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Exchange rate misalignments, growth, and institutions

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Abstract
This article revisits the relationship between economic growth and exchange rate misalignments. We aim to test whether undervaluation's impact on growth depends on institutional quality, as suggested in the previous literature. In our analysis, we focus on recent decades characterized by globalization. We use the framework of cross-country growth regressions estimated using the recently developed two-stage instrumental variable method, which allows accounting for cross sectional dependence. In addition, we use external instruments to address the potential endogeneity between economic growth and undervaluation. Our results confirm the positive relationship between undervaluation and growth across all income groups from low-income to high-income countries. The role of institutions in the transmission of undervaluation on growth appears consistently only among lower-middle-income countries. Therefore, while our results point to the positive effects of undervaluation, the support for the hope that countries can successfully compensate for poor institutional quality via the undervaluation of currencies is weaker and limited to specific stages of economic development.

Keywords Exchange rate misalignments · Undervaluation · Economic growth · Institutions · Corruption

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1 Introduction

Empirical evidence increasingly supports the hypothesis that undervalued exchange rates foster long-term economic growth (for surveys, see Frenkel and Rapetti 2015; Demir and Razmi 2022). These findings contradict the perspective of the inherently harmful nature of misalignments embedded in the "Washington Consensus" of the 1990s that used to shape many policy recommendations in previous decades (Berg and Miao 2010). However, there is substantial uncertainty regarding whether undervaluation is more favorable for developing or developed countries, and it remains unclear which mechanisms explain the positive link between undervaluation and long-term economic growth identified in the empirical literature.

More specifically, Rodrik (2008) shows that undervaluation is good for growth in developing countries, mainly through its impact on the share of tradables and industrial production. However, he does not confirm the positive effects of undervaluation on growth in developed countries. Subsequent studies have revealed that the empirical relationship between undervaluation and growth might be blurred by potential nonlinearities in the sign and size of the misalignment (Couharde and Sallenave 2013; Libman 2014; Iyke 2018; and others), by possible reverse causality from growth to the real exchange rate (Habib et al. 2017), and, occasionally, that positive impact of undervaluation on growth might appear among developed countries as well (Rapetti et al. 2012).

In this paper, we focus on the role of institutional quality in the impact of undervaluation on growth. Such a link between institutions and undervaluation was highlighted by Rodrik (2008), who recalls the evidence that institutional weakness harms producers of tradables disproportionately more than it harms producers of non-tradable goods.[1] Thus, Rodrik considers weak institutions as an additional tax levied on tradables, and the undervaluation serves as a form of compensation provided to exporters for dealing with weak institutions and absorbing higher transaction costs. Then, in his model, undervaluation increases both the competitiveness and profits of the tradable sector, which further translates into higher growth in the overall economy. Finally, the impact of undervaluation on economic growth is supposed to be more pronounced in developing countries than in developed countries, where the compensation of weak institutions is not a necessary precondition for growth in tradable production.

Notably, the causal link between undervaluation and growth in Rodrik (2008) assumes perfect capital mobility, so the share of capital allocated to tradable production is allowed to increase with their profitability. However, recent empirical literature suggests that lower-quality institutions lead to imperfect capital mobility and larger input misallocations, which could limit the growth effects of currency undervaluation (Gamberoni et al. 2016; Fidora et al. 2021). Additionally, Guzman et al. (2018) present a theoretical model in which an active real exchange rate policy can promote growth in developing countries when the weakest exchange rate applies to tradables. However, such a policy mix of carefully determined real exchange rates specific to various sectors of the economy might be impossible to achieve when institutional quality and

[1] See for example Berkowitz et al. (2006).

governance are weak. Some governments tend to provide targeted support to industries and even specific firms as a response to their rent-seeking activities rather than based on a careful analysis of the needs of the overall economy. Therefore, it remains an open question whether an active real exchange rate policy benefits developing countries more than developed countries and to what extent developing countries can compensate for their institutional weakness by undervaluing their exchange rates.

Thus, we contribute to the literature on the impact of undervaluation on growth by testing whether differences in institutional quality affect the relationship between undervaluation and growth identified in the previous literature. Unlike most of the existing literature, we focus on data beginning in the middle of the 1990s. Recent decades have been characterized by a significant shift toward the internationalization of production within global value chains (Baldwin and Lopez-Gonzales 2015), with significant implications for the dynamics of export and import prices (Georgiadis et al. 2019), which could, in turn, affect exchange rate misalignments and their effects on growth, as indicated by the lower exchange rate elasticity of exports found by Ahmed et al. (2015).

We proceed as follows. We start by verifying the positive relationship between undervaluation and growth with an updated edition of the Penn World Table (PWT version 10.01; Feenstra et al. 2015; Groningen Growth and Development Centre, 2023). Following Rodrik (2008) and others, our preferred measure of under- and overvaluation is based on the real exchange rate adjusted for the impact of the Balassa–Samuelson effect.[2]

Then we regress this measure of exchange rate misalignment, referred to as undervaluation for brevity, on economic growth using the framework of the cross-country growth regressions while accounting for biases caused by potential endogeneity of regressors and cross sectional dependence. Therefore, we rely on the two-stage instrumental variable estimator (2SIV) by Norkutė et al. (2021) and Kripfganz and Sarafidis (2021) to account for cross sectional dependence, which can lead to biased coefficient estimates when caused by unobserved common factors correlated with the regressors. This cause is relevant mainly for macroeconomic panels due to the large interconnectedness of the global economy. The 2SIV approach projects common factors from exogenous covariates using principal component analysis. It constructs instruments based on defactored coefficients in two stages, thus combining the features of the common correlated effects (Pesaran 2006) and iterative principal components (Bai 2009). On the other hand, the 2SIV method does not require bias correction for increasing N and T and is computationally inexpensive (Kripfganz and Sarafidis 2021). Moreover, the 2SIV method allows the incorporation of external instruments, which makes the method ideally suited for our analysis due to potential reverse causality between the real exchange rate and economic growth highlighted already by Woodford (2008).

Our choice of external instruments follows Habib et al. (2017) who instrument the exchange rate fluctuations by capital flows, which are largely driven by global factors and lead to exchange rate appreciations of the currencies of countries receiving more capital inflows, irrespectively to domestic fundamentals. Therefore, as a first

[2] We use the Real effective exchange rate and a deviation of the real exchange rate from the Hodrick–Prescott trend for robustness analysis.

instrument, we use global capital flows interacted with individual country financial openness because countries often resort to exchange rate policies in reaction to perceived real appreciation due to excessive capital inflows. In this case, exchange rate policies are used as a form of prudential policies to avoid Dutch disease and overheating of economies due to procyclical capital inflows (Fernandez-Arias and Levy-Yeyati 2012; Habib et al. 2017). The direct effect of capital inflows on growth via credit availability is controlled by including net capital inflows in the growth regression. Then, as a second instrument, we add the growth rate of official reserves as a proxy for exchange rate interventions, which are often used to influence the trajectory of the real exchange rate directly.

This combination of external instruments and the treatment of cross sectional dependence in the context of the undervaluation and growth relationship is our first contribution to the literature because most of the existing papers either employ a fixed effect estimator or treat endogeneity and the Nickell bias in dynamic panels (Nickell 1981) using GMM-type estimators, and Habib et al. (2017) do not account for cross sectional dependence. As robustness checks, we supplement our results with GMM estimates and by the results obtained using the bootstrap-corrected fixed effects (Everaert and Pozzi 2007; De Vos et al. 2015) that deal with Nickell bias and correct the standard errors for cross sectional dependence, but assume exogeneity of regressors.

After verifying the relationship between undervaluation and growth, we focus on the role of institutions. We consider several alternative indicators to measure institutional quality: the rule-of-law index from the World Governance Indicators (WGI) and the first principal component of all WGI indices. Additionally, the V-Dem institutional data (Coppedge et al. 2023a, 2023b; Pemstein et al. 2023) are used for sensitivity analysis. The institutional quality proxy is treated as a moderating variable, so we include the interaction term between institutions and undervaluation within the growth regression. Then we study whether the impact of institutions on the relationship between economic growth and undervaluation depends on income, that is, whether we can find a higher impact of undervaluation in developing countries with worse institutions than in countries with better institutional quality and higher income when the previous literature usually finds that undervaluation has larger effects on growth in low- to medium-income countries rather than in high-income countries (Rodrik 2008; Rapetti et al. 2012; Habib et al. 2017).

Next, to further investigate the role of institutional quality in the transmission of undervaluation on economic growth, we used cluster analysis to separate the countries in our sample into groups according to their relative institutional quality. More specifically, we transform the data on institutional quality to their relative terms by regressing the data on institutional quality on the log of real GDP per capita and construct time series of the differences between predicted and actual institutional quality. In this way, we test the role of institutional quality relative to similarly developed peers; while, the level of economic development is primarily controlled by the initial GDP. This approach mimics one of the experiments in Rodrik (2008), who performs this "first stage" regression on sample averages of variables and divides the countries into groups of equal sizes. We employ clustering over the Euclidean distance between the time series of the relative institutional qualities, so our grouping of countries reflects not just the differences in levels of institutional quality, but also their evolutions. Then we

estimate the differences in the undervaluation–growth relationship between clusters using cross-country growth regressions. Furthermore, we also estimate an extended model where the coefficients are allowed to differ with their memberships in income groups and institutional clusters.

Our results confirm the positive effects of undervaluation on economic growth. However, contrary to some of the previous literature, we find that undervaluation also has significant positive effects in high-income countries. On the contrary, a lower, but still positive, effect appears in middle-income countries. A similar U-shaped pattern in coefficients across country groups appears when focusing on the impact of a country's membership in a cluster determined by relative institutional quality. Next, institutional quality has a consistently negative impact on the transmission of undervaluation to economic growth in lower-middle-income countries, while for low-income and upper-middle-income countries, the results were not robust. Concerning high-income countries, the support for the role of institutions in the undervaluation-growth relationship disappears once four high-income oil-producing countries are excluded from the sample. Therefore, while sustained undervaluation is beneficial for economic growth, it may serve as a compensation for institutional weakness only for lower-middle-income countries.

Our paper is structured as follows. We start with a review of the recent empirical literature and a verification of the positive relationship between undervaluation and growth. The fourth section discusses why institutions might matter for the effects of undervaluation, and in Section five, we test their role in countries separated by their income levels. In Section six, we estimate how the impact of undervaluation differs between countries that differ in their relative institutional quality. Section seven complements these two perspectives by allowing for the heterogeneous impact of undervaluation on growth across income groups and institutional clusters. The main conclusions and policy implications close the paper.

2 Review of the literature

Research on the relationship between economic growth and undervaluation has attracted much attention in recent years. Several recommendations appeared that advised that countries willing to accelerate their economic growth should adopt a stable and competitive real exchange rate strategy; in other words, they should seek to achieve a stable yet undervalued exchange rate. These recommendations challenge the conventional view that all imbalances are bad and should be avoided to ensure long-term growth and overall macroeconomic stability. Although, for example, the IMF had frequently recommended exchange rate devaluation in the past, the devaluation was almost always intended to correct an overvalued exchange rate and not to maintain an undervalued exchange rate continuously, as such a policy could create inflationary pressures and reduce the financial resources available for domestic investment (Williamson 1990).

The policy of a stable and competitive real exchange rate (SCRER; Frenkel and Rapetti 2015) also differs significantly from the long-term consensus about monetary

policy that has gradually converged toward inflation targeting. While inflation targeting is characterized by a focus on domestic monetary conditions and the exchange rate is rarely used as a policy instrument (beyond occasional attempts to correct nonfundamental fluctuations; see Levy-Yeyati et al. 2013), the policy of a stable and competitive exchange rate requires relatively sophisticated policy coordination and the utilization of several policy instruments. In addition to the necessity for a permanent market presence by the central bank, the policy needs to be supplemented by capital controls, relatively restrictive fiscal policy to offset the potential for inflationary bias, and wage controls, since undervaluation implies that wages are lower than they would be in the absence of weak currency policy for a given level of economic development.[3] Contrary to inflation targeting, the SCRER policy also lacks a generally accepted theoretical grounding that would indicate the superiority of this policy over other alternatives, although such attempts are present in the literature (Guzman et al. 2018, for example).

Despite certain risks associated with extended periods of currency undervaluation and the limited anchoring of this policy in economic theory, empirical evidence that establishes a positive association between undervaluation and growth has gradually increased. Rodrik (2008) proxies the equilibrium exchange rate as purchasing power parity adjusted for the Balassa–Samuelson effect,[4] and using this indicator of misalignment, he shows that whereas overvaluation harms economic growth, undervaluation facilitates it, especially in developing countries. The main channel by which undervaluation fosters long-term growth is the expanded production of tradables in response to their rising profitability at the expense of the production of non-tradables. Finally, Rodrik (2008) argues that tradable production suffers disproportionately more from the effects of weak institutions than non-tradable production, and undervaluation functions as a kind of compensation to the producers of tradables for the economic costs arising from institutional weakness. Furthermore, Rodrik (2008) showed that the positive relationship between undervaluation and growth is stronger among developing countries, where institutional quality is generally worse than in developed countries. His results are based on splitting the sample at a GDP threshold per capita of $6000 in constant 2005 dollars and at thresholds defined by below-average, around-average, and above-average institutional quality, as measured by the World Bank's Worldwide Governance Indicators relative to GDP level.

The positive relationship between undervaluation and growth has especially been confirmed by Berg and Miao (2010), who identified misalignment using the FEER model along with the PPP-based measure utilized in the work of Rodrik (2008). On the other hand, the authors point out that the determinants of misalignment are likely to be independent drivers of economic growth. Hence, the identification of different channels is rather cumbersome.

Others, such as Colin and Razin (2012), Aguirre and Calderón (2005), Couharde and Sallenave (2013), and Missio et al. (2015), focus on the differences between large and moderate devaluations, somewhat implicitly reflecting the consensus view that large misalignments might have a detrimental effect on growth regardless of the

[3] Additionally, the policy of a stable and undervalued exchange rate can easily be considered a "beggar thy neighbor" policy that can lead to the escalation of political tensions.

[4] Thus, this approach reflects the Penn effect, which is an increasing relationship between the price level and economic performance; more on this approach is provided in Sect. 3.

direction. Indeed, these studies tend to confirm the positive impact of undervaluation on growth only to a certain threshold. The notable exception is Berg and Miao (2010), who fail to confirm nonlinearity in the size of the misalignment.

Several studies confirm the positive relationship between undervaluation and growth, but also document the effect among developed countries. Rapetti et al. (2012), for example, show that the evidence for the higher effects of undervaluation on growth in developing countries rather than developed countries is sensitive to the choice of the threshold and that the relationship is significant among developed countries. Similar results are provided by Mbaye (2012). Iyke (2018) confirms the positive effects of undervaluation in a panel of middle-income countries even after controlling for potential endogeneity using GMM. However, Habib et al. (2017) employed a two-stage IV estimator with external instruments and found large impacts on devaluations, but only for developing countries and countries with pegged currencies.

For the EU specifically, Comunale (2016) uses panel cointegration to document the significant long-term effects of real misalignments on growth with no significant differences between undervaluation and overvaluation. El-Shaggi et al. (2016) represent the perspective that countries in the EU periphery had overvalued currencies before the 2008 crisis, implicitly pointing to the negative effects of overvaluation on growth, although not explicitly testing for it. Furthermore, it is widely documented that those euro area member states that had experienced steady decreases in real unit labor costs before the Great Recession performed better than those member states that instead had observed the deterioration of their external competitiveness. Therefore, there is at least indirect evidence that undervaluation can also foster growth in developed countries.

Although most empirical papers support the positive effects of undervaluation on growth; see Frenkel and Rapetti (2015) and Demir and Razmi (2022) for surveys, some notable exceptions have also appeared. Nouira and Sekkat (2012) did not find a robust effect; Cumperayot and Kouwenberg (2016) and Goncalves and Rodrigues (2017) show that the significance of undervaluation in growth regressions disappears when controlling for the saving rate and when outliers are excluded from the sample. Exclusively for a panel of developing countries, Ribeiro et al. (2020) also fail to identify a significant effect of undervaluation on growth when controlling for the savings rate and inequality.[5]

3 Undervaluation and growth: first-hand empirical evidence

Our preferred indicator of the real equilibrium exchange rate is based on purchasing power parity, and it is precisely the same concept as in Rodrik (2008) and in many other recent contributions to the literature that have generally confirmed the positive effects of undervaluation on growth. The real exchange rate is calculated as the ratio of the nominal exchange rate, XR_{it}, of the national currency against the US dollar and

[5] Furthermore, there seems to be some sensitivity of the results to the data used for estimation. Libman (2014) shows that the size of the effect depends on the edition of Penn World Table from which the data are taken. Similarly, Cheung, Chinn and Nong (2017) show that even the size of the misalignment calculated from the Penn effect depends on a choice between the data sources, and the coefficients are not robust when choosing between the World Development Indicators and different editions of Penn World Table.

Table 1 Estimation of undervaluation

Variables	(1) RER equation
ln(GDPPC$_{ij}$)	− 0.2325***
	(0.0056)
Constant	3.2093***
	(0.0595)
Observations	7,027
R-squared	0.3999
Country FE	No
Year FE	Yes

Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1; sample 1980–2019

purchasing power parity, PPP_{it}:

$$ln(RER_{it}) = ln\left(\frac{XR_{it}}{PPP_{it}}\right) \tag{1}$$

where i represents a country index and t is a time (in years).[6] Note that the purchasing power parity conversion factor is calculated over aggregate GDP, so it includes the price level of both tradables and non-tradables. Therefore, the real exchange rate, RER_{it}, has to be adjusted for the Balassa–Samuelson effect, which implies a higher real exchange rate in countries with higher GDP.[7] Therefore, we estimate the regression:

$$ln(RER_{it}) = \alpha + \beta ln(GDPPC_{it}) + f_t + u_t \tag{2}$$

where $GDPPC_{it}$ stands for real GDP per capita (obtained from the variables $RGDPE_{it}$ and POP_{it}), f_t represents the time-fixed effects, and u_t is the error term.

Then, the undervaluation index is the simple difference between the actual real exchange rate and its fitted values ($\widehat{RER}$), as shown in Eq. (3):

$$ln(UNDERVAL_{it}) = ln(RER_{it}) - ln(\widehat{RER}_{it}) \tag{3}$$

For estimation, we used Penn World Table version 10.01 (Groningen Growth and Development Centre, 2023), which covers 183 countries between 1950 and 2019, from

[6] Our notation follows Rodrik (2008), although the variable definitions have changed between Penn World Table editions 7.0 and 8.0. Since version 8.0, the inverse of the purchasing power parity variable ($1/PLGDPO_{it}$) is equivalent to the real exchange rate, RER_{it}, and so it is not necessary to calculate the ratio $XRAT_{it}/PPP_{it}$ first.

[7] Obviously, there are other methods to calculate exchange rate misalignments. However, this paper's approach that adjusts the real exchange rate for purchasing power parity is the most popular in the recent literature investigating the effects of misalignments on growth (see Demir and Razmi 2022, Table 1). In our sensitivity analysis, we use the real effective exchange rate and the RER misalignment derived from the Hodrick–Prescott filter that were used in Iyke (2018) to assess robustness of our results.

which we excluded the observations for the years 1950 to 1979 to eliminate a large number of missing and extrapolated observations as recommended by Feenstra et al. (2015). We show the results in Table 1, and the slope coefficient at $ln(GDPPC_{it})$ is almost identical to the estimates of Rodrik, who obtained − 0.24 (Rodrik 2008, p. 371) from a different sample.[8]

Subsequently, we use this index of undervaluation as an independent variable within the cross-country growth regression (4), along with other independent variables X_{it} and country and time-fixed effects:

$$growth_{it} = \alpha + \beta_1\, ln(GDPPC_{it-1}) + \beta_2\, ln(UNDERVAL_{it}) + \xi X_{it} + f_t + f_i + u_{it} \qquad (4)$$

However, the estimation of panel regression (4) with OLS can lead to biased results due to the correlation of the lagged dependent variable with the country fixed effect, due to the endogeneity of other regressors, and due to potential cross sectional dependence. The first cause of bias, referred to as Nickell bias (Nickell 1981), arises because the lag of real GDP is implicitly included in the left-hand side variable: $growth_{it} = ln(GDPPC_{it})$—$ln(GDPPC_{it\text{-}1})$.[9] The Nickell bias is most pronounced when the number of time units is small and decreases to 0 with $T \to \infty$. The usual treatment of this bias is to utilize the GMM methods developed for the panel data, such as system GMM and difference GMM (Arellano and Bond 1991; Arellano and Bover 1995; and Blundell and Bond 1998). These estimators formulate the moment conditions with the help of further lags of the lagged dependent variable as instruments. This instrumentation strategy also handles other potentially endogenous regressors included in the regression. Therefore, GMM has been applied as a remedy to potential reverse causality between undervaluation and economic growth, although often along a standard fixed effects estimator and not always as a primary estimation methodology (Rodrik 2008; Rapetti et al. 2012; Iyke 2018). However, in applied work, the implementation of difference and system GMMs appears to be challenging because the results are often sensitive to even minor changes in the selection of instruments (highlighted by De Vos et al. 2015). Additionally, conventional test statistics, such as Hansen and Sargan tests, are biased when the number of instruments is large and do not provide reliable guidance for model selection.[10] An additional complication arises due to cross sectional dependence, because the null hypothesis of cross sectional independence has been rejected by the tests by Pesaran (2004) and Frees (1995).[11] Sarafidis and Robertson (2009) showed that both IV and GMM estimators can be biased on finite samples, mainly when the cross sectional dependence is caused by common factors and not just by the spatial structure of cross sectional units.

The alternative approaches for dealing with the Nickell bias in dynamic panel data models are inspired by Kiviet (1995), who proposed bias correction to dynamic

[8] Rodrik (2008) estimates his regressions on the sample covering 1950-2004.

[9] Formal derivation and accessible explanation can be found for example in Roodman (2009).

[10] The effects of instrument proliferation are discussed by Roodman (2007). Our experience supports the claim of De Vos et al. (2015) that results from the GMM regression are sensitive to instrument selection, especially when the time dimension T increases.

[11] The tests were implemented using the xtcsd Stata package (De Hoyos and Sarafidis 2006).

panel models estimated using the LSDV estimator. Everaet and Pozzi (2007) then developed the bootstrap-corrected fixed effects estimator as an alternative and more robust option to the GMM, further enhanced by De Vos et al. (2015) with resampling schemes that allow handling general heteroskedasticity and contemporaneous cross sectional dependence.[12] However, this estimator assumes strictly exogenous regressors. Although Rodrik (2008) defends the exogeneity of the real exchange rate misalignment on economic growth, stating that, with the exception of few developed countries, "*most governments pursue a variety of policies with the explicit goal of affecting the real exchange rate*" (p.384), the risk of reverse causality cannot be ruled out easily, as argued by Woodford (2008) and Habib et al. (2017).

With these methodological concerns in mind, our primary estimation methodology is the two-stage instrumental variable estimator (2SIV) introduced in Norkuté et al. (2021) and Kripfganz and Sarafidis (2021) developed for panels with large T and subject to cross sectional dependence driven primarily by unobserved common factors. Furthermore, the 2SIV estimator handles endogenous regressors and allows the use of external instruments to refine the estimation subject to potential reverse causality.

The 2SIV method works as follows. It is assumed that the data generating process corresponds to an autoregressive distributed lag panel data model with homogeneous slope coefficients and residuals being cross sectionally dependent due to a common factor $f_{y,t}$. In the first step, the common factor is extracted from exogenous variables using the principal component analysis. The instruments are then constructed from defactored regressors and used to obtain consistent estimates of the error terms of the model. The second stage then estimates factors from residuals from the first stage ($f_{y,t}$) and uses these estimates to obtain the complete structure of the model $y_{it} = \alpha y_{i,t\text{-}1} + \beta' x_{it} + f_{y,t} + \varepsilon_{it}$. More details and formal derivations are provided by Norkuté et al. (2021) and Kripfganz and Sarafidis (2021). This approach has multiple advantages compared to other methods developed for panel data models with large T, such as common correlated effects (Pesaran 2006) and iterative principal components (Bai 2009). In particular, no bias correction is required for valid inference, and the procedure is computationally inexpensive because of the linear structure of all underlying calculations.

