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MULTIPRIL, a New Database on Multilateral Price Levels and Currency Misalignments

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Highlights

- MULTIPRIL is a global database on Multilateral Price Levels (MPL).
- MULTIPRIL includes (i) relative price level series computed vis-à-vis two sets of trading partners according to three different trade-weighting schemes, and (ii) MPL-based currency misalignments series.
- MULTIPRIL covers a wide sample of 178 countries over the 1990-2018 period.

Abstract

This paper describes the new CEPII-MULTIPRIL database on Multilateral Price Levels (MPL) introduced in 2020. The MULTIPRIL database covers a wide sample of 178 countries over the 1990-2018 period, and includes relative price level series computed vis-à-vis two sets of trading partners (177 and the top 30) according to three different trade-weighting schemes. It also contains MPL-based currency misalignments series for 156 countries over the 1991-2018 period. MULTIPRIL offers the potential to improve the coverage and quality of worldwide price-competitiveness comparisons. By focusing on price level data, it usefully complements the EQCHANGE database on equilibrium exchange rates and currency misalignments derived from series in indices. Its multilateral setting provides a more comprehensive picture of relative price levels and currency misalignments compared to existing bilateral measures.

Keywords

Multilateral Price Levels, Equilibrium Exchange Rates, Currency Misalignments, Bayesian Model Averaging.

JEL

F31, C32, C82.

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MULTIPRIL, a new database on multilateral price levels and currency misalignments

Cécile Couharde*, Carl Grekou†, and Valérie Mignon‡

1. Introduction

The CEPII's *EQCHANGE* database provides time series of real equilibrium exchange rates and corresponding currency misalignments, which are calculated using the Behavioral Equilibrium Exchange Rate approach (BEER, see Clark and MacDonald, 1998). Because there is no universal definition of what is an equilibrium exchange rate, several assessment methods coexist in the literature. They are usually classified into three complementary approaches: (1) the *macroeconomic balance approach* —including the Fundamental Equilibrium Exchange Rate (FEER) approach and its variants; (2) the *macro-econometric approach* —the BEER approach and its variants; and (3) the external sustainability approach (MacDonald, 2000; Driver and Westaway, 2004; Couharde et al., 2018).[1]

One of the shared characteristics of these different approaches is that they rely on exchange rate indices to determine the equilibrium value of real effective exchange rates ($REER$). By construction, these time-series indices offer a picture of changes in price-competitiveness for individual countries, compared to the level prevailing in some base period. However, using such indices leaves the cross-sectional dimension unexplored and, as a consequence, hampers a complete comparison across countries. This limitation can be corrected by relying on price level data, which take into account both the cross-sectional and the dynamic components of prices. Besides, the use of such data in levels makes it

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[1] In a nutshell, the macroeconomic balance approach calculates the difference between the current account (CA) projected over the medium term at prevailing exchange rates and an estimated equilibrium current account, or CA norm. The BEER approach directly estimates an equilibrium real exchange rate for each country as a function of medium- to long-term fundamentals of the real effective exchange rate. The external sustainability approach computes the difference between the actual current account balance and the balance that would stabilize the net foreign asset position of the country at some benchmark level. See Driver and Westaway (2004) for further details.

possible to assess the distribution of currency misalignments across countries worldwide.

Thus, to complement *EQCHANGE*, we develop a new database —*MULTIPRIL*— that provides multilateral measures of price levels (MPL) for a large number of countries over the 1990-2018 period. Specifically, we describe in this paper the construction of our data set and the equilibrium exchange rate approach used to derive currency misalignments from these MPL series. Cross-country comparisons of prices are already available (see, e.g., the International Comparison Program of the World Bank, and the Penn World Table from the University of Groningen), but they involve only bilateral comparisons where price levels for individual countries are assessed relative to the United States (US). Here, we take advantage of these bilateral data to provide multilateral measures of price levels for 178 countries at an annual frequency between 1990 and 2018, according to three different trade-weighting schemes and two baskets of trading partners.

The use of such multilateral measures leads to several findings. They reproduce some basic stylized facts of International Macroeconomics, such as the Penn effect, the Balassa-Samuelson hypothesis, and the Bhagwati-Kravis-Lipsey effect. They also reveal distinct patterns of price-competitiveness across countries and over time from those depicted by bilateral price levels relative to the US. In particular, the use of multilateral measures still supports the Balassa-Samuelson effect as a factor explaining price differences between countries (the Penn effect), but leads to a stronger effect than that derived from the bilateral measures. Our multilateral measures are therefore likely to provide a different indication of the extent to which a country's real exchange rate is misaligned. Accordingly, from these MPL series, we derive internationally comparable currency misalignments defined as the difference between the observed relative price levels and their equilibrium value.[2] Due to data availability issues, this sub-database on MPL-based currency misalignments covers 156 countries from 1991 through 2018. Overall, the *MULTIPRIL* database achieves a degree of completeness in the coverage of relative price series and currency misalignments by adding the spatial dimension —through the cross-sectional component of prices— to the temporal comparisons of the *EQCHANGE* database.[3]

The rest of the paper is organized as follows. In Section 2, we describe the methodology used to construct our MPL series, present the salient features of these multilateral measures, and compare them with other existing indicators of relative price levels. In Section 3, we outline the empirical framework that underpins the determination of the

[2] As described further in Section 3, the equilibrium values of MPL series are derived from a set of robust fundamentals, obtained from a Bayesian Model Averaging analysis, on 24 determinants of real exchange rates and price levels.

[3] The structure of EQCHANGE, as well as the way to access to MULTIPRIL, are provided in Appendix A.

MPL-based currency misalignments. Finally, Section 4 concludes.

2. The MULTIPRIL database

2.1. Methodological framework and salient features

We measure the multilateral price level of country i in period t ($MPL_{i,t}$) by computing the geometric weighted average of its bilateral relative prices relative to its trading partners j:

$$MPL_{i,t} = \prod_{j=1}^{N} \left(\frac{PL_{i.US,t}}{PL_{j.US,t}} \right)^{w_{ij,t}} \tag{1}$$

where $\frac{PL_{i.US,t}}{PL_{j.US,t}}$ is the price level of country i relative to the trading partner j in period t; $PL_{i.US,t}$ and $PL_{j.US,t}$ are respectively the price levels of country i and country j relative to the US; N denotes the number of trading partners, and $w_{ij.t}$ is the trade-based weight associated to the partner j.[4] MPL defined in Equation (1) thus corresponds to the level of the real effective exchange rate of country i against its N trading partners. A unit value of $MPL_{i.t}$ is in line with absolute Purchasing Power Parity (PPP), but if $MPL_{i.t} = 1.2$, for instance, prices in country i are on average twenty percent higher than in its trading partners—at date t.

To aggregate relative price levels across trading partners, we rely on three different —trade-based— weighting schemes: (i) two fixed weighting schemes based on the average trade flows over the 2008-2012 and 1973-2016 periods; and (ii) a time-varying weighting scheme based on average trade flows over 5-year non-overlapping windows.[5] These different weighting schemes are derived for two baskets of trading partners: (i) vis-à-vis 177 trading partners (leading to broad MPL series), and (ii) vis-à-vis the top 30 trading partners (narrow MPL series). The weighted geometric mean of price levels vis-à-vis each trading partner is then taken to derive an aggregated trading partners' price level. We opt for this procedure instead of a chain aggregation methodology —i.e., a weighted average of the growth rates of bilateral price levels. Indeed, changes in chain-aggregated trading partners' relative price levels reflect only changes in the underlying relative prices. Therefore, this method annihilates the effects of the changes in the trade-weights that have been particularly significant for countries like China.

[4]These weights are normalized so that their sum is equal to one, i.e., $\sum_{j=1}^{N} = w_{ij,t} = 1$.

[5]For the sake of homogeneity, the trade-weighting schemes are similar to those used in the $EQCHANGE$ database; see Couharde et al. (2018) for further details.

Price levels for each country i relative to the US ($PL_{i,US,t}$) are from the International Comparison Program (ICP; survey year: 2011)[6] and obtained by dividing the PPP exchange rate ($PPP_{i,US,t}$) by the nominal exchange rate ($E_{i,\$,t}$), both expressed in units of the currency of country i per unit of the US dollar:

$$PL_{i.US,t} = \frac{PPP_{i.US,t}}{E_{i.\$,t}} \tag{2}$$

Our different measures of multilateral price levels are robust to the weighting schemes (Figure 1). They also follow a bimodal distribution, revealing two different types of countries. The first group includes developing and emerging economies, which exhibit significantly lower prices than their trading partners (first mode located around 0.65 – 0.7) —as can be seen in the right chart of Figure 1. The second smaller group encompasses advanced economies with relatively high price levels (second mode around 1.20), reflecting those countries' general tendency to have higher price levels.

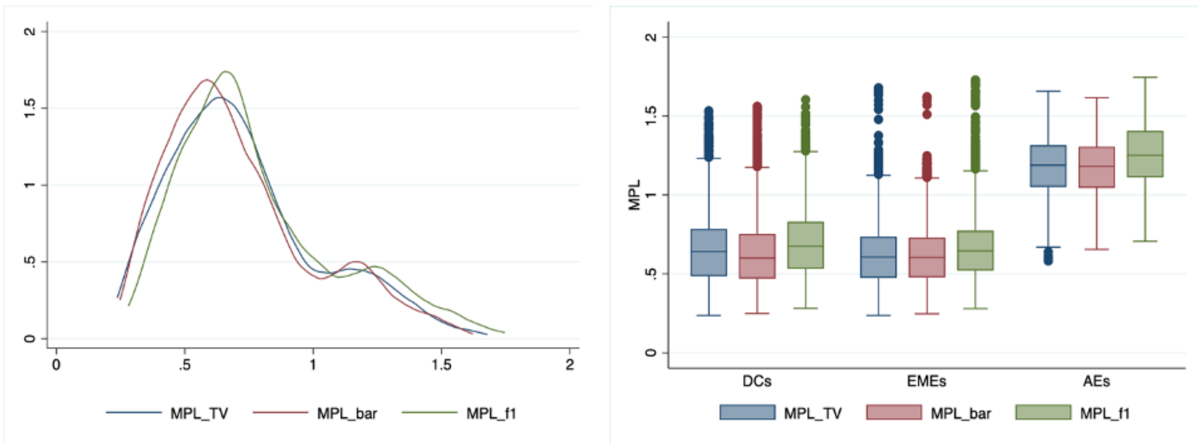

Figure 1 — Distributions of the multilateral price levels

Note: The series have been trimmed (1% at each tail of the distributions). The different measures are calculated vis-à-vis 177 trading partners. "f1": fixed weights 2008-2012; "bar": fixed weights 1973-2016; "TV": time-varying weights (5-year averages). AEs: advanced economies; DCs: developing countries; EMEs: emerging countries.

This tendency is also evident when we restrict our analysis to a single year. As an illustration, Figure 2 maps out multilateral price levels in 2018.[7] The color scheme of

[6] ICP is a worldwide statistical initiative led by the World Bank under the auspices of the United Nations Statistical Commission. Its main objective is to provide comparable price and volume measures of gross domestic product (GDP) and its expenditure aggregates among countries within and across regions. ICP collects and compares price data and GDP expenditures to estimate and publish purchasing power parities (PPPs) of the world economies.
See: https://www.worldbank.org/en/programs/icp#1

[7] Table C.1 in Appendix C provides the multilateral price levels for 2018. Recall that the *MULTIPRIL* database covers 178 countries over the 1990-2018 period. However, we present data for only 161 countries in 2018 due to some missing observations for 17 economies during this last year.

the map goes from the red (low relative prices) to the blue (high relative prices), with the darker shades indicating higher price differentials. In the case of advanced economies (AEs), it is clear from the blue shades that they tended to have higher relative prices in 2018 compared to the other countries. The five highest relative prices were observed —in decreasing order— in Australia (1.67), Switzerland (1.57), Norway (1.53), the United States (1.5), and Iceland (1.48). In contrast, multilateral price levels were substantially lower in Egypt (0.32), Algeria (0.38), Tunisia (0.39), Sudan (0.39), and India (0.42). With two notable exceptions (Japan and Korea), price levels in Asian countries were lower than in their trading partners. In other regions, the distribution of relative price levels was less uniform. In Europe, and especially within the Eurozone, there were striking differences in relative price levels across countries, with multilateral price levels ranging from 0.8 - 0.9 —for Slovakia, Slovenia, and Portugal— to 1.34 in Finland. In the Western hemisphere, the dispersion of relative price levels across countries was also significant.

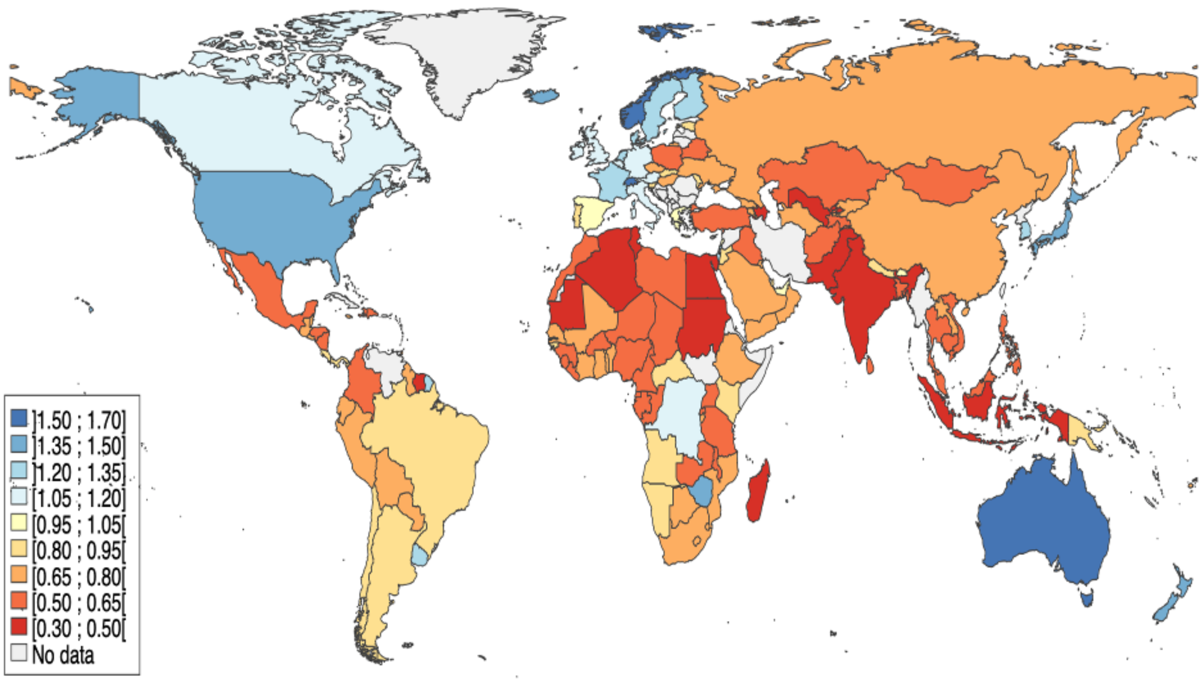

Figure 2 — Global distribution of multilateral price levels in 2018

Note: The map is based on the average MPL series over the different weighting schemes.

While Figure 2 provides some clues, we now dig deeper by examining the extent to which our measures of multilateral price levels reproduce some basic stylized facts of International Macroeconomics. We first consider the Penn effect, i.e., the extent to which the cross-country dispersion of relative prices is related to the cross-country dispersion of income levels. Providing an explanation of deviations of real exchange rates to PPP, the

Penn effect has been theoretically addressed by Balassa (1964) and Samuelson (1964) through the so-called Balassa-Samuelson hypothesis. They conjectured that the Penn effect owes not only to the fact that "rich" countries have higher absolute productivity levels than poor ones, but also because they have a relatively higher level of productivity in the traded goods' sectors —compared to the non-tradable sectors. Over time, empirical studies have confirmed the validity of the Balassa-Samuelson hypothesis[8] —at least when one considers a sample of countries at different development stages— to the point that this hypothesis is now called the Balassa-Samuelson effect. From Figure 3, it is clear that the Balassa-Samuelson hypothesis also holds in a multilateral framework —that is, when considering relative price levels vis-à-vis a set of trading partners. [9]

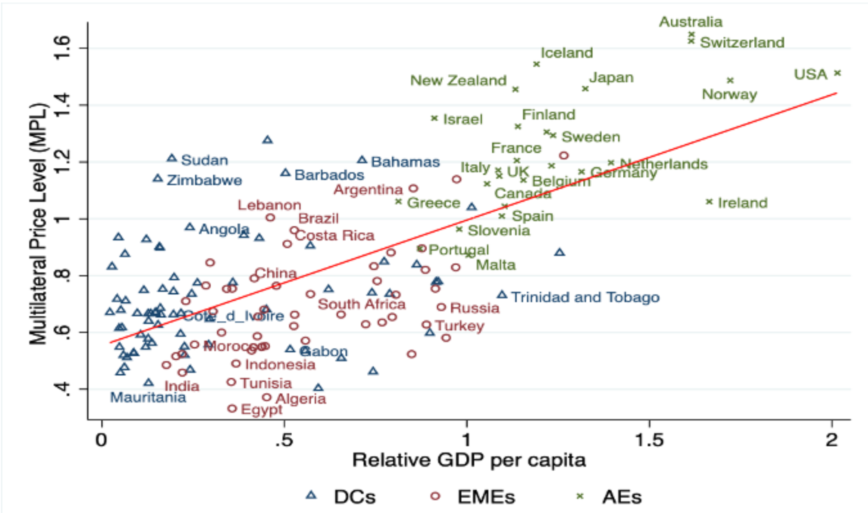

Figure 3 — Multilateral price levels and GDP per capita (2017)

Notes: MPL data correspond to the average over the three weighting schemes. Data on the relative GDP per capita —in PPP terms— are from the $RPROD$ database (CEPII). We dropped the 1% upper tail observations of the MPL series. In blue: developing countries; in red: emerging countries; in green: advanced economies.

Bhagwati (1984) and Kravis and Lipsey (1983) have also provided an alternative explanation for the Penn effect that does not require the underlying assumption of the Balassa-Samuelson model on productivity differentials. According to the Bhagwati-Kravis-Lipsey effect, deviations of the real exchange rate to PPP are explained by higher capital compared to labor endowments in developed countries, which makes labor more productive and expensive in those countries. Since non-tradables are labor-intensive, their prices tend to be higher relative to those of tradables in developed countries, providing those countries with a higher price level. As shown in Figure 4, this effect is also supported by our MPL

[8]For a recent detailed presentation and investigation, see Couharde et al. (2020) and the references therein.

[9]Similar conclusions can be drawn when relying on alternative proxies of the Balassa-Samuelson effect. See Figure C.1 in Appendix C.

series.

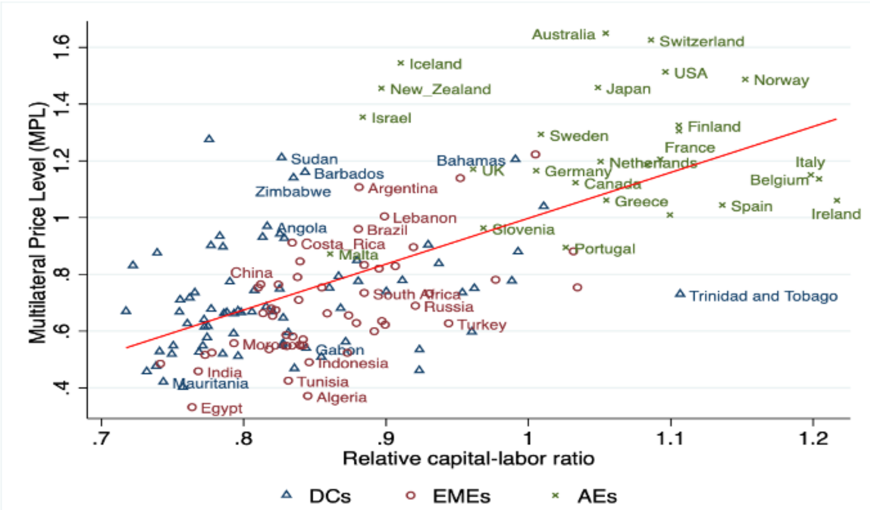

Figure 4 — Multilateral price levels and relative capital-labor ratio (2017)

Notes: The *MPL* data correspond to the average over the three weighting schemes. Data on the Capital-Labor ratio are from the Penn World Table 9.0. We dropped the 1% upper tail observations of the *MPL* series. In blue: developing countries; in red: emerging countries; in green: advanced economies.

2.2. Comparison with other existing measures of relative prices

Most studies aiming at determining real exchange rate levels use bilateral price levels with respect to the US. They usually investigate the strength of the price-income nexus, the Penn effect, and —in some cases— exploit this relationship to derive misalignment estimates (see, for example, Cheung et al., 2007; Rodrik, 2008; Coudert and Couharde, 2009; Fujii, 2015; Cheung et al., 2017).[10] By using bilateral measures, these studies can, however, lead to misleading inferences about overall price-competitiveness (Cheung et al., 2007).

As shown in Figure 5, despite the strong positive association observed between the multilateral and bilateral measures of relative price levels, most countries fell above the 45-degree line. This finding indicates that, on average, price differentials vis-à-vis trading partners are higher than vis-à-vis the US, suggesting an overestimation (underestimation) of price differentials for countries that exhibit relative lower (higher) prices vis-à-vis the US. In some cases, the differences between the two measures are substantial. In Japan (JPN), for example, price levels are twice higher vis-à-vis trading partners but only thirty percent higher vis-à-vis the US. In contrast, the price level in Bhutan (BTN) is close to that of its

[10]Without forgetting the adjusted version of the Big Mac index provided by the Economist, which accounts for relative GDP per capita to the US to assess the fair value of a currency vis-à-vis the US dollar (https://www.economist.com/news/2020/07/15/the-big-mac-index).

trading partners, but much lower than the US price level. Most of the difference between the two measures can be attributed to the higher proportion of countries exhibiting lower prices than the US price level.

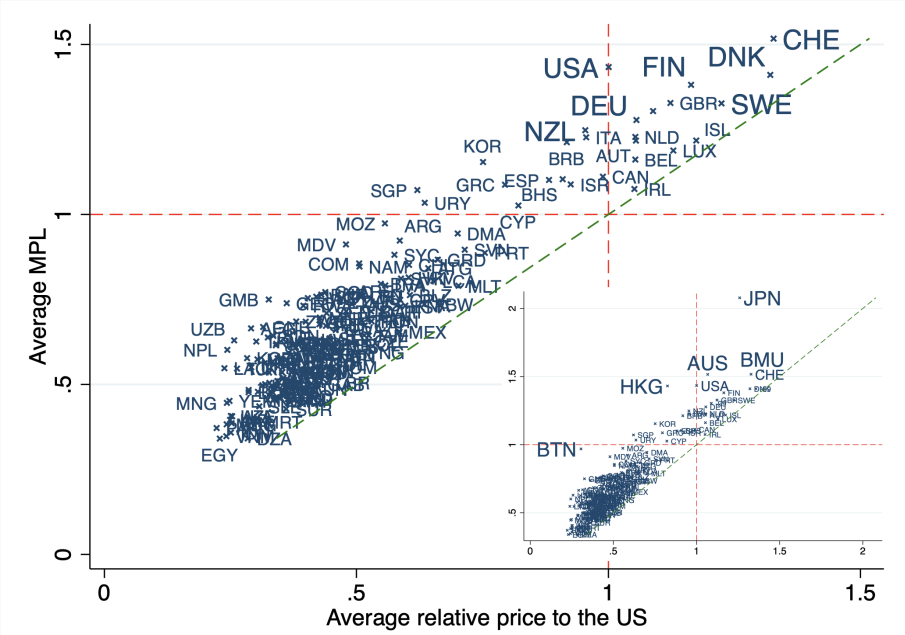

Figure 5 — Multilateral versus bilateral price levels

Figure 6 provides a temporal insight into the difference between the two measures of relative price levels. It shows that multilateral price levels have always been higher than bilateral price levels in the last 20 years. The difference has increased especially between 1990 and 2001, before stabilizing around 0.20.

