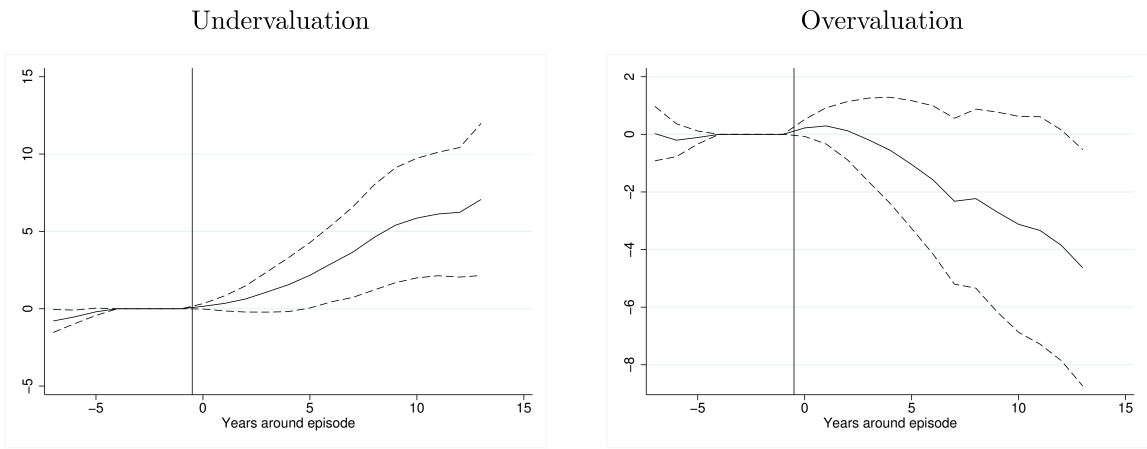
We increase the required misalignment to 20%, instead of the baseline level of 10%. The number of undervaluation episodes drop to 122, and to 128 in the overvaluation cases. It is interesting to note that the general effects (for both GDP and capital) are very similar, indicating that above some level, marginal RER misaligments are not significant. The results by income level are also very similar, with minor differences: the positive effect of undervaluation on high income countries is lower, and the negative effect of overvaluation on middle income ones is higher.

Figure 18: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP.



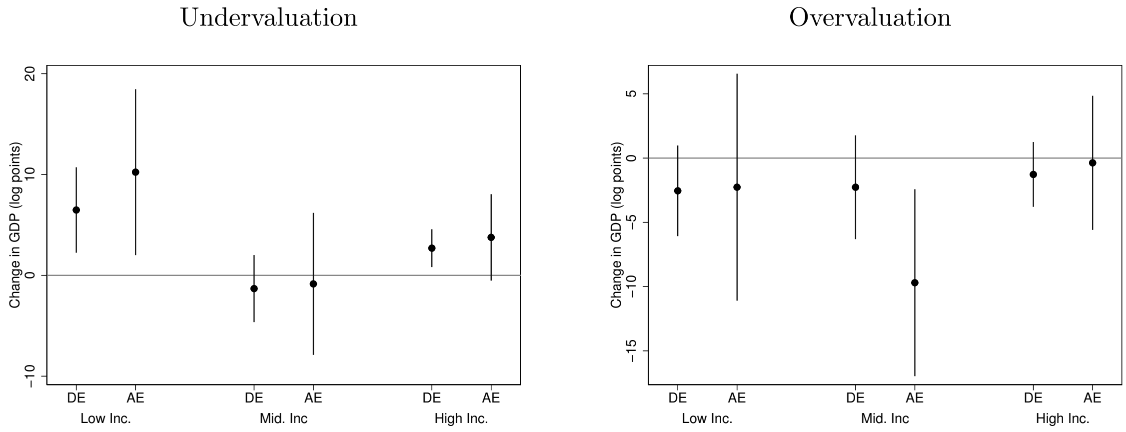
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 19: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock.



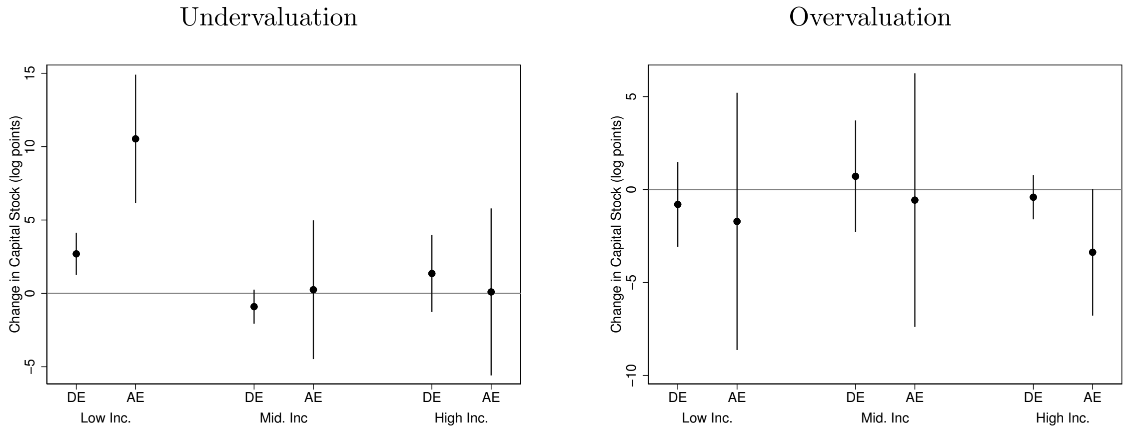
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 20: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 21: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



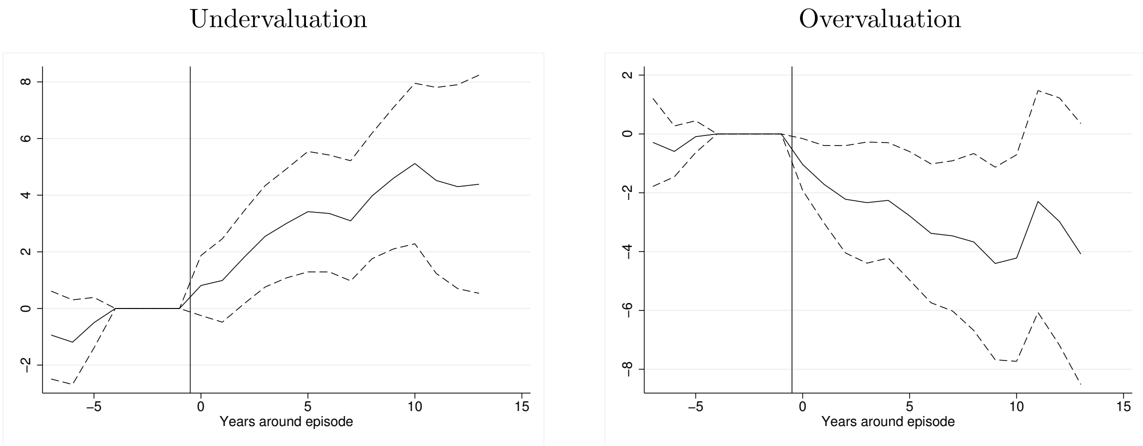
DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Less strict misalignment criteria

Decreasing the required misalignment to 5%, instead of the baseline level of 10%, we get 226 cases of undervaluation and 282 of overvaluation. It is striking to note that even with a relatively loose criteria that gives us a large number of episodes, the results are very similar. Quantitatively, the estimations tend to be slightly smaller for the increase of GDP and capital stock in the case of undervaluation. The results by income level are also very similar, with the difference that the positive effect of undervaluation being lower for high income countries.

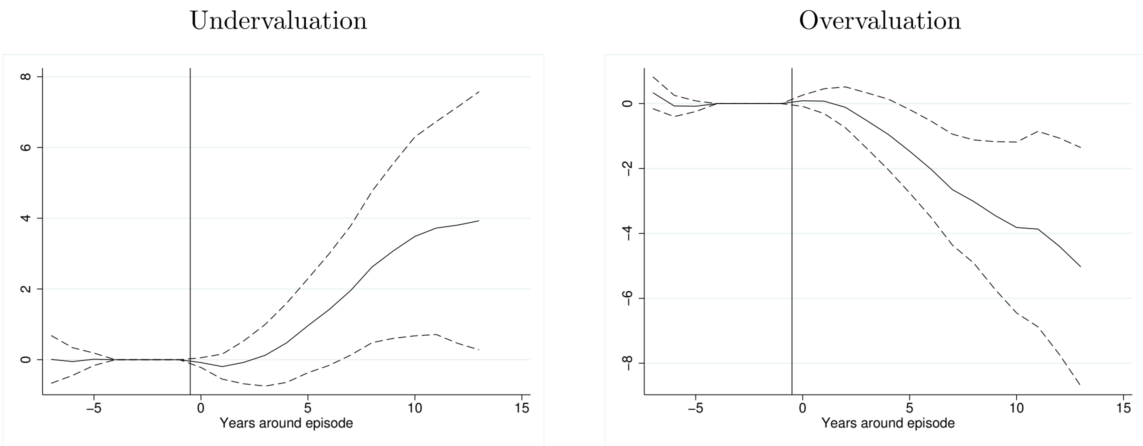
It is interesting to note that the for overvaluation, the general negative effect on GDP is slightly larger, related to the stronger negative effect on middle and high income groups for both GDP and capital stock.

Figure 22: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP.



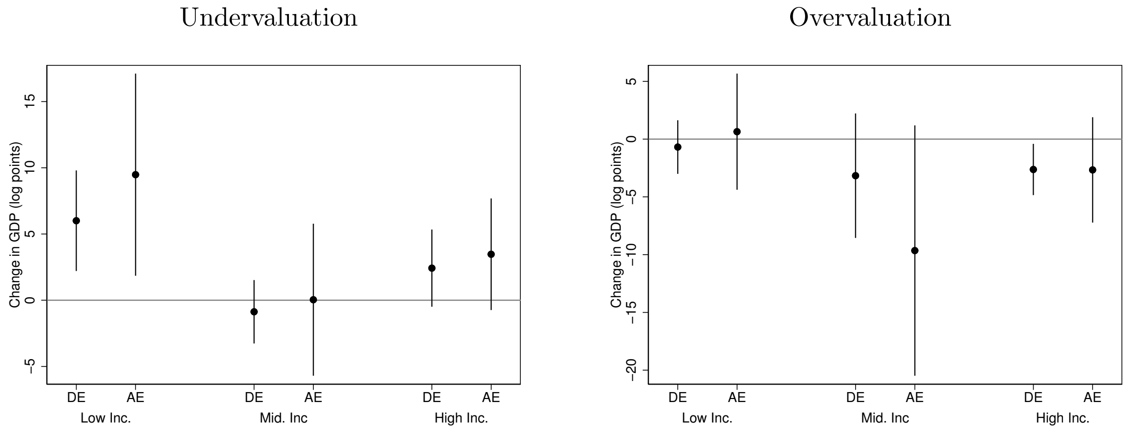
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 23: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock.



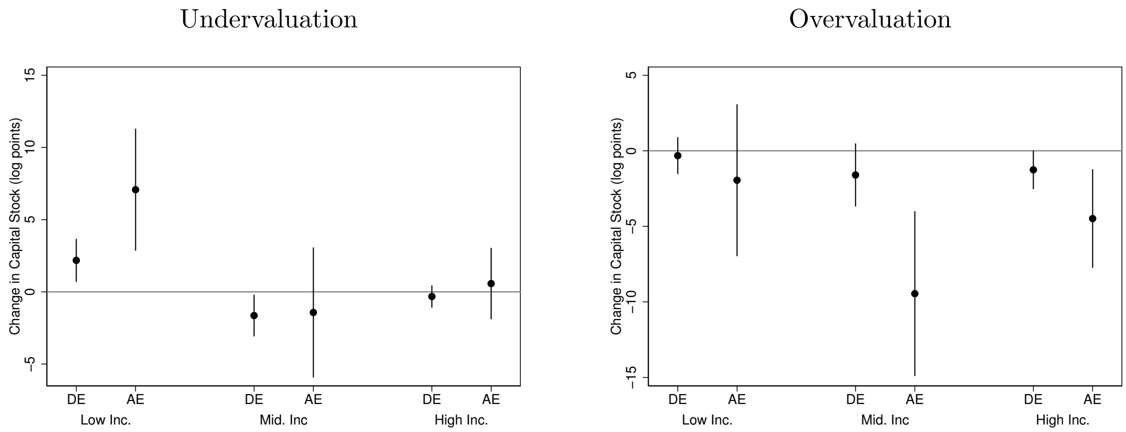
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 24: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 25: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



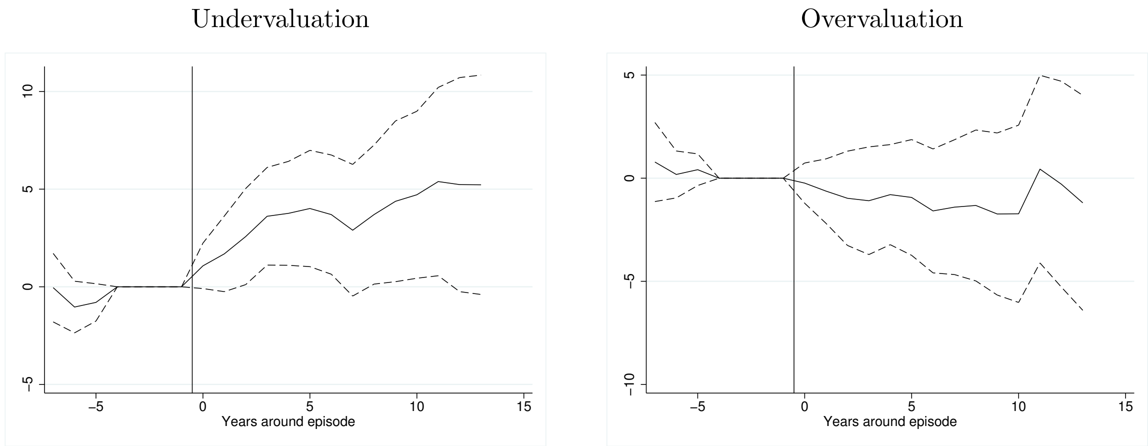
DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Less strict volatility criteria

To test the implication of the volatility criteria, we check how the estimations react within a one standard deviation of the volatility distribution. That is, we calculate the standard deviation of the standard deviation of the episodes that comply with the criteria one (a 10% misalignment of the RER), and use it to create a less strict criteria (a half standard deviation higher volatility - 0.19 for undervaluation cases, and 0.13 for overvaluation ones) and a stricter one (0.12 for undervaluation, and 0.08 for overvaluation), presented in the next subsection.