To allow estimation of Eq. (4) using the 2SIV method, we use data with annual frequency to keep T reasonably high. When using data from 1996, the year since our institutional data are available, $T = 24$, which is just slightly below 25, considered by Norkuté et al. (2021) as the lowest T in their Monte Carlo evaluations of the 2SIV method. The usual objection against annual frequency in growth regressions is that the results might be affected by short-run business cycle fluctuations more than the five-year averages commonly used in the literature. However, due to the increasing integration of the global economy and synchronization of business cycles, at least part of this short-term variation is captured by the factor structure of the 2SIV method. Nevertheless, we used fixed effects and GMM to check to what extent the results are affected by the choice of estimation methodology.

[12] The bootstrap-corrected fixed effects model was estimated in Stata using the xtbfce command (De Vos, Everaert, and Ruyssen 2015).

Our estimates start with estimating Eq. (4) without additional control variables. We utilize multiple methods: the fixed effects model, bootstrap-corrected fixed effects, 2SIV, and 2SIV with external instruments. We also add the 2SIV estimates with the real effective exchange rate and the cyclical component of the real exchange rate with respect to the US dollar extracted using the Hodrick–Prescott filter. For the BC-FE, 2SIV and GMM models used in this paper, we include the lag of economic growth as a control variable, primarily to account for autocorrelation in residuals. However, the impact of the exclusion of this variable on the coefficient estimates is relatively minor.

Our choice of external instruments follows Habib et al. (2017), which is, to our knowledge, the only study employing external instruments when estimating the effect of undervaluation on economic growth. To address the potential reverse causality between undervaluation and growth, they propose using global capital flows interacted with individual countries' financial openness because global capital flows are largely driven by common global factor rather than by country-specific fundamentals (Rey 2015; Miranda-Agrippino and Rey 2022) and lead to real appreciations in countries more exposed to these flows. In addition, countries facing excessive capital inflows often resort to exchange rate policies to prevent excessive appreciations. To control for a direct effect of capital flows on economic growth via changes in credit availability, we include net capital inflows as a control variable in the 2SIV model with external instruments, in line with Habib et al. (2017).[13] The second instrument is the growth rate of official reserves, which proxies exchange rate interventions that are often used to move the exchange rate to targeted levels, albeit for various reasons, including the attempts to offset shocks to capital inflows as well as in response to country-specific shocks.[14] Data on capital inflows and growth rates are retrieved from the External Wealth of Nations Database (Lane and Milesi-Ferretti, 2018), which has a larger country coverage than the IMF's International Finance Statistics used by Habib et al. (2017).

The results are presented in Table 2. The coefficient estimates at lnUNDERVAL range from 0.0400 to 0.0808 and are statistically significant, with the 2SIV method giving higher coefficients at lnUNDERVAL than fixed effects.[15] Therefore, we confirm the positive effect of undervaluation on economic growth. The diagnostics of the fixed

[13] To add more flexibility to the relationship between capital inflows, undervaluation and growth we have estimated our models with the second power of net capital inflows as additional regressor to account for potential nonlinearity. Our main results highlighted in the next sections remained largely robust (Appendix B).

[14] Demir and Razmi (2022) were concerned by the choice of external instruments in Habib et al. (2017), noting that *"capital flows and foreign exchange interventions may themselves directly affect growth or react to changes in the growth environment, and therefore may not be strong IVs."* Therefore, we performed thorough analysis of these instruments. The correlation between the growth of official reserves and economic growth is 0.0146 and, in the case of global capital flows interacted with financial openness, 0.0233. However, the correlations between instruments and lnUNDERVAL were also small (0.0193 and -0.1336), and we were unable to replicate Habib et al.'s results with more recent data and with the xtivreg2 Stata command. Regrettably, the replication codes to Habib et al. (2017) are not available; therefore, we were unable to verify why our replication failed. Based on our experiments, treatment of endogeneity using two-stage regression without dealing with cross sectional dependence and without inclusion of lags in the first-stage regression leads to weak instruments problem.

[15] The system GMM estimates are consistent with fixed effects, the difference GMM leads to lower and insignificant coefficients at lnUNDERVAL. These results are in Appendix, Tables 11 and 12.

Table 2 Undervaluation and growth—simple regressions

Variables	(1) Underval FE	(2) Underval BC-FE	(3) Underval 2SIV	(4) Underval 2SIV ext inst	(5) Reer 2SIV	(6) RER Cycle 2SIV
Growth(− 1)		0.2337***	0.1184***	0.1525***	0.1191***	0.1078***
		(0.0306)	(0.0212)	(0.0185)	(0.0216)	(0.0308)
$\ln(GDPPC_{ij}(-1))$	− 0.1006***	− 0.0980***	− 0.2491***	− 0.5169***	− 0.2315***	− 0.4479***
	(0.0143)	(0.0129)	(0.0163)	(0.0222)	(0.0164)	(0.0233)
lnUNDERVAL	0.0483***	0.0400***	0.0725***	0.0808***		
	(0.0115)	(0.0098)	(0.0121)	(0.0177)		
Net capital inflows				− 0.0108**		
				(0.0043)		
lnREER					0.0076	
					(0.0141)	
lnRER cycle						0.0879***
						(0.0189)
Constant	0.9626***		2.3084***	4.7552***	2.1753***	4.1328***
	(0.1332)		(0.1519)	(0.2050)	(0.1426)	(0.2012)
Observations	4,300	4,094	3,940	3,224	3,671	3,940
Number of countries	180	178	180	164	167	180
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Hansen test			22.47	39.32	9.476	10.20
p value			5.21e−05	0.00899	0.0236	0.0170
Factors_1st_stage			1	4	1	2
Factors_2nd_stage			2	2	2	2
Factor_Proportion			0.538	0.735	0.509	0.749
Instruments			6	25	6	6

Dependent variable: log GDP growth per capita. Sample 1996–2019, annual data. FE—Fixed effects. Clustered standard errors in parentheses; BC-FE—Bootstrap corrected fixed effects, bootstrap standard errors accounting for the cross sectional dependence; 2SIV ext inst—Two-stage instrumental variable estimator with external instruments. The real exchange rate (REER) was inverted, that is, positive values = undervaluation. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

effects model reveal that the null of no cross sectional dependence is rejected by the Pesaran (2004) and Frees (1995) tests; in both cases, the p value is essentially zero. The 2SIV method confirms the importance of common factors, which account for more than 50% of the variability in the data, and while the Hansen overidentification test rejected the null of instrument validity for models without external instruments, their inclusion lead to higher probability of nonrejection on the null hypothesis of

instrument validity. Therefore, these tests support our choice of the 2SIV estimator and the utilization of external coefficients. Positive effects of misalignments are obtained with the HP-filtered real exchange rate (column 6), but when REER is used, the coefficient size drops to 0.0076 and loses statistical significance.

However, differences from the lnUNDERVAL are understandable since all three alternative indicators of exchange rate misalignments are conceptually different. Although lnUNDERVAL considers the level of economic development and compares the strength of the exchange rate with the country's peers, so its deviations from zero can be pretty persistent. The cyclical component in the RER captures short-term deviations of the real exchange rate from its long-term behavior, which might not necessarily be consistent with any type of equilibrium exchange rate. Finally, the REER is centered around 100 in December 2012 and measures differences in price levels since then that might or might not mirror the overall economic performance that drives the lnUNDERVAL.

Table 3 shows that the coefficient estimates at lnUNDERVAL are consistent even when additional covariates are included. However, the estimated impact of the real effective exchange rate on growth became negative, as if the depreciation caused lower economic growth rather than otherwise. On the other hand, the results with the HP-filtered real exchange rate support the perspective that the effect of the real exchange rate on economic growth is driven mainly by misalignment rather than by a change in the real exchange rate itself.

Our fixed effects coefficients from Table 2 are about twice as high as those Rodrik reported (2008). For the 1950–2004 sample, Rodrik reports 0.017 and 0.026 for a subsample of developing countries; on the other hand, our estimates are below those of Habib et al. (2017), who use more recent data spanning from 1970 to 2010 and controls for endogeneity. In light of those differences and the results of the specification tests, we consider our results to be qualitatively and quantitatively plausible, so Tables 2 and 3 provide a reasonable starting point for a more in-depth exploration of the impact of institutions on the relationship between undervaluation and growth.

4 Institutions and the effect of undervaluation on growth

While the evidence for a robust positive association between undervaluation and growth is gradually increasing, disagreement remains about the mechanisms that explain why and how undervalued exchange rates improve long-term economic growth. Rodrik (2008) highlighted the importance of institutions, for whom weak institutions are the most prominent reason undervaluation particularly fosters economic growth in developing countries.

Rodrik's argument proceeds as follows. Although weak institutions negatively affect all sectors, firms in tradable sectors suffer disproportionately more than those in non-tradable sectors.[16] Then, undervaluation can offset the impact of weak institutions

[16] There are several reasons why tradable production suffers from the effects of weak institutions more than non-tradable production does. Most importantly, tradables are usually more sophisticated and their production more complex. Furthermore, the tradable production in developing countries is often small and suffers from underinvestment. When increasing returns are present, small firms are at a disadvantage, and

Table 3 Undervaluation and growth—with additional growth determinants

Variables	(1) Underval FE	(2) Underval BC-FE	(3) Underval 2SIV	(4) Underval 2SIV ext inst	(5) Reer 2SIV	(6) RER Cycle 2SIV
Growth(− 1)		0.2642***	0.0417***	− 0.0160	0.0947***	0.0683***
		(0.0741)	(0.0117)	(0.0130)	(0.0113)	(0.0106)
ln($GDPPC_{ij}$(− 1))	− 0.0993***	− 0.2322***	− 0.3067***	− 0.1886***	− 0.2956***	− 0.2861***
	(0.0168)	(0.0443)	(0.0127)	(0.0075)	(0.0131)	(0.0106)
lnUNDERVAL	0.0681***	0.0764*	0.1266***	0.0712***		
	(0.0147)	(0.0429)	(0.0119)	(0.0092)		
lnREER					− 0.0175	
					(0.0118)	
lnRERcycle						0.0933***
						(0.0142)
Investment	0.0147*	0.0174	0.0139**	0.0281***	0.0099*	0.0150***
	(0.0081)	(0.0294)	(0.0054)	(0.0040)	(0.0054)	(0.0054)
Gov. expenditures (log)	− 0.0415***	− 0.0610**	− 0.0892***	− 0.0497***	− 0.0672***	− 0.0762***
	(0.0116)	(0.0266)	(0.0090)	(0.0058)	(0.0085)	(0.0095)
Population growth	0.1567	− 0.6531	− 0.5437***	0.1588	− 0.3654***	− 0.3915***
	(0.3616)	(0.7094)	(0.1331)	(0.1416)	(0.1094)	(0.1045)
Openness	0.0324***	− 0.0243	− 0.0039	0.0202***	− 0.0298***	− 0.0189***
	(0.0089)	(0.0206)	(0.0058)	(0.0053)	(0.0066)	(0.0062)

Table 3 (continued)

Variables	(1) Underval FE	(2) Underval BC-FE	(3) Underval 2SIV	(4) Underval 2SIV ext inst	(5) Reer 2SIV	(6) RER Cycle 2SIV
Inflation	− 0.0980***	− 0.0602	− 0.0356***	− 0.0477***	− 0.0682***	− 0.0468***
	(0.0203)	(0.0642)	(0.0084)	(0.0075)	(0.0144)	(0.0090)
Financial openness(− 1)	0.0003	− 0.0017	0.0066**	0.0034*	0.0076***	0.0054**
	(0.0022)	(0.0082)	(0.0026)	(0.0020)	(0.0027)	(0.0026)
Net capital inflows	− 0.0056**	− 0.0071	− 0.0107***	− 0.0051***	− 0.0014	− 0.0060***
	(0.0028)	(0.0079)	(0.0030)	(0.0014)	(0.0013)	(0.0021)
Terms of trade	− 0.0221	− 0.0084	0.0707***	− 0.0250	0.0347**	0.0575***
	(0.0247)	(0.0747)	(0.0198)	(0.0163)	(0.0166)	(0.0187)
RER volatility	− 0.0026***	0.0004	− 0.0020***	− 0.0021***	− 0.0019***	− 0.0018***
	(0.0009)	(0.0027)	(0.0006)	(0.0005)	(0.0006)	(0.0006)
Constant	0.9111***		2.6977***	1.7212***	2.5269***	2.5218***
	(0.1496)		(0.1206)	(0.0736)	(0.1323)	(0.1066)
Observations	3,888	820	3,058	3,058	2,989	3,058
Number of countryID	164	164	164	164	160	164
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Instruments			66	78	66	66
N			164	164	160	164
Hansen test			76.03	90.19	72.92	69.08
p value			0.0257	0.0256	0.0441	0.0811
Factors (1st stage)			2	1	2	2

Table 3 (continued)

Variables	(1) Underval FE	(2) Underval BC-FE	(3) Underval 2SIV	(4) Underval 2SIV ext inst	(5) Reer 2SIV	(6) RER Cycle 2SIV
Factors (2nd stage)			2	2	2	2
Factor_Proportion			0.577	0.461	0.555	0.550

Dependent variable: log GDP growth per capita. Sample 1996–2019, annual data. FE—Fixed effects. Clustered standard errors in parentheses; BC-FE—Bootstrap corrected fixed effects, bootstrap standard errors accounting for the cross sectional dependence; 2SIV ext inst—Two-stage instrumental variable estimator with external instruments. The real exchange rate (REER) was inverted, that is, positive values = undervaluation. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

on producers of tradables since their production becomes cheaper and more competitive in international markets. Their profits rise, and these firms can finally accumulate the necessary capital for investment. Therefore, if any country is unable to improve its institutional framework, undervaluation is considered the second-best solution to promote economic growth.[17]

A straightforward way to gauge the effect of institutions on the relationship between undervaluation and economic growth is to treat institutions as a moderator variable and to extend Eq. (4) for an institutional variable and an interaction term between institutional quality and our measure of exchange rate misalignment lnUNDERVAL. To measure institutional quality, we use the Rule of Law from the Worldwide Governance Indicators (Kaufmann et al. 2010), the first principal component of the subindices included in the Worldwide Governance Indicators (denoted as WGI(PC)). Then, as a robustness check, we rely on the Liberal Democracy index from the V-Dem project, which is conceptually close to the Rule of Law and contains detailed indicators on electoral democracy and restrictions on executive power '*that protect the individual and minority rights against the tyranny of the state and the tyranny of the majority'* (Coppedge et al. 2023b). We also use the first principal component across the six main categories of the V-Dem indices (Electoral democracy index, Liberal democracy index, Participatory democracy index, Deliberative democracy index, and Egalitarian democracy index). In all cases, the indices are centered around zero, so for countries with the average level of institutions, the interaction term between institutions and lnUNDERVAL would equal zero.

The estimates of the models with interaction terms using the 2SIV estimator with external instruments appear in Table 4. The coefficients at the lnUNDERVAL are close to our previous results. The coefficients at the institutional quality are positive and statistically significant, in line with the intuition that good institutions foster economic growth. Most importantly, the interaction terms are statistically significant and have negative signs, implying that the impact of misalignment lnUNDERVAL on growth decreases with improved institutions. This result supports the hypothesis that undervaluation is more beneficial for countries with subpar institutional quality.

Undoubtedly, institutions are not the only reason why undervaluation might increase economic growth. Frenkel and Rapetti (2015) recall what characterizes the process of economic development: An intense structural transformation from low-productivity to high-productivity activities that are mostly tradable. The tradable-led growth channel is possible under several conditions. First, there is the possibility of increasing returns to scale, and, second, capital is allowed to flow to these high-productivity activities. The undervalued currency fosters capital accumulation in these high-productivity activities, as it compensates for market failures caused by returns on learning. This perspective of growth characterized by structural change is supported by empirical findings by McMillan and Rodrik (2011). Using sectoral data from 38 countries, they show that undervaluation supports structural change in favor of modern tradables and

Footnote 16 continued
capital flows to the non-tradable rather than the tradable sector, so the growth prospects for firms in tradables deteriorate as well. See Rigobon and Rodrik (2005) and Berkowitz, Moenius, and Pistor (2006).

[17] Rodrik supports his hypothesis with an empirical test in which countries are separated into three groups by the level of their institutional development (measured by the World Bank's Worldwide Governance Indicators) and by a theoretical model.

Table 4 Undervaluation and growth, controlling for institutional quality

	(1)	(2)	(3)	(4)
	Rule of Law	WGI (PC)	Liberal democracy	V-Dem (PC)
Variables	2SIV ext inst	2SIV ext inst	2SIV ext inst	2SIV ext inst
Growth(− 1)	0.0729***	0.1063***	0.0811***	0.1069***
	(0.0146)	(0.0117)	(0.0152)	(0.0116)
ln(GDPPCij(− 1))	− 0.1800***	− 0.1940***	− 0.1735***	− 0.1619***
	(0.0102)	(0.0096)	(0.0098)	(0.0084)
lnUNDERVAL	0.0700***	0.0779***	0.0691***	0.0766***
	(0.0085)	(0.0086)	(0.0088)	(0.0075)
Institutions	0.0408***	0.0363***	0.0129**	0.0144***
	(0.0072)	(0.0030)	(0.0058)	(0.0054)
Institutions*lnUNDERVAL	− 0.0157*	− 0.0105***	− 0.0367***	− 0.0282***
	(0.0083)	(0.0027)	(0.0076)	(0.0080)
Investment	0.0148***	0.0170***	0.0185***	0.0212***
	(0.0044)	(0.0039)	(0.0048)	(0.0043)
Gov. expenditures (log)	− 0.0564***	− 0.0468***	− 0.0530***	− 0.0437***
	(0.0076)	(0.0059)	(0.0080)	(0.0058)
Population growth	0.0007	− 0.3235	− 0.1187	− 0.3483**
	(0.2308)	(0.1979)	(0.2274)	(0.1538)
Openness	0.0114**	0.0117**	0.0128**	0.0151***
	(0.0053)	(0.0050)	(0.0057)	(0.0047)
Inflation	− 0.0435***	− 0.0485***	− 0.0494***	− 0.0599***
	(0.0092)	(0.0067)	(0.0095)	(0.0071)
Financial openness(− 1)	0.0025	0.0022	0.0030	0.0030*
	(0.0018)	(0.0017)	(0.0020)	(0.0016)
Net capital inflows	− 0.0037*	− 0.0014	− 0.0046**	− 0.0025*
	(0.0021)	(0.0017)	(0.0020)	(0.0015)
Terms of trade	− 0.0152	− 0.0231	− 0.0056	− 0.0131
	(0.0188)	(0.0188)	(0.0195)	(0.0185)
RER volatility	− 0.0026***	− 0.0022***	− 0.0024***	− 0.0020***
	(0.0006)	(0.0005)	(0.0005)	(0.0006)
Constant	1.5888***	1.7459***	1.5362***	1.4608***
	(0.0952)	(0.0895)	(0.0913)	(0.0791)
Observations	3,210	3,047	3,204	3,047
Number of countryID	155	155	155	155
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hansen	67.02	85.27	66.66	84.96

Table 4 (continued)

Variables	(1) Rule of Law 2SIV ext inst	(2) WGI (PC) 2SIV ext inst	(3) Liberal democracy 2SIV ext inst	(4) V-Dem (PC) 2SIV ext inst
p value	0.0231	0.0218	0.0248	0.0230
Factors_1st_stage	1	1	1	1
Factors_2nd_stage	2	2	2	1
Factor_Proportion	0.427	0.435	0.433	0.301
Instruments	60	75	60	75

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. 2SIV ext inst—Two-stage instrumental variable estimator with external instruments. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

the flow of labor to high-productivity sectors. The hypothesis of structural change induced by undervaluation is supported by Frenkel and Rapetti (2015) and Cimoli et al. (2013), who find that undervaluation increases extensive margins; thus, it helps firms to enter new markets and sell new products.

These empirical findings are consistent with a stylized two-period model developed by Guzman et al. (2018), in which they argue that multiple real exchange rates might be the optimal policy for growth. The existence of multiple real exchange rates within one economy can be achieved in multiple ways, notably by complementary effects of targeted fiscal instruments to the aggregate intended exchange rate misalignment. Such an economic policy can provide targeted support to the part of the tradable sector where learning spillovers to the rest of the economy are highest, so this sectoral industrial policy can bring benefits to long-term growth and development.

Furthermore, we must ask to what extent structural change and economic development characterize only developing countries, as developed countries also need to continuously adjust to structural changes in the global economy. These changes might include globalization, increasing internationalization of global production (Baldwin and Lopez-Gonzalez 2015), a gradual shift toward green technologies, automatization, artificial intelligence, and others. Undervaluation, along with subsidies, might help gain a competitive advantage when increasing returns and learning spillovers are present, regardless of whether the country is developing or developing. Additionally, while undervaluation might help compensate for weak institutions, good institutions may be needed to exploit the benefits and opportunities that the undervalued real exchange rate provides. Besides the necessity to ensure the protection of property rights, good institutions facilitate the reallocation of capital and labor to the highly productive sectors (for evidence for the EU countries, see Gamberoni et al. 2016; Fidora et al. 2021) and the adoption of structural policies that fit the needs of the highly productive sectors rather than individual firms engaged in rent-seeking or political corruption. Therefore, the role of institutional quality in the undervaluation and growth relationship is more complex and more detailed analysis is needed to uncover,

for which countries undervalued currencies are most beneficial and which countries' growth rates are relatively insensitive to exchange rate misalignments.

5 Undervaluation and institutions across income groups

Our exploration of potential differences in the impact of undervaluation on economic growth across countries starts with the estimation of growth regression with different coefficients at lnUNDERVAL for low-income, lower middle-income, upper-middle-income, and high-income countries based on the World Bank classification.[18] Therefore, we augment the cross-country growth regression by cross products between the income group dummies and exchange rate misalignment lnUNDERVAL measuring the mean impact of undervaluation on growth within a particular income group, along with interaction terms between income group dummies, lnUNDERVAL, and institutional quality to gauge different impact of institutions on the impact of exchange rate misalignment on economic growth within each particular income group:

$$\begin{aligned} growth_{it} = \alpha + \beta_1 ln\,(GDPPC_{it-1}) + \delta_j IncomeGroup_j \\ \cdot ln\,(UNDERVAL_{it}) + \gamma_j IncomeGroup_j \\ \cdot ln\,(UNDERVAL_{it}) \cdot Institutions_{it} + \xi X_{it} + f_t + f_i + u_{it} \end{aligned} \quad (5)$$

The estimates of Eq. (5) for four alternative indicators of institutional quality appear in Table 5.[19] The coefficient at *ln*UNDERVAL is positive and statistically significant in all income groups. Importantly, the size of the coefficients differs across income groups, being the highest for the low-income and high-income countries, above 0.1, and between 0.0357 and 0.0600 in the middle-income countries. This U-shaped pattern differs from existing evidence that usually finds a larger effect of undervaluation on growth in developing countries than in developed countries, where the relevant coefficients are often statistically insignificant (Rodrik 2008; Habib et al. 2017, among others). However, the previous estimates were based on samples from the 1950s and 1970s; while, our dataset starts in 1996 when the World Governance Indicators appeared. Therefore, we implicitly focus on the recent decades that differ from the previous periods in various aspects. For example, the 1980s were considered a lost decade in many countries, particularly in Latin America, but in the 1990s, economic growth accelerated due to the globalization of production enabled by the liberalization of trade and capital flows. The boom in the IT sector also created numerous new opportunities for market entrants. All in all, the changes in the global economy were

[18] We separated the countries according to the data from 2005, which is near the middle of our sample. All the historical classifications can be accessed at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.

[19] We excluded countries with missing V-Dem data so that the differences across institutional variables can be attributed solely to the differences in the measurement of institutional quality and not to sample differences. This was the case of the following countries: Aruba, Anguilla, Antigua and Barbuda, Bahamas, Belize, Brunei Darussalam, Curacao, Cayman Islands, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Macao, Monserrat, Saint Maarten (Dutch part), St. Vincent and the Grenadines, and British Virgin Islands.