Our characterization of relative price levels is thus fundamentally different from the one implied by the bilateral measure.

The way relative price levels are defined —that is, in effective or in bilateral terms—has another implication since it is also likely to lead to potential areas of mismeasurement in the magnitude of the Penn effect and currency misalignments. As an illustration, Table 1 reports the coefficient of the relative price level to per capita income —that is the Penn coefficient— estimated in a multilateral setting and a bilateral one. Although the coefficient is positive and significant in both frameworks, its value is more than doubled when all the trading partners are accounted for. In other words, a higher relative per capita income in a country i results in a much larger price level relative to its partners than to the US.

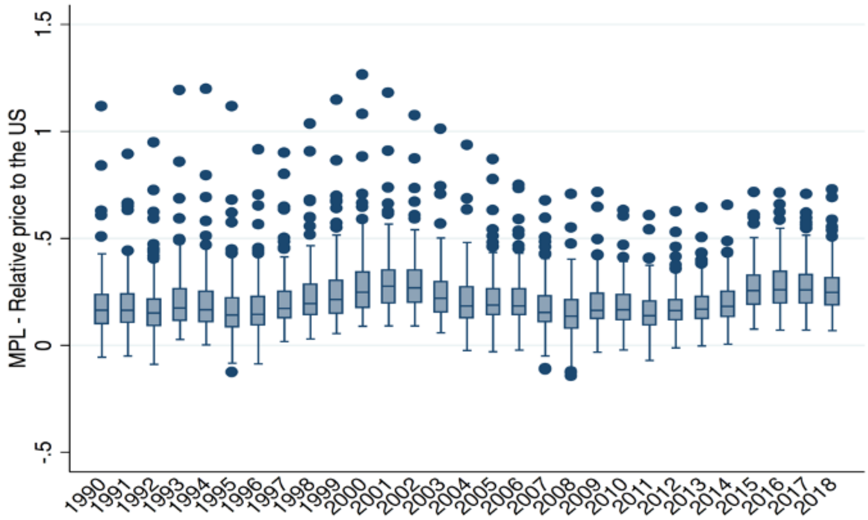

Figure 6 — Distribution of the difference between the MPL series and the relative price vis-à-vis the US

Table 1 — The Balassa-Samuelson effect, multilateral versus bilateral framework

	Price level relative to trading partners	Price level relative to the US
Relative GDP	0.223***	0.100***
	(0.006)	(0.003)
Constant	-0.179***	-0.169***
	(0.008)	(0.022)
Observations / R^2	4467 / 0.318	4467 / 0.174

Notes: *** indicates statistical significance at the 1% level. Robust standard errors are reported in parentheses. *Relative GDP* is consistent with the price level measure, i.e., vis-à-vis the trading partners or the US.

To illustrate the difference in the magnitude of the implied misalignments, the maps displayed in Figures 7 and 8 show the world distribution of currency misalignments in 2018 resulting from the multilateral and the bilateral frameworks, respectively. For most countries, currencies were less undervalued or more overvalued in the multilateral framework than in the bilateral one. This finding is important as it suggests that the evidence of a growth effect of undervaluations based on the Balassa-Samuelson hypothesis could be much weaker when using multilateral price levels than indicated by the literature relying on a bilateral framework (see Rodrik, 2008, among others).

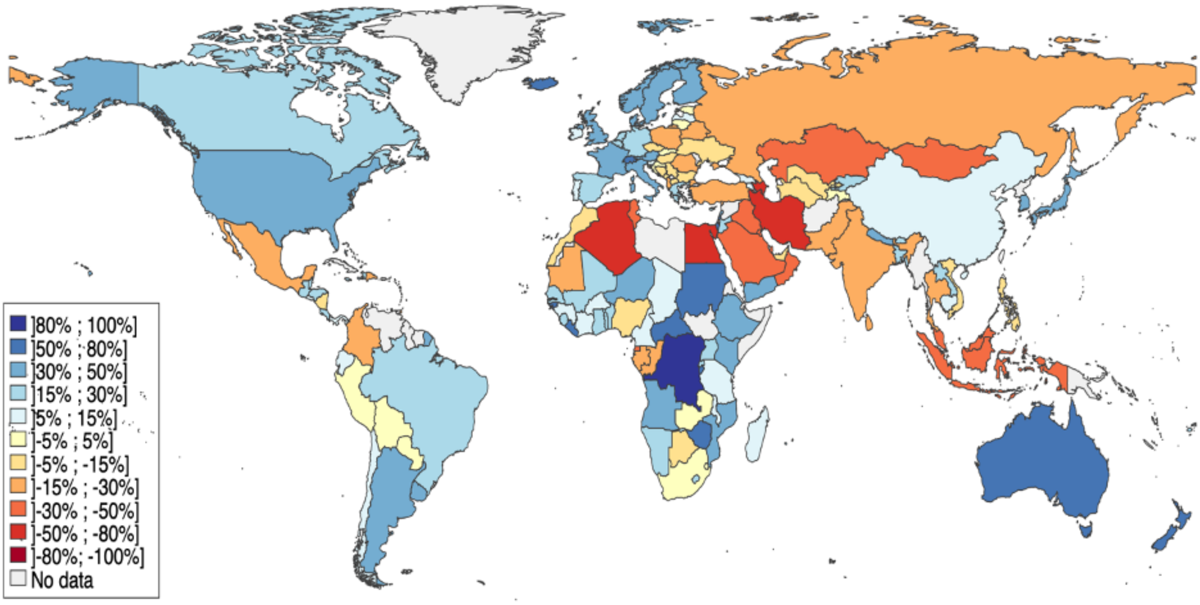

Figure 7 — BS effect-based misalignments: multilateral set-up

Notes: A positive (negative) value indicates an overvalued (undervalued) currency based on the Balassa-Samuelson effect, that is a higher (lower) price level than that implied by cross-country per capita income differences. The *MPL* data correspond to the average *MPL* series over the different weighting schemes.

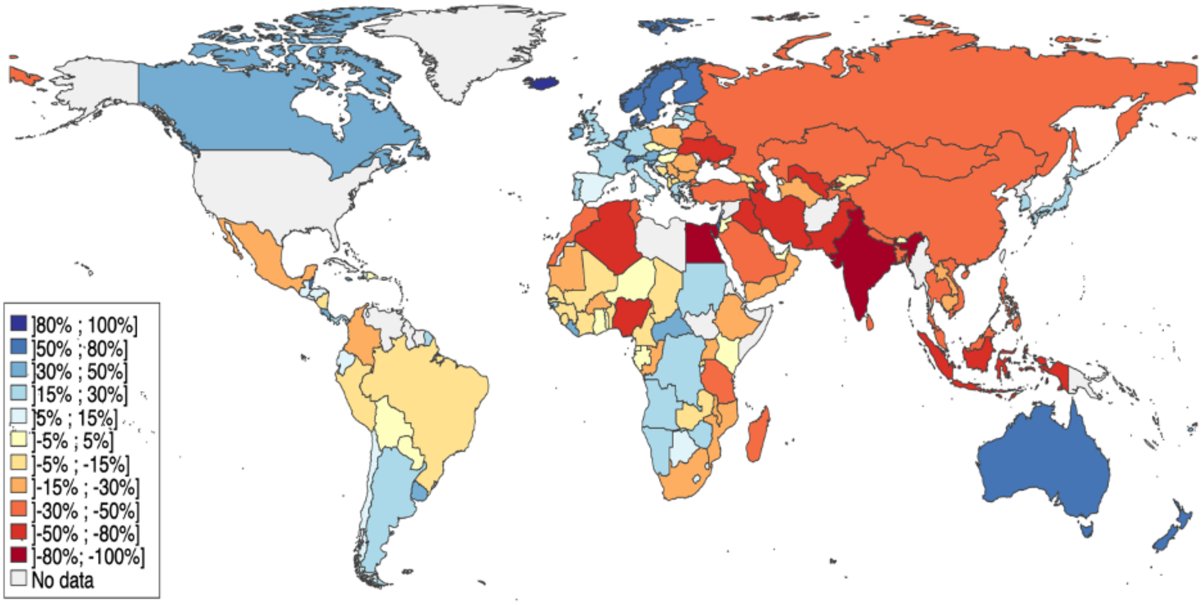

Figure 8 — BS effect-based misalignments: bilateral set-up

Notes: A positive (negative) value indicates an overvalued (undervalued) currency vis-à-vis the US dollar based on the Balassa-Samuelson effect, that is a higher (lower) price level than that implied by income per capita difference with respect to the United States. The *MPL* data correspond to the average *MPL* series over the different weighting schemes.

Since the spirit behind the calculation of our *MPL* series is relatively close to that of the IMF's *REER* level data, we finally compare our multilateral price levels with those calculated by the IMF. While both series aim to provide a multilateral assessment of relative price levels, significant differences exist in the way they are computed.

Since 2015, the IMF has developed an approach to analyze persistent differences in the level of real exchange rates across countries. It complements the External Balance Assessment (EBA) methodology, which provides measures of excessive external imbalances. The IMF's *REER* level series are constructed in a two-step process combining PPP exchange rates and *REER* indices. More specifically, the construction of the *REER* level for country i starts with the value of its price level relative to the US for the base year, i.e., 2011. The rescaled *REER* index —to the value of the base-year relative price— is then used to derive a time series; that is, the *REER* levels for the non-benchmark years are extrapolated assuming that they change in line with CPI-based *REER* indices (Mano et al., 2019). Thus, the evolution of *REER* levels fully reflects changes in the Nominal Effective Exchange Rate (*NEER*) and in the relative Consumer Price Index (CPI). However, as shown by Deaton (2012), relative inflation turns out to be a poor estimate of the actual change in PPP from one benchmark to the next. This is because the compilation of CPI only accounts for price changes and the national spending patterns while, when compiling PPPs, all sets of budget shares have to be included (see Inklaar and Timmer, 2013) —for instance by using the average share to weight the price difference for each product. Following Deaton (2012), this is likely to lead to systematic differences between domestic inflation rates and changes in PPP, with the PPP of poorer nations increasing at a faster rate than indicated by the inflation differential between poorer and richer countries.

In the CEPII's *MULTIPRIL* database, we use the WDI (World Development Indicators, World Bank) data for bilateral relative price levels with respect to the US. An important advantage of these data is that they rest on the ICP benchmarks, meaning that the comparisons across time and space rest on the same price data. It follows that the MPL series based on these PPPs give a more accurate picture than the measures which combine relative price levels (base year: 2011) with *REER* indexes' growth rates —like the IMF's series, addressing an important criticism of Deaton (2012).

Figure 9 shows the evolution of our MPL series and of the IMF's *REER* level series. To facilitate the comparison, Figure 9 also displays two other variables: (*i*) CPI-based *REER* indices (source: *EQCHANGE*), and (*ii*) *REER* level series computed using the IMF's methodology and *EQCHANGE* CPI-based *REER* indices.[11] Because the latter series are

[11]For reasons of clarity, we only plot series based on the time-varying weighting scheme. The other schemes

based on the IMF methodology, we can more easily identify those differences attributable to the trade-weighting scheme as opposed to those due to the use of purchasing power parities.

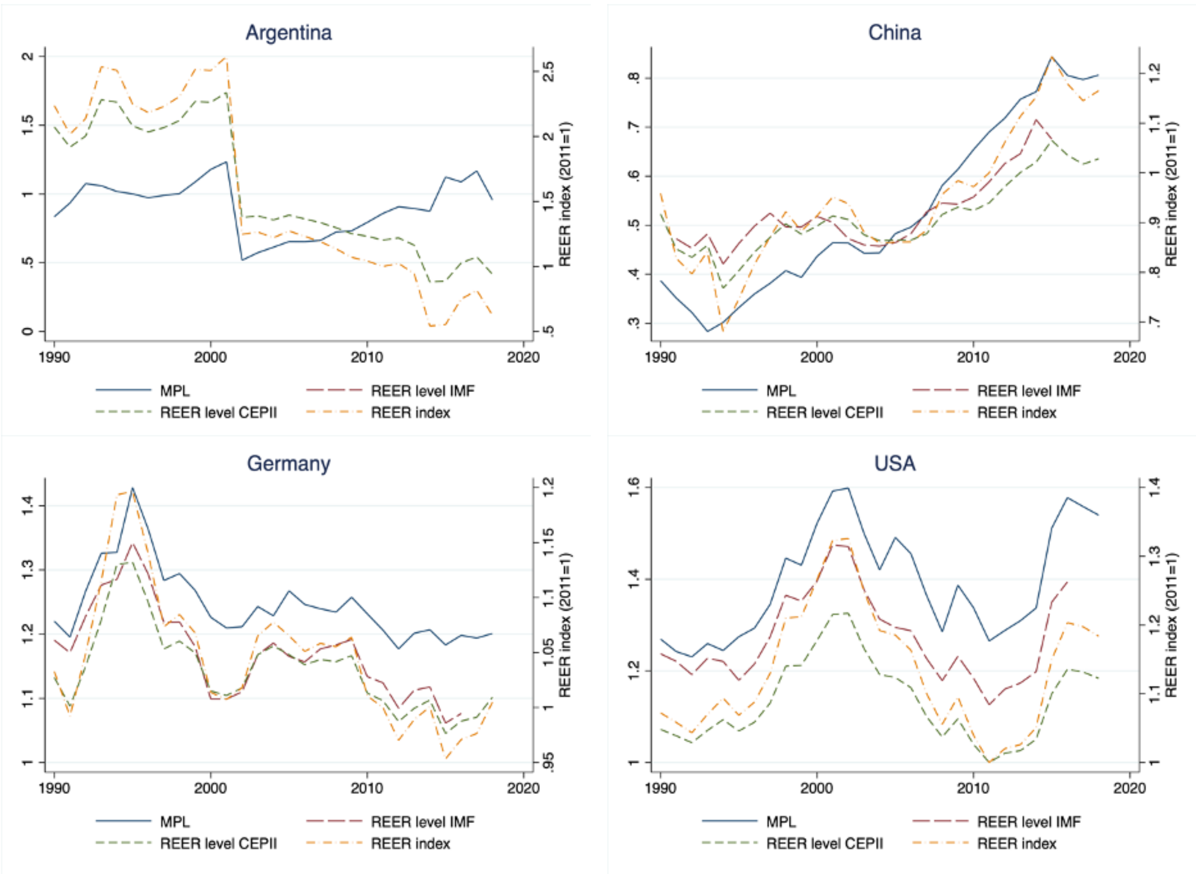

Figure 9 — Alternative measures of relative prices

Notes: For readability reasons, weighted measures are based on time-varying weights representative of average trade flows over 5-year non-overlapping windows. See Couharde et al. (2018) for further details.

The difference in how purchasing power parities are used has substantial consequences for the level of relative prices. Indeed, in advanced economies (the US and Germany), our calculations lead to higher relative price levels, despite a downward effect driven by our weighting scheme compared to the one implied by the IMF measure. The differences in measures are not solely about magnitudes, but also about the evolution of multilateral price levels over time, especially in developing and emerging countries. In particular, the case of China illustrates well the observation of Deaton (2012). Indeed, over the whole period, the *MPL* series —based on PPPs— changed at a higher rate than implied by the growth rate of the *REER* index. More specifically, the IMF's *REER level* variable indicates that prices in China were respectively around 50 percent and 30 percent lower

lead to the same observations.

than those of its trading partners in 1991 and 2016. With the MPL series, the prices were 65 percent below foreign prices in 1991, and 20 percent below in 2016. For Argentina, we even observe opposing trends between the two series. More specifically, since 2011, the MPL series show a rise in the relative price level, while the *REER level* based on the growth rate of the $REER$ index points towards the opposite trend.[12]

Overall, the way relative price levels are defined —i.e., in effective or in bilateral terms— and computed —i.e., PPPs versus extrapolations based on changes in $REER$ indexes — has important implications since it is also likely to lead to potential areas of mismeasurement in relative price levels and in the magnitude of currency misalignments. Because the extrapolated $REER$ level series are most of the time below the MPL series based on PPPs, they tend to underestimate relative price levels and generate bias in the level of misalignments. The same measurement error holds when using bilateral instead of multilateral measures of relative price levels. Relying on series computed vis-à-vis most of the trading partners and based on PPPs should thus provide misalignment values that better fit the economic reality.

3. The assessment of currency misalignments

This section describes the methodology used in estimating the equilibrium value of multilateral price levels and in deriving MPL-based currency misalignments.

3.1. Determinants of multilateral price levels

While diverse models have motivated a wide range of potential equilibrium $REER$ determinants, empirical approaches based on bilateral real exchange rates commonly juxtapose only limited subsets of candidate regressors. In light of this model uncertainty, we adopt a Bayesian Model Averaging (BMA) approach[13] to select determinants of multilateral price levels that have true predictive power.

3.1.1. The Bayesian Model Averaging (BMA) methodology

The starting point of the BMA methodology is the finding that there are different possible empirical models, each of them defined by a different combination of regressors, and by a probability of being the "true" model. BMA proceeds by estimating these different

[12] We use our computed proxy –*REER level CEPII*– since the original IMF's *REER level* series is not available for Argentina.

[13] See Hoeting et al. (1997, 1999) and Fernàndez et al. (2001a, 2001b) for further details.

models, and constructing a weighted average of all of them.

In greater detail, from X potential determinants, one obtains 2^X possible combinations and, in turn, 2^X potential models M_j with $j = 1, \ldots, 2^X$. Denoting D the dataset available, and considering θ a function of θ^j parameters to be estimated, the posterior density of the parameters for all the models under consideration is given by:

$$p(\theta|D) = \sum_{j=1}^{2^X} P(M_j|D)\ p(\theta|D, M_j) \tag{3}$$

As shown by Equation (3), the posterior density of the parameters is defined by the weighted sum of the posterior density of each considered model; the weights being given by their posterior model probability.

Given the prior model probability $p(M_j)$, the posterior model probability is calculated using the Bayes theorem as follows:

$$P(M_j|D) = \frac{p(D|M_j)\ p(M_j)}{\sum_{j=1}^{2^X}\ p(D|M_j)\ p(M_j)} \tag{4}$$

where $p(D|M_j) = \int p(D|\theta^j, M_j)\ p(\theta^j|M_j)\ d\theta^j$ is the marginal likelihood of the data given the model M_j; $p(\theta^j|M_j)$ is the prior density of the parameter θ^j under the model M_j, $p(D|\theta^j, M_j)$ is the likelihood and $p(M_j)$ is the prior probability that M_j is the "true" model.

Summing the posterior model probabilities for all the models including a specific regressor (determinant) X_k, we derive the *posterior inclusion probability* (PIP), i.e. the probability that this regressor belongs to the "true" model. It is calculated as:

$$p(\theta_k \neq 0|D) = \sum_{\theta_k \neq 0} p(M_j|D) \tag{5}$$

with θ_k denoting the parameter associated to the variable X_k.

We compute this statistic for each potential variable, i.e., determinant. Then, we include in the model each variable which is found to be robust, i.e., characterized by a posterior inclusion probability greater or equal to 0.50 (see, e.g., Fernàndez et al., 2001a).[14]

[14] Note that we follow the Fernàndez et al. (2001a)'s (hereafter FLS) methodology, which assumes equal probabilities for all models, i.e., $p(M_1) = p(M_2) = \ldots = p(M_{2^X}) = 1/2^X$.

3.1.2. The data

While the literature on real exchange rate determinants is relatively rich, it is scarcer regarding the channels through which relative price levels could be impacted. However, since the ratio of price levels measures levels of real exchange rates between countries (see Equation (1)), factors determining price level differences embody those causing differences in real exchange rates, in particular through changes in the prices of tradable and non-tradable goods. We thus rely on the literature examining the determinants of real exchange rates and price levels,[15] and select a set of 23 potential determinants.

Four key structural variables —proxies associated with the Balassa-Samuelson (thereafter, BS) effect, net foreign asset (NFA) position, terms of trade, and trade openness— have proven to be theoretically important and empirically robust determinants of long-run equilibrium real exchange rates.[16] We capture these primary real exchange rate determinants that also impact the underlying price levels through respectively the GDP per capita in PPP terms relative to the trading partners, the ratio of NFA to GDP, the ratio of export to import unit values, and the sum of exports and imports of goods and services measured in percentage of GDP.

One frequently discussed determinant is the BS effect according to which the lower the per-capita income of a country, the lower the prices of non-tradable goods and, in turn, the domestic price level. We thus expect that the catching-up process of low-income countries leads to a rise in their price levels. Another structural factor that merits examination for possible links to relative price levels is the NFA position. However, its impact on relative price levels may be ambiguous due to the existence of two antagonistic effects. The first one is a competitiveness effect, according to which a deterioration (an improvement) of the NFA position emerges because of an accumulation of current deficits (surpluses) and non-competitive (competitive) exchange rates. As a consequence, countries running current deficits (surpluses) may have an overvalued (undervalued) currency. The effect of the NFA position should thus be negative (positive) on debtor (creditor) countries' price levels. The second, intertemporal consumption effect, has the opposite consequence: countries accumulating negative (positive) NFA/GDP ratios tend to consume relatively more (less), implying higher (lower) domestic inflation and thus higher (weaker) domestic price level relative to foreign prices.

[15] See for instance Bergstrand (1991), Clague (1986), Edwards (1988), and Sarno and Taylor (2002) for a review of the literature.

[16] While some variables could have been also added to this group, note that the above four variables define our baseline specification due to data availability issues.

Terms of trade shocks are also relevant as they can affect wealth, as well as intertemporal consumption patterns. Positive terms of trade shocks cause import prices to be lower, relative to non-tradable prices, than they would be in the absence of such shocks. In other words, an improvement in the terms of trade should raise the relative price of non-tradables and, in turn, the overall price level. The higher price of non-tradable goods may also reflect a wealth effect associated with an improvement in terms of trade. Finally, as mentioned by Kravis and Lipsey (1983), the degree of openness may affect the price level through its influence on the prices of the production factors and should therefore depend on differences in factor endowments between a country and its trading partners. If trading partners are most labor-abundant (capital-abundant), the effect of openness should be negative (positive) on the home country's relative price level.

In addition to those four key variables, we consider 19 second-order determinants proposed by the literature. Specifically, we focus on the four broad variable categories below.

Demographics. We retain two demographic variables, namely the population growth rate and the old-age dependency ratio. The majority of empirical evidence concludes that both variables are associated with a higher price level through demand factors. For instance, according to Groneck and Kaufman (2017), an increase in the old-age dependency ratio raises the demand for non-tradable old-age related services relative to tradable commodities. This demand shift, in turn, lifts up the relative price level thanks to the increase in the relative price of non-tradables —due to imperfect intersectoral factor mobility.

Economic and policy environment. A stable macroeconomic environment —captured by (*i*) the expected GDP growth (2 years ahead), and (*ii*) the output gap (% potential output)— matters for limiting departure of the real exchange rate from its equilibrium level. In addition, macroeconomic policies send important signals about the commitment and credibility of authorities to efficiently manage their economy and reduce the occurrence of macroeconomic imbalances. To account for the possibility of monetary policy to affect the path of the price level through its effect on aggregate demand, we consider: (*i*) broad money (proxy for money supply), (*ii*) the real interest rate, and (*iii*) the credit gap. The impact of fiscal policy is captured by (*i*) government spending relative to GDP, and (*ii*) health expenditures relative to GDP. Through their impact on the composition of demand towards the non-tradable sector, government spending and health expenditures may contribute to an increase in relative price levels.

Specialization and participation in the globalization process. Specialization and participation in the process of globalization could have important effects on relative price levels, by delaying or accelerating their needed adjustments. Thus, we examine whether the way countries are inserted into international transactions is a significant determinant of relative price levels using (*i*) the natural resource rents (in % of GDP), (*ii*) oil rents (in % of GDP), (*iii*) the capital-labor ratio (the Bhagwati-Kravis-Lipsey effect), (*iv*) the imports-exports ratio, (*v*) the net foreign direct investment (net inflows; in % of GDP) to measure the nature of specialization and competitiveness, and (*vi*) the trade tariff rates to capture the trade regime.