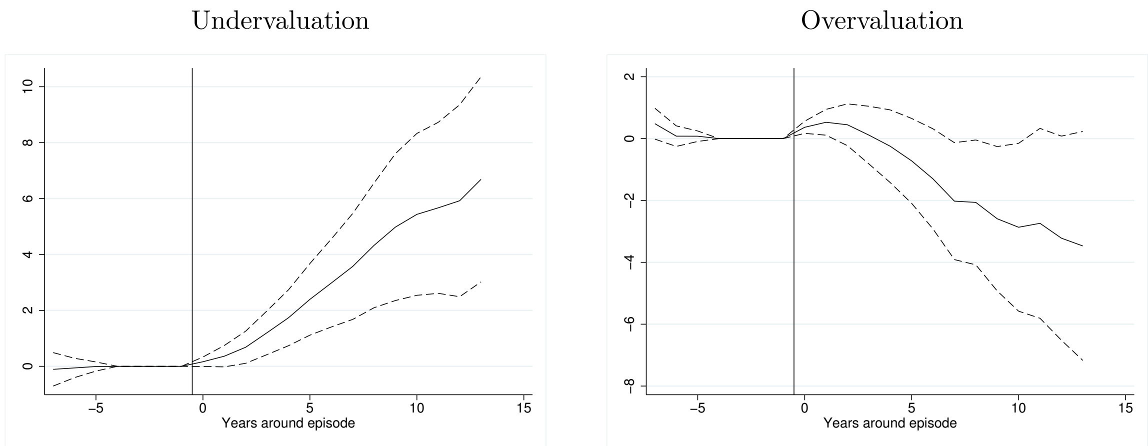
Using the less strict criteria, we have 191 undervaluation episodes and 233 overvaluation ones. The general effects on capital stock and GDP are again very similar for both types of misalignment. For the effects by income group, there is a significant reduction in the positive effect of undervaluation after the episode for low income countries.

Figure 26: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP.



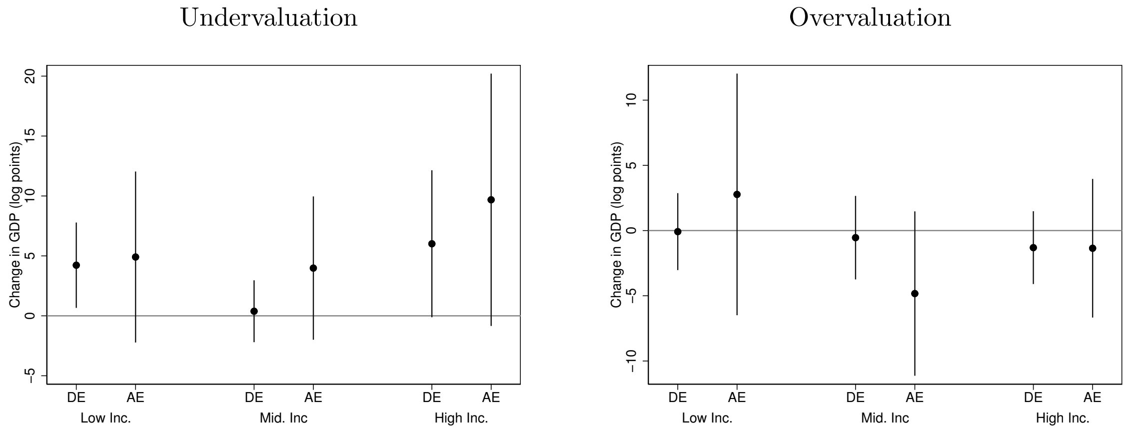
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 27: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock.



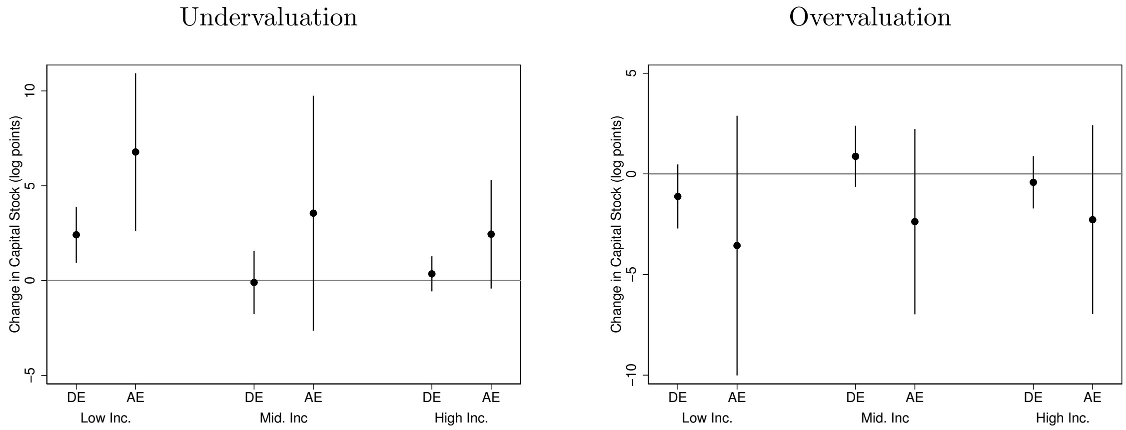
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 28: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 29: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



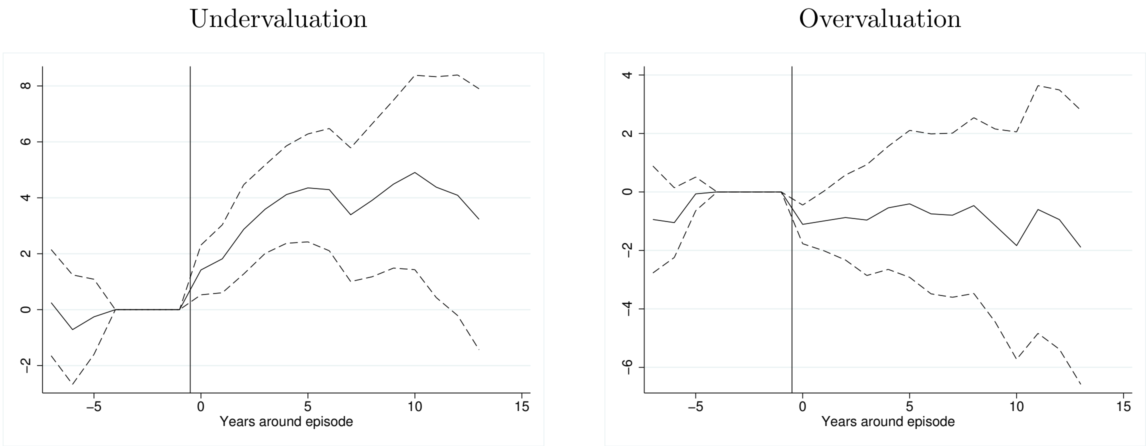
DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

More strict volatility criteria

With a more strict volatility criteria (half standard deviation lower, as indicated above), the number of undervaluation cases drop to 162, and to 213 for overvaluation ones. Again, the overall effects are very similar, although slightly smaller. The results by income level, however, change qualitatively for the undervaluation cases. Now, middle income countries also have a significant positive effect during the episode of about the same size of one for low income countries, and the positive effect for the high income group is reduced. The qualitative results for overvaluations are the same as the baseline ones.

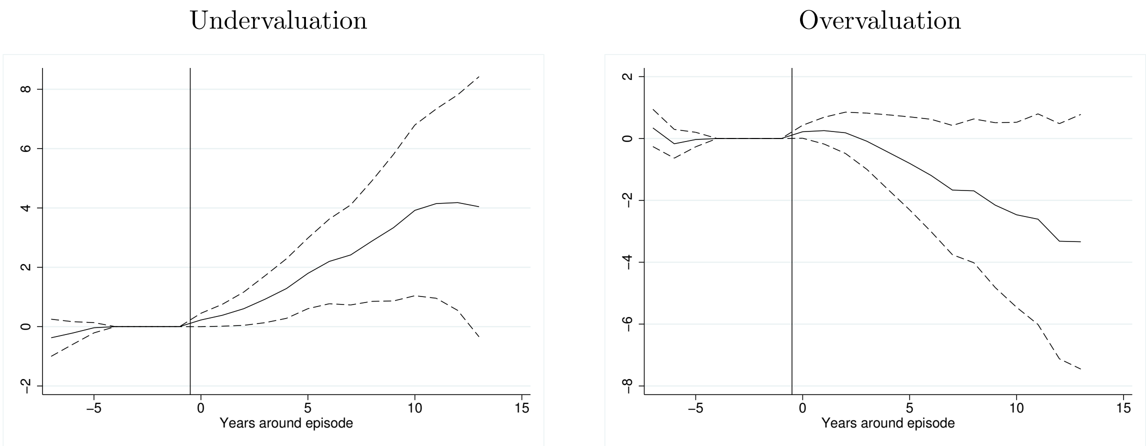
This more strict criteria affects particularly middle income undervaluation episodes, leading to a 22.6% reduction in their occurence; for low income countries, the reduction is of 13.3%. It is interesting to note that the profile of episodes dropped by the new criteria are exactly the opposite for these two groups: those dropped within the low income group are those with more positive effects, particularly after the episode, while in the case of the middle income group, those with neutral or negative effects are the ones dropped. DISCUSS MORE?

Figure 30: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP.



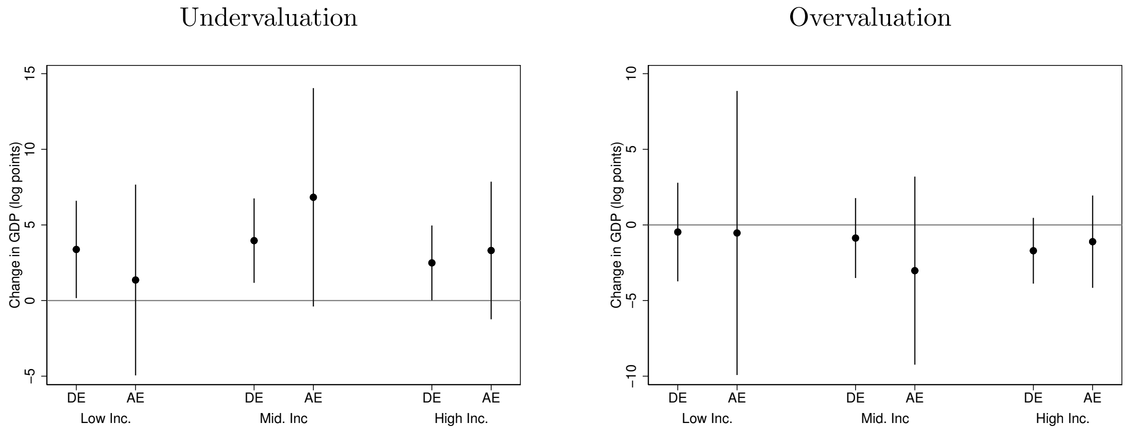
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 31: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock.