Table 5 Undervaluation and Growth: Income groups

Variables	(1) Rule of Law 2SIV ext inst	(2) WGI (PC) 2SIV ext inst	(3) Liberal democracy 2SIV ext inst	(4) V-Dem (PC) 2SIV ext inst
Growth(− 1)	0.0896***	0.0842***	0.0693***	0.0703***
	(0.0079)	(0.0072)	(0.0123)	(0.0120)
ln(GDPPCij(− 1))	− 0.1785***	− 0.1929***	− 0.1679***	− 0.1706***
	(0.0060)	(0.0064)	(0.0082)	(0.0082)
lnUNDERVAL_LIC	0.1016***	0.1117***	0.1109***	0.1154***
	(0.0145)	(0.0205)	(0.0173)	(0.0170)
lnUNDERVAL_LMIC	0.0508***	0.0362***	0.0377***	0.0357***
	(0.0119)	(0.0133)	(0.0127)	(0.0124)
lnUNDERVAL_UMIC	0.0600***	0.0599***	0.0425***	0.0449***
	(0.0090)	(0.0086)	(0.0103)	(0.0108)
lnUNDERVAL_HIC	0.1565***	0.2061***	0.1174***	0.1157***
	(0.0278)	(0.0261)	(0.0268)	(0.0264)
*Institutions**lnUNDERVAL_LIC	− 0.0405***	− 0.0137**	− 0.0061	− 0.0027
	(0.0106)	(0.0067)	(0.0179)	(0.0166)
*Institutions**lnUNDERVAL_LMIC	− 0.0248	− 0.0213***	− 0.0546***	− 0.0575***
	(0.0178)	(0.0076)	(0.0135)	(0.0139)
*Institutions**lnUNDERVAL_UMIC	0.0528***	0.0092	− 0.0208**	− 0.0282***
	(0.0151)	(0.0063)	(0.0102)	(0.0101)
*Institutions**lnUNDERVAL_HIC	− 0.0348*	− 0.0314***	− 0.0457**	− 0.0448**
	(0.0209)	(0.0076)	(0.0190)	(0.0178)
Institutions	0.0446***	0.0358***	0.0122***	0.0126***
	(0.0057)	(0.0028)	(0.0046)	(0.0048)
Investment	0.0232***	0.0237***	0.0191***	0.0189***
	(0.0029)	(0.0032)	(0.0037)	(0.0037)
Gov. expenditures (log)	− 0.0524***	− 0.0536***	− 0.0502***	− 0.0497***
	(0.0040)	(0.0037)	(0.0051)	(0.0051)
Population growth	− 0.1010	− 0.1778*	− 0.1288	− 0.1265
	(0.0972)	(0.1011)	(0.1425)	(0.1403)
Openness	0.0218***	0.0151***	0.0118**	0.0111**
	(0.0035)	(0.0032)	(0.0047)	(0.0047)
Inflation	− 0.0585***	− 0.0586***	− 0.0592***	− 0.0593***
	(0.0056)	(0.0052)	(0.0074)	(0.0074)
Financial openness(− 1)	0.0041***	0.0041***	0.0051***	0.0052***
	(0.0012)	(0.0014)	(0.0017)	(0.0018)
Net capital inflows	− 0.0038***	− 0.0049***	− 0.0042***	− 0.0043***
	(0.0011)	(0.0011)	(0.0015)	(0.0015)
Terms of trade	− 0.0445***	− 0.0241*	− 0.0137	− 0.0108
	(0.0156)	(0.0136)	(0.0171)	(0.0174)
RER volatility	− 0.0019***	− 0.0016***	− 0.0020***	− 0.0020***

Table 5 (continued)

Variables	(1) Rule of Law 2SIV ext inst	(2) WGI (PC) 2SIV ext inst	(3) Liberal democracy 2SIV ext inst	(4) V-Dem (PC) 2SIV ext inst
	(0.0004)	(0.0005)	(0.0005)	(0.0005)
Constant	1.6127***	1.7400***	1.4936***	1.5184***
	(0.0562)	(0.0610)	(0.0765)	(0.0772)
Observations	3,053	3,047	3,204	3,204
Number of countryID	155	155	155	155
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hansen	102.4	98.72	83.41	82.38
p value	0.0967	0.147	0.0521	0.0608
Factors_1st_stage	1	1	1	1
Factors_2nd_stage	1	1	2	2
Factor_Proportion	0.299	0.294	0.429	0.431
Instruments	105	105	84	84

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. 2SIV ext inst—Two-stage instrumental variable estimator with external instruments. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

so profound that high-income countries could also benefit from undervalued currencies, which makes their domestic production cheaper in comparison with other peers producing similarly sophisticated goods.

The interaction term in Eq. (5) implies that the effect of undervaluation depends on institutional quality. The hypothesis that it is possible to compensate for low-quality institutions by undervaluation predicts that the coefficient γ at the interaction term between the income group, the quality of the institution and the undervaluation shall be negative. Our estimated coefficients are not entirely consistent with this hypothesis. The highest impact of institutions on the strength of the undervaluation-growth link appears consistently in the coefficients of the high-income countries, which already had a high coefficient at lnUNDERVAL, and in lower-middle-income countries. In the following sections, we will show that the result for high-income countries is driven by a few resource-dependent high-income countries and disappears once those are excluded from the sample. For the lower-middle-income countries, the predictions align with the idea that undervaluation helps in countries with subpar institutions. However, at least some level of protection of property rights, among others, is needed to ensure positive effects on economic growth. Quantitatively smaller estimates of the coefficient γ appear among low-income countries, except for the model with the Rule of Law as a measure of institutional quality. For upper-middle-income countries, the results are inconsistent and thus do not allow for any reasonable interpretation.

We performed several robustness checks. First, we estimated Eq. (5) for each income group individually. The results remained reasonably robust (Appendix A: Table 15), meaning that our results are not affected by potential heterogeneity in the coefficients

at other covariates. Second, we replace the misalignment indicator with the cyclical component of the real exchange rate in relation to the US dollar and by the REER change (Appendix A: Table 16). In these cases, the positive impact of real depreciation appears only in high-income countries. In contrast, the mean effect in low-income and lower-middle-income countries is negative. On the other hand, the coefficients at the interaction terms are negative, in line with the hypothesis that the effects of undervaluation on growth shall be higher in the case of countries with subpar institutional quality. The coefficients at the interaction terms are smaller in the case of high-income countries, as well but not always significant.

Overall, the results from this section support the hypothesis of the positive impact of undervalued currency on economic growth, particularly when the lnUNDERVAL is used as an indicator of exchange misalignments. In that case, weaker institutions increase the effects of undervaluation in low- and lower-middle-income countries and high-income countries. When other indicators of misalignments are used, positive effects of undervaluation appear consistently in high-income countries only, and in many cases, the estimated impact of undervaluation appears negative. This confirms our intuition that alternative indicators of exchange rate misalignments represent different aspects of shifts in exchange rates.

6 Classification of countries according to their institutional development

An alternative perspective to study the role of institutional quality in the undervaluation-growth relationship is to group countries according to their institutional quality. This step was taken by Rodrik (2008), who divided the countries into three subgroups using the World Bank's Worldwide Governance Indicators based on their relative institutional quality (Rodrik 2008, pp. 395–397, Table 9 in particular). Rodrik proceeded as follows. He took a simple average of 4 subindices over the years 1996–2004 and regressed these country averages on log GDP per capita, obtaining a value of institutional index consistent with the country's GDP. Then, he divided the sample into three groups of equal size of countries with above-average, around-average, and below-average institutional quality. Finally, Rodrik found support for the positive effects of undervaluation only for countries with below- and about-average institutions. Inspired by the approach to group countries according to their relative institutional quality, we rely on cluster analysis that allows clustering based on both the levels and the evolution of institutional indicators, because it estimates the distance between countries for each point in time.

Previously, Paulus and Kristoufek (2015) used a similar approach. They clustered countries according to the Freedom from Corruption Index by the Heritage Foundation. However, many institutional indicators are closely correlated with GDP; thus, clustering over them contains the risk that one would cluster over the respective economic development rather than over the institutional quality itself. This risk is avoided by employing the concept of relative institutional quality.

Therefore, we start with regressing three alternative indicators of institutional quality on real GDP, similar to the real exchange rate regression in Eq. (2):

$$Institutions_{it} = \alpha + \beta ln(GDPPC_{it}) + f_t + u_t \tag{6}$$

Again, we are mainly interested in residuals that indicate the difference between the observed institutional quality and institutional quality consistent with the level of economic development of the particular countries, and we will refer to these residuals as the relative institutional quality.

As a proxy for $Institutions_{it}$, we use the same alternative indicators of institutional quality as in the previous section: the Rule of Law, the first principal component of the indices included in the Worldwide Governance Indicators database, the Liberal democracy index from the V-Dem project, and the first principal component of V-Dem indices. For the estimation of Eq. (6), we use data from 1996 to 2019. Until 2000, WGI institutional datasets were published biannually, so we interpolated these data to an annual frequency. The results of the first-stage regression (Eq. (6)) are provided in Table 6.

Then, we perform cluster analysis of relative indices of institutional quality obtained as residuals from the first-stage regression. We estimate the Euclidean distance d_{xy} between the residuals of Eq. (5) as

$$d_{xy} = \sqrt{\sum\nolimits_{t=1}^{T} (\widehat{u}_{it} - \widehat{u}_{jt})^2}$$

and construct a distance matrix D. For the clustering itself, we use the Ward linkage method, which minimizes the prediction error and leads to more balanced counts of units within clusters rather than alternative methods such as average clustering. The resulting dendrograms indicated the existence of five clusters; however, separating countries into the cluster with the lowest relative institutional quality was sensitive to the choice of the institutional variable. Therefore, to obtain a more robust composition

Table 6 First-stage regression: Relative institutional quality

Variables	(1) Rule of Law	(2) WGI (PC)	(2) Liberal democracy	(4) V-Dem (PC)
logrgdpePC	0.6204***	1.4552***	0.4730***	0.4579***
	(0.0079)	(0.0181)	(0.0096)	(0.0099)
Constant	− 5.4564***	− 12.7640***	− 4.3328***	− 4.2367***
	(0.0837)	(0.1874)	(0.0998)	(0.1028)
Observations	4,182	4,132	6,281	6,281
R-squared	0.5893	0.6071	0.3620	0.3523
Country FE	No	No	No	No
Year FE	Yes	Yes	Yes	Yes

Robust standard errors in parentheses, *** p < 0.01, ** p < 0.05, * p < 0.1; sample 1996–2019

of clusters, we merged two clusters with the lowest institutional quality into one. Therefore, we end up with four clusters of countries determined by relative institutional quality. The resulting dendrogram for the Rule of Law index is depicted in Fig. 1. Table 7 reports the average GDP in each cluster and the average score in the Rule of Law index, confirming that clusters are ordered from 1 to four, with cluster 1 including countries with the lowest relative institutional quality and cluster 4 with countries with the best institutions.

Note that the countries in cluster 1 are not necessarily the poorest economies due to clustering over residuals in the regressions from Table 6. Quite interestingly, the average GDP per capita in cluster 1 is the highest due to several oil-producing countries included there (Saudi Arabia, Qatar, United Arab Emirates, and Kuwait). However, most of the advanced high-income countries appear in cluster 4 depending on the variable upon which the cluster analysis is performed. Some countries from Africa or South Asia appear in the cluster of countries with the best institutional quality as well,

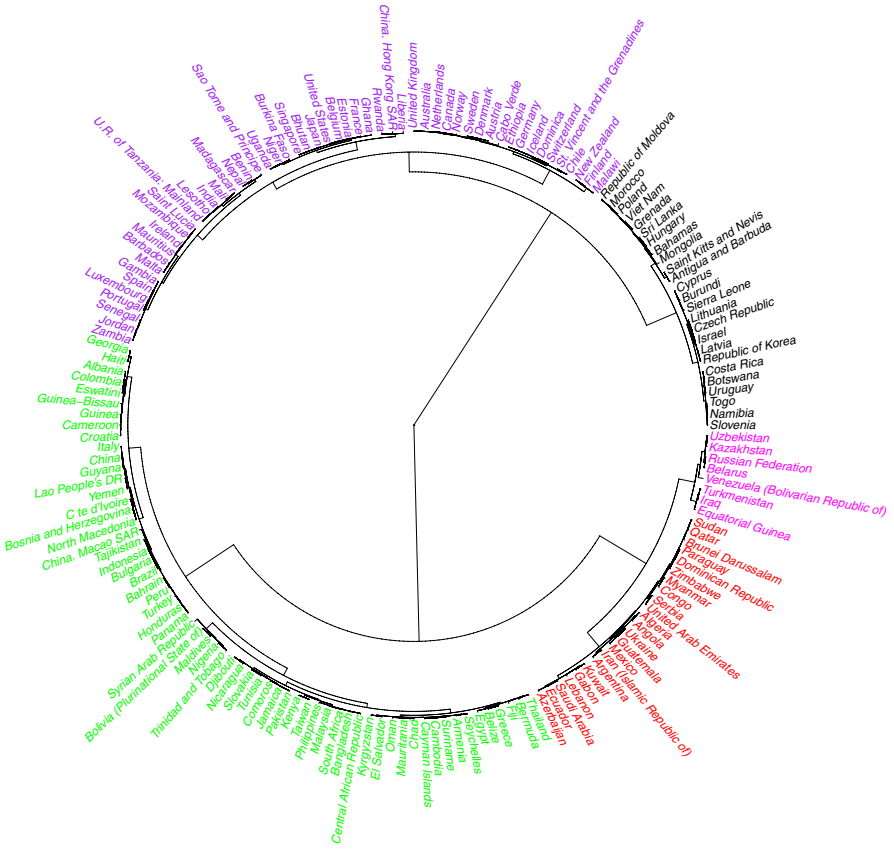

Fig. 1 Dendrogram of clustering over the rule of law index. *Note*: Rule of Law, data 1996–2019. Ward linkage method. Group 1: red, Group 2: green, Group 3: pink, Group 4: black. Group 5: violet. Clustering over the alternative institutional variables—Appendix 3. Created in RStudio

Table 7 Clusters—Descriptive statistics

	Rule of Law				WGI (PC)				Liberal Democracy				V-Dem (PC)			
	N	RLE_rel	RLE	rGDPpc	N	RLE_rel	RLE	rGDPpc	N	RLE_rel	RLE	rGDPpc	N	RLE_rel	RLE	rGDPpc
Cluster 1	30	− 0.875	− 0.739	19,680	59	− 0.600	− 0.641	14,881	19	− 0.715	− 0.236	28,362	65	− 0.404	− 0.550	12,153
Cluster 2	60	− 0.254	− 0.456	10,200	32	− 0.140	− 0.262	12,001	69	− 0.253	− 0.696	5940	26	− 0.090	− 0.601	6726
Cluster 3	29	0.256	0.337	15,290	55	0.391	0.276	14,278	30	0.275	0.399	18,702	33	0.299	0.435	18,956
Cluster 4	51	0.689	0.717	19,325	20	0.842	1.250	26,986	41	0.542	0.680	18,934	35	0.523	0.706	19,479

N is the number of countries within a given cluster. rGDPpc is the average real GDP per capita within a given cluster. RLE = Rule of Law, WGI (PC) = Worldwide Governance Indicators, 1st principal component, index V-DEM (PC) = V-DEM core indicators, 1st principal component. RLE_rel indicates the average values of residuals from the regression of RLE on real GDP per capita (Eq. (5))

such as Ethiopia or Ghana, as their institutional quality is much better than would correspond to their real GDP per capita. The composition of clusters can be found in Appendix 1.

To check whether there are differences in the effect of undervaluation on growth across clusters determined by relative institutional quality, we use the growth regressions extended for the interaction terms between undervaluation and the dummy variables C_{ji} being one when country i belongs to cluster j, as shown in Eq. (7):

$$\begin{aligned} growth_{it} = {} & \alpha + \beta_1 ln\,(GDPPC_{it-1}) + \delta_1 C_{1i} ln\,(UNDERVAL_{it}) \\ & + \delta_2 C_{2i} ln\,(UNDERVAL_{it}) + +\delta_3 C_{3i} ln\,(UNDERVAL_{it}) \\ & + \delta_4 C_{4i} ln\,(UNDERVAL_{it}) + \xi X_{it} + f_t + f_i + u_{it} \end{aligned} \tag{7}$$

Similarly to the growth Eq. (5), regression (7) includes the country- and time-fixed effects and additional control variables.[20]

We present our main results in Table 8. Generally, undervaluation has a positive effect on growth in almost all clusters. Therefore, the results of this and the previous sections are on the side of the literature that posits that undervaluation might increase the pace of economic growth, rather than on the side of skeptics (Cumperayot and Kouwenberg 2016; Goncalves and Rodrigues 2017), who failed to confirm the positive effects of undervaluation when additional control variables were included in their growth regressions, despite some disagreement caused by different approaches to measure exchange rate misalignments.

The sizes of coefficients resemble the U-shaped pattern again, implying a high impact of undervaluation on economic growth in Cluster 1 (countries with the most inferior relative institutional quality), with somewhat lower impact either in lower-middle-income or upper-middle-income countries. Then, in the case of countries with the best relative institutional quality, the coefficients increase again. In terms of statistical significance, the null of no differences between the coefficients at the interaction terms of cluster dummies and lnUNDERVAL is rejected in the case of the model with the principal component of the WGI indicators (column 2), and with the V-Dem indicators (columns 3 and 4; with the indicator of Liberal Democracy the rejection is possible at 10% only).

The reversal in the coefficients at the interaction terms with further improvements in institutional quality relative to the level of economic development is, however, only partially robust on the choice of the indicator of exchange rate misalignments. The results in Appendix A: Table 17 show that with alternative measures of exchange rate

[20] The alternative specification of Eq. (7) can be written as follows:

$$\begin{aligned} growth_{it} = {} & \alpha + \beta_1 ln\left(GDPPC_{it-1}\right) + \delta_1 ln\,(UNDERVAL_{it}) \\ & + \delta_2 C_{2i} ln\,(UNDERVAL_{it}) + \delta_3 C_{3i} ln\,(UNDERVAL_{it}) \\ & + \delta_4 C_{4i} ln\,(UNDERVAL_{it}) + \xi X_{it} + f_t + f_i + u_{it} \end{aligned}$$

Here, the coefficients $\delta_2 \ldots \delta_5$ represent the difference in the effect of undervaluation on growth in clusters 2 to 4 with respect to cluster 1. We estimated this alternative specification as well, and the results were generally equivalent to those obtained from Eq. (7).

Table 8 Impact of undervaluation on growth across clusters

Variables	(1) Rule of Law 2SIV ext inst	(2) WGI (PC) 2SIV ext inst	(3) Liberal Democracy 2SIV ext inst	(4) V-Dem (PC) 2SIV ext inst
Growth(− 1)	0.0863***	0.1009***	0.0835***	0.1086***
	(0.0121)	(0.0109)	(0.0139)	(0.0104)
ln(GDPPCij(− 1))	− 0.1816***	− 0.1941***	− 0.1643***	− 0.1522***
	(0.0092)	(0.0085)	(0.0091)	(0.0075)
Cl1*lnUNDERVAL	0.0929***	0.0967***	0.1107***	0.0840***
	(0.0179)	(0.0124)	(0.0192)	(0.0105)
Cl2*lnUNDERVAL	0.0650***	0.0274**	0.0651***	0.0539***
	(0.0118)	(0.0121)	(0.0107)	(0.0151)
Cl3*lnUNDERVAL	0.0384**	0.0892***	0.0371**	0.0495***
	(0.0156)	(0.0134)	(0.0187)	(0.0155)
Cl4*lnUNDERVAL	0.0824***	0.0781***	0.0589***	0.0892***
	(0.0185)	(0.0126)	(0.0160)	(0.0125)
Institutions	0.0401***	0.0347***	0.0051	0.0078
	(0.0070)	(0.0031)	(0.0060)	(0.0056)
Investment	0.0172***	0.0146***	0.0196***	0.0214***
	(0.0039)	(0.0034)	(0.0043)	(0.0039)
Gov. expenditures (log)	− 0.0536***	− 0.0441***	− 0.0488***	− 0.0414***
	(0.0068)	(0.0052)	(0.0065)	(0.0048)
Population growth	− 0.0740	− 0.2816*	− 0.1470	− 0.3288**
	(0.2071)	(0.1648)	(0.2049)	(0.1624)
Openness	0.0089*	0.0077*	0.0089*	0.0099**
	(0.0051)	(0.0046)	(0.0046)	(0.0043)
Inflation	− 0.0442***	− 0.0504***	− 0.0514***	− 0.0579***
	(0.0085)	(0.0058)	(0.0082)	(0.0066)
Financial openness(− 1)	0.0018	0.0035**	0.0041**	0.0030*
	(0.0018)	(0.0016)	(0.0020)	(0.0016)
Net capital inflows	− 0.0022	− 0.0016	− 0.0054***	− 0.0039***
	(0.0022)	(0.0013)	(0.0020)	(0.0014)
Terms of trade	− 0.0254	− 0.0362**	− 0.0101	− 0.0171
	(0.0178)	(0.0168)	(0.0189)	(0.0173)
RER volatility	− 0.0020***	− 0.0026***	− 0.0021***	− 0.0016***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Constant	1.6141***	1.7457***	1.4644***	1.3791***
	(0.0855)	(0.0780)	(0.0887)	(0.0706)
Observations	3,210	3,047	3,204	3,047

Table 8 (continued)

Variables	(1) Rule of Law 2SIV ext inst	(2) WGI (PC) 2SIV ext inst	(3) Liberal Democracy 2SIV ext inst	(4) V-Dem (PC) 2SIV ext inst
Number of countryID	155	155	155	155
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hansen	78.64	87.99	67.97	87.16
p value	0.00994	0.0613	0.0677	0.0690
Factors_1st_stage	1	1	1	1
Factors_2nd_stage	2	2	2	1
Factor_Proportion	0.428	0.433	0.423	0.303
Instruments	68	85	68	85
Linear Restriction test	5.905	22.51	7.575	7.915
p value	0.116	5.10e− 05	0.0557	0.0478

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. 2SIV ext inst—Two-stage instrumental variable estimator with external instruments. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

misalignments, positive effects of undervaluation appear within the cluster of countries with the worst relative institutional quality. With REER, positive signs usually appear in other clusters, too, but with the RER cycle, the impact of exchange rate misalignments is negative in clusters 2 and 3.

On the other hand, positive and usually significant effects of undervaluation in cluster 4 with countries with the best institutional quality are confirmed when the sample is shortened to end in 2014 (end date of Penn World Tables 9.0) or when either fixed effects or 2SIV without external instruments is used for the estimations with lnUNDERVAL.[21]

7 Granular evidence

7.1 Income groups and institutional clusters

The models with countries grouped according to their income or relative institutional quality revealed that undervaluation matters both in high- and low-income countries and in countries with subpar or high relative institutional quality. In contrast, the results were inconclusive for the middle-income groups and around-average relative institutions around the average. However, it is possible to incorporate both classifications into one model simultaneously to provide more granular evidence showing where undervaluation matters most and to identify countries that have a large influence on

[21] These results are available upon request.

the results on an aggregate level. To do so, we reestimate the cross-country growth regressions with interaction terms that include the income group dummies and the institutional cluster dummies, along with the exchange rate misalignment.

The results presented in Table 9, lead to the following implications. First, the highest impact of undervaluation on growth is identified in a subset of high-income countries with the lowest relative institutional quality, which include, notably, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates, which appear in cluster 1 no matter which measure of institutional quality is used for clustering. The high impact of undervaluation on the growth of these countries is intuitive. These countries have one of the highest shares of net commodity exports on GDP (IMF, 2012), and undervaluation increases revenues for exports in domestic currencies. Moreover, based on lnUNDERVAL, these countries have had strongly undervalued currencies since the early 2000s. However, as we show, the positive impact of undervaluation on growth among high-income countries prevails even if we exclude those countries from the sample.