Others. The last set of determinants consists of variables that are likely to influence relative price levels, but do not fit in the above groups of variables. We first take into account the socio-political context, measured by the severity of societal and interstate violence. As suggested by Rodrik (1999), such conflict episodes tend, indeed, to distort relative prices by delaying needed adjustments in real exchange rates or real wages. We also account for the geographic situation by using the average distance from the trade partners, and including two dummy variables, for (*i*) islands and (*ii*) landlocked countries. The literature largely agrees that the geographical remoteness by inducing high costs of trade tends to increase the cost of living.

The total size of our data set corresponds to 24 variables (including the dependent variable) for 178 countries over the 1990-2018 period. Since countries' relative position is of particular interest in explaining differences in relative price levels, some of the above determinants are expressed relative to the trading partners. The list of variables with their corresponding description, calculation details, and sources are displayed in Table B.1 in Appendix B.

3.1.3. The BMA results

Table 2 presents the results of interest from the BMA analysis, namely the posterior inclusion probabilities based on a universe of 2^{19} —i.e., 524288— possible models.[17] We report, for the different countries' samples, the results associated with each of the weighting schemes, as well as those based on the variables averaged over the three schemes —see column "Average".

Table 2 highlights the sensitivity of the results to the countries' sample and to the different trade-weighting schemes. Therefore, we consider as robust determinants of the

[17] To remove the potential influence of outliers, all the variables have been trimmed (1% at each tail of the distribution).

multilateral price levels the variables characterized by a PIP greater or equal to 0.5 (*i*) for at least two weighting schemes, and (*ii*) in at least one of the samples in column "Average". A more insightful view of the results derived from the BMA analysis is provided by the bar chart shown in Figure 10. This four-color bar chart indicates the number of times each different potential regressor has a PIP above 0.5 using a fixed weighting scheme based on the average trade flows over the 2008-2012 period ("Weights f1" in blue) and over the 1973-2016 period ("Weights bar" in salmon); a time-varying weighting scheme based on average trade flows over 5-year non-overlapping windows ("Weights TV" in grey) and an average over the three schemes ("Average" in yellow). As shown, 12 variables meet our criteria (they appear with bars composed of at least three colors) and are thus robustly related to multilateral price levels: *Age dependency ratio* (old), *Capital-Labor ratio*, *Credit gap*, *Distance*, *Imports-Exports ratio*, *Health expenditure*, *Oil rents*, *Output gap*, *Population growth*, *Real interest rate*, *Socio-political context*, and *Tariffs*. The most conclusive evidence is for Output gap which appears as the most important (i.e., robust) determinant of multilateral price levels —PIP greater than 0.5 in all the considered samples.

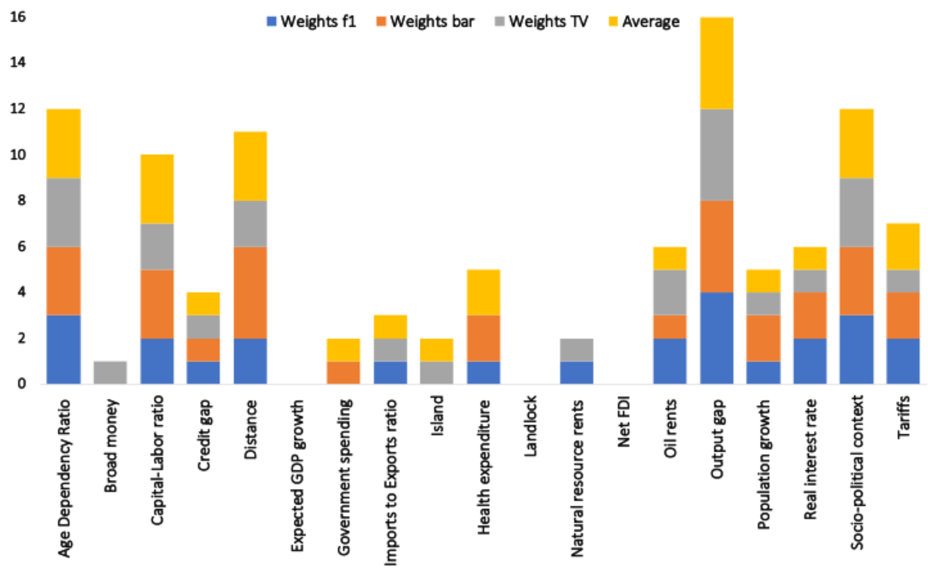

Figure 10 — Ranking of variables (summary of the BMA analysis)

Notes: The bar chart associates a colour to each trade-weighting scheme, the bar height representing the number of times the PIP of the variable is above 0.5 (see the columns of Table 2). "Weights f1": Time-invariant weighting scheme over the 2008-2012 period; "Weights bar" Time-invariant weighting scheme over the 1973-2016 period; "Weights TV" Time-varying weighting scheme based on non-overlapping five-year average weights; "Average": average over the three weighting schemes.

Table 2 — Posterior Inclusion Probabilities (PIP)

	Posterior Inclusion Probability															
	Weights f1				Weights bar				Weights TV				Average			
	Full	AEs	EMEs	DCs	Full	AEs	EMEs	DCs	Full	AEs	EMEs	DCs	Full	AEs	EMEs	DCs
Age Dependency Ratio	**1.00**	0.12	**0.99**	**0.99**	**1.00**	0.06	**1.00**	**0.89**	**1.00**	0.11	**0.98**	**1.00**	**1.00**	0.07	**0.99**	**0.99**
Broad money	0.05	0.06	0.29	0.11	0.05	0.07	0.12	0.40	0.07	0.16	0.26	**0.85**	0.05	0.11	0.24	0.47
Capital-Labor ratio	**1.00**	0.24	**1.00**	0.07	**1.00**	**0.97**	**1.00**	0.27	**1.00**	0.15	**1.00**	0.11	**1.00**	**0.84**	**1.00**	0.09
Credit gap	**0.95**	0.06	0.08	0.05	**0.98**	0.06	0.06	0.08	**0.94**	0.10	0.06	0.06	**0.96**	0.06	0.06	0.06
Distance	**1.00**	0.25	**1.00**	0.06	**1.00**	**0.89**	**1.00**	**0.59**	**1.00**	0.20	**1.00**	0.07	**1.00**	**0.83**	**1.00**	0.09
Expected GDP growth	0.04	0.10	0.10	0.22	0.04	0.07	0.26	0.20	0.08	0.06	0.21	0.08	0.05	0.06	0.17	0.14
Government spending	0.04	0.16	0.06	0.13	0.04	**0.97**	0.05	0.08	0.03	0.14	0.08	0.08	0.04	**0.83**	0.06	0.08
Health expenditure	0.20	**0.80**	0.30	0.25	0.08	**0.98**	**0.73**	0.34	0.12	0.27	0.39	0.17	0.12	**0.91**	**0.51**	0.28
Imports-Exports ratio	**0.63**	0.23	0.07	0.15	0.27	0.15	0.05	0.15	**0.77**	0.08	0.11	0.12	**0.53**	0.08	0.07	0.16
Island	0.07	0.09	0.43	0.07	0.19	0.06	0.46	0.11	0.13	0.07	**0.51**	0.08	0.12	0.08	0.48	0.07
Landlock	0.19	0.29	0.05	0.18	0.10	0.14	0.05	0.13	0.18	0.31	0.05	0.12	0.15	0.20	0.05	0.15
Natural resource rents	0.05	**0.80**	0.11	0.10	0.04	0.13	0.06	0.07	0.04	**0.92**	0.08	0.07	0.04	0.24	0.07	0.08
Net FDI	0.04	0.13	0.05	0.05	0.04	0.07	0.06	0.06	0.05	0.09	0.05	0.05	0.05	0.09	0.05	0.05
Oil rents	0.04	**0.88**	**0.93**	0.38	0.04	0.17	**1.00**	0.15	0.04	**0.93**	**0.96**	0.20	0.04	0.25	**0.97**	0.24
Output gap	**1.00**	**1.00**	**1.00**	**0.94**	**1.00**	**1.00**	**1.00**	**0.76**	**1.00**	**1.00**	**1.00**	**0.60**	**1.00**	**1.00**	**1.00**	**0.73**
Population growth	**1.00**	0.06	0.05	0.16	**1.00**	0.09	0.06	**0.54**	**1.00**	0.23	0.05	0.28	**1.00**	0.17	0.06	0.29
Real interest rate	0.05	0.06	**0.78**	**0.85**	0.09	0.14	**0.67**	**0.53**	0.04	0.07	**0.54**	0.30	0.05	0.18	**0.70**	0.43
Socio-political context	**1.00**	**1.00**	**0.99**	0.09	**1.00**	**1.00**	**0.99**	0.09	**1.00**	**1.00**	**0.99**	0.06	**1.00**	**1.00**	**0.99**	0.08
Tariffs	**0.72**	0.11	0.06	**1.00**	0.07	0.66	0.10	**0.97**	0.18	0.14	0.10	1.00	0.24	**0.60**	0.08	**1.00**

Notes: The dependent variable is the effective price level (MPL). The results are based on 100.000 burn-ins and 200.000 draws. Simulations are made using birth-death MCMC (Markov Chain Monte Carlo) sampler. In the columns "Average", we present the results when considering the variables averaged over the different weighting schemes. Variables in bold denote robust determinants. AEs: advanced economies; DCs: developing countries; EMEs: emerging countries.

3.2. Assessing real exchange rate misalignments

3.2.1. Model specification and estimation procedure

A key point is that equilibrium exchange rate approaches usually rely on a panel regression of separate $REER$ indices for each country, which contains no cross-country information. The estimation method often requires using fixed effects, which force each country's regression residuals, i.e., misalignments, to average to zero over the sample period. Results are thus sensitive to the sample span and/or the occurrence of large structural changes that are not well captured by the specification. Regression analyses based on estimates of relative price levels offer a way to overcome these drawbacks as they allow us to exploit differences in misalignments both across countries and over time.[18] Typically, to estimate multilateral price levels and derive misalignments in their cross-country dimension, the regression analysis relies on cross-sectional —or pooled— OLS estimations. As shown in Figure 11, such an approach is particularly relevant for our purpose as the cross-sectional (between countries) variation of multilateral price levels is larger than their time variation within countries.

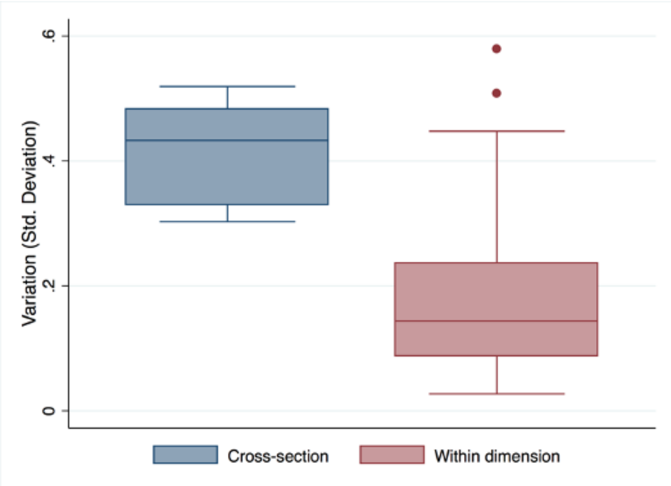

Figure 11 — Cross-sectional and within dimension variation

Note: The cross-sectional (resp. within) variation corresponds to the standard deviation between the countries by year (resp. the standard deviation of the MPL series over time and by country).

An additional point concerns the model specification. Specifically, data availability entails an awkward trade-off between the coverage of the model and its performance. Indeed, we would want to provide MPL-based misalignments for the highest number of countries —and periods—, but this broad coverage may lead to the exclusion of some variables for which data is not available, affecting the performance of the model.

[18]Additionally, since those approaches do not necessarily require the use of country fixed-effects, they allow detecting persistent currency misalignments.

Table 3 — Comparison of different models

	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)	(3.8)	(3.9)	(3.10)	(3.11)	(3.12)
l.Relative GDP PC (BS)	0.245***	0.280***	0.280***	0.276***	0.284***	0.191***	0.143***	0.140***	0.101***	0.112***	0.123***	0.077***
	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.009)	(0.009)	(0.010)	(0.011)	(0.014)	(0.014)
l.Net foreign assets	-1.871	-1.626	-1.505	-1.427	-0.815	0.339	-0.139	-0.215	0.802	1.474*	-0.701*	-0.352
	(1.302)	(1.268)	(1.393)	(1.370)	(1.171)	(0.797)	(0.989)	(0.960)	(0.755)	(0.756)	(0.361)	(0.324)
l.Terms of trade	0.308***	0.287***	0.273***	0.267***	0.199***	0.193***	0.213***	0.199***	0.197***	0.240***	0.251***	0.212***
	(0.026)	(0.025)	(0.025)	(0.025)	(0.025)	(0.023)	(0.023)	(0.024)	(0.024)	(0.029)	(0.034)	(0.045)
l.Openness	-0.059***	-0.058***	-0.058***	-0.049***	-0.054***	-0.009	-0.029***	-0.024***	-0.059***	-0.094***	-0.086***	-0.052***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.009)	(0.012)	(0.013)	(0.015)	(0.014)
Distance		0.003	0.001	0.0214*	0.034***	0.079***	0.086***	0.110***	0.114***	0.105***	0.106***	0.084***
		(0.011)	(0.011)	(0.011)	(0.010)	(0.009)	(0.009)	(0.009)	(0.010)	(0.011)	(0.011)	(0.011)
l.Imports-Exports ratio		0.118***	0.120***	0.120***	0.086***	0.079***	0.072***	0.074***	0.073***	0.095***	0.042***	0.003
		(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.014)	(0.014)	(0.011)
l.Output gap			0.768***	0.779***	0.785***	0.785***	0.791***	0.816***	0.854***	0.820***	0.817***	1.010***
			(0.113)	(0.113)	(0.105)	(0.095)	(0.096)	(0.101)	(0.102)	(0.115)	(0.137)	(0.154)
Population growth				-2.323***	-0.214	4.536***	3.734***	3.683***	2.260***	2.187***	2.162***	2.326***
				(0.353)	(0.395)	(0.606)	(0.625)	(0.620)	(0.638)	(0.737)	(0.789)	(0.731)
l.Oil rents					-0.990***	-0.492***	-0.507***	-0.521***	-0.411***	-0.469***	-0.482***	-0.364***
					(0.072)	(0.058)	(0.060)	(0.059)	(0.063)	(0.077)	(0.097)	(0.092)
Age Dependency Ratio						3.033***	2.818***	2.847***	2.445***	1.896***	1.711***	1.430***
						(0.132)	(0.141)	(0.144)	(0.150)	(0.156)	(0.157)	(0.167)
l.Capital-Labor ratio							0.595***	0.577***	1.083***	1.278***	1.251***	1.244***
							(0.070)	(0.072)	(0.083)	(0.086)	(0.093)	(0.093)
l.Credit gap								-6.479***	-7.332***	-3.629	-6.228**	3.796
								(2.458)	(2.582)	(2.781)	(2.900)	(3.647)
Socio-political context									0.015***	0.023***	0.026***	0.016***
									(0.004)	(0.004)	(0.005)	(0.006)
Real interest rate										-0.223**	-0.567***	-0.410***
										(0.107)	(0.129)	(0.145)
l.Tariffs											0.051	0.621***
											(0.113)	(0.169)
l.Health expenditure												2.859***
												(0.448)
Constant	-0.112***	-0.136	-0.129	-0.290***	-0.394***	-0.746***	-1.392***	-1.619***	-2.161***	-1.999***	-1.660***	-2.295***
	(0.042)	(0.093)	(0.093)	(0.094)	(0.088)	(0.083)	(0.114)	(0.119)	(0.125)	(0.183)	(0.245)	(0.263)
Observations / Countries	3835/162	3835/162	3834/162	3833/162	3830/162	3795/160	3740/156	3470/154	3197/139	2624/115	2024/113	1629/113
R-squared	0.449	0.478	0.492	0.497	0.531	0.614	0.625	0.613	0.630	0.666	0.707	0.705
Root Mean Squared Error	0.303	0.295	0.291	0.290	0.281	0.255	0.252	0.256	0.251	0.238	0.223	0.207

Notes: Robust standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. "l." stands for the lag operator. All the models include time fixed effects. We rely on averaged data over the different weighting schemes for variables defined in relative terms.

To address this trade-off, we start by estimating a first specification with only the four primary determinants of multilateral price levels, and progressively extend the set of explanatory variables by including other regressors based on their coverage.[19] As shown in Table 3, the R-squared ranges from 0.449 for the more parsimonious model (column 3.1) to 0.705 for the full model (column 3.12). Among the different models, the specification in column (3.7) is probably the best since it covers a large number of countries without losing too much performance compared to the full model (column 3.12). Therefore, we consider two specifications for the estimation of currency misalignments: model in column (3.7) —the baseline— and model in column (3.12) —the full model.

3.2.2. Nonlinearities

Another influencing factor in modeling multilateral price levels is that different forms of nonlinearity can be at stake. For example, some studies have documented the existence of a nonlinear relationship between relative price levels and relative GDP per capita in PPP terms (Hassan, 2016; Cheung et al., 2017). This nonlinear price-income relationship is also visible in our data, as illustrated in the left chart of Figure 12, suggesting that the BS effect can be observed when the income gap across countries is not too wide. The right chart shows an inverted U-shaped relationship between relative price levels and NFA positions according to which relative price levels would first increase and then decrease with the NFA position getting positive. As suggested before, one possible explanation is that countries accumulating positive NFA/GDP tend to consume relatively less, implying lower domestic inflation and thus weaker domestic price level relative to foreign prices.

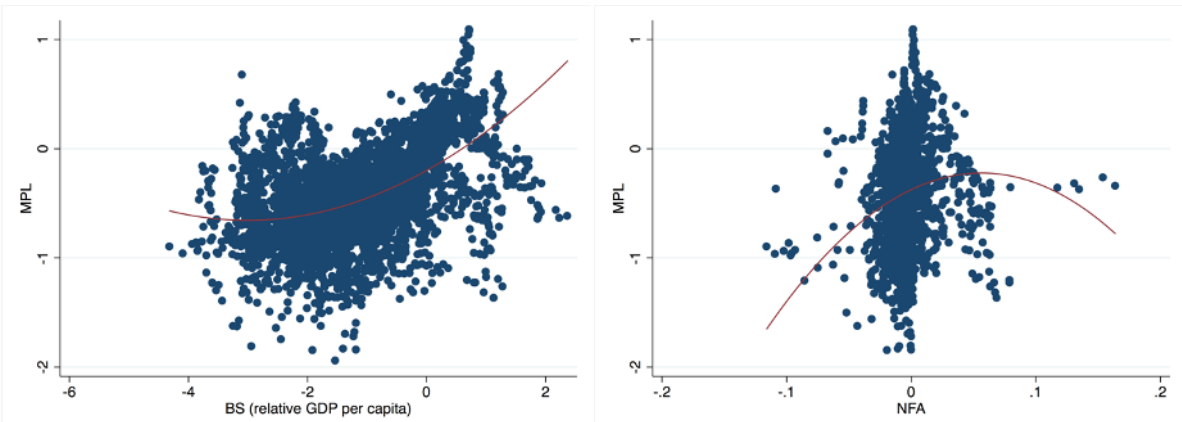

Figure 12 — Investigating nonlinearities

Note: All the measures are expressed in logarithm.

We explicitly and sequentially address the stability of the relationship between relative

[19]To mitigate endogeneity, if any, some variables are lagged. See Table B.1 in Appendix B.

price levels and these two determinants, accounting for the possibility of nonlinearities. First, we assess the nonlinearity in the price-income relationship by adding the squared relative GDP per capita to the specification. We then introduce an interaction term between a dummy variable —scoring 0 if NFA is negative and 1 otherwise— and the NFA position. The results including these nonlinear terms are reported respectively in column (4.6) and column (4.7) of Table 4. As expected, the goodness-of-fit of the model integrating these nonlinearities is higher —although marginally— than that of the baseline model— column (4.1).

Second, as countries are not at the same stage of economic development, they are heterogeneous in their price levels. As shown in Figure 2, the advanced economies (AEs) exhibit higher multilateral price levels compared to the other countries. We, therefore, pay particular attention to country heterogeneity, which, if not addressed, can generate a bias in cross-country estimates. Concretely, the preponderance of developing countries (DCs) and emerging economies (EMEs) in our sample (respectively 45.4% and 33.9% of the observations) tends to pull down the cross-sectional mean of multilateral price levels. Within the OLS framework, this characteristic may subsequently lead to important departures from the cross-sectional mean for the AEs group. As a consequence, the fitted values of multilateral price levels for those countries would be biased downward, giving rise to an upward bias in misalignments. To account for the differences in the intercept, a possible approach would be to include dummy variables —based on the stage of economic development. However, such a solution would amount to include fixed effects in the estimation.

A more satisfactory alternative is to estimate quantile regressions by decomposing multilateral price levels into ranked quantiles. The idea here is to allow the effects of the regressors to vary along with the price level distribution. Figure 13 reports the quantile regressions coefficients estimated for each variable and, for comparison, the estimated coefficients from the pooled OLS model. For most regressors, the magnitude and statistical significance of coefficients differ significantly along with the distribution of the dependent variable. We thus perform interquantile regressions and compare the overall fit of the model with that from a pooled OLS estimation. The results reported in Table 4 show that the pooled OLS estimation outperforms the interquantile regressions regarding the goodness-of-fit. As a final check, we investigate in columns (4.8) to (4.10) whether estimations based on subsamples accounting for the stage of development lead to a better fit. While this is the case for the AEs group, the goodness-of-fit for the DCs is dramatically reduced. For the sake of consistency, we retain the specification and procedure in column (4.7) of

Table 4 as our baseline model.[20]

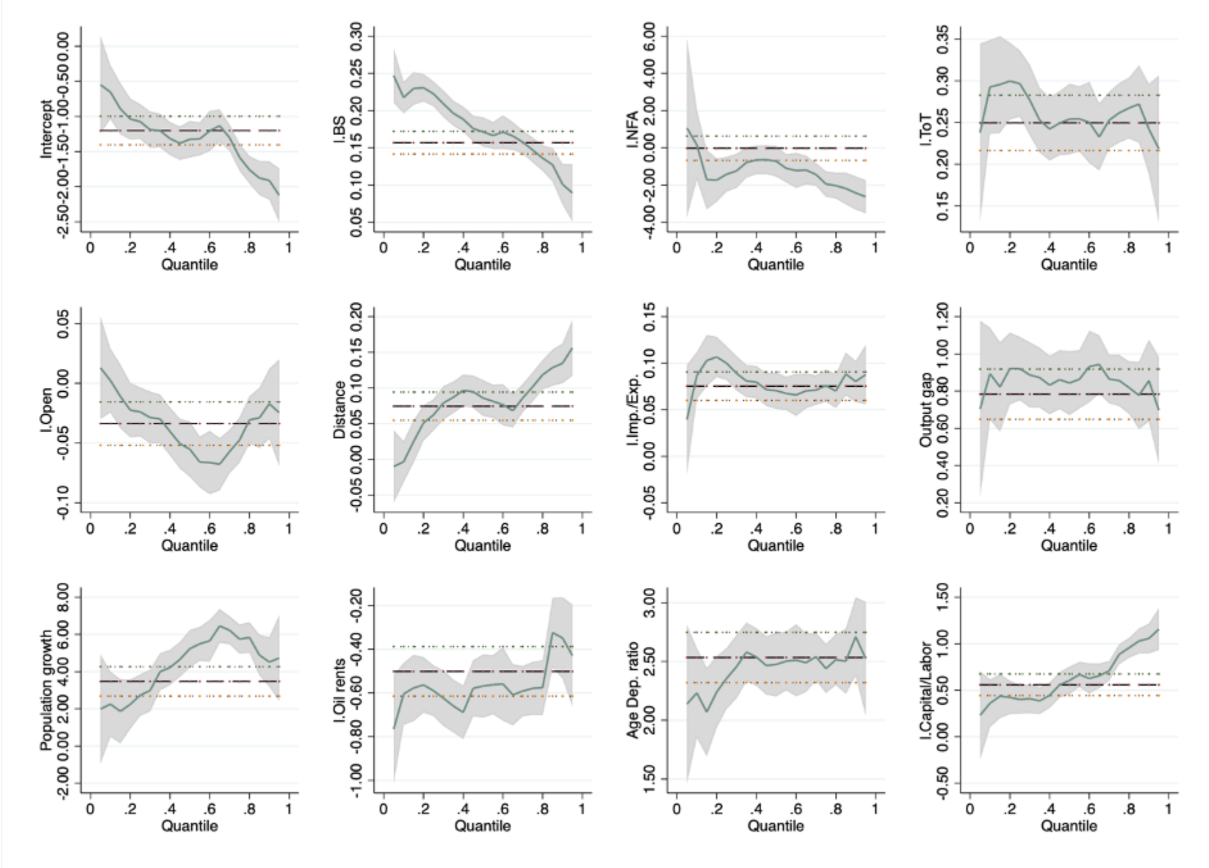

Figure 13 — Quantile regression coefficients

Notes: The *x*-axis indicates the quantiles of the MPL series. The solid green line represents the quantile regression coefficients and the shaded area the associated 95% confidence interval. The horizontal dashed red lines correspond to the OLS estimates over the full sample (the 95% confidence interval is materialized by the thin dashed lines).