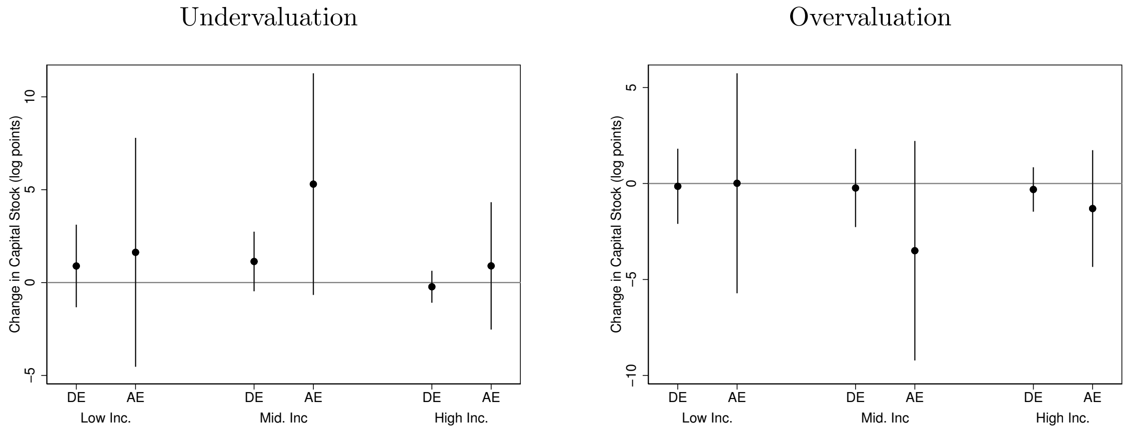
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 32: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

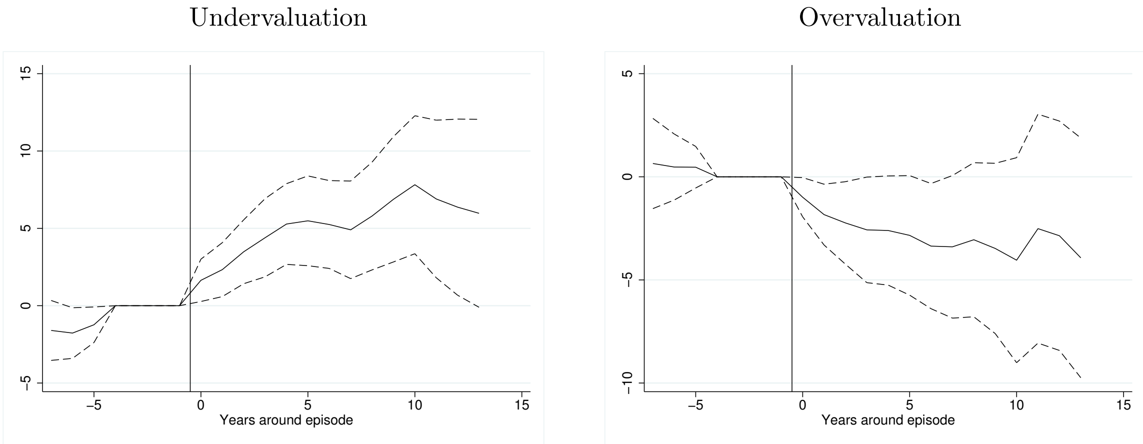
Figure 33: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

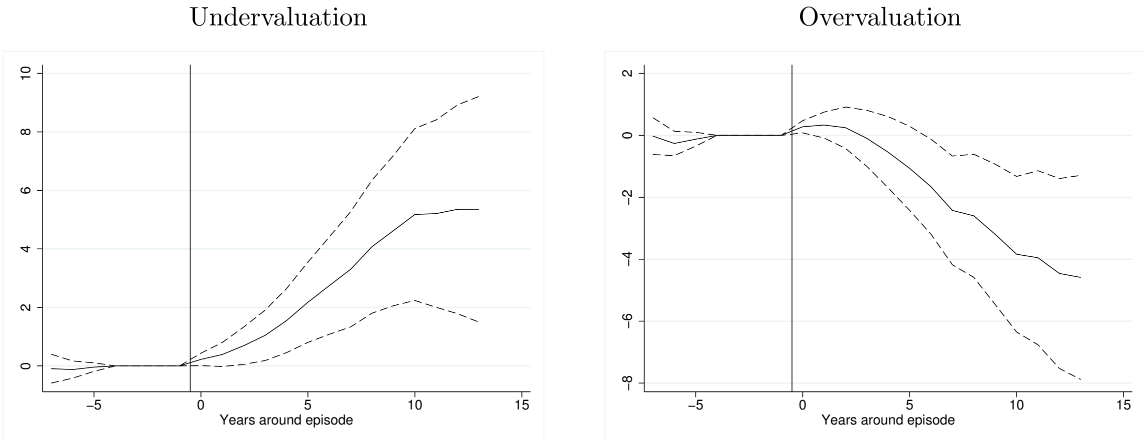
Given that important change in the results for undervaluation by income group, we test an additional threshold, intermediary between the baseline case and the most strict one (a 25% standard deviation, with the threshold for the volatility being 0.135 to undervaluation cases and 0.1 to overvaluation ones (both in S.D.)). Now income group 1 has 8.9% less (undervaluation) episodes than the baseline case and middle income countries have 14.5% less cases. The general results continue to hold, and qualitatively the results by income are also in line with the baseline case. The positive effects are already slightly smaller for the low income group and higher for the middle income one, indicating some continuity in the process of exclusion of episodes with more positive outcome for poorer countries and the opposite for middle income ones.

Figure 34: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP.



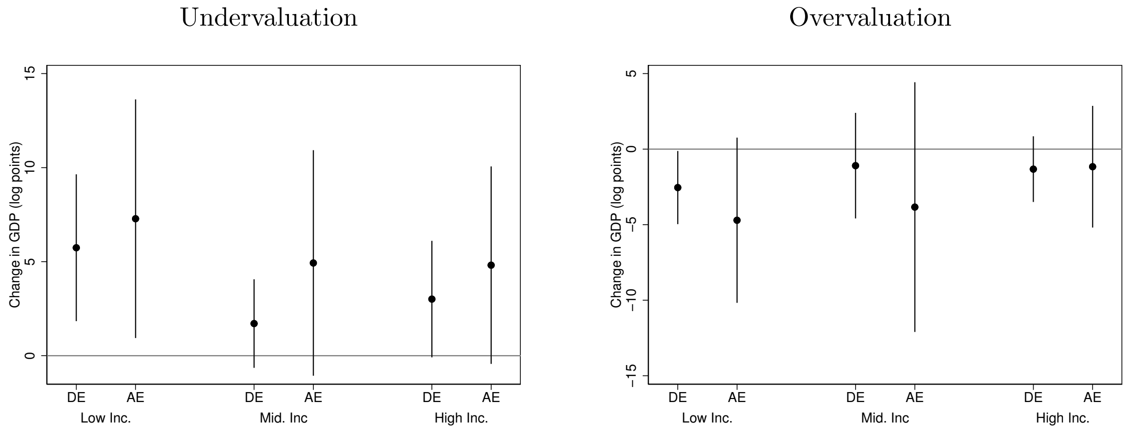
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 35: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock.



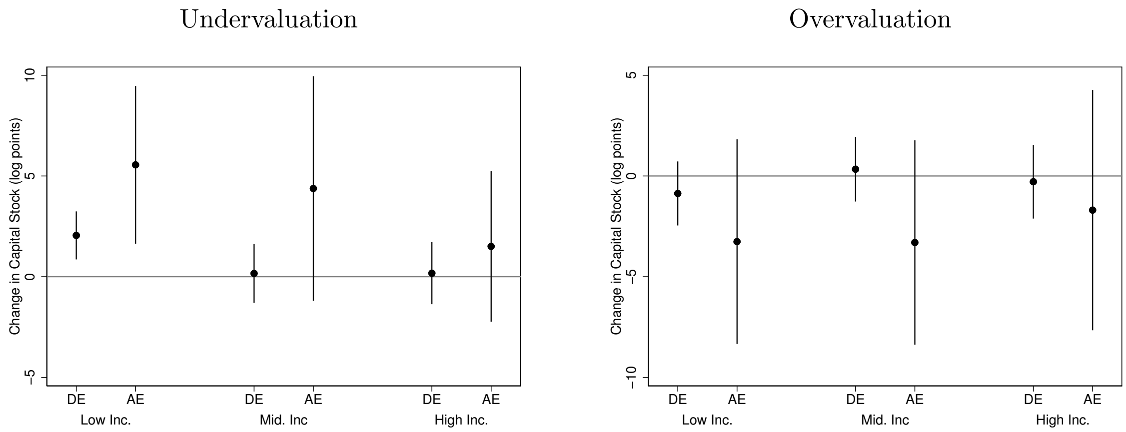
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 36: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 37: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

3 Conclusion

The effect of the real exchange rate on economic development, in particular its manipulation, has been a disputable topic for a long time, with a revival of the interest on the issue in the recent decade after a period of partial ostracism. Given the existance of theoretical channels that have positive and negative effects with under and overvaluations generating uncertainty about the overall effect, empirical research has taken the lead. As indicated, most of the literature has been founding positive effects on GDP of real exchange rate undervaluations and negative for overvaluations; however, these results are far from consensual.

In this paper we show that sustained real exchange rate misalignments have long-run consequences. The qualitative converge of results from different methods and criteria to define both the episodes and the controls give us confidence in the results. Undervaluations increase GDP per capita and the capital stock, while overvaluations affect negatively the capital stock (the effects on GDP per capita are also negative but on average non-significant at 90% of confidence). Morevoer, the effects are heterogeneous among income groups; the positive effects on GDP take place only on low and high income countries, with the final effect after 14 years surpassing 10 percent on both cases; positive effects on capital stock, however, are only seem on low income countries. Another finding of the paper is that this heterogeneity, particularly of the undervaluation episodes, relies on the degree of volatility of the misalignments episodes - when the volatility criteria becomes more strict, the average positive effect on middle income countries increase, while the one of the low income group decreases. The paper also demonstrates that countries that are relatively (compared to countries in the same income level) less specialized in commodities have a better outcome in face of exchange rate misaligments.

We belive the results achieved are particularly important given the use a multitude of recent methods that deal with important endogeneity issues, making the results robust to the most common critiques. A second contribution of the paper is to analyze episodes of sustained real exchange rate misalignments, which is particularly important for the reasons presented in the introduction. As demonstrated, the overall results are robust to changes in the criteria.

Finally, the paper also advances in a direction under explored within the literature, the effects of misaligments on structural parameters of the economies, such as components of GDP, types of exports and imports, functional distribution, and types of investments. In general, undervaluation episodes promote an increase in the share of exports and a decrease in the consumption one; a reduction in the wage-share and the relative size of the services sector; an increase in investment, particularly in machinery; and a rebalancing of imports away from consumption goods and towards intermediate and capital goods. Overvaluation episodes have a negative effect on investment, particularly on physical structures; is a associated with an increase in the consumption share; increase the share of commodities and natural-resources on the exports, while reduces the share of both low and tech manufactures; relatively increases the services sector (at least in employment terms) and decrease the manufacturing one; and also shift imports towards capital and consumption goods and against intermediate ones.

References

Abadie, A. (2021). "Using synthetic controls: Feasibility, data requirements, and methodological aspects". In: *Journal of Economic Literature* 59.2, pp. 391–425.

Acemoglu, D. et al. (2019). "Democracy does cause growth". In: *Journal of political economy* 127.1, pp. 47–100.

Angrist, J. D. and Kuersteiner, G. M. (2011). "Causal effects of monetary shocks: Semiparametric conditional independence tests with a multinomial propensity score". In: *Review of Economics and Statistics* 93.3, pp. 725–747.

Arellano, M. and Bond, S. (1991). "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations". In: *The review of economic studies* 58.2, pp. 277–297.

Arkhangelsky, D. et al. (2019). *Synthetic difference in differences.* Tech. rep. National Bureau of Economic Research.

Baldwin, R. and Krugman, P. (1989). "Persistent trade effects of large exchange rate shocks". In: *The Quarterly Journal of Economics* 104.4, pp. 635–654.

Bénassy-Quéré, A., Bussière, M., and Wibaux, P. (2021). "Trade and currency weapons". In: *Review of International Economics* 29.3, pp. 487–510.

Benigno, G., Converse, N., and Fornaro, L. (2015). "Large capital inflows, sectoral allocation, and economic performance". In: *Journal of International Money and Finance* 55, pp. 60–87.

Berg, A., Ostry, J. D., and Zettelmeyer, J. (2012). "What makes growth sustained?" In: *Journal of Development Economics* 98.2, pp. 149–166.

Bista, R. and Sheridan, B. J. (2021). "Economic growth takeoffs and the extensive and intensive margins of trade". In: *Review of Development Economics.*

Born, B. et al. (2019). "The costs of economic nationalism: evidence from the Brexit experiment". In: *The Economic Journal* 129.623, pp. 2722–2744.

Callaway, B. and Sant'Anna, P. H. (2020). "Difference-in-differences with multiple time periods". In: *Journal of Econometrics.*

Cengiz, D. et al. (2019). "The effect of minimum wages on low-wage jobs". In: *The Quarterly Journal of Economics* 134.3, pp. 1405–1454.

Cerra, M. V. and Woldemichael, M. T. (2017). *Launching export accelerations in Latin America and the world.* International Monetary Fund.

Corden, W. M. and Neary, J. P. (1982). "Booming sector and de-industrialisation in a small open economy". In: *The economic journal* 92.368, pp. 825–848.

Demir, F. and Razmi, A. (2021). "The real exchange rate and the development: theory, evidence, issues and challenges". In: *Journal of Economic Surveys*.

Di Nino, V., Eichengreen, B., and Sbracia, M. (2011). "Real exchange rates, trade, and growth: Italy 1861-2011". In: *Bank of Italy Economic History Working Paper* 10.

Dube, A. and Zipperer, B. (2015). "Pooling Multiple Case Studies Using Synthetic Controls: An Application to Minimum Wage Policies". In.

Dutt, P., Mihov, I., and Van Zandt, T. (2013). "The effect of WTO on the extensive and the intensive margins of trade". In: *Journal of international Economics* 91.2, pp. 204–219.

Ferman, B. and Pinto, C. (2019). "Inference in differences-in-differences with few treated groups and heteroskedasticity". In: *Review of Economics and Statistics* 101.3, pp. 452–467.

Ferman, B., Pinto, C., and Possebom, V. (2020). "Cherry picking with synthetic controls". In: *Journal of Policy Analysis and Management* 39.2, pp. 510–532.

Fitzgerald, D. and Haller, S. (2018). "Exporters and shocks". In: *Journal of International Economics* 113, pp. 154–171.

Fontagné, L., Martin, P., and Orefice, G. (2018). "The international elasticity puzzle is worse than you think". In: *Journal of International Economics* 115, pp. 115–129.