Second, undervaluation also has a positive effect on low-income countries. However, in this case, the values of the undervaluation coefficients depend on the membership of a specific country to a given cluster, rather than revealing any consistent pattern. In particular, the highest coefficients appear in clusters with Nigeria (Cluster 2 Rule of Law, cluster 1 WGI, cluster 3 Liberal Democracy and V-Dem) and/or Burkina Faso (Cluster 4 WGI indicators, 3 V-Dem indicators), both with relatively overvalued currencies. On the other hand, the lowest coefficient in Cluster 1 based on Liberal Democracy is associated solely with Uzbekistan, which actively pursues import substitution policies.

Third, these results do not support the findings of some of the previous literature that considered that the positive effect of undervaluation on economic growth is related solely to developing countries or countries with a lower institutional quality. Instead, the effect of undervaluation on economic growth is generally positive, and quantitatively low and statistically insignificant results appear only in a small subset of the cases considered. More specifically, tiny effects on a border or below the conventional significance criteria appear among upper-middle-income countries in clusters 3 and 4, where many of the EU new member states appear, and then for high-income countries such as South Korea, Taiwan, or Israel. These groups of countries are characterized by high trade openness, high degree of integration into the global value chain, and a large share of intermediate goods in exports. Finally, adverse effects of undervaluation are rare and, in the subset of lower-middle-income countries, driven, namely by Brazil (WGI: Cluster 2, V-Dem: Cluster 4).

7.2 Exclusion of countries potentially influencing the results

In the previous section, we have identified six countries whose presence within subgroups pushes the coefficient estimates at lnUNDERVAL upwards: Nigeria, Burkina Faso, Kuwait, Qatar, Saudi Arabia, and the United Arab Emirates. Therefore, we reestimated our growth regressions on income groups and institutional clusters from Sects. 5 and 6 (Eqs. 5 and 7) to investigate whether the identified U-shaped patterns

Table 9 Undervaluation and growth: Granular Evidence

Variables	(1) RLE	(2) WGI (PC)	(3) VDEM_lib	(4) PC V-Dem
Growth(− 1)	0.0676***	0.0893***	0.0659***	0.0930***
	(0.0085)	(0.0039)	(0.0106)	(0.0044)
ln(GDPPCij(− 1))	− 0.1802***	− 0.2053***	− 0.1742***	− 0.1686***
	(0.0065)	(0.0032)	(0.0074)	(0.0038)
Cl1*lnUNDERVAL*LIC	0.0799***	0.1636***	− 0.0050*	0.1072***
	(0.0146)	(0.0129)	(0.0027)	(0.0074)
Cl2*lnUNDERVAL*LIC	0.1377***	0.0642***	0.1181***	0.1264***
	(0.0146)	(0.0172)	(0.0129)	(0.0133)
Cl3*lnUNDERVAL*LIC	0.0620***	0.1471***	0.2271***	0.1830***
	(0.0227)	(0.0067)	(0.0301)	(0.0172)
Cl4*lnUNDERVAL*LIC	0.1376***	0.1706***	0.1249***	0.1800***
	(0.0171)	(0.0027)	(0.0223)	(0.0109)
Cl1*lnUNDERVAL*LMIC	0.1140***	0.0742***	0.1013***	0.0698***
	(0.0127)	(0.0072)	(0.0115)	(0.0075)
Cl2*lnUNDERVAL*LMIC	0.0462***	0.0096	0.0527***	0.0240***
	(0.0157)	(0.0124)	(0.0124)	(0.0082)
Cl3*lnUNDERVAL*LMIC	0.1262***	0.0774***	0.0579***	0.0343***
	(0.0138)	(0.0055)	(0.0204)	(0.0094)
Cl4*lnUNDERVAL*LMIC	0.0576***	0.0342***	− 0.0936***	− 0.1690***
	(0.0137)	(0.0031)	(0.0123)	(0.0027)
Cl1*lnUNDERVAL*UMIC	0.0305**	0.0929***	0.1517***	0.0836***
	(0.0131)	(0.0076)	(0.0087)	(0.0119)
Cl2*lnUNDERVAL*UMIC	0.0608**	0.0674***	0.0213*	0.0144***
	(0.0288)	(0.0034)	(0.0110)	(0.0032)
Cl3*lnUNDERVAL*UMIC	0.0157	0.0422***	0.0320***	0.0225***
	(0.0176)	(0.0129)	(0.0092)	(0.0058)
Cl4*lnUNDERVAL*UMIC	0.0966***	0.0709***	0.0013	0.0394***
	(0.0122)	(0.0059)	(0.0136)	(0.0079)
Cl1*lnUNDERVAL*HIC	0.3499***	0.2252***	0.2462***	0.2297***
	(0.0328)	(0.0147)	(0.0508)	(0.0419)
Cl2*lnUNDERVAL*HIC	0.0650*	0.0205***	–	− 0.1570***
	(0.0378)	(0.0037)		(0.0052)
Cl3*lnUNDERVAL*HIC	0.0089	0.0816***	− 0.0140	0.0532**
	(0.0132)	(0.0193)	(0.0144)	(0.0215)
Cl4*lnUNDERVAL*HIC	0.0771***	0.0753***	0.0791***	0.0763***
	(0.0262)	(0.0123)	(0.0227)	(0.0107)

Table 9 (continued)

Variables	(1) RLE	(2) WGI (PC)	(3) VDEM_lib	(4) PC V-Dem
Institutions	0.0323***	0.0372***	0.0063	0.0107***
	(0.0049)	(0.0016)	(0.0050)	(0.0033)
Observations	3,210	3,047	3,204	3,047
Number of countryID	155	155	155	155
Other covariates	YES	YES	YES	YES
Hansen	102.2	124.7	95.62	134.7
p value	0.142	0.295	0.297	0.125
Factors_1st_stage	1	1	1	1
Factors_2nd_stage	2	1	2	1
Factor_Proportion	0.423	0.286	0.433	0.297
Instruments	116	145	116	145

2SIV ext inst—Two-stage instrumental variable estimator with external instruments, with country and time-fixed effects. WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. LIC = low-income countries; LMIC = lower-middle-income countries, UMIC = upper-middle-income countries, HIC = high-income countries. Full results with growth determinants: Appendix A: Table 18. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

in the lnUNDERVAL coefficients remain robust when the countries mentioned above are excluded from the sample.

As expected, the main differences appear in the regression on income groups in the coefficients at the interaction terms between undervaluation and institutions in high-income countries (Table 10, panel a). These coefficients are lower by two-thirds after dropping those countries as mentioned earlier from the sample and are no longer statistically significant (except column (2) with the principal component of WGI), implying that the mechanism of compensation achieved by undervaluation for lower institutional quality is relatively minor among high-income countries. Therefore, after excluding a few resource-dependent high-income countries, the results correspond to Rodrik's (2008) hypothesis that institutions do not constrain the production of tradable goods, so inferior do not function as additional tax levied on tradables as in countries with lower income and lower-quality institutions. Similarly, the interaction coefficient between institutions and undervaluation for low-income countries also weakens. However, the positive impact of undervaluation on growth still characterizes all income groups. Therefore, the positive effect of undervaluation on growth among high-income countries remains robust.

Similarly, the results for the model with institutional clusters (Table 10, panel (b)) are consistent with our previous results presented in Table 8; therefore, we consider the result of a positive impact of undervaluation on growth among high-income countries and countries with high relative institutional quality as reasonably robust.

Table 10 Undervaluation and growth: Exclusion of countries tilting the lnUNDERVAL effect

Variables	Rule of Law 2SIV ext inst	WGI (PC) 2SIV ext inst	Liberal Democracy 2SIV ext inst	V-Dem (PC) 2SIV ext inst
(a) ***Income groups***				
	(1)	(2)	(3)	(4)
lnUNDERVAL_LIC	0.1046***	0.1126***	0.0900***	0.0911***
	(0.0147)	(0.0253)	(0.0176)	(0.0174)
lnUNDERVAL_LMIC	0.0461***	0.0280*	0.0382***	0.0356***
	(0.0119)	(0.0153)	(0.0120)	(0.0117)
lnUNDERVAL_UMIC	0.0554***	0.0652***	0.0407***	0.0429***
	(0.0087)	(0.0065)	(0.0113)	(0.0117)
lnUNDERVAL_HIC	0.1099***	0.1521***	0.0878***	0.0841***
	(0.0206)	(0.0313)	(0.0165)	(0.0163)
*Institutions**lnUNDERVAL_LIC	− 0.0248**	− 0.0101	− 0.0122	− 0.0120
	(0.0115)	(0.0078)	(0.0180)	(0.0170)
*Institutions**lnUNDERVAL_LMIC	− 0.0298*	− 0.0266***	− 0.0558***	− 0.0580***
	(0.0181)	(0.0075)	(0.0135)	(0.0138)
*Institutions**lnUNDERVAL_UMIC	0.0466***	0.0026	− 0.0190*	− 0.0268**
	(0.0145)	(0.0059)	(0.0112)	(0.0109)
*Institutions**lnUNDERVAL_HIC	− 0.0122	− 0.0187*	− 0.0185	− 0.0164
	(0.0172)	(0.0097)	(0.0148)	(0.0132)
(b)***Institutional clusters***				
	(5)	(6)	(7)	(8)
Cl1*lnUNDERVAL	0.0894***	0.0865***	0.0956***	0.1644***
	(0.0154)	(0.0113)	(0.0179)	(0.0220)
Cl2*lnUNDERVAL	0.0567***	0.0325***	0.0634***	0.0624***
	(0.0126)	(0.0116)	(0.0111)	(0.0179)
Cl3*lnUNDERVAL	0.0476***	0.0974***	0.0300**	0.0597***
	(0.0139)	(0.0125)	(0.0138)	(0.0202)
Cl4*lnUNDERVAL	0.0801***	0.0791***	0.0626***	0.0879***
	(0.0171)	(0.0113)	(0.0159)	(0.0146)

Selected parts of regression results. Growth, lag growth, institutions, and other growth determinants included. 2SIV ext inst—Two-stage instrumental variable estimator with external instruments, with country- and time-fixed effects. WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. LIC = low-income countries; LMIC = lower-middle-income countries, UMIC = upper-middle-income countries, HIC = high-income countries. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

8 Concluding remarks

In this paper, we revisit the impact of undervaluations and exchange rate misalignments on economic growth. We focus on the role of institutions in the transmission

of undervaluation to economic growth and on the differences between low-income, middle-income, and high-income countries. In particular, we test whether an undervalued exchange rate serves primarily as a compensatory mechanism for a low-quality institutional environment, as suggested by Rodrik (2008). Unlike previous studies, we estimate our models on a relatively recent data sample starting in 1996 due to the availability of data on institutional quality. Therefore, we focus on the period characterized by globalization, relatively robust economic growth, especially in developing countries, and a sharp decrease in poverty worldwide.

To measure exchange rate misalignments, we rely primarily on an index of undervaluation based on the real exchange rate adjusted for the Balassa–Samuelson effect, while also utilizing the real effective exchange rate and the cyclical component of the real exchange rate filtered using the Hodrick–Prescott filter as sensitivity checks. Then, we incorporate the undervaluation index within cross-country growth regressions. Those are estimated using two-stage instrumental variable regression that accounts for cross sectional dependence that is present in the data and allows utilization of external instruments to track potential endogeneity between economic growth and undervaluation.

First, we confirm the positive effects of undervaluation on economic growth, thus supporting the hypothesis that not all exchange rate misalignments harm economic growth. Second, we test whether institutional quality functions as a moderator variable in the undervaluation-growth relationship by extending the baseline regression with the interaction term between institutional quality and undervaluation while allowing for different effects of both the undervaluation and interaction term across countries separated by their membership in income groups. As it turns out, undervaluation has positive effects in income groups, with a U-shaped pattern in the sizes of the coefficients at undervaluation, thus with a relatively higher impact of undervaluation in low-income and high-income countries. Regarding the role of institutions, our results provide robust support for their role as a moderator variable for lower-medium-income and high-income countries. For other groups, the results are inconclusive or not robust over different indicators of institutional quality.

Then, we cluster the countries into groups based on their institutional quality relative to their levels of economic development. This exercise confirms the positive effect of undervaluation on growth in all clusters. Again, undervaluation stimulates the economic growth of countries of primarily weak and high institutional quality.

With our results on income groups with institutions as a moderator variable and on clusters determined by relative institutional quality, we investigate the variation in the impact of undervaluation on growth both across income groups and institutional clusters. This analysis allows the identification of countries that can affect the results. In particular, the significant role of institutions in the transmission of undervaluation on growth among high-income countries is driven by four oil-producing countries. Once these countries are excluded from the sample, the impact of undervaluation on growth remains robust, but in line with Rodrik's predictions, the role of institutions in the transmission mechanism disappears.

However, our main results are specific for the undervaluation index adjusted for the Balassa–Samuelson effect and do not hold for other indicators of misalignments. Nevertheless, this outcome is not that surprising as alternative measures track rather

short-term deviations of the real exchange rate from its long-term trajectory; while, the undervaluation index measures long-term departures from levels determined by the economic performance of the country's peers.

Our results have several policy implications. First, when recent data are used, sustained undervaluation of the currency supports economic growth not only in developing countries, but also in high-income countries. Regarding the role of institutional quality, our results suggest that institutions are mostly relevant in the transmission of exchange rate misalignment on growth in lower-middle-income countries. Therefore, for the mechanism suggested by Rodrik (2008), according to which undervalued currency compensates exporters for transaction costs heightened by subpar institutions, at least some degree of institutional quality is apparently needed. Therefore, countries should focus on improving the quality of their institutions that improve economic growth per se rather than hoping that they can compensate for their deficiencies through a sustained undervaluation of their exchange rates.

8.1 Replication package

The datasets of this paper (1. code and programs, 2. Data, 3. detailed readme files) are collected in the electronic supplementary material of this article. (https://drive.google.com/drive/u/1/folders/14C5z79jQpQl_6HxKfffg-fuiDAftqxtX).

See Tables 11, 12, 13, 14, 15, 16, 17 and 18.

See Tables 19, 20, 21, 22, 23 and 24.

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Declarations

Competing interests The authors have no relevant financial or non-financial interests to disclose. The authors have no competing interests to declare that are relevant to the content of this article.

Appendix

Appendix 1: Clusters

Cluster 1				Cluster 2			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
Angola	Angola	United Arab Emirates	Angola	Albania	Armenia	Angola	Burundi
United Arab Emirates	Albania	Azerbaijan	Albania	Armenia	Bangladesh	Albania	Central African Republic
Argentina	United Arab Emirates	Belarus	United Arab Emirates	Bangladesh	Bulgaria	Armenia	Côte d'Ivoire
Azerbaijan	Argentina	China	Armenia	Bulgaria	Bolivia	Burundi	D.R. of the Congo
Belarus	Azerbaijan	Algeria	Azerbaijan	Bahrain	Brazil	Bangladesh	Colombia
Brunei Darussalam	Bahrain	Equatorial Guinea	Bangladesh	Bosnia and Herzegovina	Central African Republic	Bhutan	Comoros
Congo	Bosnia and Herzegovina	China, Hong Kong SAR	Belarus	Belize	Cayman Islands	Central African Republic	Georgia
Dominican Republic	Belarus	Iran	Bhutan	Bolivia	Djibouti	Côte d'Ivoire	Guinea-Bissau
Algeria	Brunei Darussalam	Kazakhstan	China	Brazil	Georgia	Cameroon	Guatemala

Cluster 1				Cluster 2			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
Ecuador	China	Kuwait	Cameroon	Central African Republic	Guinea-Bissau	D.R. of the Congo	Guyana
Gabon	Côte d'Ivoire	Malaysia	Congo	China	Greece	Congo	Croatia
Equatorial Guinea	Cameroon	Oman	Djibouti	Côte d'Ivoire	Honduras	Colombia	Haiti
Guatemala	Congo	Qatar	Dominican Republic	Cameroon	Croatia	Comoros	Indonesia
Iran	Colombia	Russian Federation	Algeria	Colombia	Italy	Djibouti	Israel
Iraq	Comoros	Saudi Arabia	Egypt	Comoros	Kenya	Dominican Republic	Kenya
Kazakhstan	Dominican Republic	Singapore	Ethiopia	Cayman Islands	Kyrgyzstan	Ecuador	Kyrgyzstan
Kuwait	Algeria	Eswatini	Fiji	Djibouti	Cambodia	Egypt	Lesotho
Lebanon	Ecuador	Turkmenistan	Gabon	Egypt	Republic of Korea	Ethiopia	Peru
Mexico	Egypt	Uzbekistan	Guinea	Fiji	Sri Lanka	Fiji	Philippines
Myanmar	Gabon		Gambia	Georgia	Morocco	Gabon	Romania

Cluster 1				Cluster 2			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
Paraguay	Guinea		Equatorial Guinea	Guinea	Mauritania	Georgia	Sierra Leone
Qatar	Equatorial Guinea		China, Hong Kong SAR	Guinea-Bissau	Malaysia	Guinea	El Salvador
Russian Federation	Guatemala		Honduras	Greece	Nicaragua	Gambia	Togo
Saudi Arabia	Guyana		Iran	Guyana	Panama	Guinea-Bissau	Taiwan
Sudan	Haiti		Iraq	Honduras	Peru	Guatemala	Uganda
Serbia	Indonesia		Jordan	Croatia	Philippines	Guyana	South Africa
Turkmenistan	Iran		Kazakhstan	Haiti	Suriname	Honduras	
Ukraine	Iraq		Cambodia	Indonesia	Slovakia	Croatia	
Uzbekistan	Israel		Kuwait	Italy	Seychelles	Haiti	
Zimbabwe	Kazakhstan		Lao People's DR	Jamaica	Tunisia	Indonesia	
	Kuwait		Lebanon	Kyrgyzstan	Taiwan	Iraq	
	Lao People's DR		Sri Lanka	Cambodia	Viet Nam	Jordan	
	Lebanon		Morocco	Lao People's DR		Kenya	

Cluster 1				Cluster 2			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
	China, Macao SAR		Maldives	China, Macao SAR		Kyrgyzstan	
	Maldives		Mexico	Maldives		Cambodia	
	Mexico		North Macedonia	North Macedonia		Lao People's DR	
	North Macedonia		Myanmar	Mongolia		Lebanon	
	Myanmar		Mauritania	Mauritania		Sri Lanka	
	Nigeria		Malaysia	Malaysia		Morocco	
	Oman		Nicaragua	Nigeria		Maldives	
	Pakistan		Oman	Nicaragua		Mexico	
	Paraguay		Pakistan	Oman		North Macedonia	
	Qatar		Paraguay	Pakistan		Myanmar	
	Russian Federation		State of Palestine	Panama		Mauritania	
	Saudi Arabia		Qatar	Peru		Nicaragua	
	Sudan		Russian Federation	Philippines		Pakistan	

Cluster 1				Cluster 2			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
	Serbia		Rwanda	El Salvador		Peru	
	Eswatini		Saudi Arabia	Suriname		Paraguay	
	Syrian Arab Republic		Sudan	Slovakia		State of Palestine	
	Chad		Singapore	Eswatini		Romania	
	Thailand		Serbia	Seychelles		Rwanda	
	Tajikistan		Eswatini	Syrian Arab Republic		Sudan	
	Turkmenistan		Seychelles	Chad		Sierra Leone	
	Trinidad and Tobago		Syrian Arab Republic	Thailand		El Salvador	
	Turkey		Chad	Tajikistan		Serbia	
	Ukraine		Thailand	Trinidad and Tobago		Seychelles	
	Uzbekistan		Tajikistan	Tunisia		Syrian Arab Republic	
	Yemen		Turkmenistan	Turkey		Chad	
	Zimbabwe		Tunisia	Yemen		Togo	

Cluster 1				Cluster 2			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
			Turkey	South Africa		Thailand	
			Ukraine			Tajikistan	
			Uzbekistan			Tunisia	
			Viet Nam			Turkey	
			Yemen			Taiwan	
			Zimbabwe			Ukraine	
						Viet Nam	
						Yemen	
						South Africa	
						Zimbabwe	

Cluster 3				Cluster 4			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
Antigua and Barbuda	Antigua and Barbuda	Argentina	Argentina	Australia	Australia	Australia	Australia
Burundi	Burundi	Austria	Austria	Austria	Austria	Belgium	Belgium
Bahamas	Belgium	Burkina Faso	Bulgaria	Belgium	Burkina Faso	Benin	Benin
Botswana	Benin	Bulgaria	Bolivia	Benin	Barbados	Brazil	Burkina Faso
Costa Rica	Bahamas	Bolivia	Barbados	Burkina Faso	Canada	Switzerland	Brazil
Cyprus	Belize	Barbados	Botswana	Barbados	Switzerland	Chile	Switzerland
Czech Republic	Bhutan	Botswana	Canada	Bhutan	Chile	Cabo Verde	Chile
Spain	Botswana	Canada	Cyprus	Canada	Germany	Costa Rica	Cabo Verde
Grenada	Costa Rica	Cyprus	Ecuador	Switzerland	Dominica	Czech Republic	Costa Rica
China, Hong Kong SAR	Cyprus	Hungary	United Kingdom	Chile	Denmark	Germany	Czech Republic
Hungary	Czech Republic	Iceland	Ireland	Cabo Verde	Finland	Denmark	Germany

Cluster 3				Cluster 4			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
Israel	Spain	Israel	Iceland	Germany	United Kingdom	Spain	Denmark
Kenya	Estonia	Italy	Japan	Dominica	Iceland	Estonia	Spain
Saint Kitts and Nevis	Ethiopia	Japan	Republic of Korea	Denmark	Lesotho	Finland	Estonia
Republic of Korea	Fiji	Republic of Korea	Luxembourg	Estonia	Mozambique	France	Finland
Liberia	France	Lesotho	Latvia	Ethiopia	Malawi	United Kingdom	France
Sri Lanka	Ghana	Luxembourg	Republic of Moldova	Finland	Netherlands	Ghana	Ghana
Lithuania	Gambia	Republic of Moldova	Madagascar	France	Norway	Greece	Greece
Latvia	Grenada	Madagascar	Mali	United Kingdom	New Zealand	India	Hungary
Morocco	China, Hong Kong SAR	Malta	Malta	Ghana	Sweden	Ireland	India
Republic of Moldova	Hungary	Mauritius	Mongolia	Gambia		Jamaica	Italy

Cluster 3				Cluster 4			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
Namibia	India	Namibia	Mozambique	India		Liberia	Jamaica
Poland	Ireland	Nigeria	Mauritius	Ireland		Lithuania	Liberia
Sierra Leone	Jamaica	Nepal	Namibia	Iceland		Latvia	Lithuania
Slovenia	Jordan	Panama	Nigeria	Jordan		Mali	Malawi
Togo	Japan	Philippines	Netherlands	Japan		Mongolia	Niger
Taiwan	Liberia	Trinidad and Tobago	Nepal	Saint Lucia		Mozambique	Norway
Uruguay	Lithuania	Uganda	Panama	Lesotho		Malawi	New Zealand
Viet Nam	Luxembourg	United States	Suriname	Luxembourg		Niger	Poland
	Latvia	Zambia	Trinidad and Tobago	Madagascar		Netherlands	Portugal
	Republic of Moldova		U.R. of Tanzania: Mainland	Mali		Norway	Senegal
	Madagascar		United States	Malta		New Zealand	Sao Tome and Principe

Cluster 3				Cluster 4			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
	Mali		Zambia	Mozambique		Poland	Slovenia
	Malta			Mauritius		Portugal	Sweden
	Mongolia			Malawi		Senegal	Uruguay
	Mauritius			Niger		Sao Tome and Principe	
	Namibia			Netherlands		Suriname	
	Niger			Norway		Slovenia	
	Nepal			Nepal		Sweden	
	Poland			New Zealand		U.R. of Tanzania: Mainland	
	Portugal			Portugal		Uruguay	
	Rwanda			Rwanda			
	Senegal			Senegal			
	Singapore			Singapore			
	Sierra Leone			Sao Tome and Principe			
	El Salvador			Sweden			