[20] Addressing also the issue of parameters' changes over time, we again found that the pooled OLS method performs better —see Figure C.2 in Appendix C.

Table 4 — Comparison of different estimation procedures, baseline model

	Full sample	Interquantile				Full sample	Full sample	DCs	EMEs	AEs
		1^{st} quartile	2^{nd} quartile	3^{rd} quartile	4^{th} quartile					
	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)	(4.6)	(4.7)	(4.8)	(4.9)	(4.10)
l.Relative GDP PC (BS)	0.143***	-3,00E-04	0.008	0.013**	0.072***	0.326***	0.343***	0.209***	0.341***	0.564***
	(0.009)	(0.014)	(0.006)	(0.005)	(0.014)	(0.015)	(0.014)	(0.017)	(0.038)	(0.037)
l.Net foreign assets	-0.139	0.783**	-0.295	-0.272*	0.522	-0.556	1.632***	2.172***	1.713	-0.086
	(0.989)	(0.384)	(0.391)	(0.145)	(0.649)	(1.067)	(0.548)	(0.346)	(2.460)	(0.591)
l.Terms of trade	0.213***	0.130***	0.020*	-0.034**	0.123***	0.192***	0.193***	0.183***	0.216***	0.226***
	(0.023)	(0.020)	(0.012)	(0.014)	(0.030)	(0.022)	(0.021)	(0.027)	(0.033)	(0.032)
l.Openness	-0.029***	0.053***	-0.004	-0.003	-0.051***	-0.026***	-0.014*	-0.010	-0.007	-0.093***
	(0.008)	(0.015)	(0.009)	(0.006)	(0.010)	(0.008)	(0.008)	(0.016)	(0.019)	(0.008)
Distance	0.086***	-0.076***	-0.002	0.018***	0.048***	0.055***	0.064***	0.079***	0.111***	0.016
	(0.009)	(0.018)	(0.007)	(0.006)	(0.010)	(0.009)	(0.009)	(0.022)	(0.013)	(0.011)
l.Imports-Exports ratio	0.072***	0.003	0.003	0.003	-0.010	0.047***	0.051***	0.041***	0.140***	-0.236***
	(0.012)	(0.007)	(0.006)	(0.005)	(0.016)	(0.011)	(0.011)	(0.012)	(0.024)	(0.032)
l.Output gap	0.791***	0.404***	0.157***	0.069	0.558***	0.799***	0.806***	0.641***	0.995***	1.003***
	(0.096)	(0.098)	(0.046)	(0.052)	(0.142)	(0.095)	(0.093)	(0.117)	(0.127)	(0.162)
Population growth	3.734***	5.839***	0.012	0.622***	0.710	2.055***	1.693***	1.810***	-1.418*	1.255
	(0.625)	(0.972)	(0.255)	(0.199)	(0.680)	(0.622)	(0.586)	(0.605)	(0.741)	(1.044)
l.Oil rents	-0.507***	-0.176**	0.017	-0.094***	-0.311***	-0.595***	-0.570***	-0.368***	-0.676***	-0.257
	(0.060)	(0.075)	(0.031)	(0.033)	(0.106)	(0.065)	(0.064)	(0.060)	(0.152)	(0.376)
Age Dependency Ratio	2.818***	1.615***	0.245***	0.545***	1.055***	2.618***	2.425***	3.117***	0.777***	0.761***
	(0.141)	(0.267)	(0.081)	(0.078)	(0.109)	(0.140)	(0.126)	(0.247)	(0.159)	(0.137)
l.Capital-Labor ratio	0.595***	0.494***	0.012	0.035	0.174**	0.022	0.092	-0.284***	0.386***	-0.244***
	(0.070)	(0.123)	(0.046)	(0.030)	(0.069)	(0.069)	(0.066)	(0.091)	(0.138)	(0.076)
l.Squared Relative GDP PC (BS2)						0.064***	0.070***	0.031***	0.003	-0.142***
						(0.004)	(0.005)	(0.005)	(0.018)	(0.050)
l.Net foreign assets*Dum>0							-7.032***	-3.849***	-0.572	-0.062
							(1.360)	(0.504)	(9.761)	(1.454)
Constant	-1.392***	-0.608***	-0.461***	-0.442***	-0.355***	-0.555***	-0.678***	-0.463**	-1.481***	0.211
	(0.114)	(0.199)	(0.073)	(0.064)	(0.129)	(0.118)	(0.112)	(0.225)	(0.194)	(0.130)
Observations	3740/156	842/76	1017/99	888/96	993/65	3740/156	3740/156	1699/74	1267/53	774/29
(Pseudo) R-squared	0.625	0.336	0.099	0.135	0.385	0.651	0.660	0.428	0.622	0.691
Root Mean Squared Error	0.252	0.158	0.074	0.077	0.150	0.243	0.240	0.234	0.200	0.113

Notes: Robust standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. "*l*." stands for the lag operator. All the models include time fixed effects. We rely on averaged data over the different weighting schemes for variables defined in relative terms. AEs: advanced economies; DCs: developing countries; EMEs: emerging countries.

3.2.3. Final estimates

Table 5 presents the final estimates for our baseline and full models over the different trade-weighting schemes. These estimates cover the same, 1990-2018 period, but a reduced number of countries compared to the *MPL* sample (156 against 178 countries).

Table 5 — Assessing currency misalignments: baseline and full models (pooled OLS)

	Weights f1		Weights bar		Weights TV	
	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)
l.Relative GDP PC (BS)	0.320***	0.230***	0.385***	0.275***	0.309***	0.235***
	(0.013)	(0.020)	(0.015)	(0.022)	(0.015)	(0.022)
l.Squared Relative GDP PC (BS2)	0.067***	0.065***	0.079***	0.075***	0.057***	0.064***
	(0.004)	(0.007)	(0.004)	(0.007)	(0.005)	(0.007)
l.Net foreign assets	1.476**	2.122	1.570***	3.101*	1.696***	2.545
	(0.604)	(1.562)	(0.576)	(1.590)	(0.534)	(1.573)
l.Net foreign assets*Dum>0	-6.740***	-4.231**	-7.021***	-5.315***	-6.719***	-4.543**
	(1.363)	(1.792)	(1.346)	(1.806)	(1.312)	(1.816)
l.Terms of trade	0.196***	0.184***	0.198***	0.195***	0.187***	0.175***
	(0.021)	(0.042)	(0.021)	(0.040)	(0.022)	(0.044)
l.Openness	-0.019**	-0.044***	-0.010	-0.028**	-0.015*	-0.042***
	(0.008)	(0.014)	(0.008)	(0.014)	(0.008)	(0.014)
Distance	0.070***	0.068***	0.047***	0.056***	0.069***	0.066***
	(0.009)	(0.011)	(0.009)	(0.011)	(0.009)	(0.011)
l.Imports-Exports ratio	0.054***	-0.033**	0.046***	-0.040***	0.059***	-0.022*
	(0.011)	(0.013)	(0.010)	(0.015)	(0.011)	(0.013)
l.Output gap	0.800***	1.036***	0.805***	1.015***	0.812***	1.024***
	(0.091)	(0.142)	(0.094)	(0.148)	(0.094)	(0.149)
Population growth	1.636***	0.415	1.346**	0.230	2.321***	0.672
	(0.571)	(0.674)	(0.591)	(0.695)	(0.589)	(0.685)
l.Oil rents	-0.565***	-0.573***	-0.577***	-0.560***	-0.565***	-0.561***
	(0.063)	(0.109)	(0.065)	(0.105)	(0.064)	(0.108)
Age Dependency Ratio	2.454***	1.326***	2.281***	1.375***	2.613***	1.346***
	(0.124)	(0.164)	(0.122)	(0.167)	(0.131)	(0.171)
l.Capital-Labor ratio	0.153**	0.763***	-0.042	0.537***	0.190***	0.714***
	(0.064)	(0.092)	(0.065)	(0.094)	(0.067)	(0.091)
l.Credit gap		4.151		3.965		5.477
		(3.559)		(3.588)		(3.616)
Socio-political context		0.024***		0.025***		0.026***
		(0.005)		(0.006)		(0.006)
Real interest rate		-0.525***		-0.582***		-0.560***
		(0.132)		(0.133)		(0.139)
l.Tariffs		0.465***		0.346**		0.399**
		(0.151)		(0.158)		(0.160)
l.Health expenditure		2.390***		2.605***		2.455***
		(0.460)		(0.455)		(0.486)
Constant	-0.748***	-1.378***	-0.400***	-0.914***	-0.855***	-1.260***
	(0.110)	(0.254)	(0.111)	(0.262)	(0.114)	(0.264)
Observations	3740/156	1629/113	3740/156	1629/113	3740/156	1629/113
R-squared	0.653	0.734	0.675	0.743	0.662	0.730
Root Mean Squared Error	0.238	0.194	0.293	0.197	0.247	0.199

Notes: Robust standard errors are reported in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% confidence level, respectively. "l." stands for the lag operator. All the models include time fixed effects. "f1": fixed weights 2008-2012; "bar": fixed weights 1973-2016; "TV": time-varying weights (5-year averages).

The regression analysis shows that both models perform well, the R-squared ranging between 0.653 and 0.743. Most of the variables are significant even if, for some of them, their effect has been altered by the "adjustments" we made and the controls we included —compared to the BMA analysis. This is especially the case for the credit gap.

The regression largely confirms our expectations. A larger relative income is associated with a higher relative price level, although the effect is decreasing with the stage of economic development.[21] The nonlinearity in the NFA-MPL relationship is also confirmed. Relative terms of trade display a positive sign, suggesting that their improvement is associated with an increase in the countries' relative price levels. Lowered market competition and higher trade costs explain the positive and significant coefficients associated with the variables *trade tariffs* and *Distance*.

An increase in the *Imports-Exports ratio* is, according to the baseline model, associated with higher price levels. However, this effect no longer holds when the full model, which includes fewer observations on emerging and developing countries, is considered. The estimated coefficient becomes, indeed, significantly negative. This result can be explained as follows: if each country transforms imported inputs into final goods by adding nontraded inputs, a higher coverage trade ratio should lead to lower relative price levels in advanced economies and higher relative price levels in emerging and developing countries. Our empirical findings confirm this pattern. As shown by columns (4.8) to (4.10) of Table 4, the positive relationship between the relative trade coverage ratio and relative price levels is overturned for the sample of advanced economies.

The negative coefficient for *oil rents* is consistent with the "resource curse" phenomenon according to which the abundance of natural resources, instead of increasing standards of living, usually leads to non-competitive exchange rates that strangled the development of tradable non-natural resource sectors.

The demographic variables are positively correlated with multilateral price levels, as well as the *output gap*, *health expenditures*, and the *socio-political context*. The Kravis-Lipsey-Bhagwati effect is also confirmed by the positive and significant coefficients associated with the *Capital-Labor ratio*. Finally, the differential in *real interest rates* is negatively signed, suggesting that an interest rate differential in favor of the home country should decrease its relative price level.

3.3. Price levels-based misalignments

As discussed above, switching from the baseline model to the full specification entails a loss of 2111 observations due to the different data coverage. Since these two models display relative strengths and weaknesses (comprehensiveness vs. higher goodness-of-fit), it is not very meaningful to select one specification instead of the other one. We, therefore,

[21] Further note that, on average, 70% of model performance is attributable to the BS effect proxy.

average estimates of currency misalignments[22] over the two models to take advantage of their relative strengths and weaknesses, and to incorporate the uncertainty associated with the model selection process. However, this requires that the two models yield very close estimates for these means to be meaningful. As shown in Figures D.1 and D.2 in the Appendix, this condition is met for all the weighting schemes as well as the averaged misalignments —over all the weighting schemes.

Finally, we map the world distribution of currency misalignments in Figure 14, which reports the average misalignments for the considered countries in 2018.[23] The red (blue) color in the map below shows countries with undervalued (overvalued) currencies in real terms. The darker the red (the blue), the higher are real undervaluations (overvaluations).

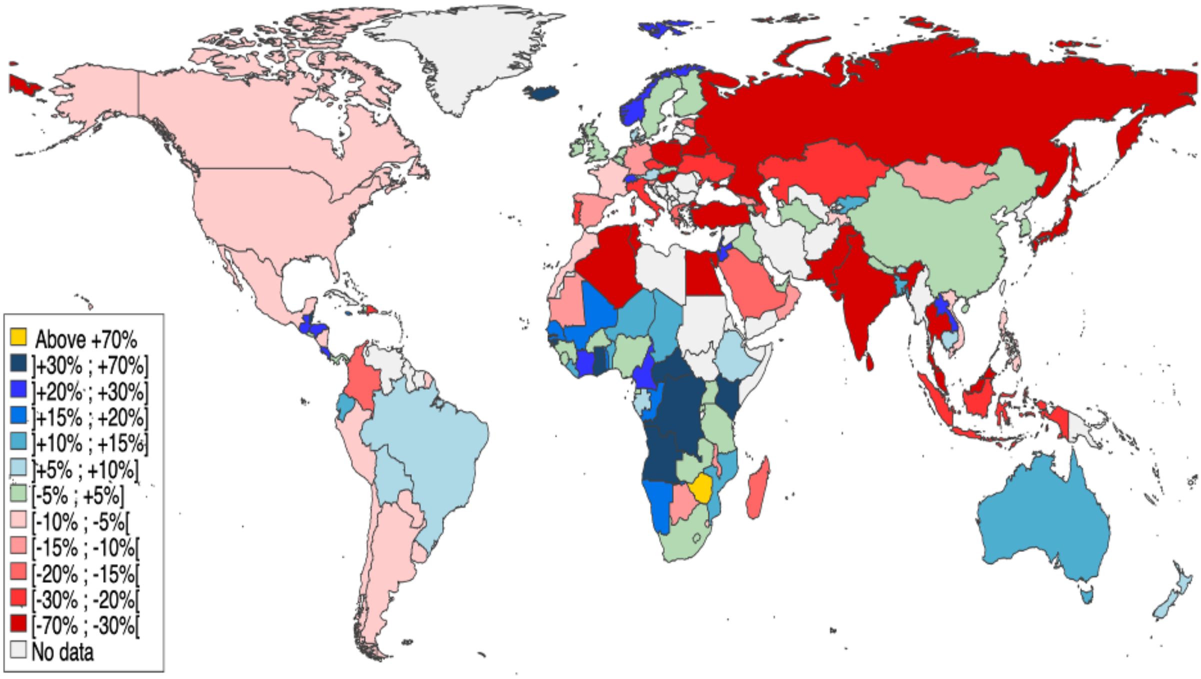

Figure 14 — Global distribution of price-based currency misalignments in 2018

Note: The map is based on the average MPL-based currency misalignments over the different weighting schemes.

Figure 14 shows that the economies with the highest misalignments in 2018 were mainly located in Africa, Asia (excluding, in particular, China), the Middle East, and the Pacific region. The most striking observation is the important heterogeneity that prevailed across African countries. Indeed, while Northern African countries exhibited undervaluations —often large as in Algeria and Egypt— sub-Saharan countries mostly presented

[22]Recall that the equilibrium exchange rate is given by the fitted value of the dependent variable. Currency misalignments are then deduced as the difference between the multilateral price level and its fitted value. A positive (resp. negative) misalignment value indicates an overvaluation (resp. undervaluation) of the currency.

[23]Table C.2 in Appendix C provides the estimated currency misalignments for the year 2018 as well as the averages over the 2014-2018 period.

sizeable overvaluations. Notwithstanding Zimbabwe, that topped the list with an overvaluation of around 81%, countries like Angola, Central African Republic, Congo D.R., Guinea-Bissau, and Kenya displayed overvaluations higher than 40%. As a consequence, few African countries (Burkina Faso, Senegal, Senegal, Sierra-Leone, South Africa, Tanzania, and Zambia) were characterized by real exchange rates close to their equilibrium level, with misalignments falling within the -/+5% interval. In contrast, Asia and, to a lesser extent, Eastern Europe/Near and the Middle East were more homogenous areas with a high concentration of countries exhibiting the largest undervaluations (India, Japan, Russia, Sri Lanka, and Thailand). In Asia, only in China, Korea, and Turkmenistan, real exchange rates could be considered at their equilibrium level while Bangladesh, Cambodia, Kyrgyzstan, and Lao displayed overvaluations.

Outside of these areas, currency misalignments were less pronounced. In the Western hemisphere, only Bolivia, Brazil, Ecuador, Guatemala, and Honduras were displaying significant overvaluations. In contrast, the estimated undervaluations found in Canada and the United States were marginal, reaching respectively -6% and -8%. In the majority of European countries, real exchange rates were also slightly undervalued, except the Norwegian krone which was highly overvalued.

Figure 14 also shows that measures of multilateral price levels (reported in Figure 3) differed markedly from currency misalignments for most countries in 2018, suggesting that they could lead to misleading conclusions when comparing price-competitiveness across economies. For example, countries in North America and in Western Europe displayed undervalued real exchange rates in 2018 while their price levels were higher than those of their trading partners. Higher prices in those countries were, therefore, primarily explained by structural factors, and could not be considered as reflecting large price-competitiveness disadvantages. The difference was less pronounced for Australia and Northern European countries. In West African countries, despite lower relative price levels, real exchange rates were highly overvalued, suggesting huge price-competitiveness disadvantages. In contrast, real undervaluations in Eastern Asian countries were stronger, compared to their price advantages depicted by their relative price levels.

4. Conclusion

This paper describes the conceptual framework and the methodology underlying the new *MULTIPRIL* database on Multilateral Price Levels (*MPL*) developed by the CEPII.

It also provides detailed results for patterns in relative price levels and MPL-based misalignments, together with their analysis. $MULTIPRIL$ usefully complements the information provided by the $EQCHANGE$ database regarding equilibrium exchange rates and currency misalignments. $MULTIPRIL$ is also designed to give an accurate picture of the differences in relative price levels around the world, which requires constructing multilateral instead of bilateral relative price level series. Our multilateral approach represents, therefore, a major step forward from the usual bilateral framework.

MPL measures cover 178 countries and are computed vis-à-vis two baskets of trading partners: (i) 177 trading partners, and (ii) the top 30 trading partners. The series span the 1990-2018 period, and rely on the three weighting schemes —consistent with the trading partners basket— included in $EQCHANGE$: (i) two fixed weighting schemes based on the average trade flows over the 2008-2012 and 1973-2016 periods; and (ii) a time-varying one based on average trade flows over 5-year non-overlapping windows.

Depictions of relative price levels and movements based on our multilateral measures bring new insights as they often contrast with those based on bilateral price levels vis-à-vis the US. However, the cross-country dispersion of relative price levels reproduces some empirical regularities already highlighted within a bilateral framework, such as the Penn effect, as well as its two main theoretical explanations, the Balassa-Samuelson and the Bhagwati-Kravis-Lipsey effects. We also confirm the relevance of a set of relative price levels' determinants using a Bayesian analysis. Our methodology appears to be particularly suitable as our empirical framework succeeds in capturing much of the cross-sectional variation of the MPL series. For the sake of completeness, the $MULTIPRIL$ database also includes price-based misalignments for 156 countries over the 1991-2018 period.

By providing consistent data for international economic analyses of systematic patterns in relative price levels and trends, as well as estimates of the world distribution of price-competitiveness levels through price-based misalignments, the $MULTIPRIL$ database can generate additional studies than those based on real effective exchange rate indexes and bilateral price level measures. Therefore, with the release of this new database, we hope to lay the groundwork for researchers and analysts to improve our understanding of global imbalances, as well as the definition of policy adjustments and structural changes to correct them.

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Appendices

A. MULTIPRIL: access to data

MULTIPRIL is a sub-database of the CEPII's *EQCHANGE* database. The data are freely available online from the *EQCHANGE* download page (http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=34) upon registration. Figure A.1 shows the structure of *EQCHANGE* and how the *MULTIPRIL* sub-databse fits in.

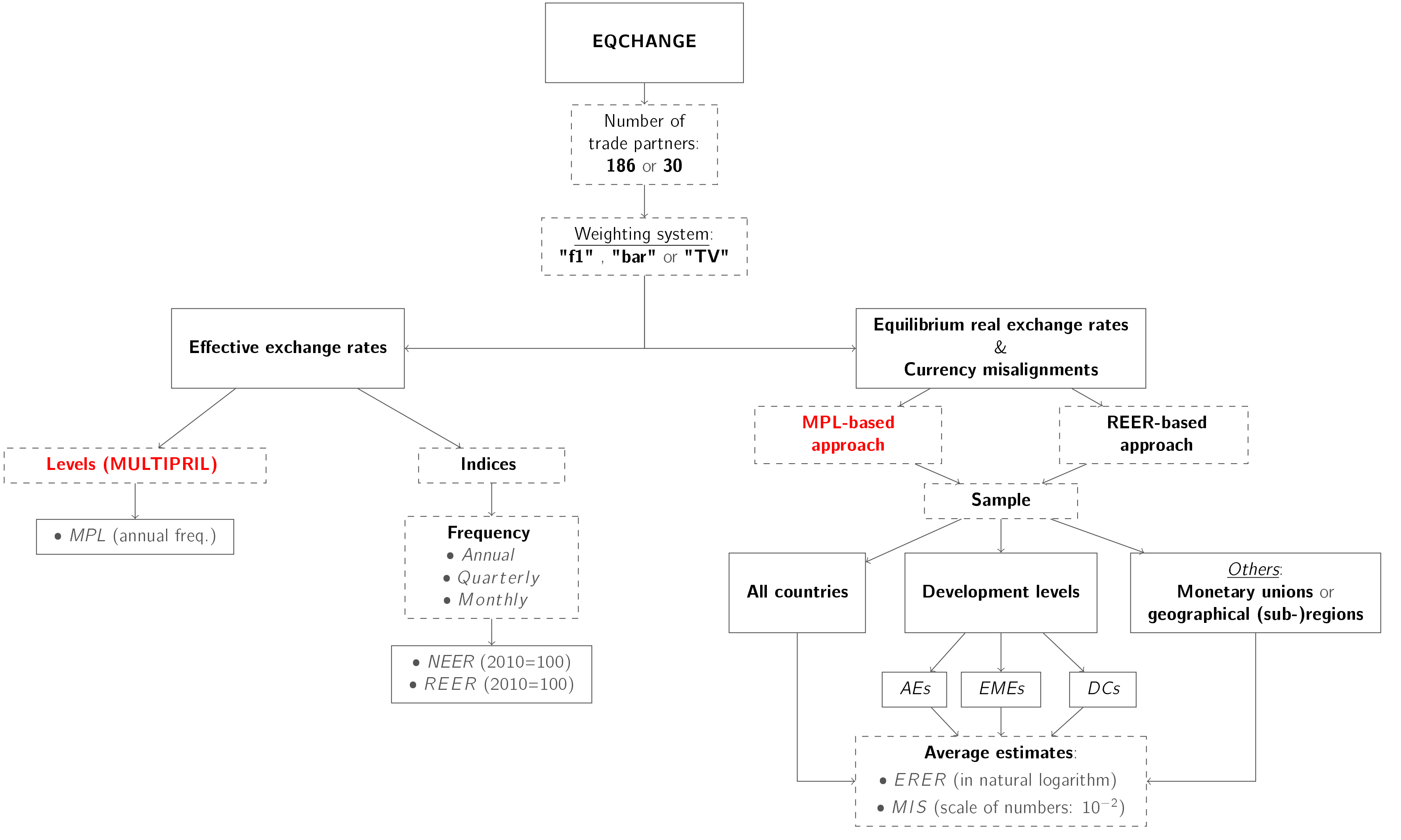

Figure A.1 — Structure of *EQCHANGE*

Notes: Fixed weights based on the 2008-2012 (resp. 1973-2016) period are referred as "*weights f1*" (resp."*weights bar*"). Similarly, time-varying weights are referred as "*weights TV*". The considered periods are: 1973-1979; 1980-1984; 1985-1989; 1990-1994; 1995-1999; 2000-2004; 2005-2009; 2010-2016. *AEs*: advanced economies; *EMEs*: emerging economies; *DCs*: developing countries.