Freund, C. and Pierola, M. D. (2012). "Export surges". In: *Journal of Development Economics* 97.2, pp. 387–395.

Gala, P. (2007). "Real exchange rate levels and economic development: theoretical analysis and econometric evidence". In: *Cambridge Journal of economics* 32.2, pp. 273–288.

Girardi, D., Paternesi Meloni, W., and Stirati, A. (2020). "Reverse hysteresis? Persistent effects of autonomous demand expansions". In: *Cambridge Journal of Economics* 44.4, pp. 835–869.

Goya, D. (2020). "The exchange rate and export variety: A cross-country analysis with long panel estimators". In: *International Review of Economics & Finance* 70, pp. 649–665.

Guzman, M., Ocampo, J. A., and Stiglitz, J. E. (2018). "Real exchange rate policies for economic development". In: *World Development* 110, pp. 51–62.

Habib, M. M., Mileva, E., and Stracca, L. (2017). "The real exchange rate and economic growth: Revisiting the case using external instruments". In: *Journal of International Money and Finance* 73, pp. 386–398.

Hausmann, R., Pritchett, L., and Rodrik, D. (2005). "Growth accelerations". In: *Journal of economic growth* 10.4, pp. 303–329.

Ilzetzki, E., Reinhart, C. M., and Rogoff, K. S. (2019). "Exchange arrangements entering the twenty-first century: Which anchor will hold?" In: *The Quarterly Journal of Economics* 134.2, pp. 599–646.

Imbens, G. W. and Wooldridge, J. M. (2009). "Recent developments in the econometrics of program evaluation". In: *Journal of economic literature* 47.1, pp. 5–86.

Jordà, Ò. (2005). "Estimation and inference of impulse responses by local projections". In: *American economic review* 95.1, pp. 161–182.

Jordà, Ò. and Taylor, A. M. (2016). "The time for austerity: estimating the average treatment effect of fiscal policy". In: *The Economic Journal* 126.590, pp. 219–255.

Korinek, A. and Serven, L. (2016). "Undervaluation through foreign reserve accumulation: Static losses, dynamic gains". In: *Journal of International Money and Finance* 64, pp. 104–136.

Krugman, P. (1987). "The narrow moving band, the Dutch disease, and the competitive consequences of Mrs. Thatcher: Notes on trade in the presence of dynamic scale economies". In: *Journal of development Economics* 27.1-2, pp. 41–55.

Levy-Yeyati, E., Sturzenegger, F., and Gluzmann, P. A. (2013). "Fear of appreciation". In: *Journal of Development Economics* 101, pp. 233–247.

Libman, E., Montecino, J. A., and Razmi, A. (2019). "Sustained investment surges". In: *Oxford Economic Papers* 71.4, pp. 1071–1095.

Matsuyama, K. (1991). "Increasing returns, industrialization, and indeterminacy of equilibrium". In: *The Quarterly Journal of Economics* 106.2, pp. 617–650.

McMillan, M. S. and Rodrik, D. (2011). *Globalization, structural change and productivity growth.* Tech. rep. National Bureau of Economic Research.

Melitz, M. J. (2003). "The impact of trade on intra-industry reallocations and aggregate industry productivity". In: *econometrica* 71.6, pp. 1695–1725.

Miao, Y. and Berg, M. A. (2010). *The real exchange rate and growth revisited: The Washington Consensus strikes back?* International Monetary Fund.

Prasad, E., Rajan, R., and Subramanian, A. (2007). "Foreign Capital and Economic Growth". In: *Brookings Papers on Economic Activity* 38.1, pp. 153–230.

Rapetti, M. (2013). "Macroeconomic policy coordination in a competitive real exchange rate strategy for development". In: *Journal of Globalization and Development* 3.2, pp. 1–31.

Rapetti, M. (2020). “The real exchange rate and economic growth: A survey”. In: *Journal of Globalization and Development* 11.2.

Rapetti, M., Skott, P., and Razmi, A. (2012). “The real exchange rate and economic growth: are developing countries different?” In: *International Review of Applied Economics* 26.6, pp. 735–753.

Razmi, A., Rapetti, M., and Skott, P. (2012). “The real exchange rate and economic development”. In: *Structural Change and Economic Dynamics* 23.2, pp. 151–169.

Rodrik, D. (2008). “The real exchange rate and economic growth”. In: *Brookings papers on economic activity* 2008.2, pp. 365–412.

— (2016). “Premature deindustrialization”. In: *Journal of economic growth* 21.1, pp. 1–33.

Ros, J. (2015). *Development Macroeconomics in Latin America and Mexico: Essays on Monetary, Exchange Rate, and Fiscal Policies.* Springer.

Schröder, M. (2013). “Should developing countries undervalue their currencies?” In: *Journal of Development Economics* 105, pp. 140–151.

Sun, L. and Abraham, S. (2020). “Estimating dynamic treatment effects in event studies with heterogeneous treatment effects”. In: *Journal of Econometrics.*

Wooldridge, J. M. (2007). “Inverse probability weighted estimation for general missing data problems”. In: *Journal of econometrics* 141.2, pp. 1281–1301.

Appendices

A List of Variables

Table 9: List of variables

Variable	Definition	Source
GDP	GDP per capita at constant national prices	PWT 10.0
C	Consumption per capita at constant national prices	PWT 10.0
G	Government per capita at constant national prices	PWT 10.0
I	Investment per capita at constant national prices	PWT 10.0
X	Exports per capita at constant national prices	PWT 10.0
M	Imports per capita at constant national prices	PWT 10.0
lexpy_na	Sophistication index of the country's exports	Hoyos, Libman, and Razmi (2021)
lexpy_r	Sophistication index of the country's exports	Hoyos, Libman, and Razmi (2021)
I_Struc	Investment at constant national prices in residential and non-residential structures	PWT 10.0
I_Other	Investment at constant national prices in other assets	PWT 10.0
I_TraEq	Investment at constant national prices in transport equipment	PWT 10.0
I_Mach	Investment at constant national prices in machinery and (non-transport) equipment	PWT 10.0
K	Capital stock at constant national prices	PWT 10.0
wage_share	Share of labour compensation at in GDP at current national prices	PWT 10.0
shareKgoodsM	Share of capital goods imported	Hoyos, Libman, and Razmi (2021)
shareintgoodsM	Share of intermediate goods imported	Hoyos, Libman, and Razmi (2021)
shareconsgoodsM	Share of consumption goods imported	Hoyos, Libman, and Razmi (2021)
sharenesM	Share of other goods imported	Hoyos, Libman, and Razmi (2021)
sharecomm	Share of commodities exported	Hoyos, Libman, and Razmi (2021)
sharehightech	Share of high-tech manufactures exported	Hoyos, Libman, and Razmi (2021)
sharelowtech	Share of low-tech manufactures exported	Hoyos, Libman, and Razmi (2021)
sharemediumtech	Share medium-tech manufactures	Hoyos, Libman, and Razmi (2021)
sharenatres	Share of natural resource-based manufactures exported	Hoyos, Libman, and Razmi (2021)
shareothertrans	Share of other goods exported	Hoyos, Libman, and Razmi (2021)
C_share	Share of consumption on GDP	Authors' ellaboration based on PWT 10.0
G_share	Share of government on GDP	Authors' ellaboration based on PWT 10.0
I_share	Share of investment on GDP	Authors' ellaboration based on PWT 10.0
X_share	Share of exports on GDP	Authors' ellaboration based on PWT 10.0
M_share	Share of imports on GDP	Authors' ellaboration based on PWT 10.0
Agr	Agriculture, forestry, and fishing, VA (% GDP)	World Bank
Man	Manufacturing, VA (% GDP)	World Bank
Serv	Services, VA (% GDP)	World Bank
Serv_emp	Employment in services (% total)	World Bank
Agr_emp	Employment in agriculture (% total)	World Bank
Ind_emp	Employment in industry (% total)	World Bank
eci	Economic Complexity Index	Atlas of Economic Complexity
hhi	Exports diversification index (Herfindahl-Hirschman Index)	Hoyos, Libman, and Razmi (2021)

B Pre-treatment trend and Selection on Variables Assumption

Selection on Variables Assumption

Table 10: Undervaluation - General

	(1)	(2)
VARIABLES	treatment_aux	treatment_aux
lag4y	-1.247*	-1.277*
	(0.647)	(0.661)
lag3y	1.567*	1.652*
	(0.944)	(0.967)
lag2y	0.646	0.681
	(0.861)	(0.881)
lag1y	-1.051*	-1.142*
	(0.589)	(0.599)
lag1Mis	0.453**	0.458**
	(0.210)	(0.208)
lag2Mis	-0.258	-0.237
	(0.376)	(0.369)
lag3Mis	0.150	0.130
	(0.408)	(0.404)
lag4Mis	-1.291***	-1.304***
	(0.284)	(0.279)
lag1TB_share	0.938**	1.133**
	(0.453)	(0.454)
lag2TB_share	-0.079	-0.091
	(0.223)	(0.171)
lag3TB_share	0.187	0.067
	(0.324)	(0.184)
lag4TB_share	-0.219***	-0.243***
	(0.077)	(0.082)
cap_cont_index	0.189**	0.197**
	(0.090)	(0.090)
lag4tot	0.270	
	(0.362)	
lag3tot	0.297	
	(0.427)	
lag2tot	-0.281	
	(0.406)	
lag1tot	-0.461	
	(0.324)	
Constant	-0.276	-0.243
	(0.498)	(0.492)
Observations	3,753	3,753
Lags of GDP	0.0130	0.00732
Lags of REER Misaliagment	0	0
Lags of Trade Balance (% GDP)	0.0281	0.0124
Lags of ToT	0.246	
Pseudo R2	0.141	0.138

Table 11: Undervaluation - Low income countries

VARIABLES	(1) treat1	(2) treat1
lag4y	-2.987***	-2.943***
	(0.923)	(0.924)
lag3y	2.349*	2.250
	(1.406)	(1.410)
lag2y	1.131	1.338
	(1.338)	(1.316)
lag1y	-0.871	-1.009
	(0.860)	(0.851)
lag1Mis	0.434	0.444
	(0.290)	(0.293)
lag2Mis	-0.478	-0.493
	(0.482)	(0.491)
lag3Mis	0.229	0.201
	(0.621)	(0.635)
lag4Mis	-1.032**	-0.992**
	(0.444)	(0.446)
lag1TB_share	0.820	0.941
	(0.827)	(0.868)
lag2TB_share	0.537	0.359
	(0.829)	(0.861)
lag3TB_share	0.139	0.129
	(0.200)	(0.169)
lag4TB_share	-0.326***	-0.288***
	(0.094)	(0.094)
cap_cont_index	0.139	0.134
	(0.115)	(0.115)
lag4tot	-0.453	
	(0.456)	
lag3tot	1.035*	
	(0.565)	
lag2tot	-0.244	
	(0.503)	
lag1tot	-0.175	
	(0.480)	
Constant	2.190***	2.078***
	(0.736)	(0.725)
Observations	1,794	1,794
Lags of GDP	7.37e-08	1.68e-07
Lags of REER Misaliagment	1.31e-05	1.41e-05
Lags of Trade Balance (% GDP)	0.00425	0.00522
Lags of ToT	0.344	
Pseudo R2	0.172	0.168

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Undervaluation - Middle income countries

	(1)	(2)	(3)	(4)
VARIABLES	treat3	treat3	treat3	treat3
lag4y	0.214	0.182		
	(0.584)	(0.609)		
lag3y	0.544	0.567		
	(0.855)	(0.855)		
lag2y	-0.328	-0.274		
	(0.761)	(0.770)		
lag1y	-0.381	-0.407		
	(0.563)	(0.549)		
lag1Mis	0.038	0.051	0.019	0.090
	(0.295)	(0.297)	(0.291)	(0.278)
lag2Mis	0.275	0.284	0.288	0.264
	(0.510)	(0.495)	(0.522)	(0.508)
lag3Mis	-0.085	-0.093	-0.120	-0.030
	(0.538)	(0.516)	(0.542)	(0.513)
lag4Mis	-0.705**	-0.697**	-0.620*	-0.717**
	(0.350)	(0.339)	(0.328)	(0.317)
lag1TB_share	0.689			
	(0.605)			
lag2TB_share	-0.460			
	(0.947)			
lag3TB_share	0.419			
	(1.218)			
lag4TB_share	-0.369			
	(0.663)			
cap_cont_index	0.277*	0.267*	0.255*	0.285**
	(0.149)	(0.150)	(0.146)	(0.142)
lag4tot	0.606	0.688	0.714	
	(0.469)	(0.469)	(0.461)	
lag3tot	-0.502	-0.561	-0.556	
	(0.484)	(0.454)	(0.464)	
lag2tot	-0.086	-0.069	-0.091	
	(0.659)	(0.642)	(0.668)	
lag1tot	-0.440	-0.522	-0.540	
	(0.426)	(0.447)	(0.448)	
Constant	-1.782**	-1.999**	-1.402***	-1.467***
	(0.864)	(0.809)	(0.362)	(0.371)
Observations	1,646	1,646	1,646	1,646
Lags of GDP	0.551	0.507		
Lags of REER Misaliagment	0.000742	0.000817	0.00432	0.00344
Lags of Trade Balance (% GDP)	0.786			
Lags of ToT	0.206	0.146	0.125	
Pseudo R2	0.0841	0.0823	0.0792	0.0682

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 13: Undervaluation - High income countries