Cluster 3				Cluster 4			
Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA	Rule of law	Governance indicators	V-Dem liberal democracy	V-Dem PCA
	Sao Tome and Principe			U.R. of Tanzania: Mainland			
	Slovenia			Uganda			
	Togo			United States			
	U.R. of Tanzania: Mainland			St. Vincent and the Grenadines			
	Uganda			Zambia			
	Uruguay						
	United States						
	South Africa						
	Zambia						

Appendix 2: Variables and sources

Variable	Description	Sources and notes
$GDPPC_{it}$	Real GDP per capita ($RGDPE_{it}/POP_{it}$)	Penn World Table 10.01
RER_{it}	Real exchange rate ($1/PL\_GDPO_{it}$)	Penn World Table 10.01
Rule of Law (RLE)	Original scale (-2.5; 2.5)	Worldwide Governance Indicators, World Bank
Governance Indicators (WGI)	Principal component of variables in WGI (Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, Control of Corruption)	Worldwide Governance Indicators, World Bank
Investment	Share of gross capital formation at current PPPs; $\ln(CSH\_I_{ij})$	Penn World Table 10.01
Government cons	Share of government consumption at current PPPs; $\ln(CSH\_G_{ij})$	Penn World Table 10.01
Human capital	Human capital index, $\ln(HC_{ij})$	Penn World Table 10.01
Population growth	$\ln(POP_{it})$—$\ln(POP_{it-1})$	Penn World Table 10.01
Openness	$\ln(CSH\_X_{it}$—$CSH\_M_{it})$	Penn World Table 10.01; note that the share of import, CSH_M has negative sign in PWT
Terms of trade	$\ln(PL\_X/PL\_M)$	Penn World Table 10.01
RER volatility	$\ln(\sqrt{((\ln(XR_{it})-\ln(XR_{it-1}))^2})$	Penn World Table 10.01

Variable	Description	Sources and notes
Financial openness	The Chinn-Ito index (kaopen)	https://web.pdx.edu/~ito/Chinn-Ito_website.htm
REER	Real Effective Exchange Rate (number of trading partners 170), Darvas (2021)	https://www.bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database
Total liabilities	Total financial liabilities to nonresidents	External Wealth of Nations dataset: https://www.brookings.edu/articles/the-external-wealth-of-nations-database/ (Milesi-Ferretti GM, 2022)
Total assets excl gold	Total financial claims on nonresidents (excluding gold holdings)	External Wealth of Nations dataset: https://www.brookings.edu/articles/the-external-wealth-of-nations-database/ (Milesi-Ferretti GM, 2022)
FX Reserves minus gold	Stock of central bank foreign exchange reserves excluding gold holdings	External Wealth of Nations dataset: https://www.brookings.edu/articles/the-external-wealth-of-nations-database/ (Milesi-Ferretti GM, 2022)

Variable	Description	Sources and notes
GDP US	GDP in US dollars (calculated at the period-average US dollar exchange rate)	External Wealth of Nations dataset: https://www.brookings.edu/articles/the-external-wealth-of-nations-database/ (Milesi-Ferretti GM, 2022)
Liberal democracy index (VDEM_lib)	Original scale (0;1), standardized	The V-Dem Dataset v.13 (https://v-dem.net/data/the-v-dem-dataset/)
Core V-Dem indicators (pc1_VDEM)	Principal component of core V-Dem indices (Electoral democracy index, Liberal democracy index, Participatory democracy index, Deliberative democracy index, Egalitarian democracy index)	The V-Dem Dataset v.13 (https://v-dem.net/data/the-v-dem-dataset/)

Appendix 3: Dendrograms over the alternative indicators of institutional quality

See Figs. 2, 3 and 4.

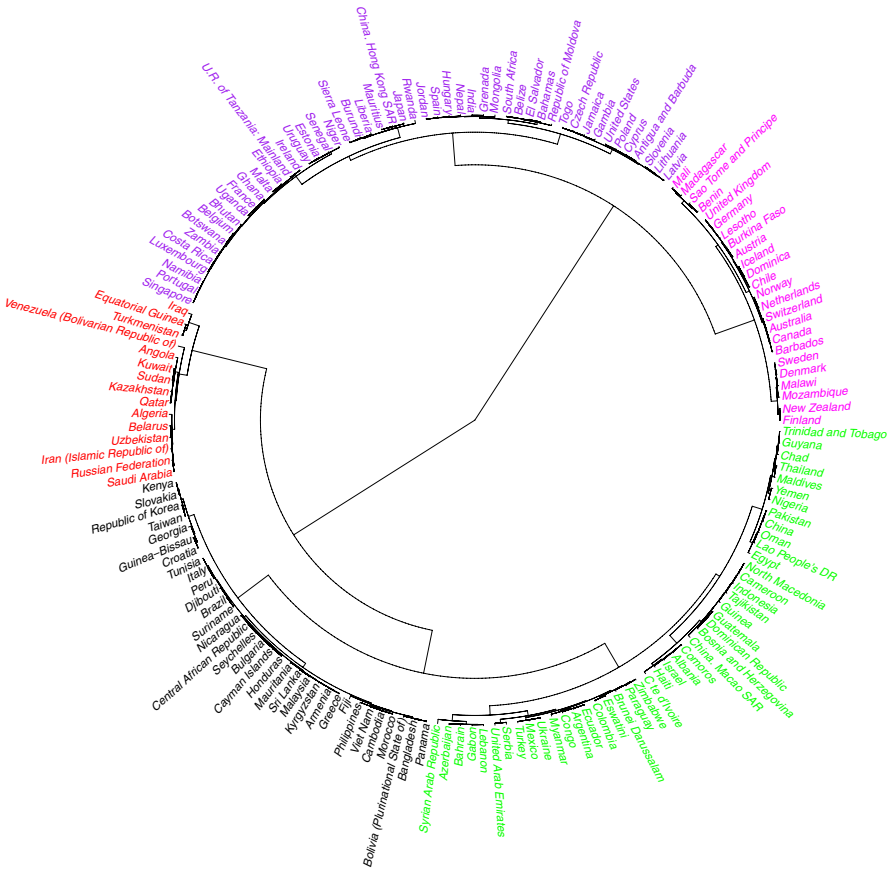

Fig. 2 Dendrogram of clustering over the Worldwide Governance Indicators (first principal component). *Note*: Created in RStudio.

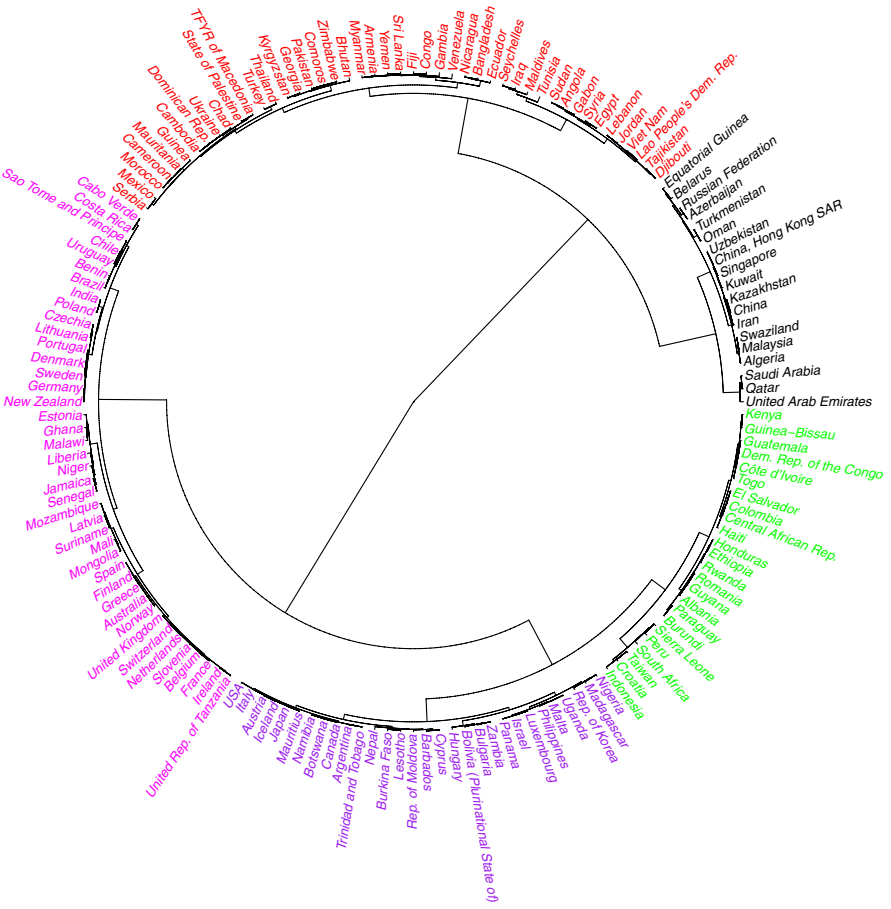

Fig. 3 Dendrogram of clustering over the Liberal Democracy (V-Dem Project). *Note*: Created in RStudio

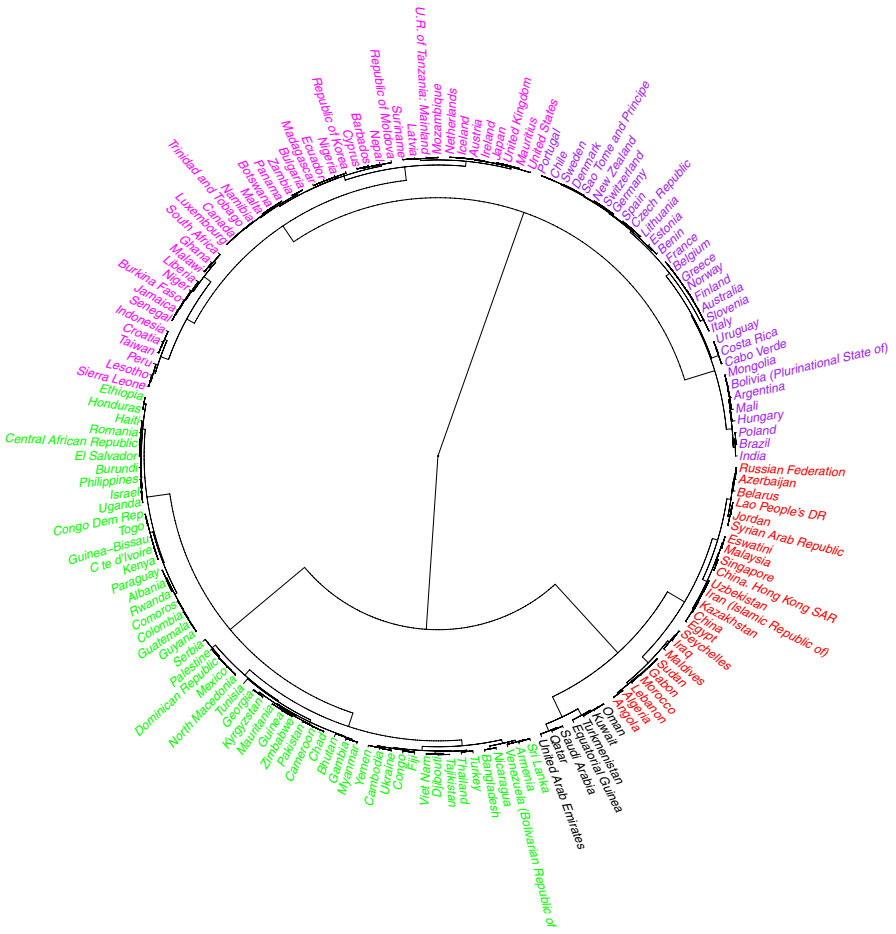

Fig. 4 Dendrogram of clustering over the V-Dem Core indicators. (First principal component). *Note*: Created in RStudio

Appendix A: Additional tables

See Tables 11, 12, 13, 14, 15, 16, 17 and 18.

Table 11 Undervaluation and growth—fixed effects and GMM

Variables	(1) FE	(2) FE	(3) System GMM Max lags Collapse	(4) Diff GMM Max lags Collapse	(5) System GMM Max lags Collapse—II	(6) Diff GMM Max lags Collapse
Growth(− 1)		0.2007***	0.1781***	0.2070***		
		(0.0283)	(0.0310)	(0.0324)		
ln(GDPPC$_{ij}$(− 1))	− 0.0717***	− 0.0791***	− 0.0013	− 0.0592***	− 0.0012	− 0.0560***
	(0.0071)	(0.0072)	(0.0019)	(0.0070)	(0.0019)	(0.0075)
lnUNDERVAL	0.0436***	0.0442***	0.0427***	0.0126	0.0436***	0.0195
	(0.0088)	(0.0082)	(0.0129)	(0.0145)	(0.0140)	(0.0165)
Constant	0.6898***	0.7543***	0.0230		0.0173	
	(0.0672)	(0.0680)	(0.0173)		(0.0173)	
Observations	6,731	6,551	6,551	6,371	6,731	6,551
Number of countryID	180	180	180	180	180	180
Time FE	YES	YES	YES	YES	YES	YES
Hansen test			104.1	99.18	114.1	113.5
d.f			76	74	77	75
p-val			0.0178	0.0271	0.00390	0.00272
AR2-test			0.154	0.637	− 2.332	− 2.294
ARp-val			0.877	0.524	0.0197	0.0218
Instruments			117	114	118	115

Dependent variable: log GDP growth per capita. Sample 1996–2019, annual data. FE—fixed effects. clustered standard errors in parentheses.. The real exchange rate (REER) was inverted, i.e., positive values = undervaluation. *** p < 0.01, ** p < 0.05, * p < 0.1

Table 12 Undervaluation and growth, additional growth determinants, GMM

Variables	(1) FE	(2) System GMM Max lags Collapse	(3) Diff GMM Max lags Collapse
Growth(− 1)		0.1262***	0.1203***
		(0.0325)	(0.0310)
ln($GDPPC_{ij}$(− 1))	− 0.0993***	− 0.0350***	− 0.0974***
	(0.0168)	(0.0097)	(0.0165)
lnUNDERVAL	0.0681***	0.0596***	0.0504**
	(0.0147)	(0.0218)	(0.0229)
Investment	0.0147*	− 0.0148	0.0067
	(0.0081)	(0.0224)	(0.0132)
Gov. expenditures (log)	− 0.0415***	− 0.0880***	− 0.0511***
	(0.0116)	(0.0195)	(0.0189)
Population growth	0.1567	0.5195	0.7900
	(0.3616)	(0.6124)	(0.5317)
Openness	0.0324***	0.0593***	0.0581***
	(0.0089)	(0.0185)	(0.0167)
Inflation	− 0.0980***	− 0.1310***	− 0.0888***
	(0.0203)	(0.0258)	(0.0208)
Financial openness(− 1)	0.0003	0.0264***	0.0004
	(0.0022)	(0.0059)	(0.0105)
Net capital inflows	− 0.0056**	− 0.0064	− 0.0054
	(0.0028)	(0.0070)	(0.0057)
Terms of trade	− 0.0221	0.0024	− 0.0493
	(0.0247)	(0.0632)	(0.0506)
RER volatility	− 0.0026***	− 0.0046***	− 0.0031***
	(0.0009)	(0.0013)	(0.0011)
Constant	0.9111***	0.1822	
	(0.1496)	(0.1225)	
Observations	3,888	3,746	3,582
Number of countryID	164	164	164
Country FE	YES	YES	YES
Year FE	YES	YES	YES
Time FE		YES	YES
Hansen		143.7	141.8
d.f		252	241
p value		1	1

Table 12 (continued)

Variables	(1) FE	(2) System GMM Max lags Collapse	(3) Diff GMM Max lags Collapse
AR2-test		− 0.767	− 0.730
ARp-val		0.443	0.465
Instruments		287	275

Dependent variable: log GDP growth per capita. Sample 1996–2019, annual data. FE—fixed effects. clustered standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 13 Undervaluation and growth, controlling for institutional quality—Sensitivity analysis I

Variables	(1) lnUNDERVAL RLE 2SIV ext. inst	(2) UNDERVAL LibDem 2SIV ext. inst	(3) RER cycle RLE 2SIV ext. inst	(4) RER cycle LibDem 2SIV ext. inst	(5) lnREER RLE 2SIV ext. inst	(6) lnREER LibDem 2SIV ext. inst
Growth(− 1)	0.0729***	0.0811***	0.1273***	0.0825***	0.1789***	0.0886***
	(0.0146)	(0.0152)	(0.0151)	(0.0178)	(0.0119)	(0.0175)
$\ln(GDPPC_{ij}(-1))$	− 0.1800***	− 0.1735***	− 0.1559***	− 0.1601***	− 0.1640***	− 0.1706***
	(0.0102)	(0.0098)	(0.0098)	(0.0102)	(0.0075)	(0.0104)
Misalignment	0.0700***	0.0691***	0.0881***	0.0490***	− 0.0015	− 0.0048
	(0.0085)	(0.0088)	(0.0146)	(0.0185)	(0.0091)	(0.0111)
Institutions	0.0408***	0.0129**	0.0329***	0.0005	0.1572***	− 0.0460
	(0.0072)	(0.0058)	(0.0066)	(0.0064)	(0.0428)	(0.0441)
Institutions**Misalignment*	− 0.0157*	− 0.0367***	− 0.0398***	− 0.0452***	0.0286***	− 0.0104
	(0.0083)	(0.0076)	(0.0128)	(0.0136)	(0.0092)	(0.0096)
Investment	0.0148***	0.0185***	0.0132***	0.0124**	0.0146***	0.0096*
	(0.0044)	(0.0048)	(0.0042)	(0.0053)	(0.0033)	(0.0057)
Gov. expenditures (log)	− 0.0564***	− 0.0530***	− 0.0503***	− 0.0559***	− 0.0386***	− 0.0669***
	(0.0076)	(0.0080)	(0.0075)	(0.0083)	(0.0047)	(0.0085)
Population growth	0.0007	− 0.1187	0.0191	0.0024	− 0.1926	0.0590
	(0.2308)	(0.2274)	(0.1923)	(0.3154)	(0.1546)	(0.2770)
Openness	0.0114**	0.0128**	− 0.0046	− 0.0093	− 0.0002	− 0.0073
	(0.0053)	(0.0057)	(0.0044)	(0.0057)	(0.0040)	(0.0054)

Table 13 (continued)

Variables	(1) lnUNDERVAL RLE 2SIV ext. inst	(2) UNDERVAL LibDem 2SIV ext. inst	(3) RER cycle RLE 2SIV ext. inst	(4) RER cycle LibDem 2SIV ext. inst	(5) lnREER RLE 2SIV ext. inst	(6) lnREER LibDem 2SIV ext. inst
Inflation	− 0.0435***	− 0.0494***	− 0.0378***	− 0.0385***	− 0.0575***	− 0.0498***
	(0.0092)	(0.0095)	(0.0091)	(0.0133)	(0.0113)	(0.0135)
Financial openness(− 1)	0.0025	0.0030	0.0022	0.0041*	0.0031**	0.0035
	(0.0018)	(0.0020)	(0.0019)	(0.0024)	(0.0015)	(0.0022)
Net capital inflows	− 0.0037*	− 0.0046**	− 0.0032*	− 0.0020	− 0.0037***	− 0.0012
	(0.0021)	(0.0020)	(0.0018)	(0.0021)	(0.0012)	(0.0017)
Terms of trade	− 0.0152	− 0.0056	− 0.0010	0.0115	− 0.0044	0.0007
	(0.0188)	(0.0195)	(0.0185)	(0.0206)	(0.0147)	(0.0201)
RER volatility	− 0.0026***	− 0.0024***	− 0.0021***	− 0.0024***	− 0.0022***	− 0.0019***
	(0.0006)	(0.0005)	(0.0006)	(0.0006)	(0.0006)	(0.0007)
Constant	1.5888***	1.5362***	1.3685***	1.3840***	1.4676***	1.4385***
	(0.0952)	(0.0913)	(0.0919)	(0.1022)	(0.0729)	(0.1003)
Observations	3,210	3,204	3,210	3,361	3,011	3,315
Number of countryID	155	155	155	155	153	153
Country FE	YES	YES	YES	YES	YES	YES

Table 13 (continued)

Variables	(1) lnUNDERVAL RLE 2SIV ext. inst	(2) UNDERVAL LibDem 2SIV ext. inst	(3) RER cycle RLE 2SIV ext. inst	(4) RER cycle LibDem 2SIV ext. inst	(5) lnREER RLE 2SIV ext. inst	(6) lnREER LibDem 2SIV ext. inst
Year FE	YES	YES	YES	YES	YES	YES
Hansen	67.02	66.66	64.12	46.16	81.25	54.62
p-val	0.0231	0.0248	0.0398	0.0391	0.0426	0.00551
Factors_1st_stage	1	1	1	1	1	1
Factors_2nd_stage	2	2	2	2	1	2
Factor_Proportion	0.427	0.433	0.408	0.427	0.287	0.431
Instruments	60	60	60	45	75	45

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component from core V-Dem indicators. FE—fixed effects. clustered standard errors in parentheses; 2SIV ext inst—two-stage instrumental variable estimator with external instruments. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 14 Undervaluation and growth, controlling for institutional quality—sensitivity analysis II

	(1)	(2)	(3)	(4)
	System GMM	Diff GMM	System GMM	Diff GMM
	Max lags	Max lags	Max lags	Max lags
Variables	Collapse	Collapse	Collapse	Collapse
L.growth_l	0.1115***	0.1274***	0.1249***	0.1123***
	(0.0375)	(0.0362)	(0.0362)	(0.0322)
LAG_logrgdpePC	− 0.1576***	− 0.1312***	− 0.0514***	− 0.1066***
	(0.0345)	(0.0213)	(0.0127)	(0.0179)
lnUNDERVAL	0.0511	0.0537**	0.0573**	0.0608**
	(0.0313)	(0.0264)	(0.0243)	(0.0255)
RLE	0.2106***	0.0909***		
	(0.0514)	(0.0299)		
RLE_lnUNDERVAL	− 0.0839**	− 0.0466*		
	(0.0340)	(0.0271)		
VDEM_lib			− 0.0140	0.0054
			(0.0208)	(0.0137)
VDEM_lib_lnUNDERVAL			− 0.0963***	− 0.0567***
			(0.0203)	(0.0193)
logcsh_i	− 0.0313	− 0.0012	0.7701	0.9655
	(0.0220)	(0.0146)	(0.6837)	(0.6027)
logcsh_g	− 0.1276***	− 0.0768***	0.0593***	0.0583***
	(0.0292)	(0.0231)	(0.0213)	(0.0176)
loggrowth_pop	0.8874	0.8897	− 0.1258***	− 0.0833***
	(0.8051)	(0.6557)	(0.0247)	(0.0205)
openness	0.0453**	0.0552***	0.0214***	− 0.0047
	(0.0215)	(0.0187)	(0.0057)	(0.0087)
inflation	− 0.0917***	− 0.0684***	− 0.0094	− 0.0092
	(0.0257)	(0.0232)	(0.0077)	(0.0064)
finopen_lag	0.0169*	− 0.0055	− 0.0534	− 0.0798
	(0.0101)	(0.0085)	(0.0706)	(0.0597)
netcapitalinflow	− 0.0114	− 0.0100	− 0.0048***	− 0.0033***
	(0.0099)	(0.0080)	(0.0013)	(0.0012)
tot	− 0.0792	− 0.1344**	0.0366**	− 0.0212
	(0.0812)	(0.0627)	(0.0173)	(0.0214)
revolut	− 0.0044***	− 0.0030**	− 0.0304	− 0.0237
	(0.0014)	(0.0013)	(0.0190)	(0.0184)
Constant	1.1967***		0.3036**	
	(0.3132)		(0.1275)	

Table 14 (continued)