B. Data

Table B.1 — Data: definitions and sources

Variables	Sources
Relative price to the US: corresponds to the price level ratio of PPP conversion factor (GDP) to market exchange rate.	WDI
Fundamentals	
The Balassa-Samuelson effect proxy (relative): measured as the country GDP per capita in PPP terms relative to that of its trading partners —geometric— average. Data on GDP per capita in PPP terms are from the WDI database.	*EQCHANGE*
The net foreign asset position: measured as the sum of the foreign assets (held by monetary authorities) and the deposit money banks minus the foreign liabilities (%GDP).	Lane & Milesi-Ferretti [a]
Terms of trade (relative): percentage ratio of the export unit value indexes to the import unit value indexes, measured relative to the base year 2000.	UNCTAD
Trade openness (relative): sum of exports and imports of goods and services measured (%GDP).	WDI
Other determinants	
Age Dependency Ratio (old-age; relative): corresponds to the ratio of older dependents —people older than 64— to the working-age population —those ages 15-64.	WDI
Broad money (M3; %GDP, relative)	WDI
Capital-Labor ratio (relative): measured as the capital stock per employee.	PWT 9.0
Credit gap (relative): measured as the cyclical component (HP filter) of the domestic credit provided by financial sector (% of GDP). The data on the domestic credit are from the WDI database.	Authors
Distance (relative) | The *distw* measure (*GeoDist* database): distance between two countries based on bilateral distances between the biggest cities of those two countries; the inter-city distances are weighted by the share of the city in the overall country's population.	CEPII
Expected GDP growth (relative): GDP growth forecasts 2 years ahead.	WEO
Government spending (relative): general government final consumption expenditure (% of GDP).	WEO
Health expenditure (relative): domestic general government health expenditure per capita (%GDP).	WDI
Imports-Exports ratio (relative): Imports-Exports ratio of goods and services (% of GDP).	WDI
Island: dummy variable scoring 1 if the country is an island, 0 otherwise.	Authors
Landlock: dummy variable scoring 1 if the country is landlocked, 0 otherwise.	Authors
Natural resource rents (relative): measured as the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents (%GDP).	WDI
Net FDI (relative): net FDI outflows (%GDP).	WDI

(Continued on next page).

Table B.1 — Data: definitions and sources (Continued)

Variables	Sources
Oil rents (relative): measured as the difference between the value of crude oil production at world prices and total costs of production (%GDP).	WDI
Output gap (relative): measured as the cyclical component (HP filter) of the GDP; expressed as share of potential GDP (permanent component). Data on the GDP are from the WDI database.	Authors
Population growth (relative): annual population growth rate.	WDI
Real interest rate (relative): correspond to the lending interest rate adjusted for inflation (measured by the GDP deflator).	WDI
Socio-political context (relative): measured by the magnitude scores of all societal and interstate major episodes of political violence. https://www.systemicpeace.org/warlist/warlist.htm	Center for Systemic Peace
Tariffs (relative): average of effectively applied rates weighted by the product import shares corresponding to each partner country.	WDI

Note: "relative" indicates that the variable is considered in relative terms, i.e., relative to its trading partners geometric average. The weights used are from the *EQCHANGE* database (CEPII).
WDI: *World Development Indicators* (World Bank)
WEO: *World Economic Outlook* (International Monetary Fund)
a: updated using information provided by the IMF (*International Financial Statistics* and *WEO*)

Table B.2 — List of countries

Advanced	Emerging		Developing			
Australia	Albania	Latvia	Afghanistan*	Fiji*	Montenegro*	Trinidad &Tobago*
Austria	Algeria	Lebanon	Angola	Gabon	Mozambique	Turkmenistan
Belgium	Argentina	Lithuania	Antigua & Barbuda	Gambia	Namibia	United Arab Emirates
Canada	Armenia	Macedonia	Azerbaijan	Ghana	Nepal	Uganda
Cyprus	Aruba	Malaysia	Bahamas*	Grenada	Nicaragua	Uzbekistan*
Denmark	Belarus	Mexico	Bahrain	Guinea	Niger	Vanuatu*
Finland	Bermuda*	Morocco	Bangladesh	Guinea Bissau	Nigeria	Yemen*
France	Bosnia & Herzegovina	Pakistan	Barbados	Guyana*	Oman	Zambia
Germany	Brazil	Panama	Belize	Haiti	Palau*	Zimbabwe
Greece	Bulgaria	Peru	Benin	Honduras	Papua New Guinea*	
Hong Kong	Chile	Philippines	Bhutan	Iran	Paraguay	
Iceland	China	Poland	Bolivia	Iraq	Qatar	
Ireland	Colombia	Romania	Botswana	Kenya	Rwanda	
Israel	Costa Rica	Russia	Brunei Darussalam	Kiribati*	Samoa*	
Italy	Croatia	Serbia	Burkina Faso	Kuwait	Sao Tome & Principe*	
Japan	Czech Rep	Slovakia	Burundi	Kyrgyz Rep.	Saudi Arabia	
Luxembourg	Dominican Rep.	South Africa	Cabo Verde	Lao PDR	Senegal	
Malta	Ecuador	Sri Lanka	Cambodia	Lesotho	Seychelles	
Netherlands	Egypt	Thailand	Cameroon	Liberia	Sierra Leone	
New Zealand	El Salvador	Tunisia	Central African Rep.	Libya*	Solomon Islands*	
Norway	Georgia	Turkey	Chad	Madagascar	St. Kitts and Nevis*	
Portugal	Guatemala	Ukraine	Comoros	Malawi	St. Lucia	
Singapore	Hungary	Uruguay	Congo	Maldives	Sudan	
Slovenia	India	Venezuela R.B.	Congo DR	Mali	Suriname*	
Spain	Indonesia	Vietnam	Côte d'Ivoire	Marshall Islands*	Swaziland	
Sweden	Jamaica		Dominica*	Mauritania	Tajikistan	
Switzerland	Jordan		Equatorial Guinea	Mauritius	Tanzania	
United Kingdom	Kazakhstan		Estonia	Moldova Rep.*	Togo	
United States	Korea		Ethiopia	Mongolia	Tonga*	

Note: " * " indicates the countries excluded when assessing currency misalignments due to data availability issues.

C. Further results

Table C.1 — The multilateral price levels in 2018

Country	Average 2018	Average 5 years		Country	Average 2018	Average 5 years	
Afghanistan	0.646	0.682	(0.03)	Denmark	1.298	1.322	(0.02)
Albania	(a)	0.522	(0.02)	Dominica	0.901	0.910	(0.05)
Algeria	0.380	0.392	(0.03)	Dominican Rep.	0.539	0.557	(0.01)
Angola	0.825	0.916	(0.09)	Ecuador	0.755	0.745	(0.03)
Antigua and Barbuda	0.877	0.868	(0.04)	Egypt	0.324	0.427	(0.09)
Argentina	0.905	0.993	(0.11)	El Salvador	0.675	0.676	(0.01)
Armenia	0.708	0.749	(0.03)	Equatorial Guinea	0.640	0.610	(0.07)
Aruba	(a)	0.763	(0.02)	Estonia	0.824	0.823	(0.01)
Australia	1.664	1.715	(0.11)	Ethiopia	0.668	0.675	(0.06)
Austria	1.177	1.185	(0.01)	Fiji	0.706	0.718	(0.02)
Azerbaijan	0.434	0.472	(0.10)	Finland	1.343	1.342	(0.01)
Bahamas	(a)	1.173	(0.07)	France	1.205	1.214	(0.02)
Bahrain	0.874	0.860	(0.02)	Gabon	0.585	0.563	(0.04)
Bangladesh	0.630	0.596	(0.06)	Gambia	0.736	0.726	(0.06)
Barbados	(a)	1.153	(0.02)	Georgia	0.781	0.794	(0.02)
Belarus	0.645	0.662	(0.04)	Germany	1.175	1.170	(0.01)
Belgium	1.146	1.137	(0.01)	Ghana	0.749	0.729	(0.04)
Belize	0.752	0.750	(0.03)	Greece	1.022	1.060	(0.02)
Benin	0.671	0.666	(0.00)	Grenada	0.928	0.904	(0.05)
Bhutan	1.046	1.025	(0.02)	Guatemala	0.752	0.716	(0.05)
Bolivia	0.686	0.648	(0.03)	Guinea	0.516	0.540	(0.03)
Bosnia and Herzegovina	(a)	0.655	(0.00)	Guinea Bissau	0.940	0.878	(0.06)
Botswana	0.720	0.699	(0.04)	Guyana	0.727	0.731	(0.05)
Brazil	0.839	0.903	(0.08)	Haiti	0.606	0.573	(0.03)
Brunei Darussalam	0.588	0.588	(0.07)	Honduras	0.646	0.655	(0.02)
Bulgaria	(a)	0.647	(0.02)	Hong Kong	1.200	1.167	(0.06)
Burkina Faso	0.557	0.529	(0.03)	Hungary	0.709	0.709	(0.02)
Burundi	0.657	0.660	(0.08)	Iceland	1.476	1.374	(0.15)
Cabo Verde	0.676	0.675	(0.01)	India	0.415	0.428	(0.02)
Cambodia	0.544	0.528	(0.03)	Indonesia	0.463	0.475	(0.01)
Cameroon	0.633	0.619	(0.01)	Iran	(a)	0.461	(0.01)
Canada	1.116	1.139	(0.05)	Iraq	0.583	0.543	(0.07)
Central African Rep.	0.830	0.779	(0.05)	Ireland	1.061	1.053	(0.03)
Chad	0.509	0.500	(0.03)	Israel	1.306	1.303	(0.03)
Chile	0.915	0.878	(0.03)	Italy	1.143	1.170	(0.03)
China	0.775	0.776	(0.02)	Jamaica	0.723	0.699	(0.03)
Colombia	0.593	0.610	(0.07)	Japan	1.412	1.428	(0.07)
Comoros	0.924	0.894	(0.02)	Jordan	0.819	0.816	(0.05)
Congo	0.582	0.527	(0.09)	Kazakhstan	0.558	0.619	(0.09)
Congo D.R.	1.052	0.986	(0.06)	Kenya	0.917	0.846	(0.07)
Costa Rica	0.895	0.913	(0.04)	Kiribati	0.875	0.883	(0.02)
Côte d'Ivoire	0.667	0.668	(0.01)	Korea Rep.	1.208	1.203	(0.01)
Croatia	(a)	0.782	(0.01)	Kuwait	0.762	0.711	(0.10)
Cyprus	(a)	1.023	(0.02)	Kyrgyz Rep.	0.669	0.641	(0.03)
Czech Rep.	0.774	0.745	(0.02)	Lao PDR	0.746	0.767	(0.03)

Notes: Entries correspond to the averages of the MPL series over the different weighting schemes. Figures in parentheses correspond the standard deviation associated to the average over the last 5 years (i.e., 2014-2018).
" (a) ": Data available until 2017

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Table C.1 — The multilateral price levels in 2018 (Continued)

Country	Average 2018	Average 5 years		Country	Average 2018	Average 5 years	
Latvia	(a)	0.882	(0.01)	Rwanda	0.614	0.661	(0.03)
Lebanon	1.013	0.956	(0.08)	Samoa	0.779	0.785	(0.03)
Lesotho	0.772	0.767	(0.02)	Sao Tome and Principe	0.966	0.898	(0.04)
Liberia	0.625	0.650	(0.04)	Saudi Arabia	0.662	0.624	(0.04)
Libya	0.504	0.440	(0.05)	Senegal	0.691	0.667	(0.02)
Lithuania	(a)	0.820	(0.02)	Serbia	(a)	0.654	(0.01)
Luxembourg	1.218	1.200	(0.02)	Seychelles	0.824	0.834	(0.04)
Macedonia, TFYR	(a)	0.616	(0.01)	Sierra Leone	0.518	0.548	(0.05)
Madagascar	0.440	0.437	(0.01)	Singapore	1.096	1.080	(0.02)
Malawi	0.527	0.512	(0.03)	Slovakia	0.820	0.822	(0.00)
Malaysia	0.545	0.557	(0.04)	Slovenia	0.917	0.958	(0.02)
Maldives	1.261	1.228	(0.10)	Solomon Islands	1.339	1.283	(0.08)
Mali	0.700	0.687	(0.01)	South Africa	0.730	0.701	(0.03)
Malta	(a)	0.867	(0.01)	Spain	1.041	1.047	(0.01)
Marshall Islands	1.291	1.286	(0.08)	Sri Lanka	0.510	0.539	(0.02)
Mauritania	0.418	0.424	(0.01)	St. Kitts and Nevis	0.764	0.760	(0.02)
Mauritius	0.777	0.768	(0.01)	St. Lucia	0.968	0.918	(0.05)
Mexico	0.556	0.581	(0.05)	Sudan	0.393	0.889	(0.31)
Moldova Rep.	0.832	0.769	(0.05)	Suriname	0.481	0.558	(0.11)
Mongolia	0.548	0.560	(0.02)	Swaziland (Eswatini)	0.757	0.743	(0.01)
Montenegro	(a)	0.737	(0.01)	Sweden	1.226	1.290	(0.04)
Morocco	0.558	0.553	(0.01)	Switzerland	1.567	1.628	(0.05)
Mozambique	0.653	0.703	(0.12)	Tajikistan	0.541	0.626	(0.08)
Namibia	0.939	0.861	(0.06)	Tanzania	0.567	0.586	(0.01)
Nepal	0.872	0.786	(0.06)	Thailand	0.588	0.558	(0.02)
Netherlands	1.213	1.202	(0.02)	Togo	0.675	0.658	(0.01)
New Zealand	1.374	1.421	(0.04)	Tonga	0.830	0.840	(0.04)
Nicaragua	0.525	0.545	(0.02)	Trinidad and Tobago	0.749	0.748	(0.02)
Niger	0.637	0.614	(0.02)	Tunisia	0.393	0.443	(0.03)
Nigeria	0.527	0.612	(0.10)	Turkey	0.503	0.648	(0.09)
Norway	1.526	1.486	(0.03)	Turkmenistan	0.759	0.822	(0.07)
Oman	0.657	0.654	(0.04)	Uganda	0.581	0.627	(0.05)
Pakistan	0.448	0.465	(0.03)	Ukraine	0.652	0.578	(0.05)
Palau	1.121	1.112	(0.06)	United Arab Emirates	0.974	0.968	(0.04)
Panama	0.819	0.811	(0.04)	United Kingdom	1.179	1.255	(0.08)
Papua New Guinea	0.810	0.813	(0.02)	United States	1.496	1.464	(0.09)
Paraguay	0.714	0.717	(0.03)	Uruguay	1.204	1.156	(0.03)
Peru	0.675	0.669	(0.01)	Uzbekistan	0.437	0.689	(0.19)
Philippines	0.501	0.542	(0.03)	Vanuatu	1.310	1.295	(0.04)
Poland	0.642	0.651	(0.01)	Venezuela, R.B.	(b)	1.129	—
Portugal	0.904	0.885	(0.02)	Vietnam	0.508	0.512	(0.01)
Qatar	0.817	0.788	(0.08)	Yemen	0.682	0.735	(0.09)
Romania	(a)	0.636	(0.00)	Zambia	0.560	0.566	(0.05)
Russia	0.667	0.667	(0.06)	Zimbabwe	1.401	1.161	(0.16)

Note: Entries correspond to the averages of the MPL series over the different weighting schemes. Figures in parentheses correspond the standard deviation associated to the average over the last 5 years (i.e., 2014-2018).
" (a) ": Data available until 2017
" (b) ": Data available until 2014

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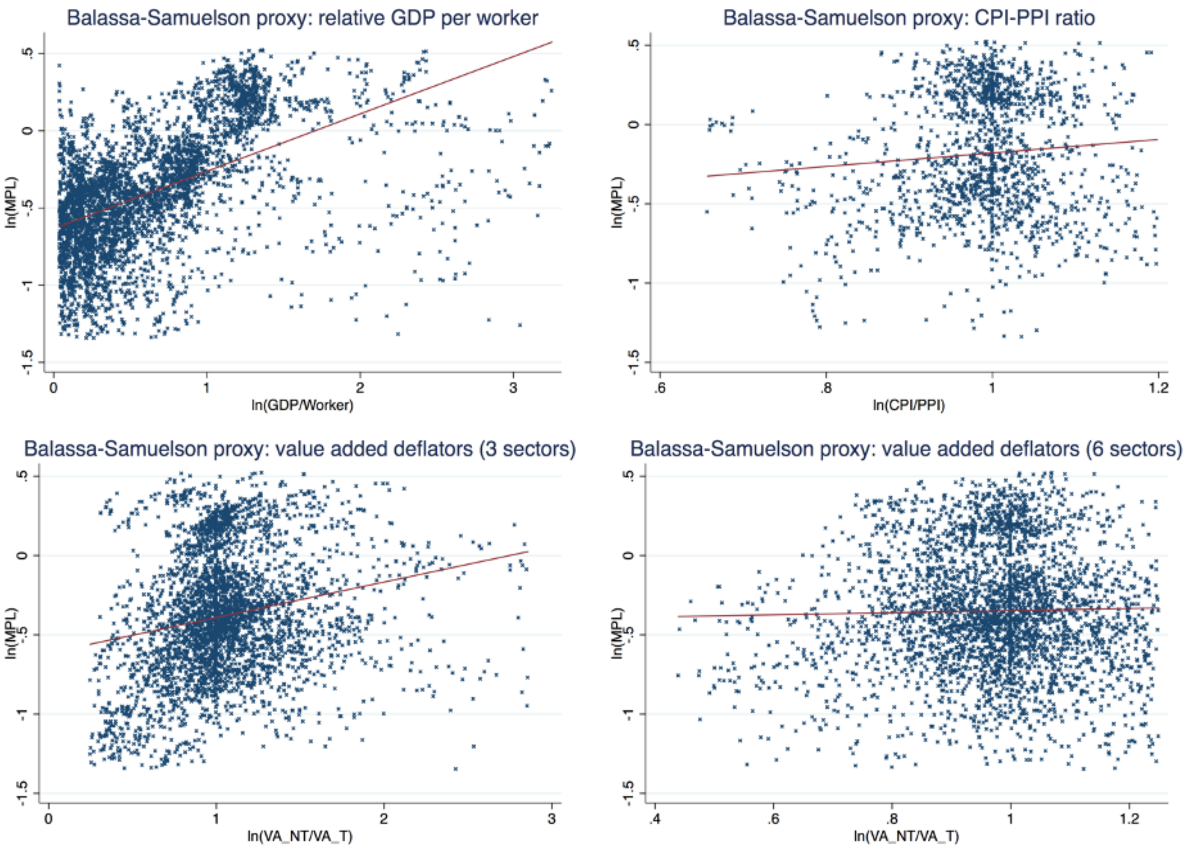

Figure C.1 — The Balassa-Samuelson effect's proxies

Note: The Balassa-Samuelson effect's proxies are from the *RPROD* database (CEPII). All the proxies are computed relative to the trading partners.

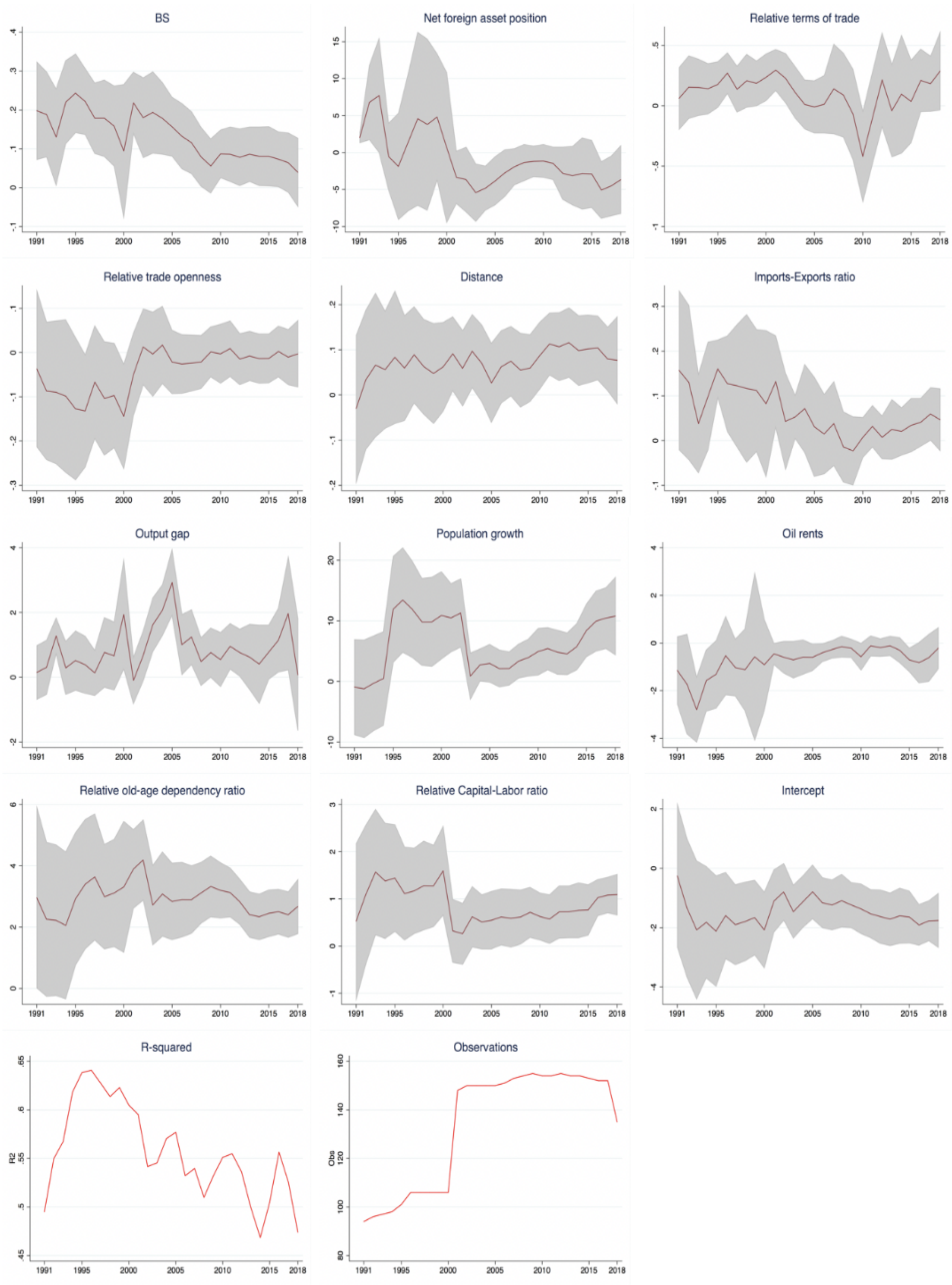

Figure C.2 — Rolling regression results

Note: The solid red lines correspond to the obtained coefficients. The shaded area corresponds to the 95% confidence intervals.