	(1)
VARIABLES	treat4
lag4y	5.692
	(3.983)
lag3y	-3.810
	(6.634)
lag2y	2.127
	(8.791)
lag1y	-2.242
	(6.366)
lag1Mis	5.807**
	(2.366)
lag2Mis	-6.699*
	(3.617)
lag3Mis	4.891
	(3.425)
lag4Mis	-6.175**
	(2.491)
lag1TB_share	22.305***
	(7.807)
lag2TB_share	-38.606***
	(9.664)
lag3TB_share	15.549**
	(6.596)
lag4TB_share	-2.148
	(5.499)
cap_cont_index	0.924**
	(0.361)
lag4tot	7.488**
	(3.356)
lag3tot	-2.553
	(4.150)
lag2tot	-4.259
	(3.399)
lag1tot	1.329
	(2.184)
Constant	-18.278***
	(5.700)
Observations	420
Lags of GDP	0.0164
Lags of REER Misaliagment	0.000718
Lags of Trade Balance (% GDP)	0.00249
Lags of ToT	0.0232
Pseudo R2	0.400

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 14: Overvaluation - General

VARIABLES	(1) treatment_aux	(2) treatment_aux
lag4y	0.521	
	(0.565)	
lag3y	0.246	
	(0.866)	
lag2y	-1.344*	
	(0.776)	
lag1y	0.583	
	(0.532)	
lag1Mis	-0.950***	-0.871**
	(0.362)	(0.363)
lag2Mis	0.706*	0.590*
	(0.378)	(0.354)
lag3Mis	-0.132	-0.160
	(0.230)	(0.218)
lag4Mis	0.725***	0.799***
	(0.200)	(0.191)
lag1TB_share	-0.028	-0.046
	(0.128)	(0.129)
lag2TB_share	-0.110	-0.104
	(0.135)	(0.135)
lag3TB_share	-0.013	0.004
	(0.147)	(0.147)
lag4TB_share	-0.344**	-0.356**
	(0.157)	(0.158)
cap_cont_index	-0.358***	-0.349***
	(0.078)	(0.076)
lag4tot	-0.924**	-0.901**
	(0.375)	(0.373)
lag3tot	0.829	0.831
	(0.544)	(0.537)
lag2tot	0.731	0.697
	(0.591)	(0.588)
lag1tot	-0.743	-0.745
	(0.476)	(0.479)
Constant	-1.637***	-1.627***
	(0.337)	(0.197)
Observations	3,590	3,590
Lags of GDP	0.221	
Lags of REER Misaliagment	7.73e-08	1.58e-08
Lags of Trade Balance (% GDP)	0.000175	1.20e-05
Lags of ToT	0.0398	0.0434
Pseudo R2	0.137	0.135

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 15: Overvaluation - Low income countries

VARIABLES	(1) treat1
lag4y	1.589**
	(0.671)
lag3y	-0.817
	(1.072)
lag2y	-1.092
	(1.646)
lag1y	-0.173
	(1.091)
lag1Mis	-1.769***
	(0.551)
lag2Mis	1.592***
	(0.505)
lag3Mis	-0.006
	(0.389)
lag4Mis	0.979**
	(0.402)
lag1TB_share	-0.398
	(0.711)
lag2TB_share	0.312
	(0.729)
lag3TB_share	0.473
	(0.551)
lag4TB_share	-0.558***
	(0.110)
cap_cont_index	-0.374***
	(0.127)
lag4tot	-0.566
	(0.494)
lag3tot	-0.139
	(0.800)
lag2tot	2.314***
	(0.803)
lag1tot	-1.785***
	(0.608)
Constant	1.352**
	(0.625)
Observations	1,775
Lags of GDP	2.25e-10
Lags of REER Misaliagment	9.31e-11
Lags of Trade Balance (% GDP)	2.44e-07
Lags of ToT	0.0144
Pseudo R2	0.185

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 16: Overvaluation - Middle income countries

	(1)	(2)	(3)
VARIABLES	treat3	treat3	treat3
lag4y	-1.598**	-1.626**	-1.633**
	(0.792)	(0.759)	(0.743)
lag3y	2.229*	2.280**	2.251**
	(1.213)	(1.136)	(1.122)
lag2y	-1.556	-1.574	-1.580
	(0.986)	(0.993)	(0.979)
lag1y	1.067	1.060	1.108
	(0.775)	(0.766)	(0.748)
lag1Mis	-0.432	-0.450	-0.460
	(0.336)	(0.345)	(0.337)
lag2Mis	0.479	0.508	0.512
	(0.424)	(0.419)	(0.416)
lag3Mis	-0.166	-0.183	-0.187
	(0.267)	(0.268)	(0.270)
lag4Mis	0.510***	0.518***	0.513***
	(0.176)	(0.181)	(0.181)
lag1TB_share	1.397*	1.429*	1.520**
	(0.751)	(0.740)	(0.744)
lag2TB_share	-1.104	-1.059	-1.064
	(0.967)	(0.919)	(0.914)
lag3TB_share	-2.164**	-2.429**	-2.416**
	(0.965)	(0.994)	(1.005)
lag4TB_share	1.500	1.711*	1.644*
	(0.995)	(0.979)	(0.985)
cap_cont_index	-0.092	-0.080	
	(0.121)	(0.124)	
lag4tot	-0.581		
	(0.613)		
lag3tot	0.890		
	(0.632)		
lag2tot	-0.946		
	(0.818)		
lag1tot	0.633		
	(0.705)		
Constant	-3.167***	-3.155***	-3.240***
	(0.780)	(0.772)	(0.762)
Observations	1,815	1,815	1,835
Lags of GDP	0.0769	0.0657	0.0446
Lags of REER Misaliagment	0.00303	0.00226	0.00223
Lags of Trade Balance (% GDP)	0.00648	0.00515	0.00573
Lags of ToT	0.525		
Pseudo R2	0.114	0.111	0.109

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 17: Overvaluation - High income countries

VARIABLES	(1) treat4	(2) treat4
lag4y	7.677**	7.803**
	(3.426)	(3.512)
lag3y	-3.930	-4.332
	(4.302)	(4.456)
lag2y	-15.515***	-15.136***
	(4.123)	(4.200)
lag1y	13.433***	13.320***
	(3.390)	(3.475)
lag1Mis	-4.337***	-4.422***
	(1.485)	(1.418)
lag2Mis	6.176**	5.852**
	(2.481)	(2.437)
lag3Mis	-2.920	-2.841
	(2.026)	(2.158)
lag4Mis	0.631	0.967
	(1.495)	(1.364)
lag1TB_share	-3.293	-2.618
	(7.383)	(7.328)
lag2TB_share	-10.227	-11.134*
	(6.468)	(6.383)
lag3TB_share	-1.317	-2.766
	(8.048)	(7.428)
lag4TB_share	9.669	11.331
	(7.402)	(6.976)
cap_cont_index	-0.510*	-0.551*
	(0.270)	(0.285)
lag4tot	-3.347	
	(2.322)	
lag3tot	2.553	
	(3.423)	
lag2tot	0.916	
	(4.362)	
lag1tot	-0.212	
	(2.072)	
Constant	-19.081***	-19.027***
	(4.272)	(4.200)
Observations	464	464
Lags of GDP	4.58e-07	4.61e-07
Lags of REER Misaliagment	0.00550	0.00131
Lags of Trade Balance (% GDP)	0.0225	0.0150
Lags of ToT	0.659	
Pseudo R2	0.312	0.308

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Pre-treatment trends - ideal number of lags to control for

The table reports within estimates of the effect of lagged variables of interest on episodes. In each column we add a different number of lags of the variable of interest - 2, 4, 6, and 8 lags. Below each model we report the p-value for three tests of joint significance: i) of the first two lags; ii) of the first 4 lags; iii) and the p-value of the additional lags. In all specifications we include a full set of country and year fixed effects. Standard errors robust against heteroskedasticity and serial correlation at the country level are in parentheses.

That is, we estimate models with episodes (of under or overvaluation) as dependent variable on different lags of log of GDP or log of capital stock, our main variables, as explanatory variables. These models test whether, once we control for a given number of lags (as well as country and year fixed affects), an episode is (conditionally) uncorrelated with past dynamics of the variable of interest.

As shown by the p-values reported at the bottom rows, for undervaluation episodes, the first four lags of the variable of interest are jointly significant predictors of a contemporary episode and deeper lags are non-significant. That is, after controlling for these lags, the correlation between episodes and transitory movements in the variables of interest disappears. On top of that, the idea that 4 lags are sufficient is strengthened by the results of the correlation of the residuals with episodes indicated in our liner estimations (table 2).

In the case of overvaluation, the result indicates no correlation between the past dynamics of the variables and episodes. However, given the indications of correlations on the residuals in our linear estimation (table 3), we opted to also control for four lags.

Table 18: Undervaluation - GDP

VARIABLES	(1) treatment_aux	(2) treatment_aux	(3) treatment_aux	(4) treatment_aux	(5) treatment_aux
L.y	-0.007	-0.097***	-0.113**	-0.130**	-0.128**
	(0.007)	(0.036)	(0.045)	(0.051)	(0.053)
L2.y		0.091**	0.097	0.090	0.062
		(0.038)	(0.063)	(0.070)	(0.071)
L3.y			0.039	0.057	0.079
			(0.062)	(0.069)	(0.074)
L4.y			-0.030	-0.028	-0.046
			(0.043)	(0.066)	(0.073)
L5.y				0.022	0.024
				(0.061)	(0.066)
L6.y				-0.019	-0.014
				(0.040)	(0.057)
L7.y					-0.043
					(0.070)
L8.y					0.055
					(0.050)
Constant	0.070	0.059	0.067	0.081	0.099
	(0.063)	(0.065)	(0.071)	(0.078)	(0.083)
Observations	6,039	5,915	5,667	5,419	5,171
R-squared	0.045	0.046	0.046	0.046	0.050
Number of id	124	124	124	124	124
p-value for the first 2 lags		0.0170	0.0238	0.0170	0.0141
p-value for the first 4 lags			0.0743	0.0540	0.0437
p-value for additional lags				0.894	0.712

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Undervaluation - Capital Stock

VARIABLES	(1) treatment_aux	(2) treatment_aux	(3) treatment_aux	(4) treatment_aux	(5) treatment_aux
L.K	-0.013***	-0.270***	-0.265*	-0.306*	-0.259
	(0.005)	(0.085)	(0.156)	(0.173)	(0.180)
L2.K		0.257***	-0.047	-0.017	-0.185
		(0.086)	(0.339)	(0.378)	(0.415)
L3.K			0.565	0.547	0.746
			(0.349)	(0.441)	(0.499)
L4.K			-0.271	-0.259	-0.333
			(0.164)	(0.437)	(0.481)
L5.K				0.094	0.142
				(0.375)	(0.453)
L6.K				-0.079	-0.530
				(0.158)	(0.439)
L7.K					0.764*
					(0.452)
L8.K					-0.372*
					(0.224)
Constant	0.181***	0.186***	0.240***	0.292***	0.369***
	(0.067)	(0.070)	(0.078)	(0.087)	(0.093)
Observations	6,039	5,915	5,667	5,419	5,171
R-squared	0.046	0.047	0.048	0.048	0.053
Number of id	124	124	124	124	124
p-value for the first 2 lags		9.84e-05	0.000586	0.000513	0.000705
p-value for the first 4 lags			6.44e-05	0.00131	0.00246
p-value for additional lags				0.843	0.557

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 20: Overvaluation - GDP

VARIABLES	(1) treatment_aux	(2) treatment_aux	(3) treatment_aux	(4) treatment_aux	(5) treatment_aux
L.y	-0.004	0.056	0.051	0.043	0.050
	(0.006)	(0.046)	(0.049)	(0.054)	(0.059)
L2.y		-0.059	-0.106	-0.141	-0.137
		(0.046)	(0.077)	(0.089)	(0.093)
L3.y			0.026	0.037	0.051
			(0.072)	(0.084)	(0.093)
L4.y			0.030	0.079	0.076
			(0.052)	(0.086)	(0.092)
L5.y				0.062	0.095
				(0.070)	(0.077)
L6.y				-0.080*	-0.146*
				(0.047)	(0.082)
L7.y					-0.072
					(0.089)
L8.y					0.090
					(0.065)
Constant	0.028	0.022	-0.009	-0.014	-0.068
	(0.057)	(0.060)	(0.066)	(0.076)	(0.088)
Observations	5,787	5,663	5,415	5,167	4,919
R-squared	0.073	0.073	0.073	0.074	0.078
Number of id	124	124	124	124	124
p-value for the first 2 lags		0.420	0.386	0.224	0.312
p-value for the first 4 lags			0.569	0.345	0.417
p-value for additional lags				0.215	0.0830

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 21: Overvaluation - Capital Stock