Variables	(1) System GMM Max lags Collapse	(2) Diff GMM Max lags Collapse	(3) System GMM Max lags Collapse	(4) Diff GMM Max lags Collapse
Observations	3,548	3,393	3,543	3,388
Number of countryID	155	155	155	155
Year FE	YES	YES	YES	YES
Hansen	131.2	131.6	130.3	137.7
p-val	1	1	1	1
Instruments	335	321	335	321
Time FE	YES	YES	YES	YES
d.f	298	285	298	285
AR2-test	− 0.678	− 0.533	− 0.627	− 0.662
ARp-val	0.498	0.594	0.531	0.508

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component from core V-Dem indicators. FE—fixed effects. clustered standard errors in parentheses; 2SIV ext inst—two-stage instrumental variable estimator with external instruments. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 15 Undervaluation and growth: income groups—separate clusters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	2SIV ext inst	2SIV ext inst	2SIV ext inst	2SIV ext inst	2SIV ext inst	2SIV ext inst	2SIV ext inst	2SIV ext inst
	RLE	RLE	RLE	RLE	LibDem	LibDem	LibDem	LibDem
Variables	LIC	LMIC	UMIC	HIC	LIC	LMIC	UMIC	HIC
Growth(− 1)	− 0.0126	− 0.0681***	− 0.1336***	0.2064***	− 0.0032	− 0.0458***	− 0.0161	0.2378***
	(0.0111)	(0.0127)	(0.0313)	(0.0288)	(0.0134)	(0.0147)	(0.0189)	(0.0187)
ln(GDPPCij(− 1))	− 0.2039***	− 0.1578***	− 0.1734***	− 0.3673***	− 0.1923***	− 0.1449***	− 0.1977***	− 0.3671***
	(0.0096)	(0.0094)	(0.0202)	(0.0315)	(0.0094)	(0.0083)	(0.0203)	(0.0198)
lnUNDERVAL	0.1338***	0.0610***	0.0557**	0.2541***	0.1465***	0.0513***	0.0537***	0.1603***
	(0.0147)	(0.0122)	(0.0225)	(0.0498)	(0.0146)	(0.0099)	(0.0157)	(0.0212)
Institutions	0.0154*	0.0456***	0.0358***	0.0501***	0.0068	0.0122*	− 0.0063	− 0.0093
	(0.0079)	(0.0088)	(0.0129)	(0.0111)	(0.0087)	(0.0065)	(0.0107)	(0.0098)
Institutions.lnUNDERVAL	− 0.0286**	− 0.0363**	0.0415	− 0.0733***	− 0.0079	− 0.0399***	− 0.0418**	− 0.1136***
	(0.0132)	(0.0145)	(0.0365)	(0.0248)	(0.0132)	(0.0103)	(0.0170)	(0.0156)
Investment	0.0303***	− 0.0124**	0.0394***	0.0298***	0.0299***	− 0.0112**	0.0461***	0.0412***
	(0.0024)	(0.0055)	(0.0139)	(0.0086)	(0.0029)	(0.0053)	(0.0121)	(0.0088)
Gov. expenditures (log)	− 0.0229***	− 0.0827***	− 0.1377***	− 0.2024***	− 0.0237***	− 0.0747***	− 0.1449***	− 0.2000***
	(0.0051)	(0.0090)	(0.0165)	(0.0161)	(0.0056)	(0.0091)	(0.0124)	(0.0160)
Population growth	3.0358***	− 0.0074	0.1615	− 0.1234	2.6064***	− 0.1346	0.7139	− 0.0132
	(0.3701)	(0.3277)	(1.3490)	(0.1237)	(0.4652)	(0.2626)	(0.9650)	(0.0828)
Openness	0.0233***	0.0394***	− 0.0138	− 0.0373***	0.0221***	0.0373***	− 0.0371***	− 0.0459***
	(0.0049)	(0.0059)	(0.0286)	(0.0110)	(0.0043)	(0.0068)	(0.0064)	(0.0125)

Table 15 (continued)

Variables	(1) 2SIV ext inst RLE LIC	(2) 2SIV ext inst RLE LMIC	(3) 2SIV ext inst RLE UMIC	(4) 2SIV ext inst RLE HIC	(5) 2SIV ext inst LibDem LIC	(6) 2SIV ext inst LibDem LMIC	(7) 2SIV ext inst LibDem UMIC	(8) 2SIV ext inst LibDem HIC
Inflation	− 0.0861***	0.0065	− 0.0028	− 0.0675***	− 0.0871***	0.0025	− 0.0552**	− 0.0979***
	(0.0055)	(0.0104)	(0.0182)	(0.0175)	(0.0055)	(0.0089)	(0.0225)	(0.0165)
Financial openness(− 1)	0.0122***	− 0.0025	− 0.0022	0.0247***	0.0120***	0.0009	− 0.0072***	0.0205***
	(0.0028)	(0.0026)	(0.0018)	(0.0037)	(0.0037)	(0.0024)	(0.0025)	(0.0038)
Net capital inflows	− 0.0443***	− 0.0252***	0.0027***	− 0.0007	− 0.0424***	− 0.0196***	0.0015	0.0029
	(0.0027)	(0.0063)	(0.0009)	(0.0022)	(0.0023)	(0.0064)	(0.0017)	(0.0021)
Terms of trade	− 0.0575***	− 0.0703***	− 0.0933	0.3204***	− 0.0656***	− 0.0530**	0.0134	0.3201***
	(0.0190)	(0.0226)	(0.1009)	(0.0340)	(0.0166)	(0.0223)	(0.0324)	(0.0566)
RER volatility	− 0.0004	− 0.0033***	− 0.0023	− 0.0036***	− 0.0004	− 0.0029***	− 0.0008	− 0.0037***
	(0.0006)	(0.0005)	(0.0014)	(0.0004)	(0.0007)	(0.0004)	(0.0014)	(0.0008)
Constant	1.6068***	1.3374***	1.5544***	3.4911***	1.5119***	1.2143***	1.7852***	3.5441***
	(0.0862)	(0.0824)	(0.2168)	(0.3631)	(0.0868)	(0.0676)	(0.2025)	(0.1914)
Observations	1,001	1,033	587	746	1,001	1,033	614	774
Number of countryID	46	48	27	34	46	48	27	34
Country FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 15 (continued)

Variables	(1) 2SIV ext inst RLE LIC	(2) 2SIV ext inst RLE LMIC	(3) 2SIV ext inst RLE UMIC	(4) 2SIV ext inst RLE HIC	(5) 2SIV ext inst LibDem LIC	(6) 2SIV ext inst LibDem LMIC	(7) 2SIV ext inst LibDem UMIC	(8) 2SIV ext inst LibDem HIC
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Hansen	38.82	38.25	20.27	26.13	36.60	37.68	14.03	23.59
p value	0.158	0.173	0.930	0.715	0.225	0.190	0.597	0.0988
Factors_1st_stage	1	1	1	1	1	1	1	1
Factors_2nd_stage	1	1	1	1	1	1	1	1
Factor_Proportion	0.271	0.274	0.451	0.344	0.261	0.273	0.397	0.370
Instruments	45	45	45	45	45	45	30	30

2SIV ext inst—two-stage instrumental variable estimator with external instruments. LIC = low-income countries; LMIC = lower medium-income countries, UMIC = upper medium-income countries, HIC = high-income countries. RLE: Rule of law, WGI database. LibDem. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 16 Undervaluation and growth: income groups—RER cycle and REER

Variables	(1) RER cycle RLE	(2) RER cycle WGI (PC)	(3) RER cycle LibDem	(4) RER cycle V-Dem (PC)	(5) REER data RLE	(6) REER data WGI (PC)	(7) REER data LibDem	(8) REER data V-Dem (PC)
Growth(− 1)	0.1452***	0.1463***	0.1128***	0.1118***	0.1747***	0.1246***	0.1285***	0.1308***
	(0.0106)	(0.0104)	(0.0127)	(0.0122)	(0.0078)	(0.0066)	(0.0121)	(0.0118)
ln(GDPPCij(− 1))	− 0.1536***	− 0.1633***	− 0.1553***	− 0.1548***	− 0.1806***	− 0.2052***	− 0.1731***	− 0.1760***
	(0.0048)	(0.0051)	(0.0061)	(0.0061)	(0.0061)	(0.0058)	(0.0083)	(0.0085)
Misalignment_LIC	− 0.0941***	− 0.0773***	0.1090***	0.0969***	− 0.0718***	− 0.0789***	− 0.0667***	− 0.0693***
	(0.0305)	(0.0300)	(0.0277)	(0.0290)	(0.0127)	(0.0124)	(0.0176)	(0.0166)
Misalignment_LMIC	− 0.0286*	− 0.0199	0.0444**	0.0424**	− 0.0592***	− 0.0616***	− 0.0199	− 0.0241*
	(0.0151)	(0.0162)	(0.0202)	(0.0213)	(0.0127)	(0.0139)	(0.0148)	(0.0141)
Misalignment_UMIC	0.0331**	0.0322**	0.0640**	0.0742**	− 0.0276**	− 0.0200	0.0080	0.0168
	(0.0135)	(0.0125)	(0.0301)	(0.0323)	(0.0123)	(0.0160)	(0.0202)	(0.0212)
Misalignment_HIC	0.2023***	0.2207***	0.1876***	0.2098***	0.1526***	0.1533***	0.1171***	0.1273***
	(0.0391)	(0.0367)	(0.0560)	(0.0552)	(0.0240)	(0.0266)	(0.0281)	(0.0289)
Institutions_Misalignment_LIC	− 0.3425***	− 0.1280***	− 0.1178***	− 0.1418***	− 0.0412***	− 0.0210***	− 0.0476***	− 0.0557***
	(0.0294)	(0.0126)	(0.0366)	(0.0401)	(0.0122)	(0.0051)	(0.0109)	(0.0107)
Institutions_Misalignment_LMIC	− 0.1632***	− 0.0741***	− 0.0990***	− 0.1095***	− 0.0314**	− 0.0178***	− 0.0431***	− 0.0532***
	(0.0178)	(0.0079)	(0.0237)	(0.0269)	(0.0122)	(0.0053)	(0.0108)	(0.0107)

Table 16 (continued)

Variables	(1) RER cycle RLE	(2) RER cycle WGI (PC)	(3) RER cycle LibDem	(4) RER cycle V-Dem (PC)	(5) REER data RLE	(6) REER data WGI (PC)	(7) REER data LibDem	(8) REER data V-Dem (PC)
Institutions_Misalignment_UMIC	0.0572***	0.0063	− 0.0376	− 0.0520*	− 0.0291**	− 0.0153***	− 0.0415***	− 0.0500***
	(0.0197)	(0.0074)	(0.0260)	(0.0270)	(0.0124)	(0.0054)	(0.0104)	(0.0103)
Institutions_Misalignment_HIC	− 0.0400	− 0.0227**	− 0.0368	− 0.0558	− 0.0369***	− 0.0188***	− 0.0369***	− 0.0480***
	(0.0277)	(0.0114)	(0.0372)	(0.0365)	(0.0119)	(0.0050)	(0.0107)	(0.0107)
Institutions	0.0373***	0.0303***	0.0036	0.0033	− 0.1322**	− 0.0631**	− 0.1969***	− 0.2410***
	(0.0050)	(0.0019)	(0.0055)	(0.0056)	(0.0571)	(0.0250)	(0.0495)	(0.0490)
Investment	0.0186***	0.0159***	0.0191***	0.0184***	0.0182***	0.0167***	0.0137***	0.0126***
	(0.0032)	(0.0031)	(0.0038)	(0.0038)	(0.0025)	(0.0029)	(0.0044)	(0.0045)
Gov. expenditures (log)	− 0.0457***	− 0.0459***	− 0.0465***	− 0.0464***	− 0.0395***	− 0.0492***	− 0.0456***	− 0.0440***
	(0.0041)	(0.0041)	(0.0066)	(0.0065)	(0.0031)	(0.0035)	(0.0056)	(0.0056)
Population growth	− 0.0185	− 0.1495	0.1429	0.1044	− 0.0413	− 0.0521	− 0.0844	− 0.0688
	(0.1265)	(0.1238)	(0.1572)	(0.1559)	(0.0901)	(0.0845)	(0.1371)	(0.1335)
Openness	0.0013	− 0.0051*	0.0005	0.0009	− 0.0031	− 0.0059*	− 0.0080*	− 0.0053
	(0.0030)	(0.0030)	(0.0039)	(0.0039)	(0.0029)	(0.0033)	(0.0044)	(0.0043)

Table 16 (continued)

Variables	(1) RER cycle RLE	(2) RER cycle WGI (PC)	(3) RER cycle LibDem	(4) RER cycle V-Dem (PC)	(5) REER data RLE	(6) REER data WGI (PC)	(7) REER data LibDem	(8) REER data V-Dem (PC)
Inflation	− 0.0661***	− 0.0603***	− 0.0507***	− 0.0507***	− 0.0866***	− 0.1017***	− 0.0748***	− 0.0774***
	(0.0051)	(0.0054)	(0.0081)	(0.0080)	(0.0072)	(0.0078)	(0.0096)	(0.0095)
Financial openness(− 1)	0.0014	0.0003	0.0045***	0.0045***	0.0030**	0.0050***	0.0039**	0.0033*
	(0.0012)	(0.0012)	(0.0016)	(0.0016)	(0.0014)	(0.0015)	(0.0017)	(0.0017)
Net capital inflows	− 0.0040***	− 0.0036***	− 0.0039**	− 0.0039**	− 0.0030***	− 0.0028***	− 0.0023*	− 0.0020
	(0.0012)	(0.0012)	(0.0016)	(0.0016)	(0.0011)	(0.0011)	(0.0013)	(0.0013)
Terms of trade	− 0.0097	− 0.0003	0.0015	0.0047	− 0.0218**	− 0.0397***	0.0013	0.0025
	(0.0154)	(0.0153)	(0.0177)	(0.0178)	(0.0111)	(0.0108)	(0.0140)	(0.0140)
RER volatility	− 0.0016***	− 0.0014***	− 0.0011**	− 0.0013***	− 0.0013***	− 0.0015***	− 0.0016***	− 0.0016***
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0005)	(0.0004)
Constant	1.3752***	1.4574***	1.3816***	1.3766***	1.5875***	1.7908***	1.5539***	1.5900***
	(0.0443)	(0.0505)	(0.0635)	(0.0631)	(0.0757)	(0.0768)	(0.0936)	(0.0980)
Observations	3,053	3,047	3,204	3,204	3,011	3,005	3,160	3,160
Number of countryID	155	155	155	155	153	153	153	153
Hansen	109.7	107.7	87.46	85.38	99.82	119.5	78.45	81.37
p-val	0.0368	0.0487	0.0274	0.0383	0.130	0.00815	0.106	0.0704

Table 16 (continued)

Variables	(1) RER cycle RLE	(2) RER cycle WGI (PC)	(3) RER cycle LibDem	(4) RER cycle V-Dem (PC)	(5) REER data RLE	(6) REER data WGI (PC)	(7) REER data LibDem	(8) REER data V-Dem (PC)
Factors_1st_stage	1	1	1	1	1	1	1	1
Factors_2nd_stage	1	1	1	1	2	2	2	2
Factor_Proportion	0.297	0.295	0.279	0.280	0.416	0.435	0.416	0.417
Instruments	105	105	84	84	105	105	84	84

2SIV estimator with external instruments. LIC = low-income countries; LMIC = lower medium-income countries, UMIC = upper medium-income countries, HIC = high-income countries. RLE: Rule of law, WGI database. LibDem. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 17 Undervaluation and growth: income groups—RER cycle and REER

Variables	(1) Rule of law lnUNDERVAL	(2) LibDem lnUNDERVAL	(3) Rule of law RER cycle	(4) LibDem RER cycle	(5) Rule of law REER	(6) LibDem REER
L.growth_l	0.0863***	0.0835***	0.1645***	0.1735***	0.0886***	0.0880***
	(0.0121)	(0.0139)	(0.0141)	(0.0092)	(0.0173)	(0.0159)
LAG_logrgdpePC	− 0.1816***	− 0.1643***	− 0.1667***	− 0.4420***	− 0.1643***	− 0.1619***
	(0.0092)	(0.0091)	(0.0085)	(0.0120)	(0.0106)	(0.0097)
Cl1**Institutions***lnUNDERVAL	0.0929***	0.1107***	0.0315***	0.0631***	0.0706***	0.0293
	(0.0179)	(0.0192)	(0.0091)	(0.0160)	(0.0252)	(0.0332)
Cl2**Institutions***lnUNDERVAL	0.0650***	0.0651***	− 0.0305	− 0.0519***	0.0648**	0.0777**
	(0.0118)	(0.0107)	(0.0195)	(0.0168)	(0.0256)	(0.0303)
Cl3**Institutions***lnUNDERVAL	0.0384**	0.0371**	− 0.0411**	− 0.0504***	0.0295	− 0.0019
	(0.0156)	(0.0187)	(0.0209)	(0.0157)	(0.0324)	(0.0247)
Cl4**Institutions***lnUNDERVAL	0.0824***	0.0589***	− 0.0026	− 0.0094	0.0336	0.0152
	(0.0185)	(0.0160)	(0.0177)	(0.0252)	(0.0248)	(0.0282)
Institutions	0.0401***	0.0051	0.0316***	− 0.0023	0.0282***	0.0017
	(0.0070)	(0.0060)	(0.0065)	(0.0056)	(0.0083)	(0.0064)
logcsh_i	0.0172***	0.0196***	0.0159***	0.0125**	0.0152***	0.0132**
	(0.0039)	(0.0043)	(0.0041)	(0.0058)	(0.0048)	(0.0053)
logcsh_g	− 0.0536***	− 0.0488***	− 0.0447***	− 0.0654***	− 0.0578***	− 0.0540***
	(0.0068)	(0.0065)	(0.0057)	(0.0087)	(0.0077)	(0.0073)
loggrowth_pop	− 0.0740	− 0.1470	− 0.0440	− 0.6754***	0.0399	0.0521

Table 17 (continued)

Variables	(1) Rule of law lnUNDERVAL	(2) LibDem lnUNDERVAL	(3) Rule of law RER cycle	(4) LibDem RER cycle	(5) Rule of law REER	(6) LibDem REER
	(0.2071)	(0.2049)	(0.1496)	(0.1109)	(0.3153)	(0.3149)
openness	0.0089*	0.0089*	− 0.0069	− 0.0293***	− 0.0117**	− 0.0076
	(0.0051)	(0.0046)	(0.0044)	(0.0053)	(0.0054)	(0.0055)
inflation	− 0.0442***	− 0.0514***	− 0.0661***	− 0.0722***	− 0.0354***	− 0.0435***
	(0.0085)	(0.0082)	(0.0105)	(0.0079)	(0.0119)	(0.0116)
finopen_lag	0.0018	0.0041**	0.0024	0.0066***	0.0037*	0.0032
	(0.0018)	(0.0020)	(0.0017)	(0.0020)	(0.0022)	(0.0023)
netcapitalinflow	− 0.0022	− 0.0054***	− 0.0027*	− 0.0003	− 0.0005	− 0.0019
	(0.0022)	(0.0020)	(0.0014)	(0.0015)	(0.0022)	(0.0021)
tot	− 0.0254	− 0.0101	− 0.0002	0.0284**	0.0073	0.0069
	(0.0178)	(0.0189)	(0.0159)	(0.0132)	(0.0184)	(0.0200)
revolut	− 0.0020***	− 0.0021***	− 0.0018***	− 0.0007	− 0.0028***	− 0.0023***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0006)
Constant	1.6141***	1.4644***	1.4200***	3.8311***	1.4209***	1.4065***
	(0.0855)	(0.0887)	(0.0893)	(0.1132)	(0.1049)	(0.1021)
Observations	3,210	3,204	3,166	3,005	3,367	3,361
Number of countryID	155	155	153	153	155	155

Table 17 (continued)

Variables	(1) Rule of law lnUNDERVAL	(2) LibDem lnUNDERVAL	(3) Rule of law RER cycle	(4) LibDem RER cycle	(5) Rule of law REER	(6) LibDem REER
Hansen	78.64	67.97	66.45	76.31	50.59	48.08
p-val	0.00994	0.0677	0.0858	0.255	0.0428	0.0695
Factors_1st_stage	1	1	1	4	1	1
Factors_2nd_stage	2	2	2	2	2	2
Factor_Proportion	0.428	0.423	0.411	0.691	0.424	0.423
Instruments	68	68	68	85	51	51
LinRestriction	5.905	7.575	14.14	29.13	2.546	5.545
pvalLR	0.116	0.0557	0.00272	2.10e− 06	0.467	0.136

2SIV estimator with external instruments, with country and year fixed effects. LIC = low-income countries; LMIC = lower medium-income countries, UMIC = upper medium-income countries, HIC = high-income countries. LibDem. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 18 Undervaluation and growth: Granular Evidence, with growth determinants

Variables	(1) 2SIV ext inst RLE	(2) 2SIV ext inst WGI	(3) 2SIV ext inst VDEM_lib	(4) 2SIV ext inst PC V-Dem
Growth(− 1)	0.0676***	0.0893***	0.0659***	0.0930***
	(0.0085)	(0.0039)	(0.0106)	(0.0044)
ln(GDPPCij(− 1))	− 0.1802***	− 0.2053***	− 0.1742***	− 0.1686***
	(0.0065)	(0.0032)	(0.0074)	(0.0038)
Cl1**Institutions*lnUNDERVAL*LIC	0.0799***	0.1636***	− 0.0050*	0.1072***
	(0.0146)	(0.0129)	(0.0027)	(0.0074)
Cl2**Institutions*lnUNDERVAL*LIC	0.1377***	0.0642***	0.1181***	0.1264***
	(0.0146)	(0.0172)	(0.0129)	(0.0133)
Cl3**Institutions*lnUNDERVAL*LIC	0.0620***	0.1471***	0.2271***	0.1830***
	(0.0227)	(0.0067)	(0.0301)	(0.0172)
Cl4**Institutions*lnUNDERVAL*LIC	0.1376***	0.1706***	0.1249***	0.1800***
	(0.0171)	(0.0027)	(0.0223)	(0.0109)
Cl1**Institutions*lnUNDERVAL*LMIC	0.1140***	0.0742***	0.1013***	0.0698***
	(0.0127)	(0.0072)	(0.0115)	(0.0075)
Cl2**Institutions*lnUNDERVAL*LMIC	0.0462***	0.0096	0.0527***	0.0240***
	(0.0157)	(0.0124)	(0.0124)	(0.0082)
Cl3**Institutions*lnUNDERVAL*LMIC	0.1262***	0.0774***	0.0579***	0.0343***
	(0.0138)	(0.0055)	(0.0204)	(0.0094)
Cl4**Institutions*lnUNDERVAL*LMIC	0.0576***	0.0342***	− 0.0936***	− 0.1690***
	(0.0137)	(0.0031)	(0.0123)	(0.0027)
Cl1**Institutions*lnUNDERVAL*UMIC	0.0305**	0.0929***	0.1517***	0.0836***
	(0.0131)	(0.0076)	(0.0087)	(0.0119)
Cl2**Institutions*lnUNDERVAL*UMIC	0.0608**	0.0674***	0.0213*	0.0144***
	(0.0288)	(0.0034)	(0.0110)	(0.0032)
Cl3**Institutions*lnUNDERVAL*UMIC	0.0157	0.0422***	0.0320***	0.0225***
	(0.0176)	(0.0129)	(0.0092)	(0.0058)
Cl4**Institutions*lnUNDERVAL*UMIC	0.0966***	0.0709***	0.0013	0.0394***
	(0.0122)	(0.0059)	(0.0136)	(0.0079)
Cl1**Institutions*lnUNDERVAL*HIC	0.3499***	0.2252***	0.2462***	0.2297***
	(0.0328)	(0.0147)	(0.0508)	(0.0419)
Cl2**Institutions*lnUNDERVAL*HIC	0.0650*	0.0205***	–	− 0.1570***
	(0.0378)	(0.0037)		(0.0052)

Table 18 (continued)

Variables	(1) 2SIV ext inst RLE	(2) 2SIV ext inst WGI	(3) 2SIV ext inst VDEM_lib	(4) 2SIV ext inst PC V-Dem
Cl3**Institutions*lnUNDERVAL*HIC	0.0089	0.0816***	− 0.0140	0.0532**
	(0.0132)	(0.0193)	(0.0144)	(0.0215)
Cl4**Institutions*lnUNDERVAL*HIC	0.0771***	0.0753***	0.0791***	0.0763***
	(0.0262)	(0.0123)	(0.0227)	(0.0107)
Institutions	0.0323***	0.0372***	0.0063	0.0107***
	(0.0049)	(0.0016)	(0.0050)	(0.0033)
Investment	0.0146***	0.0169***	0.0163***	0.0163***
	(0.0026)	(0.0019)	(0.0030)	(0.0017)
Gov. expenditures (log)	− 0.0579***	− 0.0592***	− 0.0585***	− 0.0553***
	(0.0039)	(0.0020)	(0.0038)	(0.0020)
Population growth	− 0.1490***	− 0.0916*	− 0.2981**	− 0.1377**
	(0.0540)	(0.0475)	(0.1269)	(0.0557)
Openness	0.0128***	0.0119***	0.0114***	0.0129***
	(0.0038)	(0.0022)	(0.0028)	(0.0023)
Inflation	− 0.0540***	− 0.0648***	− 0.0685***	− 0.0746***
	(0.0056)	(0.0020)	(0.0030)	(0.0025)
Financial openness(− 1)	0.0025*	0.0024***	0.0026*	0.0016*
	(0.0013)	(0.0007)	(0.0013)	(0.0010)
Net capital inflows	− 0.0044***	− 0.0062***	− 0.0045***	− 0.0054***
	(0.0011)	(0.0003)	(0.0010)	(0.0006)
Terms of trade	− 0.0243*	− 0.0384***	− 0.0192	− 0.0207***
	(0.0140)	(0.0064)	(0.0130)	(0.0078)
RER volatility	− 0.0023***	− 0.0021***	− 0.0018***	− 0.0021***
	(0.0004)	(0.0003)	(0.0004)	(0.0002)
Constant	1.5892***	1.8283***	1.5356***	1.4916***
	(0.0655)	(0.0396)	(0.0718)	(0.0401)
Observations	3,210	3,047	3,204	3,047
Number of countryID	155	155	155	155

Table 18 (continued)

Variables	(1) 2SIV ext inst RLE	(2) 2SIV ext inst WGI	(3) 2SIV ext inst VDEM_lib	(4) 2SIV ext inst PC V-Dem
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Other covariates	YES	YES	YES	YES
Hansen	102.2	124.7	95.62	134.7
p-val	0.142	0.295	0.297	0.125
Factors_1st_stage	1	1	1	1
Factors_2nd_stage	2	1	2	1
Factor_Proportion	0.423	0.286	0.433	0.297
Instruments	116	145	116	145

2SIV ext inst—two-stage instrumental variable estimator with external instruments. LIC = low-income countries; LMIC = lower medium-income countries, UMIC = upper medium-income countries, HIC = high-income countries. RLE: Rule of law, WGI database. LibDem. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Appendix B: Nonlinear impact of net capital inflows on growth

See Tables 19, 20, 21, 22, 23 and 24.