Table C.2 — Currency misalignments (%)

	2018		2014-2018			2018		2014-2018	
	Mean	Sd.	Mean	Sd.		Mean	Sd.	Mean	Sd.
Albania	—		-18.18	2.09	Cambodia	5.45	2.25	0.71	2.05
Algeria	-38.49	2.33	-29.53	2.24	Cameroon	22.36	2.24	18.13	2.10
Angola	57.64	2.47	53.73	3.00	Canada	-6.00	2.28	0.68	2.00
Argentina	-7.62	2.61	-6.01	2.62	Central African Rep.	42.97	3.38	39.13	4.01
Armenia	0.21	2.23	7.29	2.17	Chad	12.93	2.61	6.98	2.72
Aruba	—		-32.23	3.56	Chile	-9.40	2.26	-6.03	2.17
Australia	14.47	2.43	20.18	2.52	China	4.40	2.32	8.49	2.33
Austria	7.18	2.29	6.84	2.16	Colombia	-18.03	2.21	-4.29	2.51
Azerbaijan	-25.41	2.71	-12.95	2.88	Comoros	29.62	2.58	23.38	2.59
Bahrain	-2.53	2.81	-1.81	2.60	Congo	15.18	3.60	10.51	3.12
Bangladesh	13.89	2.27	4.70	2.07	Congo, D.R.	58.99	2.91	48.62	2.56
Barbados	—		33.35	2.26	Costa Rica	21.50	2.21	24.55	2.05
Belarus	-34.81	2.31	-31.80	2.33	Côte d'Ivoire	22.42	2.25	20.25	2.31
Belgium	1.84	2.38	-0.89	2.38	Croatia	—		-18.32	2.20
Belize	30.50	2.31	29.44	2.06	Cyprus	—		20.53	2.65
Benin	13.70	2.19	10.81	2.18	Czech Rep.	-28.66	2.28	-25.15	2.13
Bhutan	6.94	2.28	8.72	2.06	Denmark	9.70	2.26	10.59	2.12
Bolivia	7.52	2.31	2.70	2.38	Dominican Rep.	-21.72	2.17	-15.44	2.10
Bosnia and Herzegovina	—		-2.92	2.22	Ecuador	13.22	2.23	10.05	2.15
Botswana	-11.08	2.18	-8.18	2.30	Egypt	-63.38	2.52	-36.67	3.09
Brazil	9.33	2.28	15.53	2.42	El Salvador	-2.32	2.22	-4.26	1.98
Brunei Darussalam	-14.98	6.25	-10.90	5.90	Equatorial Guinea	-3.53	2.83	-11.89	2.94
Bulgaria	—		-27.81	2.83	Estonia	-18.68	2.36	-11.32	2.22
Burkina Faso	4.81	2.42	-3.26	2.40	Ethiopia	9.76	2.69	5.02	2.47
Burundi	—		1.47	3.07	Finland	-1.05	2.38	4.24	2.19
Cabo Verde	37.51	2.53	36.39	2.46	France	-5.95	2.32	-4.19	2.19

Note: "Sd." stands for standard deviations.

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Table C.2 — Currency misalignments (%; Continued)

	2018		2014-2018			2018		2014-2018	
	Mean	Sd.	Mean	Sd.		Mean	Sd.	Mean	Sd.
Gabon	6.08	2.34	4.01	2.76	Kenya	42.55	2.21	32.45	2.13
Gambia	24.50	2.24	22.66	2.12	Korea	2.97	2.23	3.42	2.28
Georgia	-12.38	2.51	-6.89	2.33	Kuwait	3.70	3.98	-3.60	4.31
Germany	-12.93	2.44	-15.47	2.35	Kyrgyz Rep.	14.80	2.25	5.95	2.33
Ghana	31.69	2.15	31.59	1.98	Lao P.D.R.	25.68	2.45	23.59	2.15
Greece	-19.66	2.51	-11.71	2.41	Latvia	—		-6.81	2.22
Grenada	—		25.35	2.27	Lebanon	37.64	2.58	25.97	2.73
Guatemala	24.18	2.17	20.02	2.22	Lesotho	—		8.29	2.64
Guinea	-2.74	2.29	-1.39	2.19	Liberia	14.75	4.01	13.02	3.88
Guinea Bissau	47.82	2.29	43.42	2.07	Lithuania	—		-13.01	2.36
Haiti	-1.98	2.87	-6.11	2.56	Luxembourg	9.06	3.32	20.31	3.49
Honduras	22.70	2.19	20.95	2.04	Macedonia (TFYR)	—		-14.87	2.13
Hong Kong	-14.43	3.70	-15.74	3.56	Madagascar	-17.85	2.62	-21.15	2.51
Hungary	-30.68	2.32	-21.01	2.17	Malawi	-12.40	2.44	-13.14	2.33
Iceland	39.91	3.33	38.93	2.98	Malaysia	-36.90	2.27	-28.41	2.17
India	-44.56	2.32	-38.11	2.65	Maldives	57.86	2.71	47.67	2.70
Indonesia	-25.54	2.33	-23.66	2.23	Mali	15.57	2.19	14.91	1.94
Iran	—		-36.60	2.10	Malta	—		-12.64	3.06
Iraq	4.56	2.95	1.70	3.02	Mauritania	-12.80	2.33	-11.00	2.32
Ireland	-0.75	2.71	5.89	2.86	Mauritius	-22.27	2.50	-14.38	2.51
Israel	29.44	2.34	35.73	2.41	Mexico	-6.70	2.24	6.52	2.66
Italy	-22.29	2.66	-20.24	2.68	Mongolia	-13.53	2.44	-10.50	2.50
Jamaica	16.11	2.24	13.39	2.21	Morocco	-5.11	2.30	-5.52	2.15
Japan	-53.09	4.31	-40.33	4.13	Mozambique	10.01	2.49	19.49	2.95
Jordan	29.10	2.26	15.82	2.51	Namibia	18.93	2.14	8.03	2.17
Kazakhstan	-27.08	2.40	-13.45	2.58	Nepal	4.91	4.13	1.69	3.30

Note: "Sd." stands for standard deviations.

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Table C.2 — Currency misalignments (%; Continued)

	2018		2014-2018			2018		2014-2018	
	Mean	Sd.	Mean	Sd.		Mean	Sd.	Mean	Sd.
Netherlands	-2.22	2.30	-1.19	2.15	Slovenia	-11.06	2.34	1.24	2.16
New Zealand	6.42	2.62	13.24	2.59	South Africa	-3.62	2.28	-6.22	2.28
Nicaragua	-7.60	2.21	-11.82	2.28	Spain	-14.45	2.38	-12.87	2.45
Niger	14.32	2.53	4.08	2.67	Sri Lanka	-47.08	2.32	-39.35	2.22
Nigeria	3.54	2.25	16.83	2.70	St. Lucia	—		37.71	2.15
Norway	27.48	2.56	20.61	2.59	Swaziland	-5.06	2.19	-8.25	2.19
Oman	-12.50	2.65	-16.61	3.29	Sweden	-2.29	2.42	4.25	2.25
Pakistan	-30.76	2.37	-30.97	2.11	Switzerland	21.52	2.32	22.10	2.24
Panama	1.14	2.22	1.05	2.16	Tajikistan	-8.56	2.48	-0.54	3.74
Paraguay	-8.38	2.25	-6.63	2.24	Tanzania	-2.47	2.34	-3.47	2.22
Peru	-5.70	2.22	-2.33	2.12	Thailand	-31.69	2.26	-30.51	2.13
Philippines	-6.59	2.25	2.87	2.44	Togo	18.28	2.24	9.70	2.26
Poland	-31.29	2.46	-17.71	2.34	Tunisia	-33.22	2.42	-23.14	2.33
Portugal	-27.76	2.43	-24.13	2.35	Turkey	-46.37	2.56	-21.23	2.44
Qatar	-20.49	3.85	-36.57	4.61	Turkmenistan	-3.08	2.36	-0.53	2.21
Romania	—		-27.63	2.15	Uganda	0.17	2.38	7.11	2.11
Russia	-35.79	2.26	-26.05	2.46	Ukraine	-28.21	2.56	-28.26	2.66
Rwanda	3.88	2.20	7.11	2.20	United Arab Emirates	3.75	3.98	3.03	3.88
Saudi Arabia	-16.68	2.85	-19.21	2.84	United Kingdom	0.03	2.28	5.95	2.20
Senegal	17.60	2.21	14.90	2.22	United States	-8.09	2.52	-17.10	3.08
Serbia	—		-23.93	2.12	Uruguay	-6.64	2.45	-7.56	2.43
Seychelles	-5.03	2.34	-7.36	2.09	Venezuela, R.B.	—		66.11	4.15
Sierra Leone	-1.25	2.44	2.59	2.36	Vietnam	-6.71	2.36	-7.08	2.08
Singapore	-26.74	2.91	-22.68	3.32	Zambia	-0.61	2.23	0.32	2.08
Slovakia	-0.33	2.41	7.58	2.32	Zimbabwe	80.95	2.30	63.23	2.72

Note: "Sd." stands for standard deviations.

D. Figures

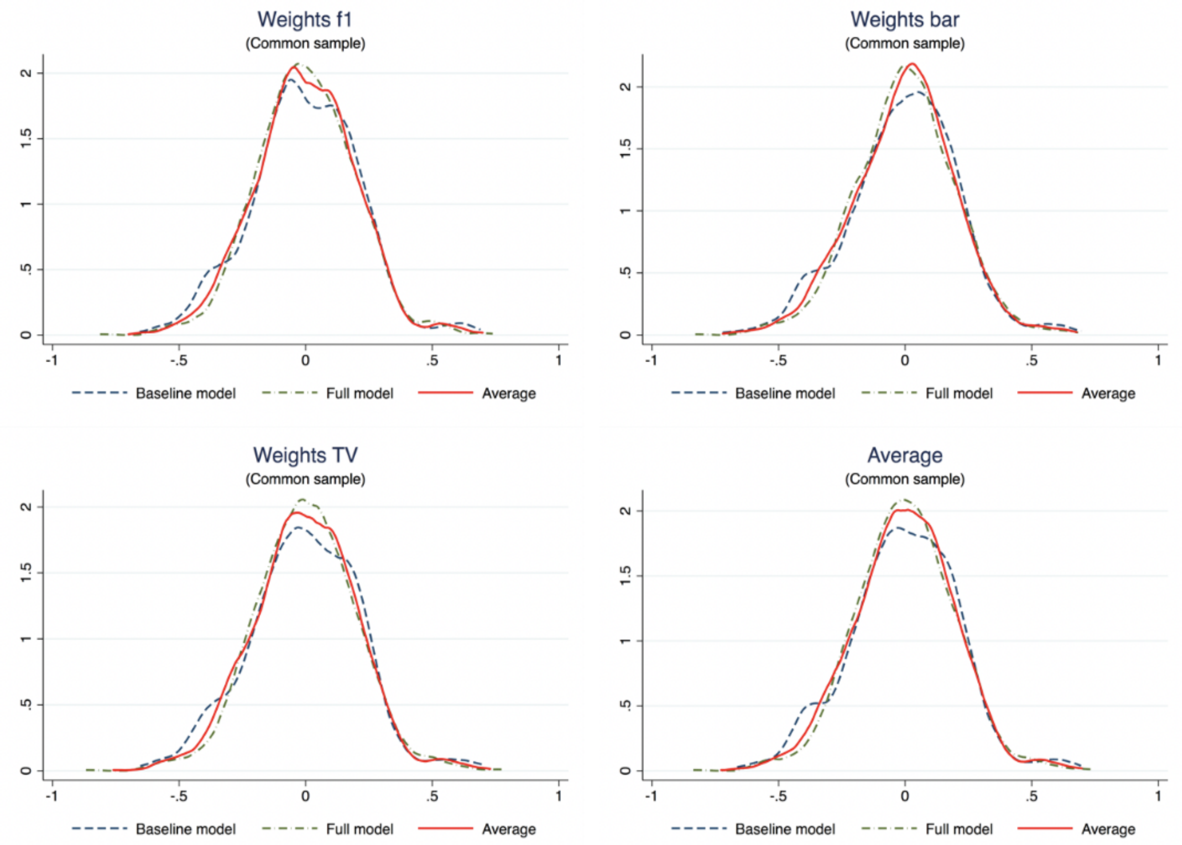


Figure D.1 — Distributions of the estimated currency misalignments

Note: The plots correspond to the kernel distributions. The common sample consists of observations included in the full model.

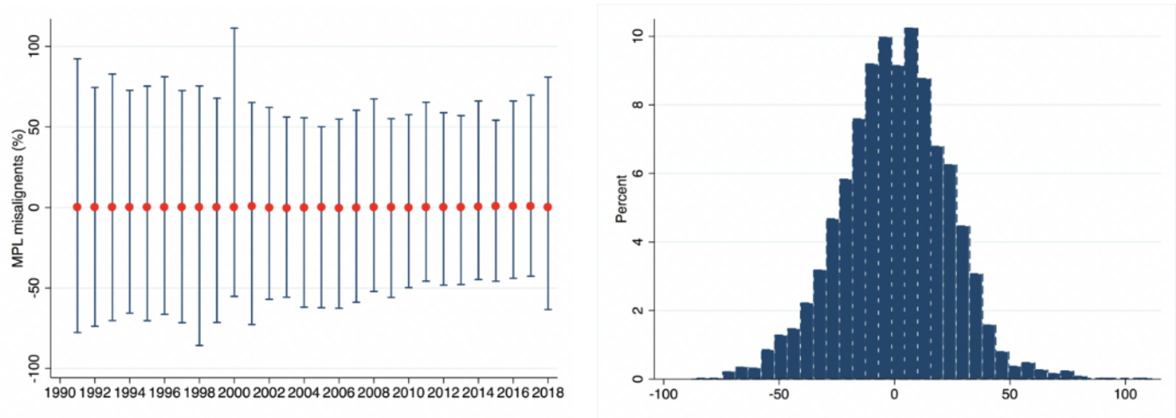


Figure D.2 — Distribution of the average MPL-based misalignments

Notes: The average MPL-based misalignments correspond to the average of the misalignments over all the different weighting schemes. In the left chart, the bars correspond to the range of the estimate (i.e. Min-Max) and red dots indicate the average by year over all the countries. The y-axis in the right chart indicates the percentage of observations.

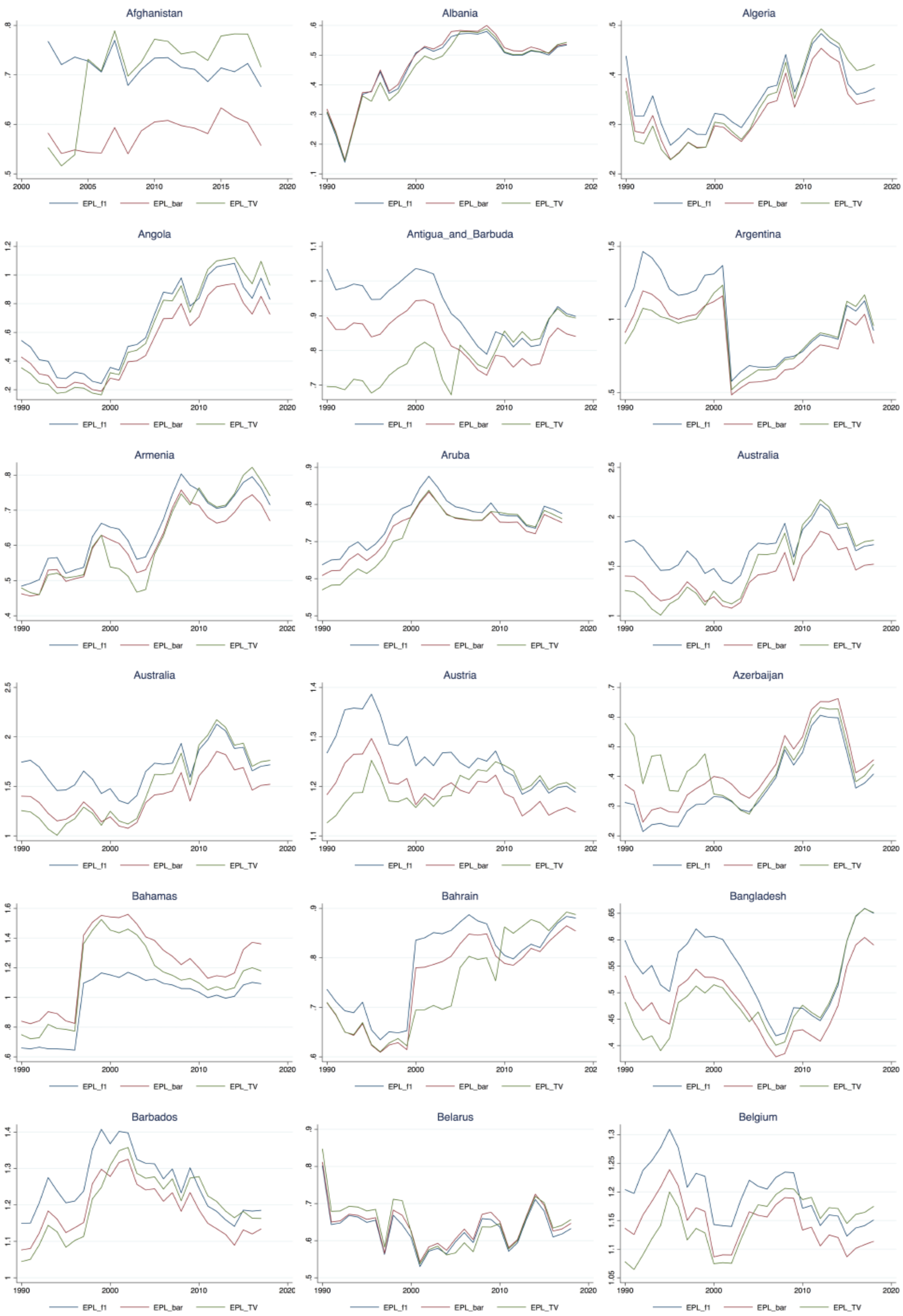


Figure C.3 — The multilateral price levels (MPL)

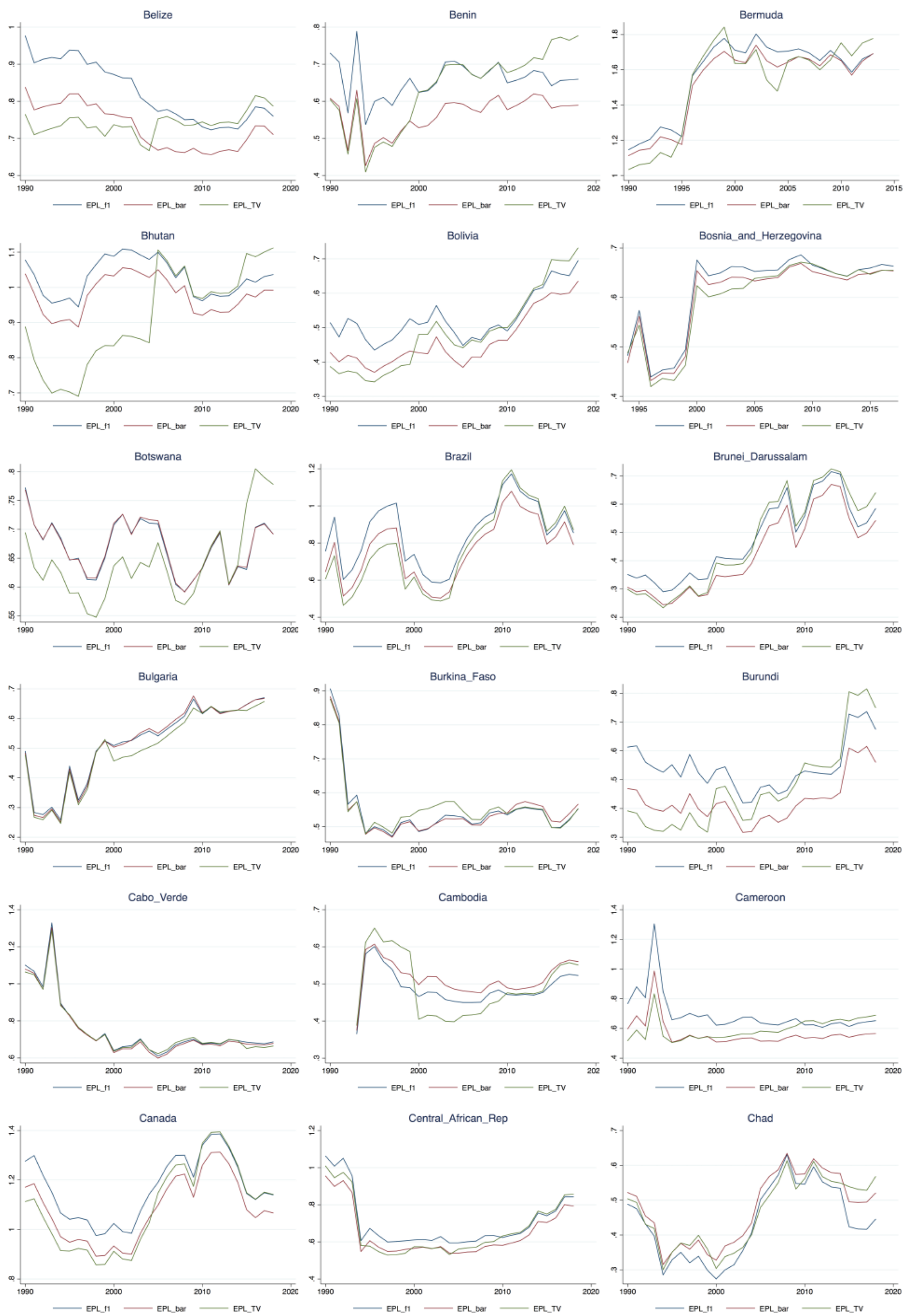
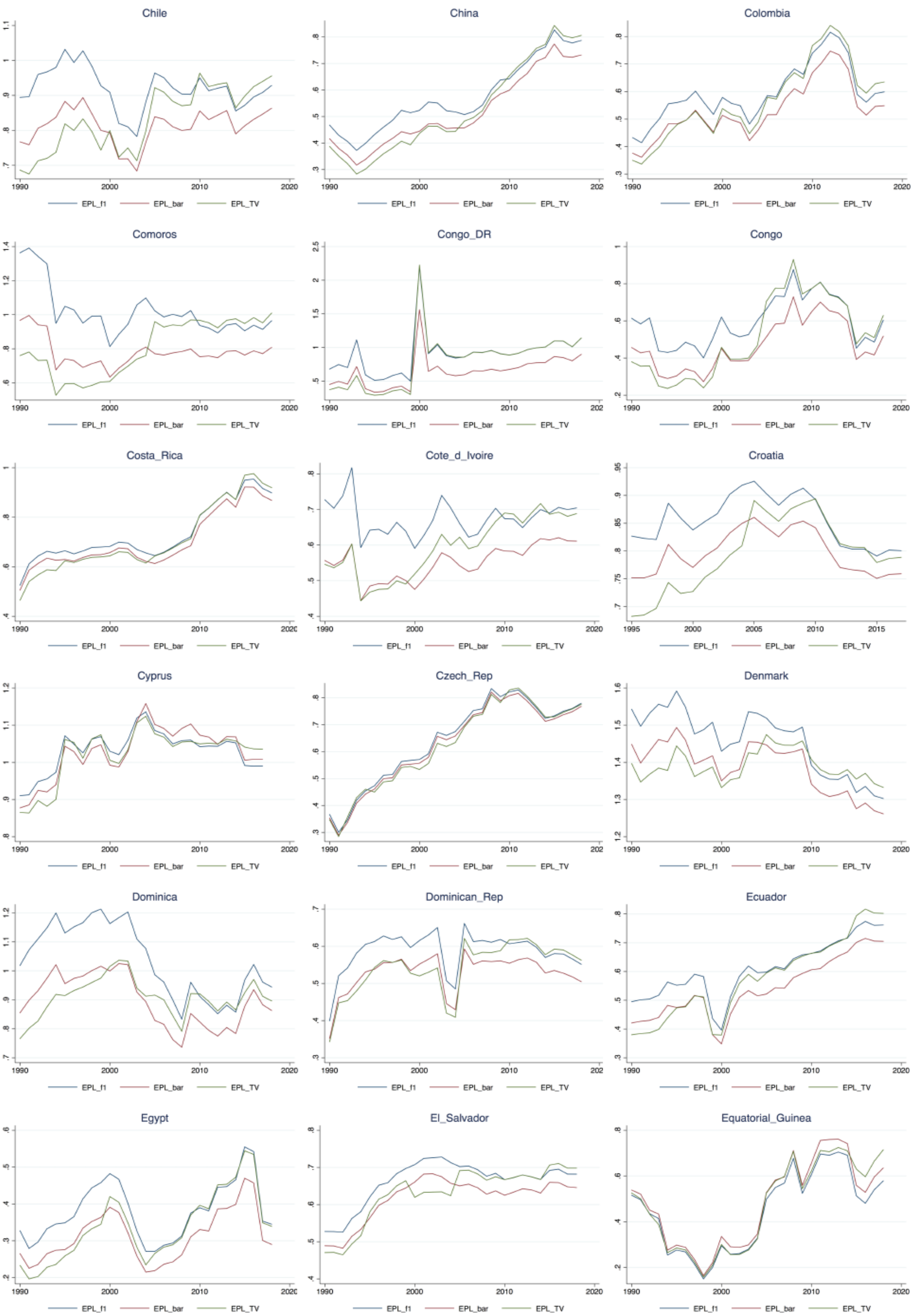