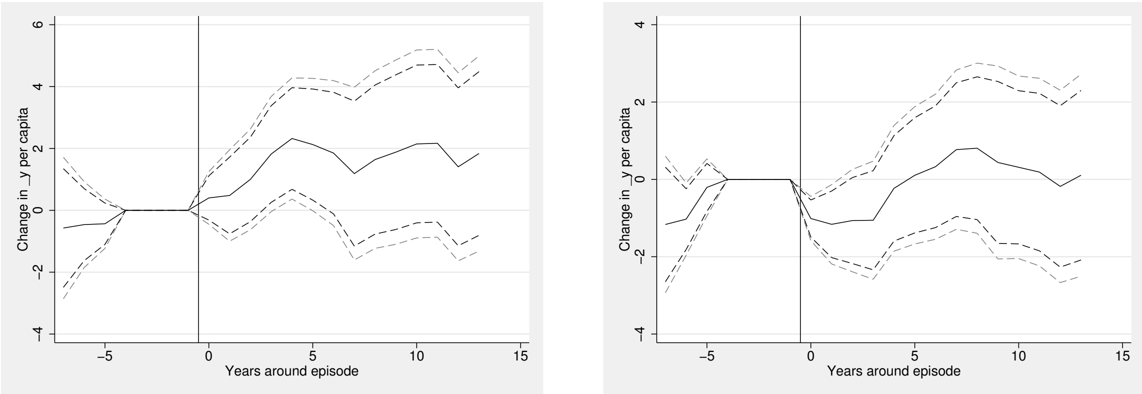
VARIABLES	(1) treatment_aux	(2) treatment_aux	(3) treatment_aux	(4) treatment_aux	(5) treatment_aux
L.K	0.002	0.132	0.244	0.247	0.223
	(0.005)	(0.094)	(0.187)	(0.206)	(0.203)
L2.K		-0.129	-0.250	-0.263	-0.140
		(0.095)	(0.369)	(0.411)	(0.416)
L3.K			-0.109	-0.255	-0.177
			(0.407)	(0.534)	(0.478)
L4.K			0.121	0.564	0.183
			(0.209)	(0.664)	(0.513)
L5.K				-0.395	0.446
				(0.553)	(0.526)
L6.K				0.111	-1.055*
				(0.216)	(0.582)
L7.K					0.377
					(0.503)
L8.K					0.167
					(0.220)
Constant	-0.039	-0.048	-0.098	-0.137	-0.345***
	(0.068)	(0.072)	(0.083)	(0.098)	(0.112)
Observations	5,787	5,663	5,415	5,167	4,919
R-squared	0.073	0.073	0.073	0.073	0.079
Number of id	124	124	124	124	124
p-value for the first 2 lags		0.296	0.328	0.384	0.290
p-value for the first 4 lags			0.458	0.584	0.394
p-value for additional lags				0.763	0.0820

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

C Synthetic control

Figure 38: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of GDP (control created as a synthetic control) - average effect by income group

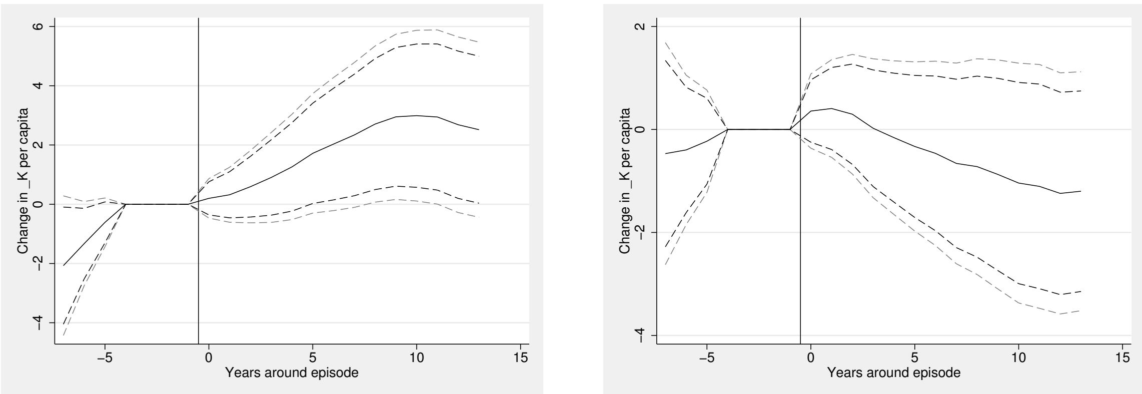
Undervaluation　　　　Overvaluation



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 39: Semiparametric estimates of the over-time effects of real exchange rate misalignment on the log of capital stock (control created as a synthetic control) - average effect by income group

Undervaluation　　　　Overvaluation

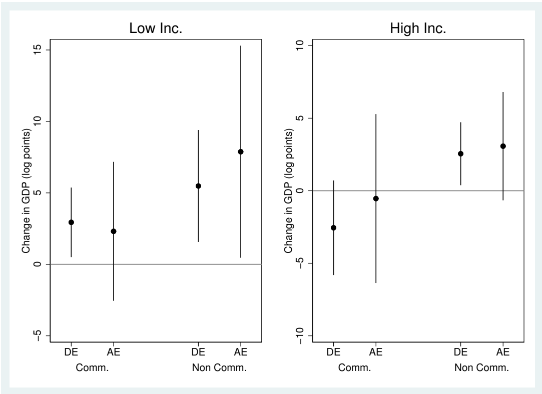


DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

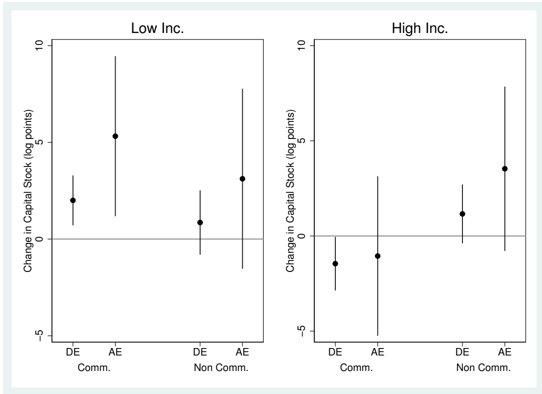
D Commodity exporters - Stacked data

Figure 40: Local projections with stacked data of the over-time effects of real exchange rate undervaluation - average effect by type of exports and income group

GDP



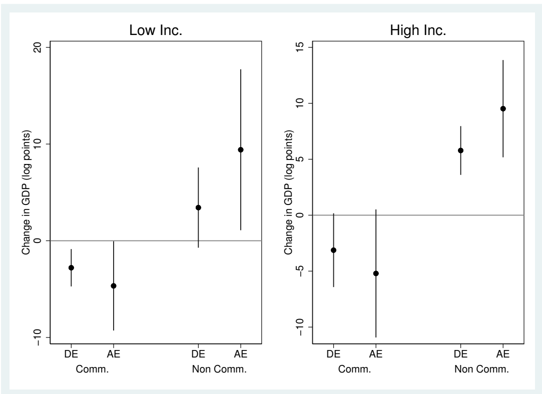
Capital Stock



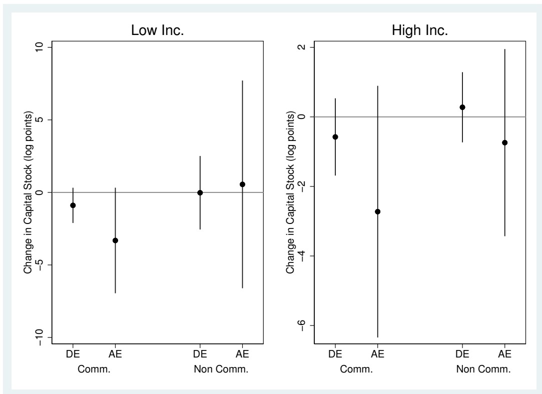
DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 41: Local projections with stacked data of the over-time effects of real exchange rate overvaluation - by type of exports and income group

GDP



K

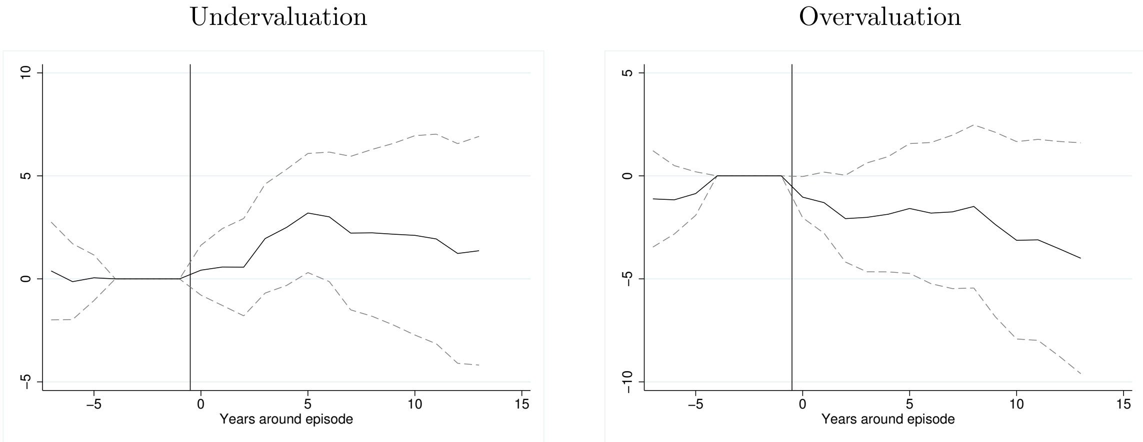


DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

E Alternative criteria

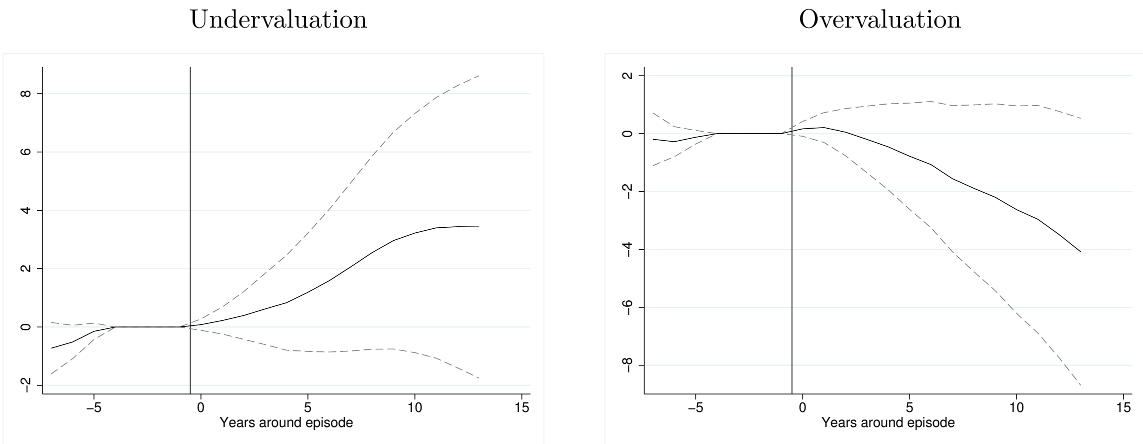
More strict misalignment criteria

Figure 42: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP



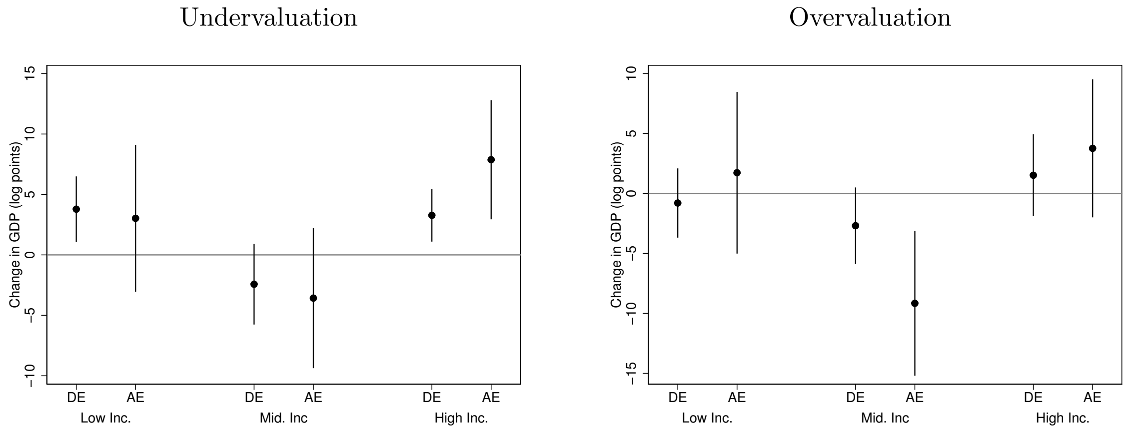
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 43: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital stock.