Table 19 Undervaluation and growth—FE, BC-FE, 2S-IV without and with nonlinearity

Variables	(1) FE	(2) BC-FE	(3) 2S-IV	(4) 2S-IV ext inst	(5) 2S-IV ext inst
Growth(− 1)		0.2337***	0.1184***	0.1525***	− 0.0860***
		(0.0306)	(0.0212)	(0.0185)	(0.0193)
ln(GDPPC$_{ij}$(− 1))	− 0.1006***	− 0.0980***	− 0.2491***	− 0.5169***	− 0.2645***
	(0.0143)	(0.0129)	(0.0163)	(0.0222)	(0.0211)
lnUNDERVAL	0.0483***	0.0400***	0.0725***	0.0808***	0.0917***
	(0.0115)	(0.0098)	(0.0121)	(0.0177)	(0.0146)
Net capital inflows				− 0.0108**	− 0.0102***
				(0.0043)	(0.0022)
(Net capital inflows)^2					− 0.0034***
					(0.0005)
Constant	0.9626***		2.3084***	4.7552***	2.4594***
	(0.1332)		(0.1519)	(0.2050)	(0.1933)
Observations	4,300	4,094	3,940	3,224	3,224
Number of countries	180	178	180	164	164
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Hansen test			22.47	39.32	42.71
p value			5.21e− 05	0.00899	0.0151
Factors_1st_stage			1	4	3
Factors_2nd_stage			2	2	2
Factor_Proportion			0.538	0.735	0.508
Instruments			6	25	30

Dependent variable: log GDP growth per capita. Sample 1996–2019, annual data. FE—fixed effects. clustered standard errors in parentheses; BC-FE—bootstrap corrected fixed effects, bootstrap standard errors accounting for the cross sectional dependence; 2SIV ext inst—two-stage instrumental variable estimator with external instruments. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 20 Undervaluation and growth, growth determinants—nonlinearity

Variables	(1) Underval FE	(2) Underval BC-FE	(3) Underval 2SIV	(4) Underval 2SIV ext inst	(5) Underval 2SIV ext inst
Growth(− 1)		0.2642***	0.0417***	− 0.0160	− 0.0086
		(0.0741)	(0.0117)	(0.0130)	(0.0108)
$\ln(GDPPC_{ij}(-1))$	− 0.0993***	− 0.2322***	− 0.3067***	− 0.1886***	− 0.2538***
	(0.0168)	(0.0443)	(0.0127)	(0.0075)	(0.0098)
lnUNDERVAL	0.0681***	0.0764*	0.1266***	0.0712***	0.0974***
	(0.0147)	(0.0429)	(0.0119)	(0.0092)	(0.0096)
Net capital inflows	− 0.0056**	− 0.0071	− 0.0107***	− 0.0051***	− 0.0074***
	(0.0028)	(0.0079)	(0.0030)	(0.0014)	(0.0013)
$(\text{Net capital inflows})^2$					− 0.0015***
					(0.0003)
Investment	0.0147*	0.0174	0.0139**	0.0281***	0.0178***
	(0.0081)	(0.0294)	(0.0054)	(0.0040)	(0.0047)
Gov. expenditures (log)	− 0.0415***	− 0.0610**	− 0.0892***	− 0.0497***	− 0.0440***
	(0.0116)	(0.0266)	(0.0090)	(0.0058)	(0.0083)
Population growth	0.1567	− 0.6531	− 0.5437***	0.1588	0.3059*
	(0.3616)	(0.7094)	(0.1331)	(0.1416)	(0.1620)
Openness	0.0324***	− 0.0243	− 0.0039	0.0202***	0.0154***
	(0.0089)	(0.0206)	(0.0058)	(0.0053)	(0.0040)
Inflation	− 0.0980***	− 0.0602	− 0.0356***	− 0.0477***	− 0.0606***
	(0.0203)	(0.0642)	(0.0084)	(0.0075)	(0.0090)
Financial openness(− 1)	0.0003	− 0.0017	0.0066**	0.0034*	0.0072***
	(0.0022)	(0.0082)	(0.0026)	(0.0020)	(0.0019)
Terms of trade	− 0.0221	− 0.0084	0.0707***	− 0.0250	0.0092
	(0.0247)	(0.0747)	(0.0198)	(0.0163)	(0.0154)
RER volatility	− 0.0026***	0.0004	− 0.0020***	− 0.0021***	− 0.0022***
	(0.0009)	(0.0027)	(0.0006)	(0.0005)	(0.0005)
Constant	0.9111***		2.6977***	1.7212***	2.3065***
	(0.1496)		(0.1206)	(0.0736)	(0.0992)

Table 20 (continued)

Variables	(1) Underval FE	(2) Underval BC-FE	(3) Underval 2SIV	(4) Underval 2SIV ext inst	(5) Underval 2SIV ext inst
Observations	3,888	820	3,058	3,058	3,058
Number of countryID	164	164	164	164	164
Country FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Instruments			66	78	84
N			164	164	164
Hansen test			76.03	90.19	94.98
p value			0.0257	0.0256	0.0303
Factors (1st stage)			2	1	3
Factors (2nd stage)			2	2	2
Factor_Proportion			0.577	0.461	0.500

Dependent variable: log GDP growth per capita. Sample 1996–2019, annual data. FE—fixed effects. clustered standard errors in parentheses; BC-FE—bootstrap corrected fixed effects, bootstrap standard errors accounting for the cross sectional dependence; 2SIV ext inst—two-stage instrumental variable estimator with external instruments. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 21 Undervaluation and growth, controlling for institutional quality—nonlinearity

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
Growth(− 1)	0.0729***	− 0.0302	0.1063***	− 0.0376***	0.0811***	− 0.0450**	0.1069***	− 0.0438***
	(0.0146)	(0.0188)	(0.0117)	(0.0122)	(0.0152)	(0.0194)	(0.0116)	(0.0138)
$\ln(GDPPC_{ij}(-1))$	− 0.1800***	− 0.2749***	− 0.1940***	− 0.2629***	− 0.1735***	− 0.2743***	− 0.1619***	− 0.2373***
	(0.0102)	(0.0156)	(0.0096)	(0.0118)	(0.0098)	(0.0164)	(0.0084)	(0.0116)
lnUNDERVAL	0.0700***	0.0840***	0.0779***	0.0843***	0.0691***	0.0901***	0.0766***	0.0874***
	(0.0085)	(0.0112)	(0.0086)	(0.0094)	(0.0088)	(0.0100)	(0.0075)	(0.0086)
Institutions	0.0408***	0.0445***	0.0363***	0.0421***	0.0129**	0.0260***	0.0144***	0.0172***
	(0.0072)	(0.0073)	(0.0030)	(0.0040)	(0.0058)	(0.0067)	(0.0054)	(0.0057)
Institutions*lnUNDERVAL	− 0.0157*	− 0.0249***	− 0.0105***	− 0.0159***	− 0.0367***	− 0.0516***	− 0.0282***	− 0.0466***
	(0.0083)	(0.0091)	(0.0027)	(0.0035)	(0.0076)	(0.0090)	(0.0080)	(0.0082)
Net capital inflows	− 0.0037*	− 0.0112***	− 0.0014	− 0.0107***	− 0.0046**	− 0.0106***	− 0.0025*	− 0.0091***
	(0.0021)	(0.0021)	(0.0017)	(0.0012)	(0.0020)	(0.0019)	(0.0015)	(0.0014)
$(\text{Net capital inflows})^2$		− 0.0051***		− 0.0024***		− 0.0048***		− 0.0021***
		(0.0004)		(0.0003)		(0.0004)		(0.0003)
Investment	0.0148***	0.0188***	0.0170***	0.0095**	0.0185***	0.0140**	0.0212***	0.0123***

Table 21 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
	(0.0044)	(0.0053)	(0.0039)	(0.0048)	(0.0048)	(0.0054)	(0.0043)	(0.0047)
Gov. expenditures (log)	− 0.0564***	− 0.0442***	− 0.0468***	− 0.0577***	− 0.0530***	− 0.0399***	− 0.0437***	− 0.0468***
	(0.0076)	(0.0079)	(0.0059)	(0.0076)	(0.0080)	(0.0080)	(0.0058)	(0.0079)
Population growth	0.0007	0.4906***	− 0.3235	0.4198**	− 0.1187	0.4054**	− 0.3483**	− 0.0475
	(0.2308)	(0.1823)	(0.1979)	(0.1914)	(0.2274)	(0.1932)	(0.1538)	(0.2251)
Openness	0.0114**	0.0074	0.0117**	0.0016	0.0128**	0.0026	0.0151***	0.0090*
	(0.0053)	(0.0066)	(0.0050)	(0.0052)	(0.0057)	(0.0066)	(0.0047)	(0.0053)
Inflation	− 0.0435***	− 0.0546***	− 0.0485***	− 0.0562***	− 0.0494***	− 0.0591***	− 0.0599***	− 0.0649***
	(0.0092)	(0.0077)	(0.0067)	(0.0064)	(0.0095)	(0.0080)	(0.0071)	(0.0071)
Financial openness(− 1)	0.0025	0.0027	0.0022	0.0048***	0.0030	0.0032	0.0030*	0.0052***
	(0.0018)	(0.0021)	(0.0017)	(0.0018)	(0.0020)	(0.0022)	(0.0016)	(0.0018)
Terms of trade	− 0.0152	0.0139	− 0.0231	− 0.0136	− 0.0056	0.0321	− 0.0131	− 0.0062
	(0.0188)	(0.0186)	(0.0188)	(0.0172)	(0.0195)	(0.0206)	(0.0185)	(0.0158)
RER volatility	− 0.0026***	− 0.0024***	− 0.0022***	− 0.0020***	− 0.0024***	− 0.0019***	− 0.0020***	− 0.0022***

Table 21 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0004)
Constant	1.5888***	2.4810***	1.7459***	2.3332***	1.5362***	2.4613***	1.4608***	2.1236***
	(0.0952)	(0.1516)	(0.0895)	(0.1125)	(0.0913)	(0.1572)	(0.0791)	(0.1103)
Observations	3,210	3,210	3,047	3,047	3,204	3,204	3,047	3,047
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Instruments	60	64	75	80	60	64	75	80
N	155	155	155	155	155	155	155	155
Hansen	67.02	75.34	85.27	83.71	66.66	75.96	84.96	93.01
p value	0.0231	0.00917	0.0218	0.0591	0.0248	0.00807	0.0230	0.0129
Factors_1st_stage	1	3	1	3	1	3	1	3
Factors_2nd_stage	2	2	2	2	2	2	1	2
Factor_Proportion	0.427	0.484	0.435	0.472	0.433	0.497	0.301	0.485

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. 2SIV ext inst—two-stage instrumental variable estimator with external instruments. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 22 Undervaluation and Growth: Income groups—nonlinearity

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
Growth(− 1)	0.0896***	0.0609***	0.0842***	0.0550***	0.0693***	0.0435***	0.0703***	0.0399***
	(0.0079)	(0.0064)	(0.0072)	(0.0063)	(0.0123)	(0.0106)	(0.0120)	(0.0103)
$\ln(GDPPC_{ij}(-1))$	− 0.1785***	− 0.1335***	− 0.1929***	− 0.1469***	− 0.1679***	− 0.1229***	− 0.1706***	− 0.1233***
	(0.0060)	(0.0057)	(0.0064)	(0.0064)	(0.0082)	(0.0077)	(0.0082)	(0.0078)
lnUNDERVAL_LIC	0.1016***	0.0486***	0.1117***	0.0725***	0.1109***	0.1031***	0.1154***	0.1023***
	(0.0145)	(0.0161)	(0.0205)	(0.0161)	(0.0173)	(0.0153)	(0.0170)	(0.0151)
lnUNDERVAL_LMIC	0.0508***	0.0732***	0.0362***	0.0463***	0.0377***	0.0496***	0.0357***	0.0547***
	(0.0119)	(0.0109)	(0.0133)	(0.0119)	(0.0127)	(0.0108)	(0.0124)	(0.0106)
lnUNDERVAL_UMIC	0.0600***	0.0393***	0.0599***	0.0474***	0.0425***	0.0444***	0.0449***	0.0462***
	(0.0090)	(0.0079)	(0.0086)	(0.0071)	(0.0103)	(0.0083)	(0.0108)	(0.0087)
lnUNDERVAL_HIC	0.1565***	0.0926***	0.2061***	0.1366***	0.1174***	0.1161***	0.1157***	0.1142***
	(0.0278)	(0.0315)	(0.0261)	(0.0260)	(0.0268)	(0.0192)	(0.0264)	(0.0187)
*Institutions**lnUNDERVAL_LIC	− 0.0405***	− 0.0274**	− 0.0137**	− 0.0025	− 0.0061	0.0478**	− 0.0027	0.0498**
	(0.0106)	(0.0126)	(0.0067)	(0.0046)	(0.0179)	(0.0196)	(0.0166)	(0.0196)
*Institutions**lnUNDERVAL_LMIC	− 0.0248	− 0.0161	− 0.0213***	− 0.0231***	− 0.0546***	− 0.0259*	− 0.0575***	− 0.0172
	(0.0178)	(0.0154)	(0.0076)	(0.0064)	(0.0135)	(0.0143)	(0.0139)	(0.0140)

Table 22 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
*Institutions**lnUNDERVAL_UMIC	0.0528***	0.0148	0.0092	0.0047	− 0.0208**	− 0.0174**	− 0.0282***	− 0.0211***
	(0.0151)	(0.0133)	(0.0063)	(0.0052)	(0.0102)	(0.0083)	(0.0101)	(0.0081)
*Institutions**lnUNDERVAL_HIC	− 0.0348*	− 0.0217	− 0.0314***	− 0.0185***	− 0.0457**	− 0.0418***	− 0.0448**	− 0.0388***
	(0.0209)	(0.0200)	(0.0076)	(0.0071)	(0.0190)	(0.0142)	(0.0178)	(0.0138)
Institutions	0.0446***	0.0305***	0.0358***	0.0322***	0.0122***	0.0105**	0.0126***	0.0103**
	(0.0057)	(0.0044)	(0.0028)	(0.0020)	(0.0046)	(0.0045)	(0.0048)	(0.0047)
Investment	0.0232***	0.0180***	0.0237***	0.0156***	0.0191***	0.0207***	0.0189***	0.0204***
	(0.0029)	(0.0028)	(0.0032)	(0.0027)	(0.0037)	(0.0039)	(0.0037)	(0.0040)
Gov. expenditures (log)	− 0.0524***	− 0.0397***	− 0.0536***	− 0.0425***	− 0.0502***	− 0.0390***	− 0.0497***	− 0.0382***
	(0.0040)	(0.0034)	(0.0037)	(0.0038)	(0.0051)	(0.0043)	(0.0051)	(0.0042)
Population growth	− 0.1010	− 0.2099***	− 0.1778*	− 0.1351**	− 0.1288	− 0.3975***	− 0.1265	− 0.3960***
	(0.0972)	(0.0677)	(0.1011)	(0.0680)	(0.1425)	(0.0934)	(0.1403)	(0.0941)
Openness	0.0218***	0.0267***	0.0151***	0.0206***	0.0118**	0.0250***	0.0111**	0.0257***

Table 22 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
	(0.0035)	(0.0045)	(0.0032)	(0.0042)	(0.0047)	(0.0051)	(0.0047)	(0.0049)
Inflation	− 0.0585***	− 0.0808***	− 0.0586***	− 0.0854***	− 0.0592***	− 0.0797***	− 0.0593***	− 0.0811***
	(0.0056)	(0.0064)	(0.0052)	(0.0062)	(0.0074)	(0.0090)	(0.0074)	(0.0090)
Financial openness(− 1)	0.0041***	0.0008	0.0041***	− 0.0009	0.0051***	0.0004	0.0052***	0.0002
	(0.0012)	(0.0012)	(0.0014)	(0.0012)	(0.0017)	(0.0013)	(0.0018)	(0.0013)
Net capital inflows	− 0.0038***	− 0.0049***	− 0.0049***	− 0.0052***	− 0.0042***	− 0.0068***	− 0.0043***	− 0.0070***
	(0.0011)	(0.0009)	(0.0011)	(0.0007)	(0.0015)	(0.0011)	(0.0015)	(0.0011)
(Net capital inflows)^2		− 0.0010***		− 0.0009***		− 0.0009***		− 0.0009***
		(0.0001)		(0.0001)		(0.0001)		(0.0001)
Terms of trade	− 0.0445***	− 0.0561***	− 0.0241*	− 0.0365**	− 0.0137	− 0.0091	− 0.0108	− 0.0060
	(0.0156)	(0.0158)	(0.0136)	(0.0148)	(0.0171)	(0.0163)	(0.0174)	(0.0168)
RER volatility	− 0.0019***	− 0.0016***	− 0.0016***	− 0.0016***	− 0.0020***	− 0.0011**	− 0.0020***	− 0.0011**

Table 22 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
	(0.0004)	(0.0004)	(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Constant	1.6127***	1.2278***	1.7400***	1.3374***	1.4936***	1.1324***	1.5184***	1.1383***
	(0.0562)	(0.0567)	(0.0610)	(0.0613)	(0.0765)	(0.0783)	(0.0772)	(0.0796)
Observations	3,053	3,053	3,047	3,047	3,204	3,204	3,204	3,204
Number of countryID	155	155	155	155	155	155	155	155
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Hansen	102.4	110.5	98.72	117.4	83.41	86.08	82.38	87.96
p value	0.0967	0.0609	0.147	0.0235	0.0521	0.0582	0.0608	0.0440
Factors_1st_stage	1	1	1	1	1	1	1	1
Factors_2nd_stage	1	1	1	1	2	1	2	1
Factor_Proportion	0.299	0.305	0.294	0.300	0.429	0.296	0.431	0.296
Instruments	105	110	105	110	84	88	84	88

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. 2SIV ext inst—two-stage instrumental variable estimator with external instruments. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 23 Impact of undervaluation on growth across clusters—nonlinearity

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
Growth(− 1)	0.0863***	0.0163	0.1009***	− 0.0010	0.0835***	0.0119	0.1086***	0.0636***
	(0.0121)	(0.0127)	(0.0109)	(0.0117)	(0.0139)	(0.0136)	(0.0104)	(0.0088)
ln($GDPPC_{ij}$(− 1))	− 0.1816***	− 0.1912***	− 0.1941***	− 0.2006***	− 0.1643***	− 0.1768***	− 0.1522***	− 0.1274***
	(0.0092)	(0.0101)	(0.0085)	(0.0100)	(0.0091)	(0.0103)	(0.0075)	(0.0055)
Cl1*lnUNDERVAL	0.0929***	0.0956***	0.0967***	0.1153***	0.1107***	0.1323***	0.0840***	0.0640***
	(0.0179)	(0.0202)	(0.0124)	(0.0118)	(0.0192)	(0.0162)	(0.0105)	(0.0085)
Cl2*lnUNDERVAL	0.0650***	0.0936***	0.0274**	0.0577***	0.0651***	0.0665***	0.0539***	0.0658***
	(0.0118)	(0.0138)	(0.0121)	(0.0169)	(0.0107)	(0.0122)	(0.0151)	(0.0095)
Cl3*lnUNDERVAL	0.0384**	− 0.0073	0.0892***	0.0586***	0.0371**	0.0774***	0.0495***	0.0241*
	(0.0156)	(0.0193)	(0.0134)	(0.0126)	(0.0187)	(0.0188)	(0.0155)	(0.0134)
Cl4*lnUNDERVAL	0.0824***	0.0854***	0.0781***	0.0872***	0.0589***	0.0549***	0.0892***	0.0695***
	(0.0185)	(0.0128)	(0.0126)	(0.0103)	(0.0160)	(0.0160)	(0.0125)	(0.0131)
Institutions	0.0401***	0.0435***	0.0347***	0.0340***	0.0051	0.0082*	0.0078	0.0026
	(0.0070)	(0.0061)	(0.0031)	(0.0033)	(0.0060)	(0.0047)	(0.0056)	(0.0044)
Investment	0.0172***	0.0207***	0.0146***	0.0157***	0.0196***	0.0180***	0.0214***	0.0191***
	(0.0039)	(0.0044)	(0.0034)	(0.0041)	(0.0043)	(0.0042)	(0.0039)	(0.0040)