Figure C.3 — The multilateral price levels (MPL)



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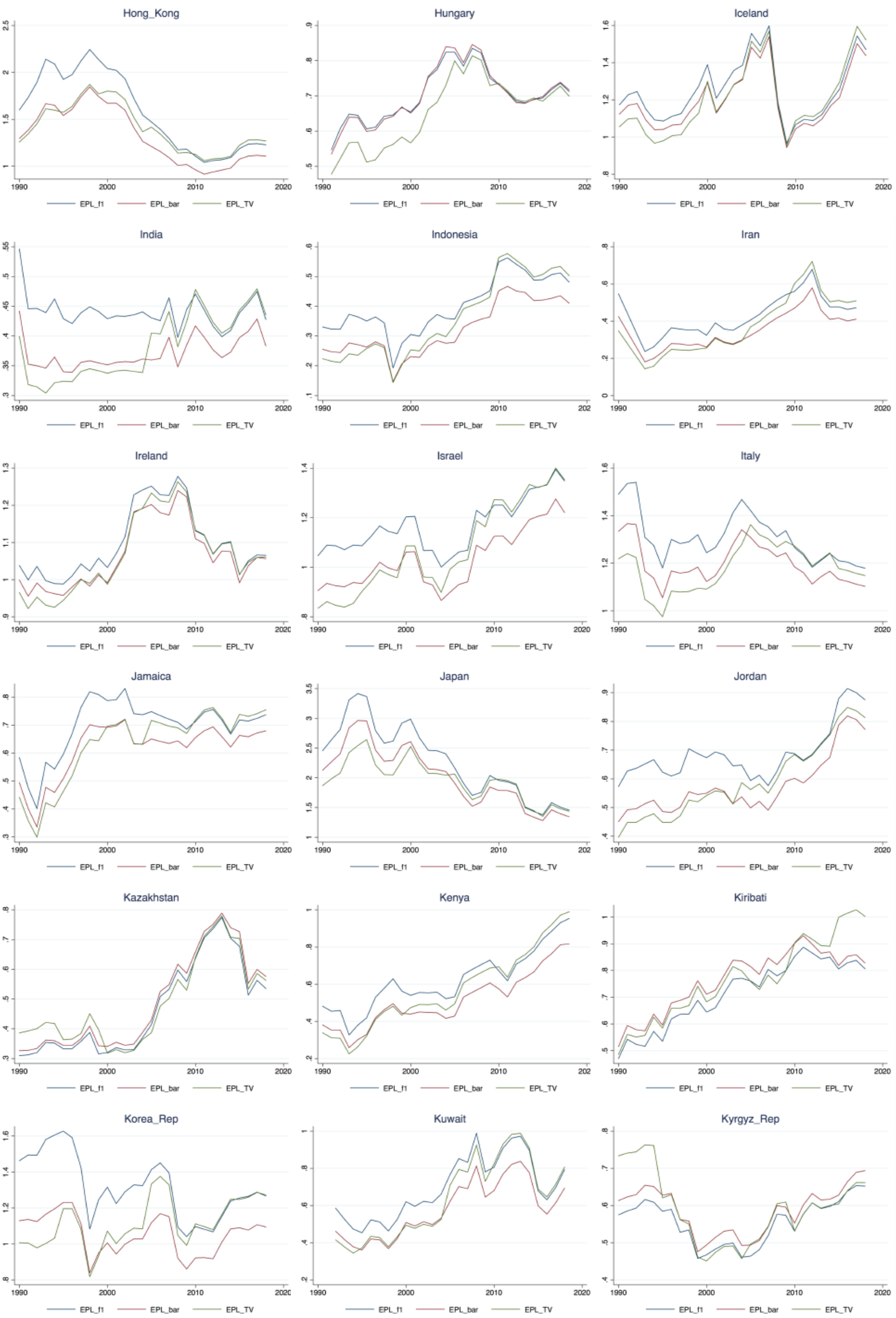
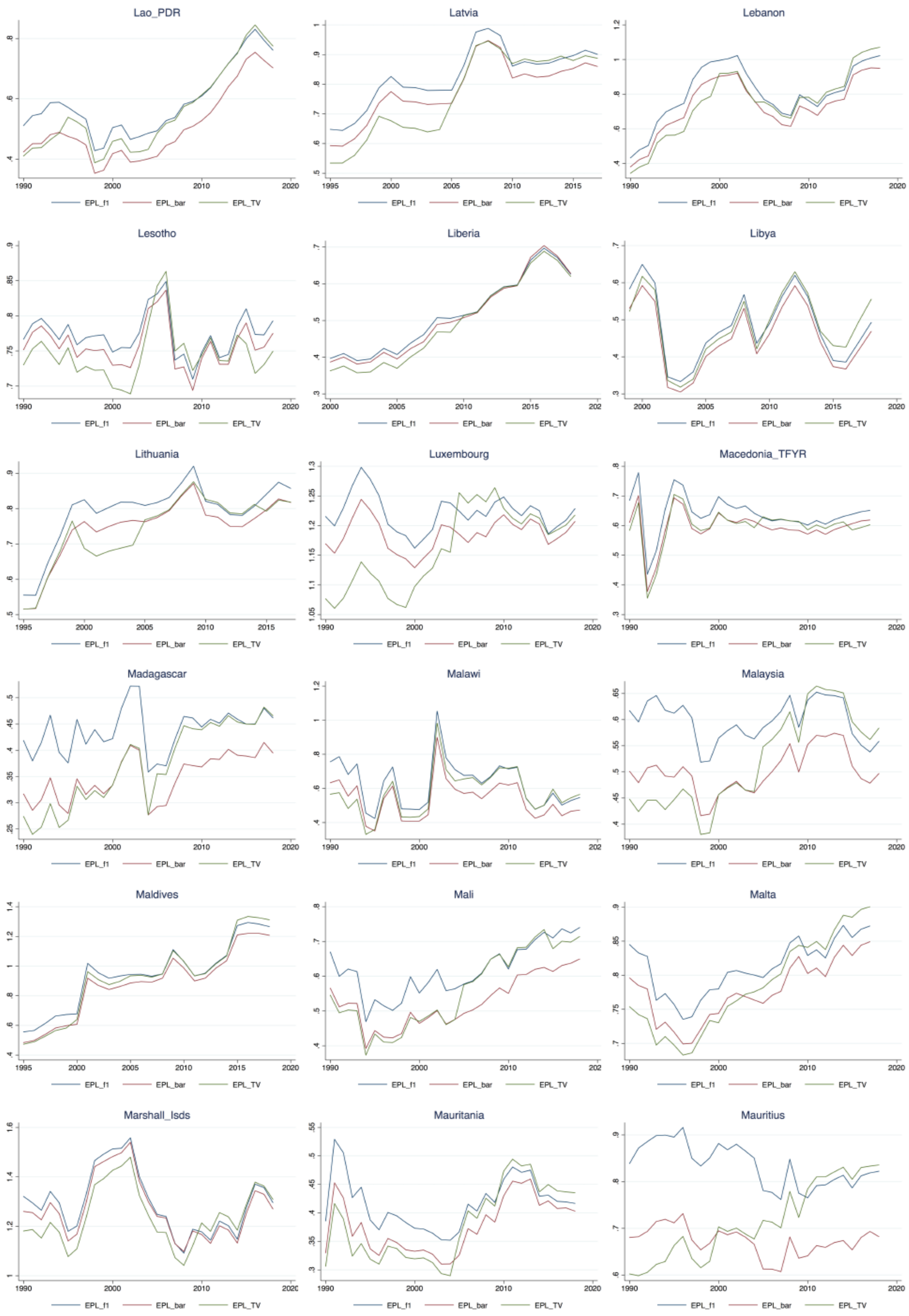


Figure C.3 — The multilateral price levels (MPL)



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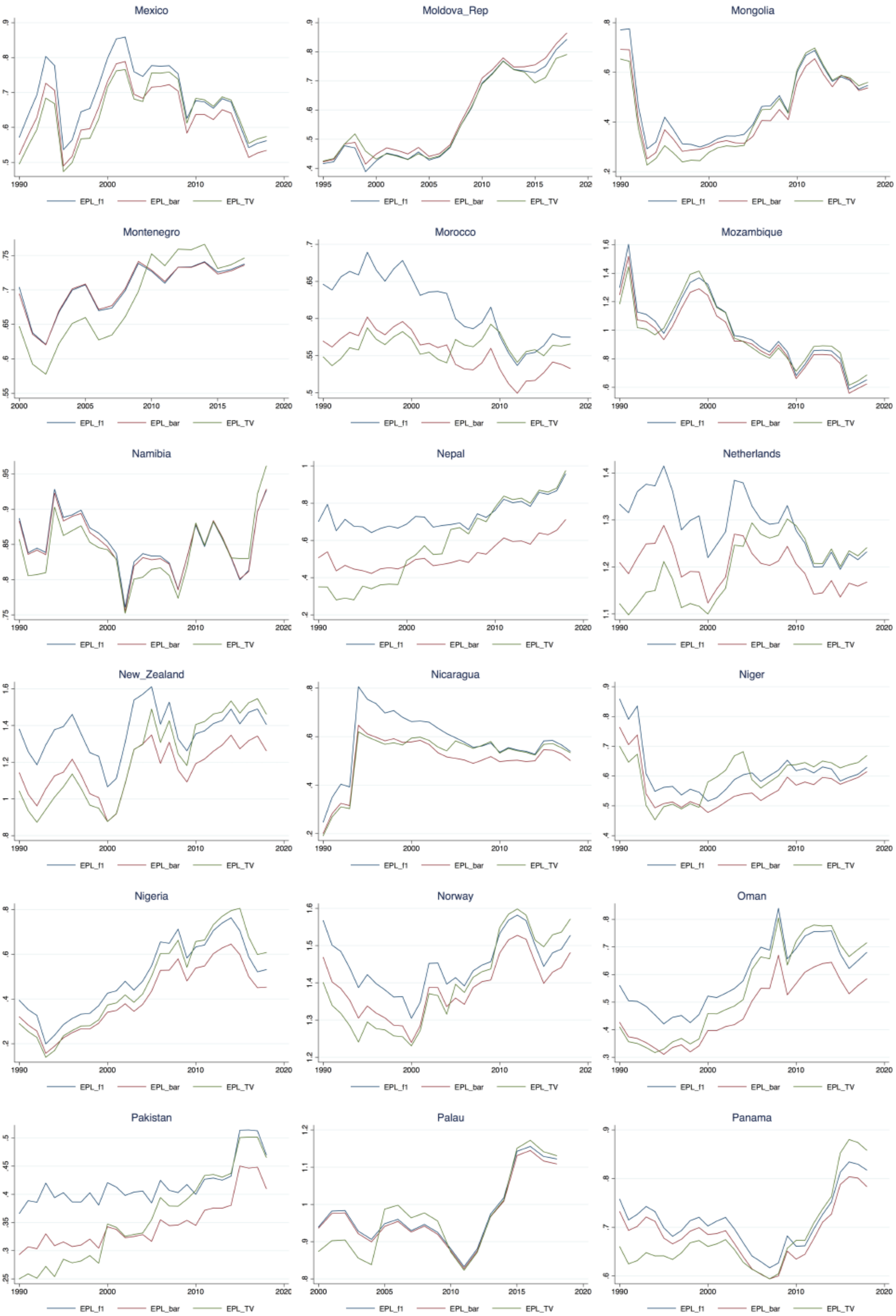

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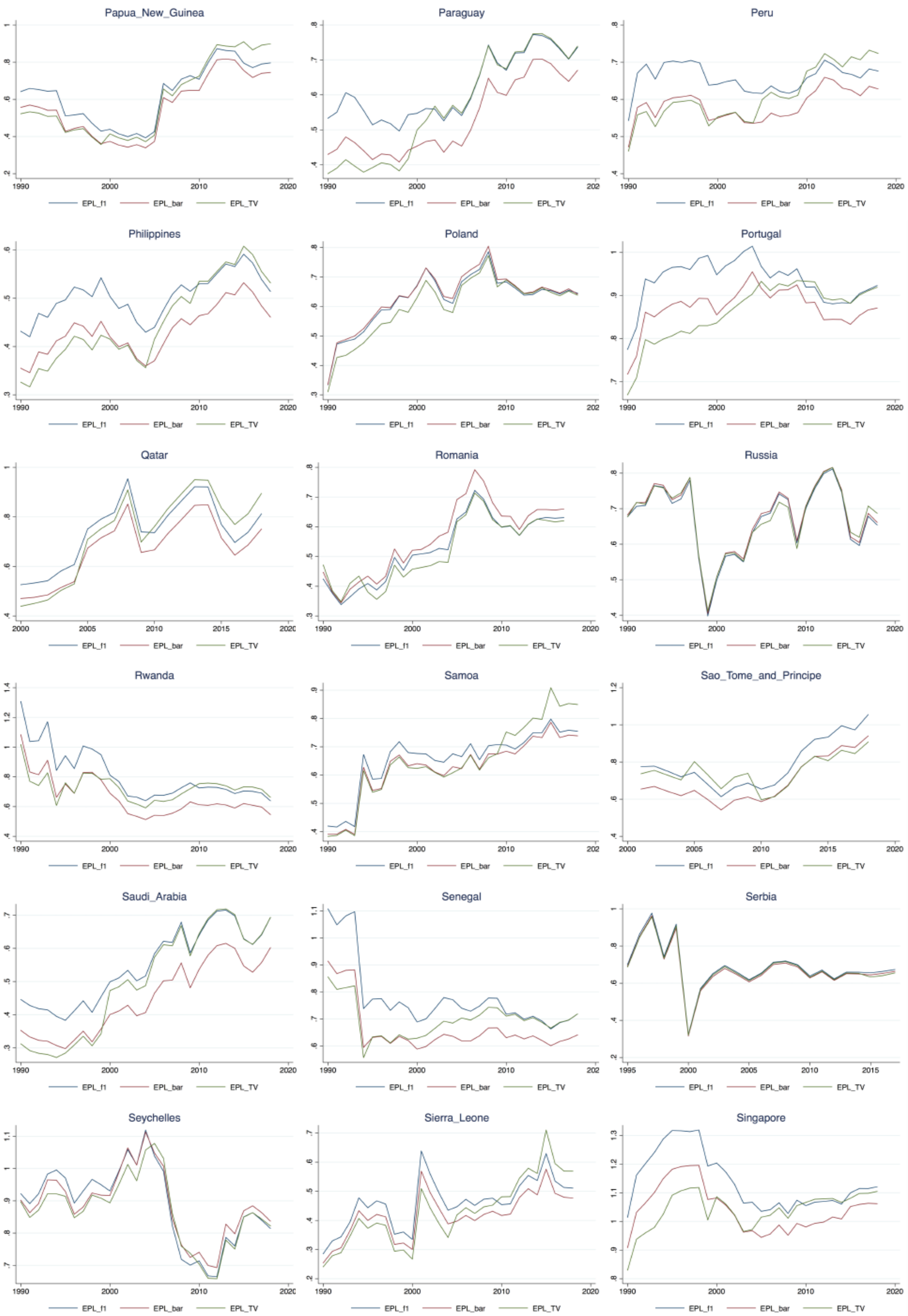

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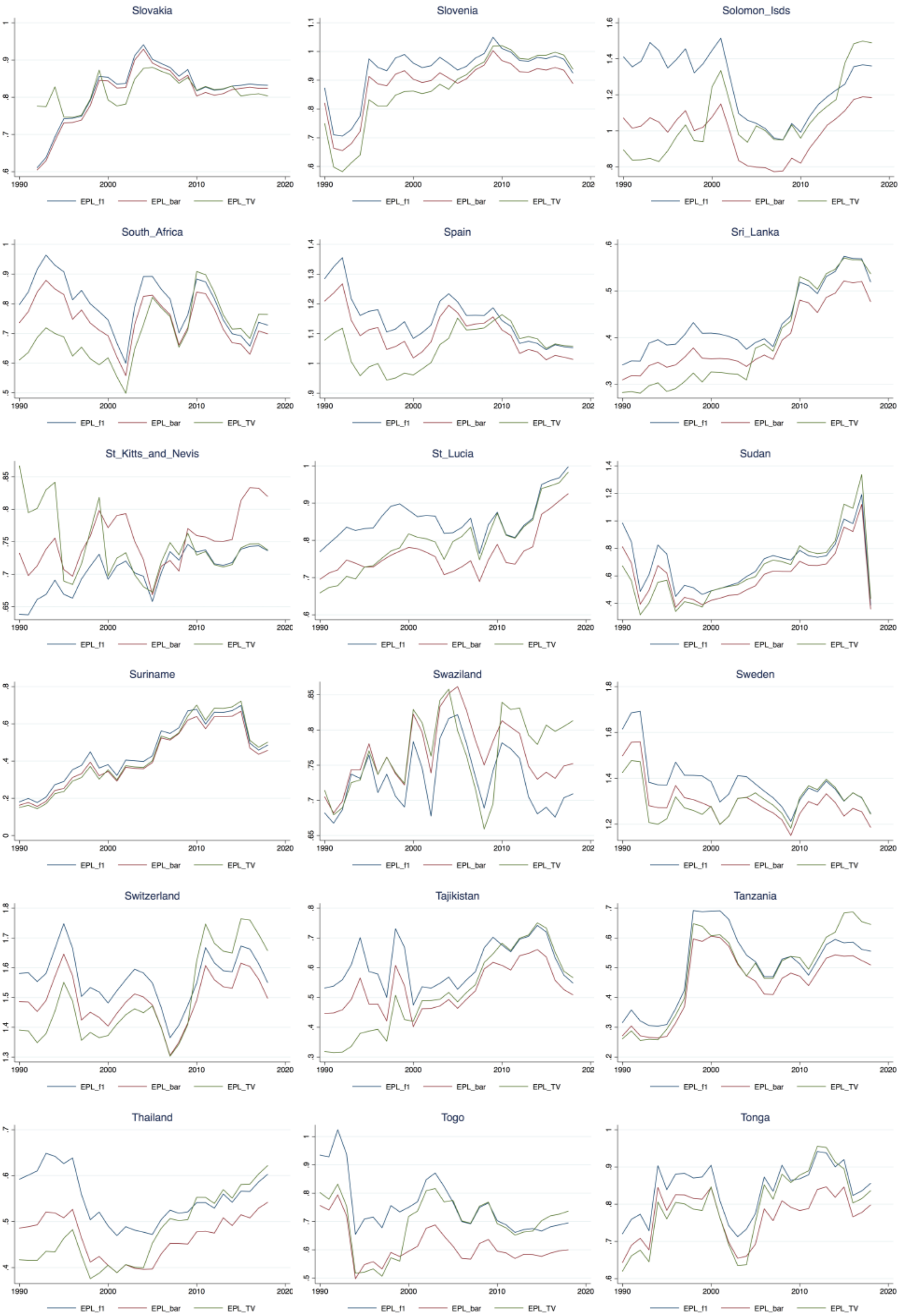

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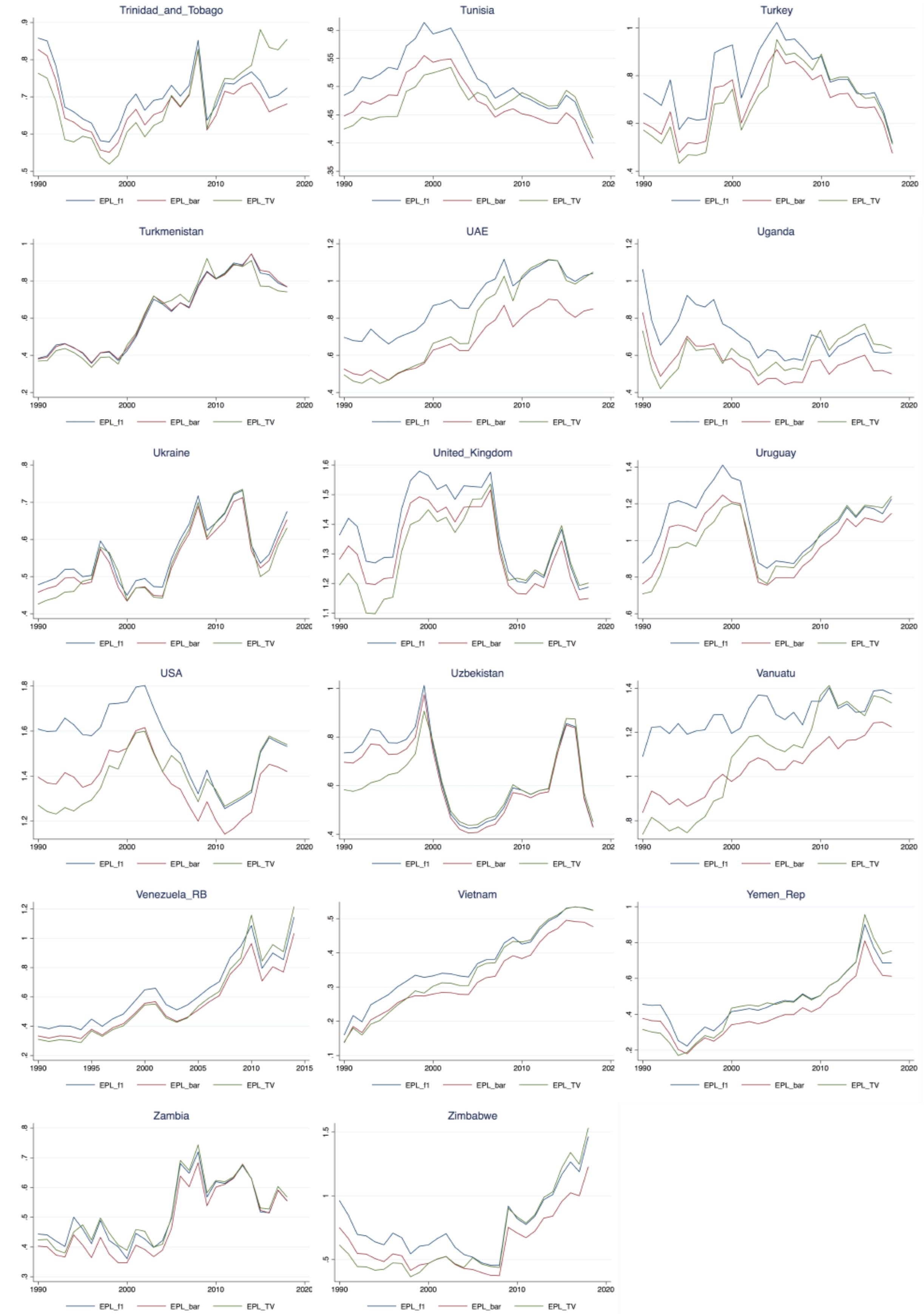