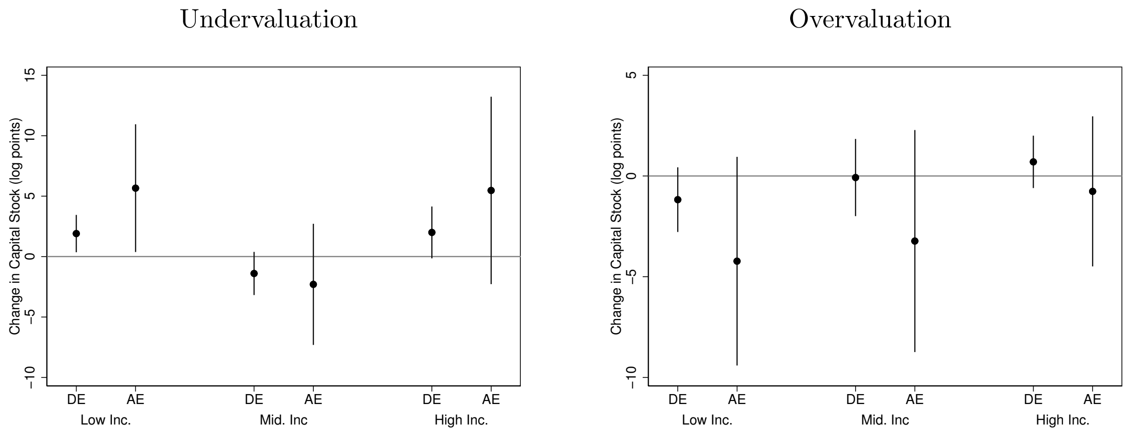
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 44: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

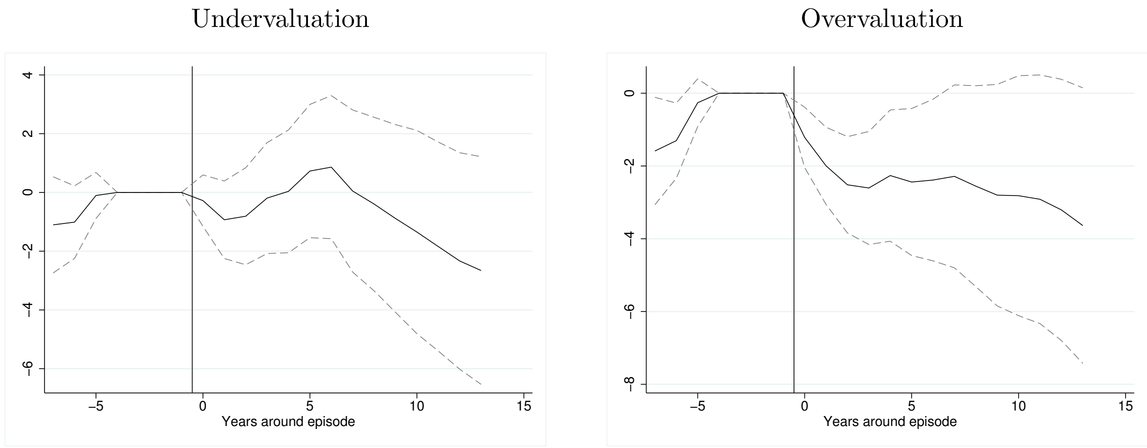
Figure 45: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

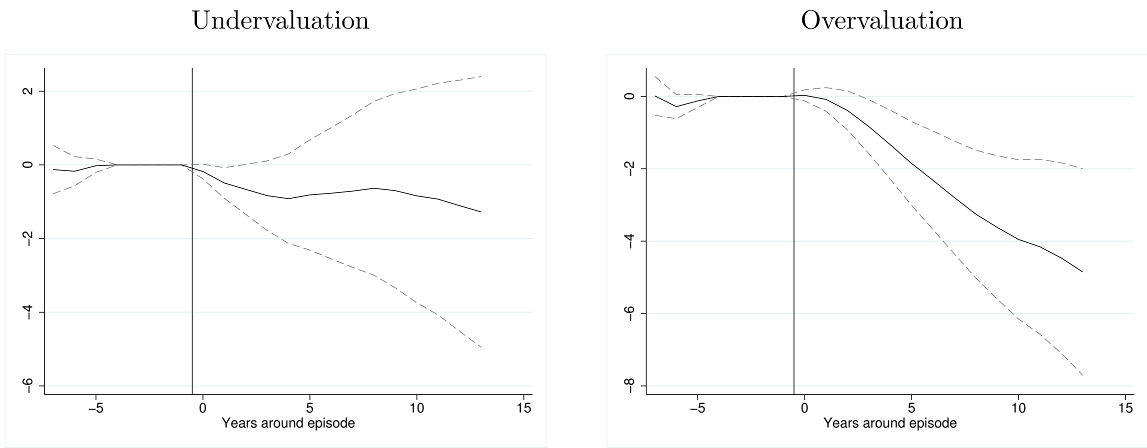
Less strict misalignment criteria

Figure 46: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP



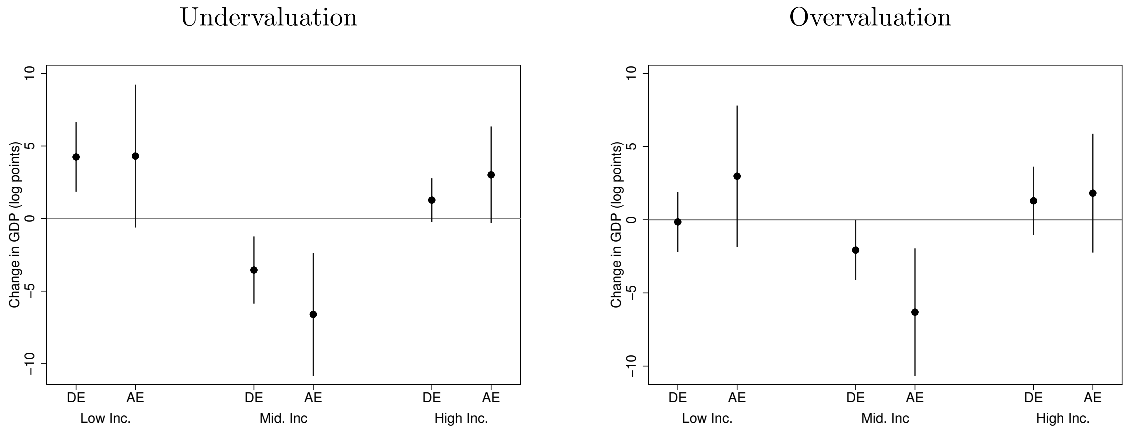
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 47: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital stock.



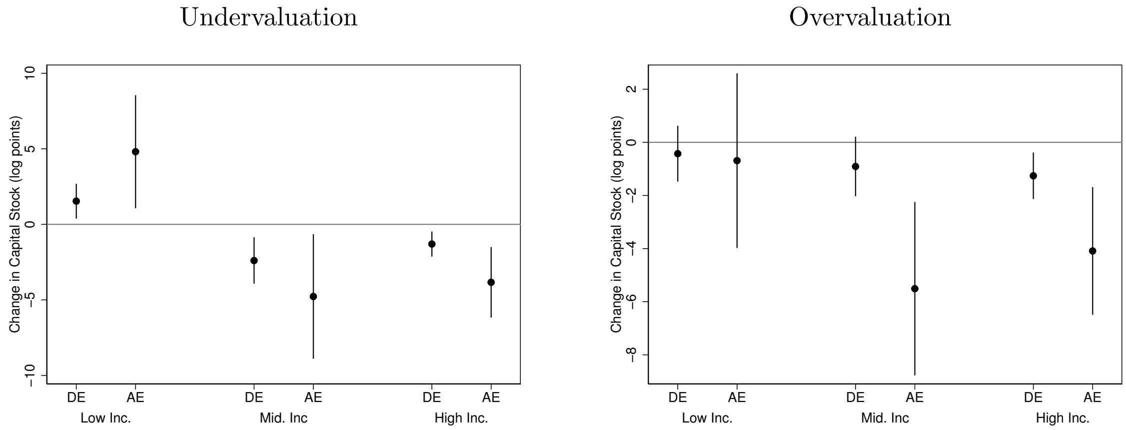
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 48: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

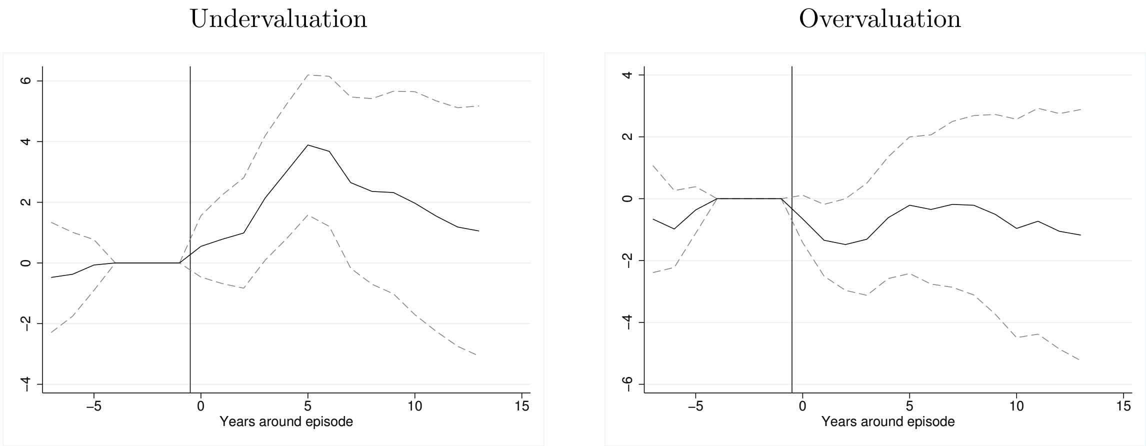
Figure 49: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

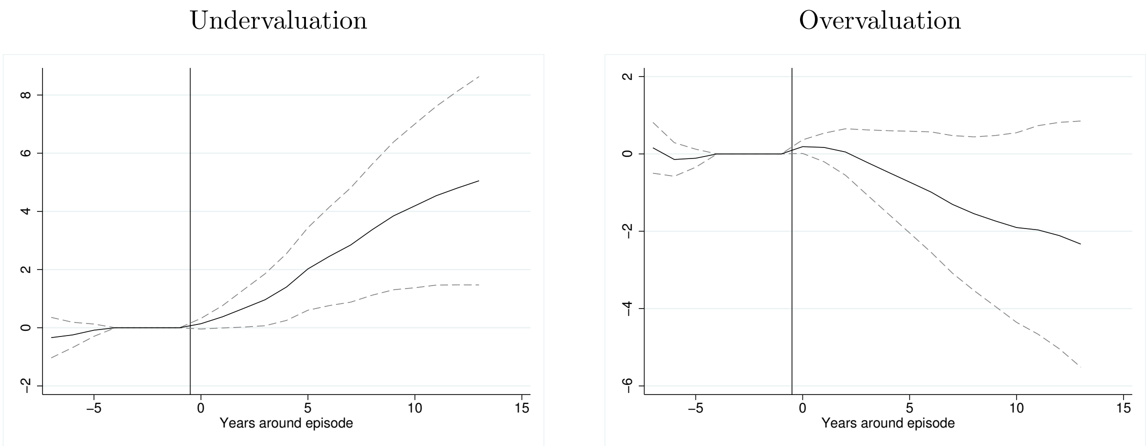
Less strict volatility criteria

Figure 50: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP



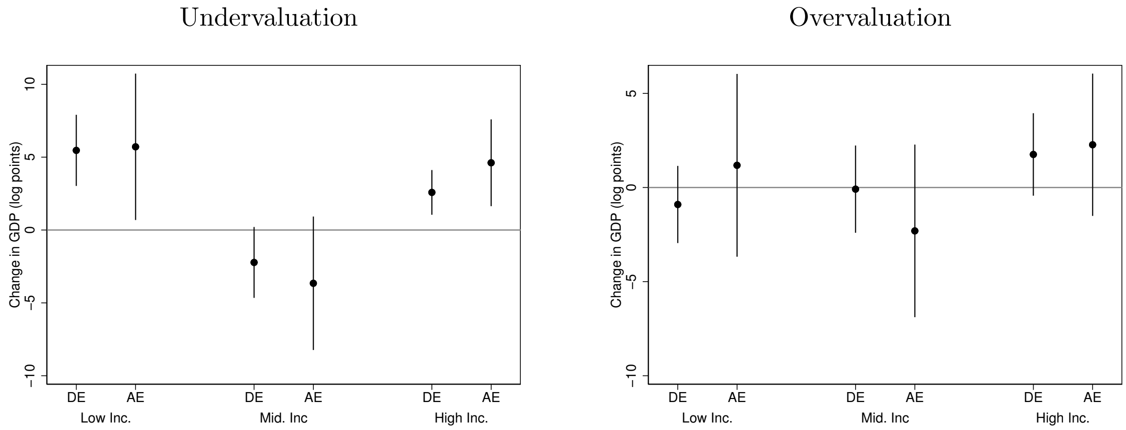
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 51: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital stock.