Table 23 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
Gov. expenditures (log)	− 0.0536***	− 0.0459***	− 0.0441***	− 0.0566***	− 0.0488***	− 0.0447***	− 0.0414***	− 0.0386***
	(0.0068)	(0.0068)	(0.0052)	(0.0053)	(0.0065)	(0.0062)	(0.0048)	(0.0037)
Population growth	− 0.0740	− 0.1052	− 0.2816*	− 0.1054	− 0.1470	− 0.0785	− 0.3288**	− 0.3816***
	(0.2071)	(0.1536)	(0.1648)	(0.0989)	(0.2049)	(0.1613)	(0.1624)	(0.0846)
Openness	0.0089*	0.0163**	0.0077*	0.0137***	0.0089*	0.0169***	0.0099**	0.0197***
	(0.0051)	(0.0064)	(0.0046)	(0.0049)	(0.0046)	(0.0053)	(0.0043)	(0.0047)
Inflation	− 0.0442***	− 0.0719***	− 0.0504***	− 0.0772***	− 0.0514***	− 0.0864***	− 0.0579***	− 0.0727***
	(0.0085)	(0.0078)	(0.0058)	(0.0058)	(0.0082)	(0.0081)	(0.0066)	(0.0077)
Financial openness(− 1)	0.0018	0.0024	0.0035**	0.0067**	0.0041**	0.0037	0.0030*	0.0016
	(0.0018)	(0.0023)	(0.0016)	(0.0026)	(0.0020)	(0.0024)	(0.0016)	(0.0014)
Net capital inflows	− 0.0022	− 0.0048***	− 0.0016	− 0.0071***	− 0.0054***	− 0.0048***	− 0.0039***	− 0.0059***
	(0.0022)	(0.0017)	(0.0013)	(0.0011)	(0.0020)	(0.0015)	(0.0014)	(0.0009)

Table 23 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
(Net capital inflows)^2		− 0.0023***		− 0.0023***		− 0.0020***		− 0.0010***
		(0.0004)		(0.0003)		(0.0004)		(0.0001)
Terms of trade	− 0.0254	− 0.0113	− 0.0362**	− 0.0038	− 0.0101	0.0093	− 0.0171	− 0.0393**
	(0.0178)	(0.0175)	(0.0168)	(0.0174)	(0.0189)	(0.0183)	(0.0173)	(0.0160)
RER volatility	− 0.0020***	− 0.0020***	− 0.0026***	− 0.0021***	− 0.0021***	− 0.0018***	− 0.0016***	− 0.0015***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Constant	1.6141***	1.7332***	1.7457***	1.7931***	1.4644***	1.5934***	1.3791***	1.1701***
	(0.0855)	(0.0951)	(0.0780)	(0.0913)	(0.0887)	(0.0955)	(0.0706)	(0.0574)
Observations	3,210	3,210	3,047	3,047	3,204	3,204	3,047	3,047
Number of countryID	155	155	155	155	155	155	155	155
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hansen	78.64	77.49	87.99	89.62	67.97	79.12	87.16	92.01
p value	0.00994	0.0245	0.0613	0.0906	0.0677	0.0183	0.0690	0.0657

Table 23 (continued)

Variables	(1) Rule of law 2SIV ext inst	(2) Rule of law 2SIV ext inst	(3) WGI (PC) 2SIV ext inst	(4) WGI (PC) 2SIV ext inst	(5) Liberal democracy 2SIV ext inst	(6) Liberal democracy 2SIV ext inst	(7) V-Dem (PC) 2SIV ext inst	(8) V-Dem (PC) 2SIV ext inst
Factors_1st_stage	1	2	1	2	1	2	1	1
Factors_2nd_stage	2	2	2	2	2	2	1	1
Factor_Proportion	0.428	0.432	0.433	0.432	0.423	0.424	0.303	0.306
Instruments	68	72	85	90	68	72	85	90
Linear Restriction test	5.905	21.77	22.51	16.21	7.575	16.59	7.915	13.18
p value	0.116	7.28e− 05	5.10e− 05	0.00103	0.0557	0.000860	0.0478	0.00427

WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. 2SIV ext inst—two-stage instrumental variable estimator with external instruments. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. Standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; sample 1996–2019

Table 24 Undervaluation and growth: Granular Evidence—nonlinearity

Variables	(1) Rule of law	(2) Rule of law	(3) WGI (PC)	(4) WGI (PC)	(5) Liberal democracy	(6) Liberal democracy	(7) V-Dem (PC)	(8) V-Dem (PC)
Growth(− 1)	0.0676***	− 0.0131	0.0893***	− 0.0269***	0.0659***	− 0.0046	0.0930***	− 0.0234***
	(0.0085)	(0.0088)	(0.0039)	(0.0053)	(0.0106)	(0.0102)	(0.0044)	(0.0046)
ln(GDPPCij(− 1))	− 0.1802***	− 0.1903***	− 0.2053***	− 0.2184***	− 0.1742***	− 0.1859***	− 0.1686***	− 0.1841***
	(0.0065)	(0.0079)	(0.0032)	(0.0039)	(0.0074)	(0.0080)	(0.0038)	(0.0045)
Cl1*lnUNDERVAL*LIC	0.0799***	0.0593***	0.1636***	0.1459***	− 0.0050*	0.0079***	0.1072***	0.0718***
	(0.0146)	(0.0187)	(0.0129)	(0.0100)	(0.0027)	(0.0024)	(0.0074)	(0.0094)
Cl2*lnUNDERVAL*LIC	0.1377***	0.1451***	0.0642***	0.0824***	0.1181***	0.0847***	0.1264***	0.1064***
	(0.0146)	(0.0160)	(0.0172)	(0.0250)	(0.0129)	(0.0144)	(0.0133)	(0.0099)
Cl3*lnUNDERVAL*LIC	0.0620***	− 0.0335	0.1471***	0.0896***	0.2271***	0.2278***	0.1830***	0.1686***
	(0.0227)	(0.0212)	(0.0067)	(0.0114)	(0.0301)	(0.0118)	(0.0172)	(0.0120)
Cl4*lnUNDERVAL*LIC	0.1376***	0.0898***	0.1706***	0.1092***	0.1249***	0.1090***	0.1800***	0.1456***
	(0.0171)	(0.0135)	(0.0027)	(0.0030)	(0.0223)	(0.0120)	(0.0109)	(0.0079)
Cl1*lnUNDERVAL*LMIC	0.1140***	0.1312***	0.0742***	0.1156***	0.1013***	0.1481***	0.0698***	0.1034***
	(0.0127)	(0.0150)	(0.0072)	(0.0070)	(0.0115)	(0.0093)	(0.0075)	(0.0063)
Cl2*lnUNDERVAL*LMIC	0.0462***	0.0811***	0.0096	0.0583***	0.0527***	0.0921***	0.0240***	0.0860***
	(0.0157)	(0.0136)	(0.0124)	(0.0150)	(0.0124)	(0.0130)	(0.0082)	(0.0073)
Cl3*lnUNDERVAL*LMIC	0.1262***	0.0462***	0.0774***	0.0720***	0.0579***	0.0170	0.0343***	0.0116
	(0.0138)	(0.0053)	(0.0055)	(0.0126)	(0.0204)	(0.0186)	(0.0094)	(0.0145)

Table 24 (continued)

Variables	(1) Rule of law	(2) Rule of law	(3) WGI (PC)	(4) WGI (PC)	(5) Liberal democracy	(6) Liberal democracy	(7) V-Dem (PC)	(8) V-Dem (PC)
Cl4*lnUNDERVAL*LMIC	0.0576***	0.1180***	0.0342***	0.0719***	− 0.0936***	0.0053	− 0.1690***	− 0.0136***
	(0.0137)	(0.0068)	(0.0031)	(0.0036)	(0.0123)	(0.0154)	(0.0027)	(0.0043)
Cl1*lnUNDERVAL*UMIC	0.0305**	0.0625***	0.0929***	0.0785***	0.1517***	0.1529***	0.0836***	0.0654***
	(0.0131)	(0.0194)	(0.0076)	(0.0088)	(0.0087)	(0.0072)	(0.0119)	(0.0097)
Cl2*lnUNDERVAL*UMIC	0.0608**	0.0869***	0.0674***	0.1107***	0.0213*	0.0786***	0.0144***	0.0136**
	(0.0288)	(0.0248)	(0.0034)	(0.0075)	(0.0110)	(0.0170)	(0.0032)	(0.0063)
Cl3*lnUNDERVAL*UMIC	0.0157	0.0341	0.0422***	0.0327*	0.0320***	0.0676***	0.0225***	0.0525***
	(0.0176)	(0.0254)	(0.0129)	(0.0177)	(0.0092)	(0.0110)	(0.0058)	(0.0041)
Cl4*lnUNDERVAL*UMIC	0.0966***	0.0839***	0.0709***	0.0738***	0.0013	0.0012	0.0394***	0.0574***
	(0.0122)	(0.0217)	(0.0059)	(0.0045)	(0.0136)	(0.0232)	(0.0079)	(0.0103)
Cl1*lnUNDERVAL*HIC	0.3499***	0.2041***	0.2252***	0.1485***	0.2462***	0.1378***	0.2297***	0.1494***
	(0.0328)	(0.0094)	(0.0147)	(0.0071)	(0.0508)	(0.0260)	(0.0419)	(0.0188)
Cl2*lnUNDERVAL*HIC	0.0650*	− 0.0258**	0.0205***	0.0533***	–	–	− 0.1570***	− 0.0607***
	(0.0378)	(0.0108)	(0.0037)	(0.0052)			(0.0052)	(0.0049)
Cl3*lnUNDERVAL*HIC	0.0089	0.0289***	0.0816***	0.0921***	− 0.0140	0.0250	0.0532**	0.0662**
	(0.0132)	(0.0073)	(0.0193)	(0.0241)	(0.0144)	(0.0218)	(0.0215)	(0.0299)
Cl4*lnUNDERVAL*HIC	0.0771***	0.0555**	0.0753***	0.0899***	0.0791***	0.0893***	0.0763***	0.1041***
	(0.0262)	(0.0273)	(0.0123)	(0.0164)	(0.0227)	(0.0272)	(0.0107)	(0.0128)

Table 24 (continued)

Variables	(1) Rule of law	(2) Rule of law	(3) WGI (PC)	(4) WGI (PC)	(5) Liberal democracy	(6) Liberal democracy	(7) V-Dem (PC)	(8) V-Dem (PC)
Institutions	0.0323***	0.0384***	0.0372***	0.0365***	0.0063	0.0104**	0.0107***	0.0103***
	(0.0049)	(0.0042)	(0.0016)	(0.0016)	(0.0050)	(0.0041)	(0.0033)	(0.0019)
Investment	0.0146***	0.0179***	0.0169***	0.0136***	0.0163***	0.0197***	0.0163***	0.0190***
	(0.0026)	(0.0025)	(0.0019)	(0.0020)	(0.0030)	(0.0025)	(0.0017)	(0.0019)
Gov. expenditures (log)	− 0.0579***	− 0.0518***	− 0.0592***	− 0.0646***	− 0.0585***	− 0.0546***	− 0.0553***	− 0.0642***
	(0.0039)	(0.0040)	(0.0020)	(0.0022)	(0.0038)	(0.0041)	(0.0020)	(0.0018)
Population growth	− 0.1490***	− 0.1999**	− 0.0916*	− 0.1521***	− 0.2981**	− 0.0943	− 0.1377**	− 0.2922***
	(0.0540)	(0.0806)	(0.0475)	(0.0327)	(0.1269)	(0.1124)	(0.0557)	(0.0536)
Openness	0.0128***	0.0233***	0.0119***	0.0167***	0.0114***	0.0254***	0.0129***	0.0209***
	(0.0038)	(0.0044)	(0.0022)	(0.0019)	(0.0028)	(0.0035)	(0.0023)	(0.0026)
Inflation	− 0.0540***	− 0.0823***	− 0.0648***	− 0.0905***	− 0.0685***	− 0.0897***	− 0.0746***	− 0.0882***
	(0.0056)	(0.0052)	(0.0020)	(0.0027)	(0.0030)	(0.0040)	(0.0025)	(0.0042)
Financial openness(− 1)	0.0025*	0.0031*	0.0024***	0.0030**	0.0026*	0.0021	0.0016*	0.0038***
	(0.0013)	(0.0017)	(0.0007)	(0.0014)	(0.0013)	(0.0017)	(0.0010)	(0.0011)
Net capital inflows	− 0.0044***	− 0.0052***	− 0.0062***	− 0.0065***	− 0.0045***	− 0.0057***	− 0.0054***	− 0.0086***
	(0.0011)	(0.0011)	(0.0003)	(0.0004)	(0.0010)	(0.0010)	(0.0006)	(0.0006)

Table 24 (continued)

Variables	(1) Rule of law	(2) Rule of law	(3) WGI (PC)	(4) WGI (PC)	(5) Liberal democracy	(6) Liberal democracy	(7) V-Dem (PC)	(8) V-Dem (PC)
(Net capital inflows)^2		− 0.0014***		− 0.0022***		− 0.0020***		− 0.0028***
		(0.0003)		(0.0001)		(0.0003)		(0.0002)
Terms of trade	− 0.0243*	− 0.0144	− 0.0384***	− 0.0352***	− 0.0192	− 0.0203*	− 0.0207***	− 0.0219***
	(0.0140)	(0.0117)	(0.0064)	(0.0050)	(0.0130)	(0.0113)	(0.0078)	(0.0071)
RER volatility	− 0.0023***	− 0.0022***	− 0.0021***	− 0.0024***	− 0.0018***	− 0.0020***	− 0.0021***	− 0.0021***
	(0.0004)	(0.0004)	(0.0003)	(0.0002)	(0.0004)	(0.0004)	(0.0002)	(0.0002)
Constant	1.5892***	1.7123***	1.8283***	1.9426***	1.5356***	1.6688***	1.4916***	1.6412***
	(0.0655)	(0.0750)	(0.0396)	(0.0432)	(0.0718)	(0.0750)	(0.0401)	(0.0524)
Observations	3,210	3,210	3,047	3,047	3,204	3,204	3,047	3,047
Number of countryID	155	155	155	155	155	155	155	155
Hansen	102.2	103.5	124.7	135.8	95.62	111.1	134.7	127.1
p value	0.142	0.175	0.295	0.169	0.297	0.0857	0.125	0.335
Factors_1st_stage	1	2	1	2	1	2	1	2
Factors_2nd_stage	2	2	1	2	2	2	1	1
Factor_Proportion	0.423	0.432	0.286	0.440	0.433	0.431	0.297	0.284
Instruments	116	120	145	150	116	120	145	150

2SIV ext inst—two-stage instrumental variable estimator with external instruments, with country and time-fixed effects. WGI (PC) = Worldwide Governance Indicators, 1st principal component. V-Dem (PC) = 1st principal component of core V-Dem indicators. Cl1–Cl4: dummies representing cluster membership of country *i* based on relative institutional quality. LIC = low-income countries; LMIC = lower middle-income countries, UMIC = upper middle-income countries, HIC = high-income countries. Full results with growth determinants: Appendix A: Table 18. Standard errors in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1; sample 1996–2019

References

Aguirre A, Calderón C (2005) Real exchange rate misalignments and economic performance. Documentos De Trabajo (banco Central De Chile) 315:1–49

Ahmed S, Appendino M, Ruta M (2015) Depreciations without exports? Global value chains and the exchange rate elasticity of exports. The World Bank Policy Research WP No. 7390.

Arellano M, Bond S (1991) Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev Econ Stud 58(2):277–297

Arellano M, Bover O (1995) Another look at the instrumental variable estimation of error-components models. J Econom 68(1):29–51

Bai J (2009) Panel data models with interactive fixed effects. Econometrica 77(4):1229–1279

Baldwin R, Lopez-Gonzalez J (2015) Supply-chain trade: a portrait of global patterns and several testable hypotheses. World Economy 38(11):1682–1721. https://doi.org/10.1111/twec.12189

Berg MA, Miao Y (2010) The real exchange rate and growth revisited: the Washington Consensus strikes back? (No. 10-58). International Monetary Fund.

Berkowitz D, Moenius J, Pistor K (2006) Trade, law, and product complexity. Rev Econ Stat 88(2):363–373

Blundell R, Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. J Econom 87(1):115–143

Christiansen LE, Prati MA, Ricci MLA, Tressel MT (2009) External balance in low income countries (No. 9-221). International Monetary Fund.

Cheung YW, Chinn M, Nong X (2017) Estimating currency misalignment using the Penn effect: it is not as simple as it looks. Int Finance 20(3):222–242

Cimoli M, Fleitas S, Porcile G (2013) Technological intensity of the export structure and the real exchange rate. Econ Innov New Technol 22(4):353–372

Comunale M (2017) Dutch disease, real effective exchange rate misalignments and their effect on GDP growth in EU. J Int Money Financ 73:350–370

Coppedge M, Gerring J, Henrik Knutsen C, Lindberg SI, Teorell J, Altman D, Bernhard M, Cornell A, Steven Fish M, Gastaldi L, Gjerløw H, Glynn A, God AG, Grahn S, Hicken A, Kinzelbach K, Krusell J, Marquardt KL (2023a) V-Dem [Country-Year/Country-Date] Dataset v13, Varieties of Democracy (V-Dem) Project. https://doi.org/10.23696/V-demds23.

Coppedge M, Gerring J, Knutsen CH, Lindberg SI, Teorell J, Altman D, Bernhard M, Cornell A, Steven Fish M, Gastaldi L, Gjerløw H, Glynn A, Grahn S, Hicken A, Kinzelbach K, Marquardt KL, McMann K, Mechkova V, Neundorf A (2023b) V-Dem Codebook v13, Varieties of Democracy (V-Dem) Project

Couharde C, Sallenave A (2013) How do currency misalignments' threshold affect economic growth? J Macroecon 36:106–120

Cumperayot P, Kouwenberg R (2016) Currency wars: who gains from the battle?. Available at SSRN 2714277.

Darvas Z (2021) Timely measurement of real effective exchange rates. Working Paper 2021/15, Bruegel, 23 December 2021.

Demir F, Razmi A (2022) The real exchange rate and development theory, evidence, issues and challenges. J Econ Surv 36(2):386–428

De Hoyos RE, Sarafidis V (2006) Testing for cross-sectional dependence in panel-data models. Stand Genomic Sci 6(4):482–496

De Vos I, Everaert G, Ruyssen I (2015) Bootstrap-based bias correction and inference for dynamic panels with fixed effects. Stand Genomic Sci 15(4):986–1018

El-Shagi M, Lindner A, von Schweinitz G (2016) Real effective exchange rate misalignment in the euro area: a counterfactual analysis. Rev Int Econ 24(1):37–66

Everaert G, Pozzi L (2007) Bootstrap-based bias correction for dynamic panels. J Econ Dyn Control 31(4):1160–1184

Feenstra RC, Inklaar R, Timmer MP (2015) The next generation of the Penn World Table. Am Econ Rev 105(10):3150–3182

Fidora, M., Giordano, C., & Schmitz, M. (2021). Real exchange rate misalignments in the euro area. Open Economies Review, 32, 71-107. Fidora, M., Giordano, C. & Schmitz, M. Real Exchange Rate Misalignments in the Euro Area. Open Econ Rev 32:71–107 (2021). https://doi.org/10.1007/s11079-020-09596-1

Frees EW (1995) Assessing cross-sectional correlation in panel data. J Econom 69:393–414

Frenkel R, Rapetti M (2015) The real exchange rate as a target of macroeconomic policy. In: Calcagno A, et al (ed) Rethinking development strategies after the financial crisis: Making the case for policy space, vol I. UNCTAD, pp 81–92
Freund C, Pierola MD (2015) Export superstars. Rev Econ Stat 97(5):1023–1032
Gamberoni E, Giordano C, Lopez-Garcia P (2016) Capital and labour (mis) allocation in the euro area: some stylized facts and determinants. ECB Working Paper No. 1981.
Georgiadis G, Gräb J, Khalil M (2019) Global value chain participation and exchange rate pass-through. ECB Working Paper, No. 2327.
Goncalves C, Rodrigues M (2017) Exchange rate misalignment and growth: A myth?. International Monetary Fund, WP/17/283.
Groningen Growth and Development Centre (2023) Penn World Table version 10.01. https://doi.org/10.34894/QT5BCC, DataverseNL, V1.
Guzman M, Ocampo JA, Stiglitz JE (2018) Real exchange rate policies for economic development. World Dev 110:51–62
Habib MM, Mileva E, Stracca L (2017) The real exchange rate and economic growth: revisiting the case using external instruments. J Int Money Financ 73:386–398
International Monetary Fund (2012) Commodity price swings and commodity exporters. World Economic Outlook, April, 2012, Chapter 4.
Iyke BN (2018) The real effect of currency misalignment on productivity growth: evidence from middle-income economies. Empirical Economics 55(4):1637–1659
Kaufmann D, Kraay A, Mastruzzi M (2010) The worldwide governance indicators: methodology and analytical issues. World Bank Policy Research Working Paper (5430).
Kiviet JF (1995) On bias, inconsistency, and efficiency of various estimators in dynamic panel data models. J Economet 68(1):53–78
Kripfganz S, Sarafidis V (2021) Instrumental-variable estimation of large-T panel-data models with common factors. Stand Genomic Sci 21(3):659–686
Levy-Yeyati E, Sturzenegger F, Gluzmann PA (2013) Fear of appreciation. J Dev Econ 101:233–247
Libman E (2014) Tipo de cambio real y crecimiento. Reseña de la literatura y nuevos resultados empíricos. Desarrollo Económico 53(211):345–371
Mbaye S (2012) Real exchange rate undervaluation and growth: is there a total factor productivity growth channel?. Working Papers halshs-00687948, HAL.
McMillan MS, Rodrik D (2011) Globalization, structural change and productivity growth. National Bureau of Economic Research. Working paper No. w17143.
Milesi-Ferretti GM (2022) The External Wealth of Nations Database. The Brookings Institution (based on Lane PR. Milesi-Ferretti GM (2018) The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis. IMF Econ Rev 66:189–222
Miranda-Agrippino S, Rey H (2022) The Global Financial cycle. In: Gopinath G, Helpman E, Rogoff K (eds) Handbook of International Economics, vol 6. Elsevier, Amsterdam, pp 1–43
Missio FJ, Jayme FG Jr, Britto G, Luis Oreiro J (2015) Real exchange rate and economic growth: new empirical evidence. Metroeconomica 66(4):686–714
Nickell S (1981) Biases in dynamic models with fixed effects. Econometrica 49(6):1417–1426
Norkutė M, Sarafidis V, Yamagata T, Cui G (2021) Instrumental variable estimation of dynamic linear panel data models with defactored regressors and a multifactor error structure. J Economet 220(2):416–446
Nouira R, Sekkat K (2012) Desperately seeking the positive impact of undervaluation on growth. J Macroecon 34(2):537–552
Paulus M, Kristoufek L (2015) Worldwide clustering of the corruption perception. Physica A 428:351–358. https://doi.org/10.1016/j.physa.2015.01.065
Pemstein D, Marquardt KL, Tzelgov E, Wang YT, Krusell J, Miri F (2023) The V-dem measurement model: latent variable analysis for cross-national and cross-temporal expert-coded data. V-Dem Working Paper No. 21. 8th edition. University of Gothenburg: Varieties of Democracy Institute.
Pesaran MH (2004) General diagnostic tests for cross section dependence in panels. University of Cambridge, Faculty of Economics, Cambridge Working Papers in Economics No. 0435
Pesaran MH (2006) Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica 74:967–1012
Rapetti M, Skott P, Razmi A (2012) The real exchange rate and economic growth: are developing countries different? Int Rev Appl Econ 26(6):735–753

Razin O, Collins SM (1997) Real exchange rate misalignments and growth. National Bureau of Economic Research. Working paper No. w6174.
Rey, H. (2015). Dilemma not trilemma: the global financial cycle and monetary policy independence (No. w21162). National Bureau of Economic Research.
Ribeiro RS, McCombie JS, Lima GT (2020) Does real exchange rate undervaluation really promote economic growth? Struct Chang Econ Dyn 52:408–417
Rigobon R, Rodrik D (2005) Rule of law, democracy, openness, and income: estimating the interrelationships. Econ Transit 13(3):533–564
Rodrik D (2008) The real exchange rate and economic growth. Brook Pap Econ Act 2:365–412. https://doi.org/10.1353/eca.0.0020
Roodman D (2009) How to do xtabond2: an introduction to difference and system GMM in Stata. Stand Genomic Sci 9(1):86–136
Sarafidis V, Robertson D (2009) On the impact of error cross-sectional dependence in short dynamic panel estimation. Econom J 12(1):62–81
Williamson J (1990) What Washington means by policy reform. In: Williamson J (ed) Latin American adjustment: how much has happened, vol 1, pp 90–120
Woodford M (2008) Discussion on the real exchange rate and economic growth. Brook Pap Econ Act 39(2):420–437