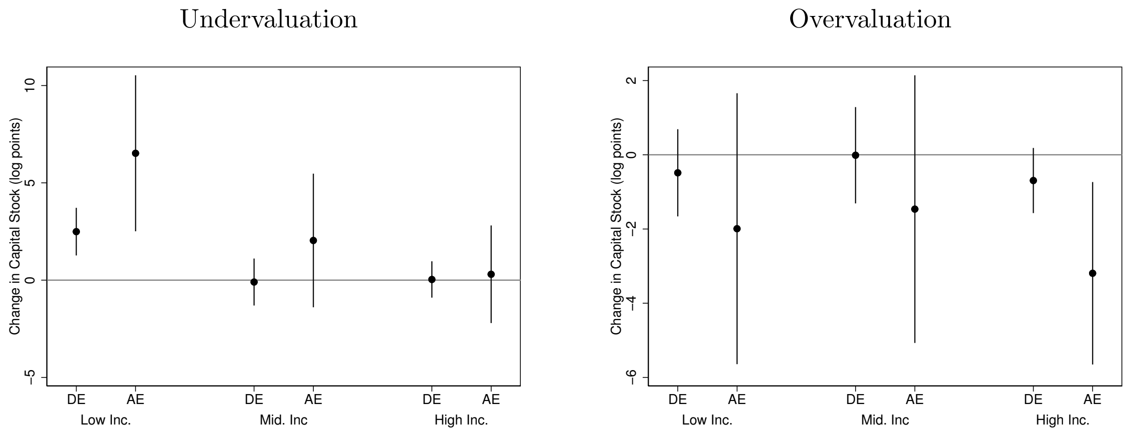
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 52: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

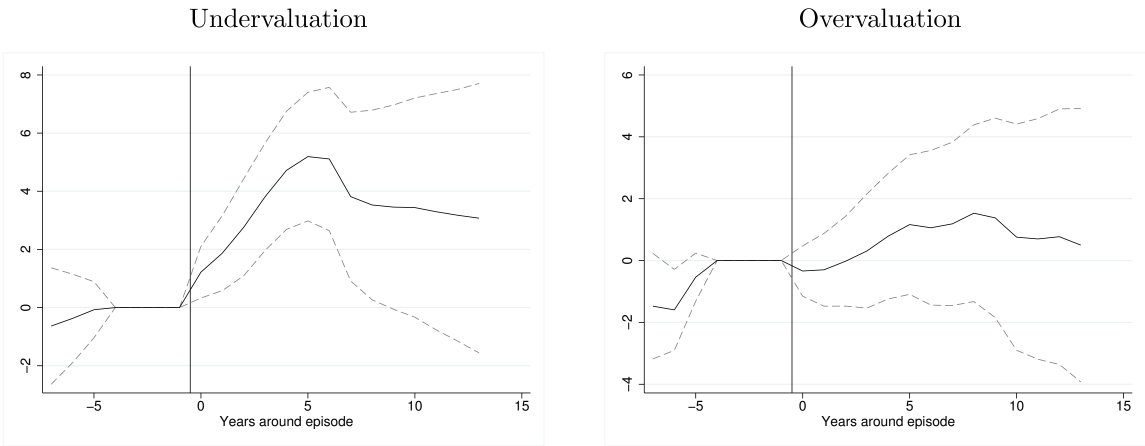
Figure 53: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

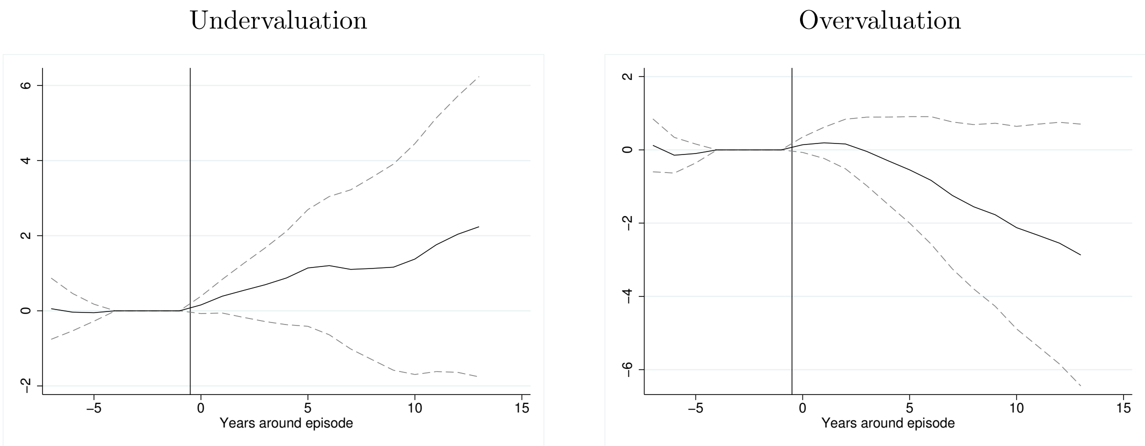
More strict volatility criteria

Figure 54: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP



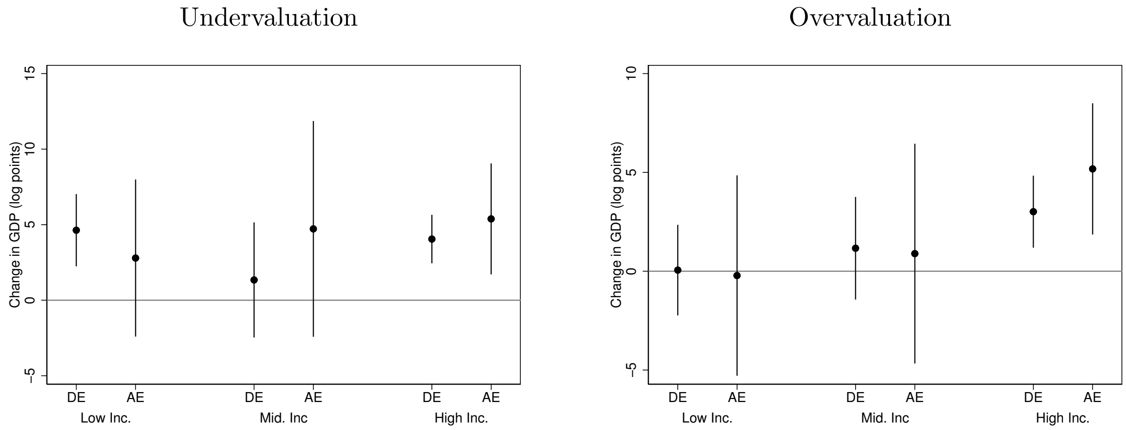
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 55: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital stock.



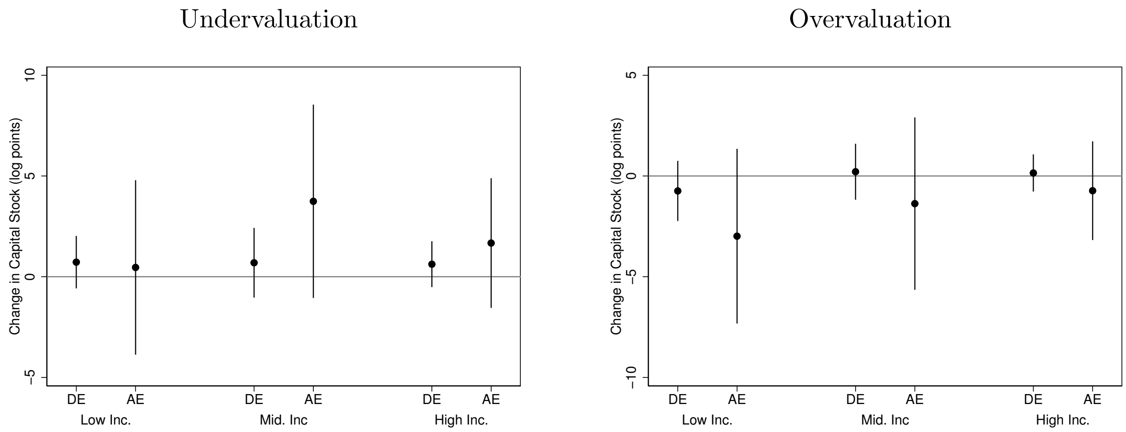
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 56: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

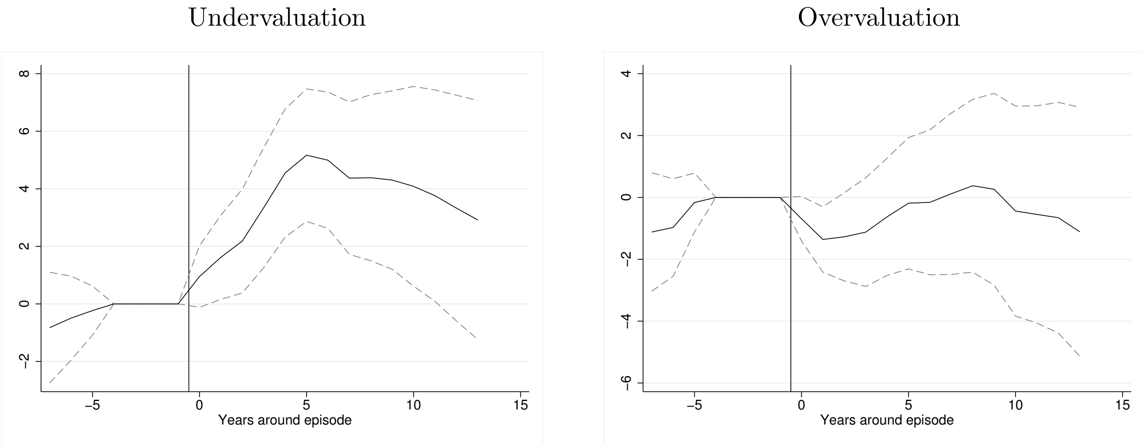
Figure 57: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

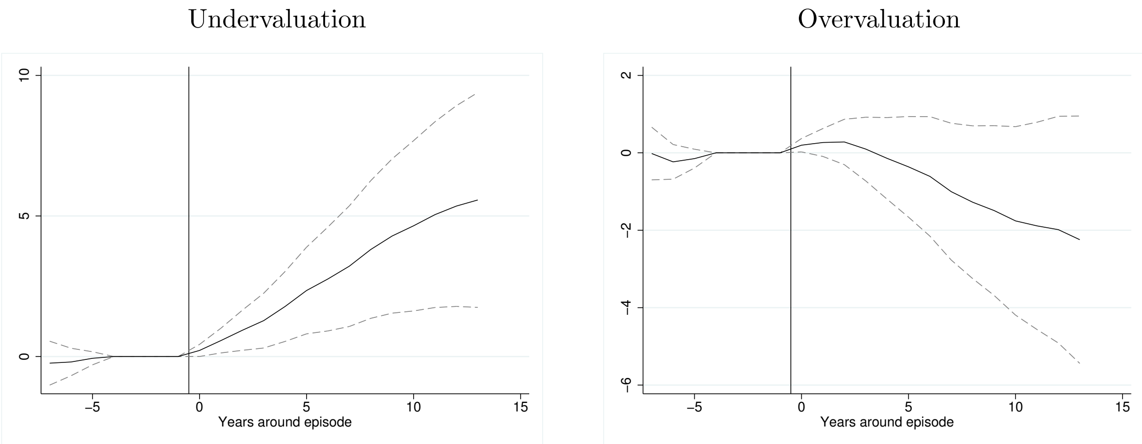
With a 25% standard deviation stricter only:

Figure 58: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP



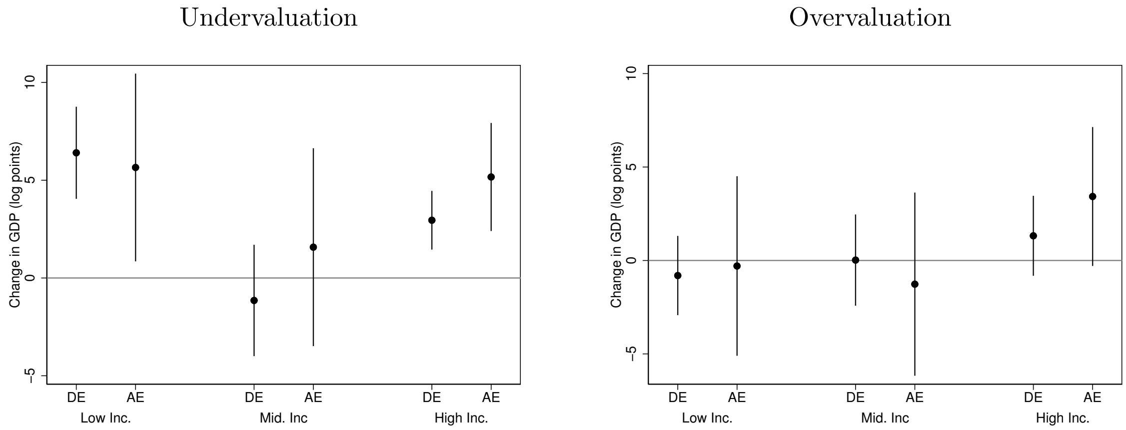
The solid line plots the estimated average effect on GDP per capita on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 59: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital stock.



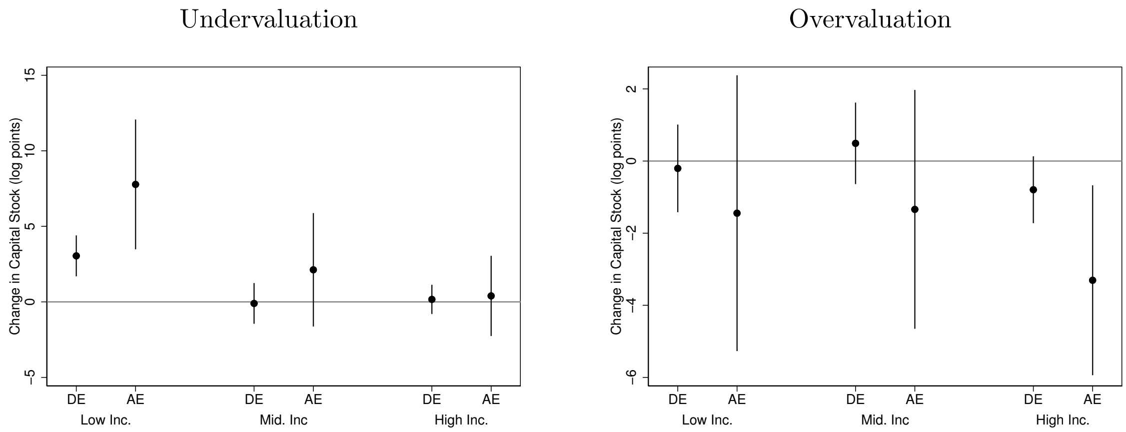
The solid line plots the estimated average effect on capital stock on countries that had an undevaluation episode (in log points), with a 95 percent confidence interval in gray dashed lines, and 90 percent in black dashed lines. Time (in years) relative to the year of the episode.

Figure 60: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of GDP - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)

Figure 61: Local projections with stacked data of the over-time effects of real exchange rate misalignment on the log of capital - average effect by income group



DE= During Episode (time 0 to 6); AE= After episode (time 7 to 13)