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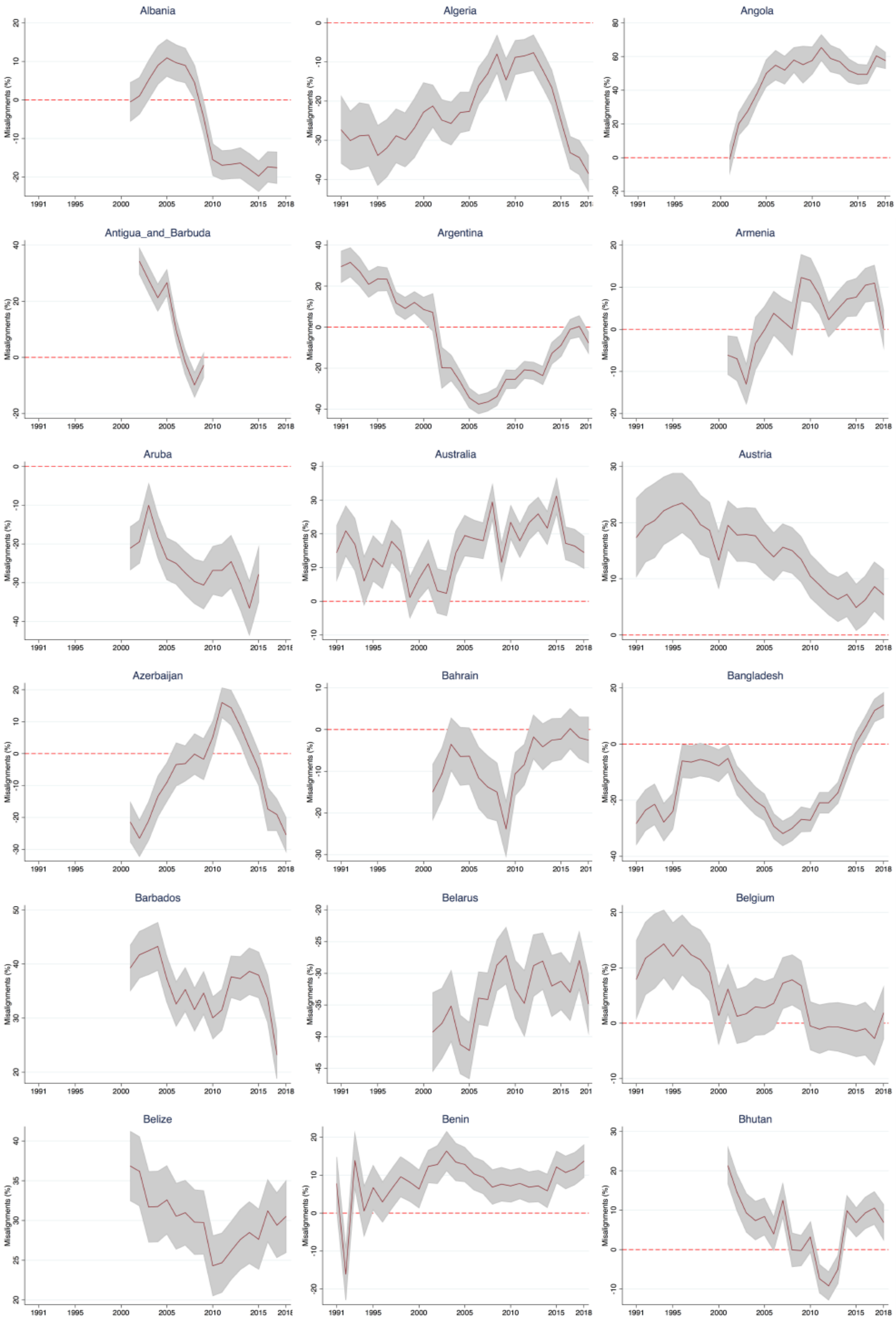
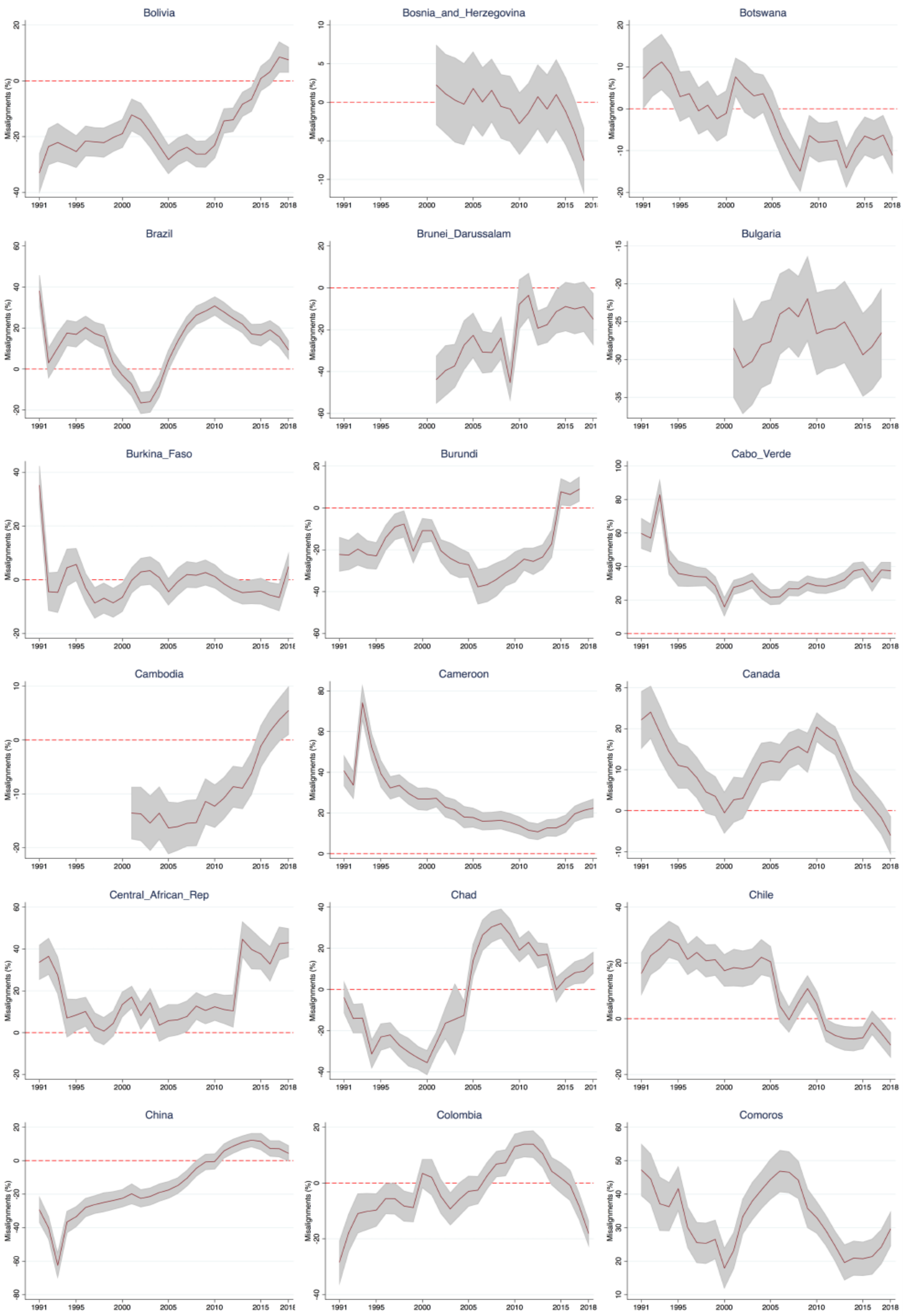


Figure C.4 — The MPL-based Misalignments (%)

Note: A positive (resp. negative) value indicates an overvaluation (resp. undervaluation). The shaded area corresponds to the 95% confidence interval.



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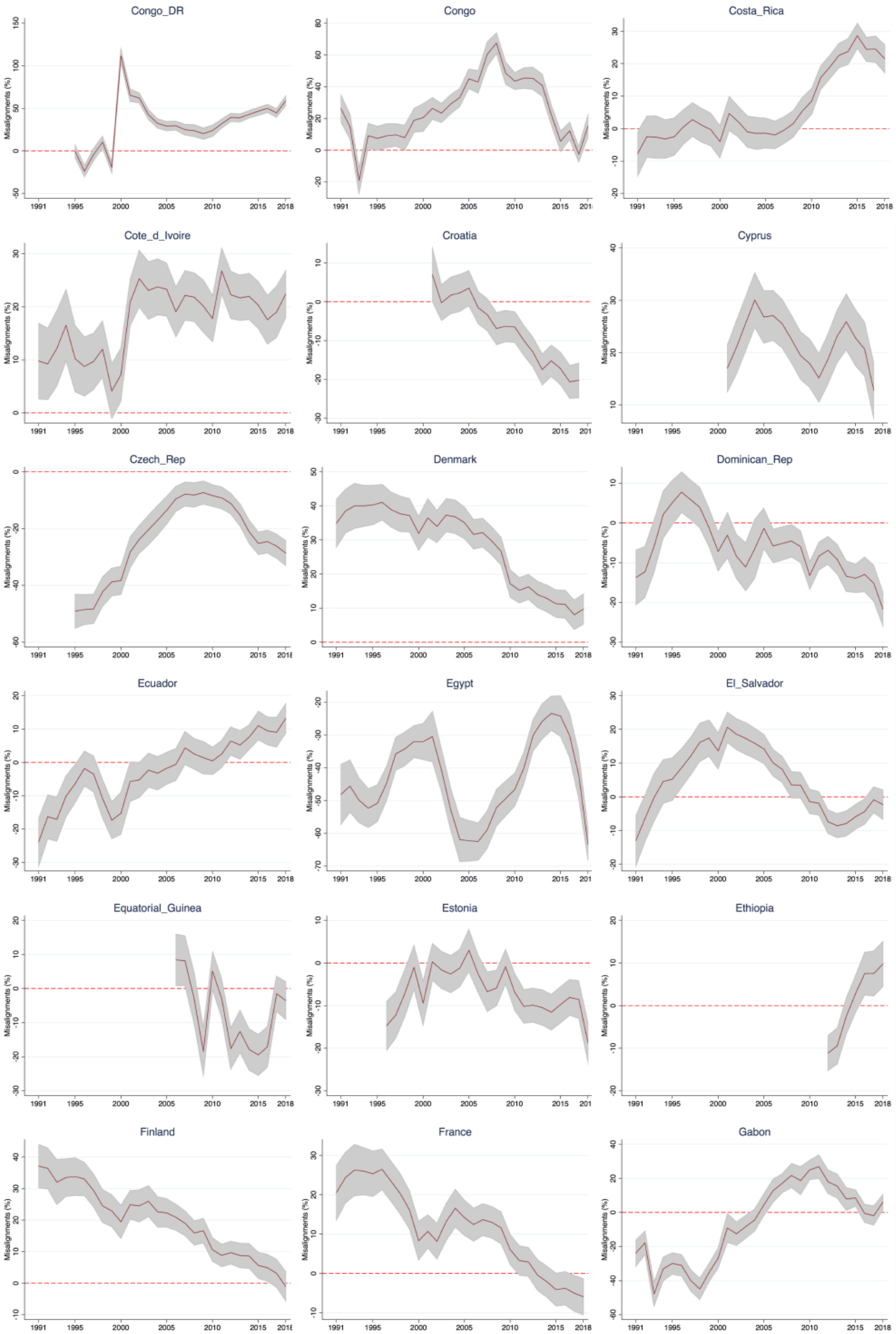

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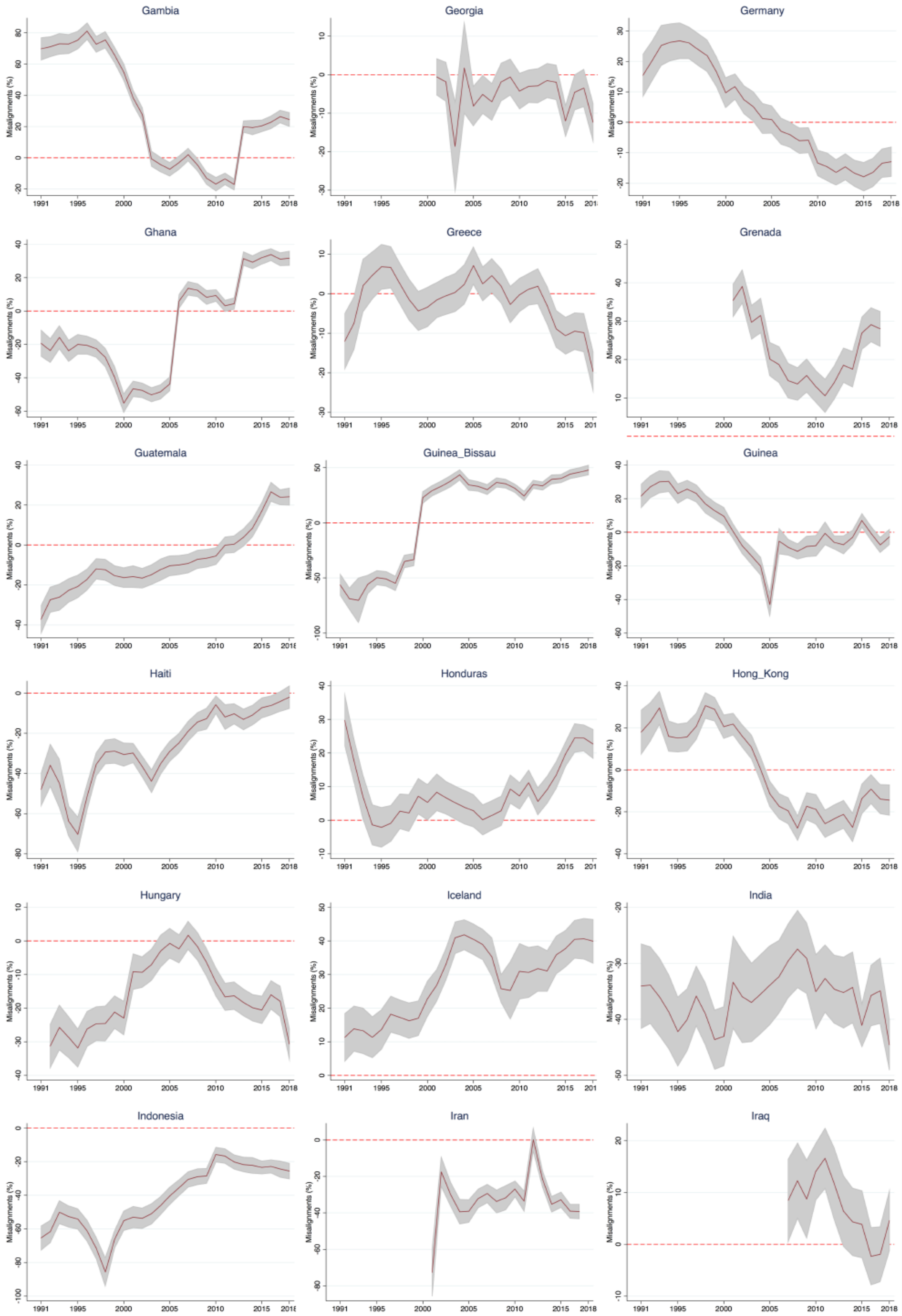

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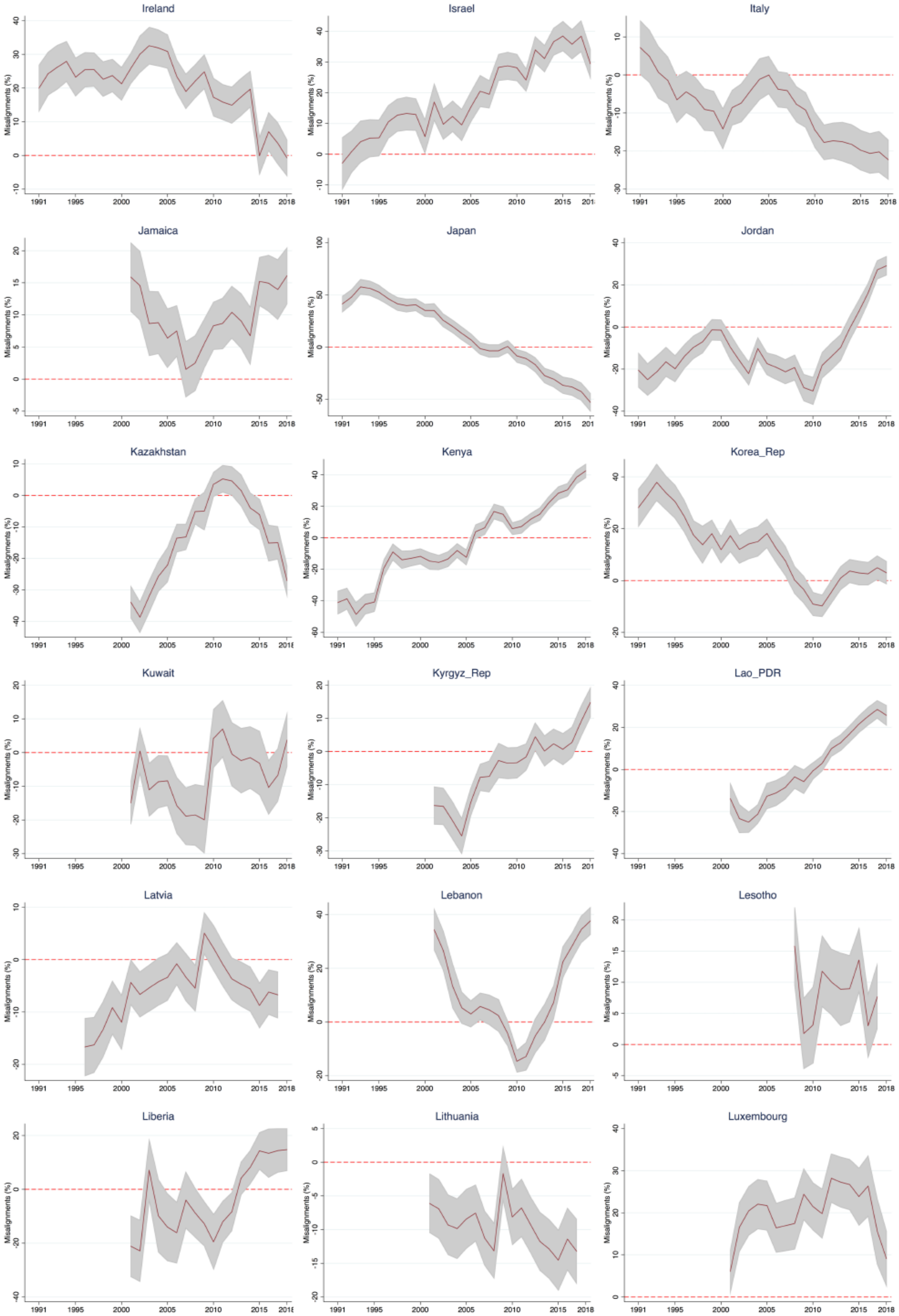

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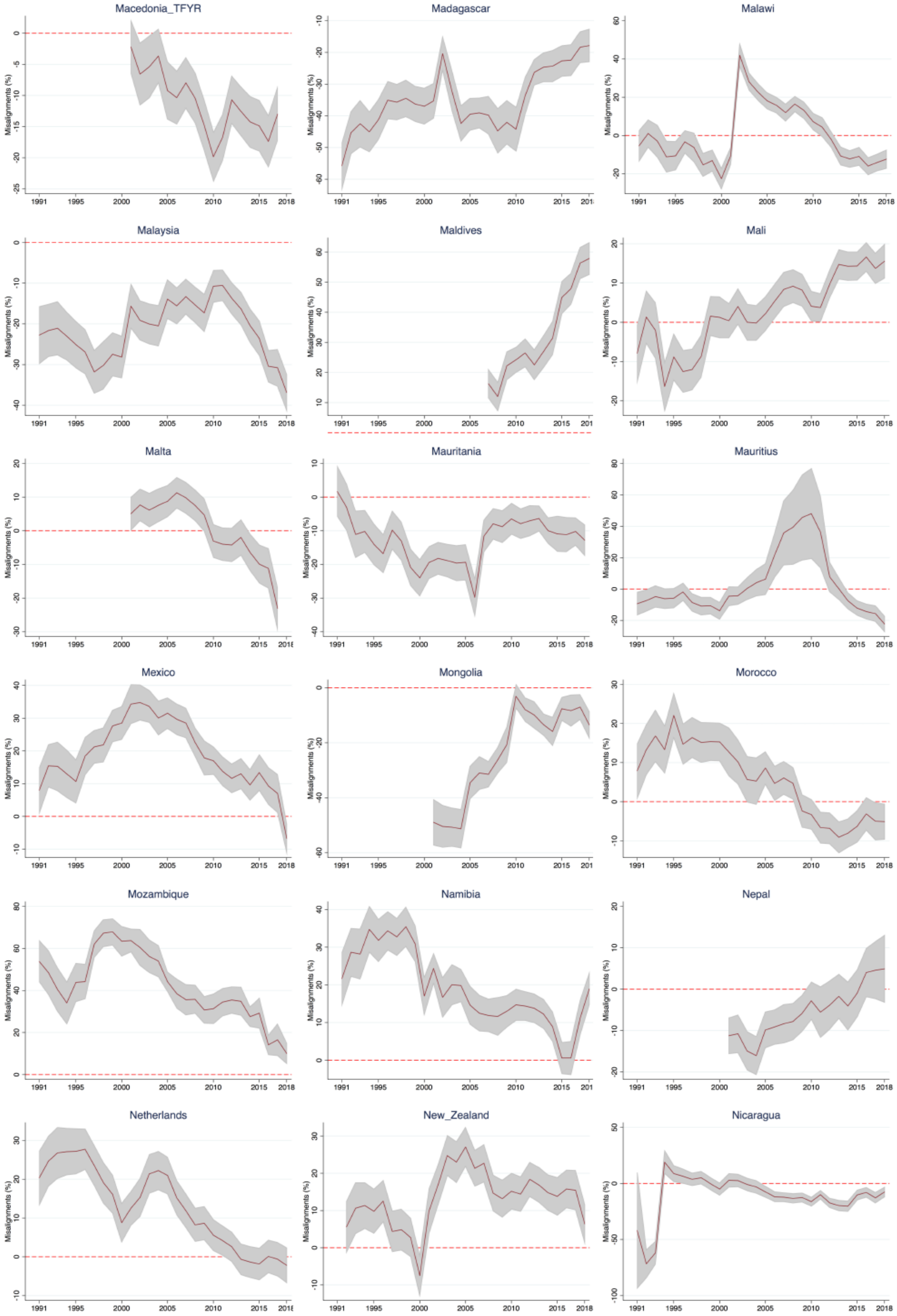

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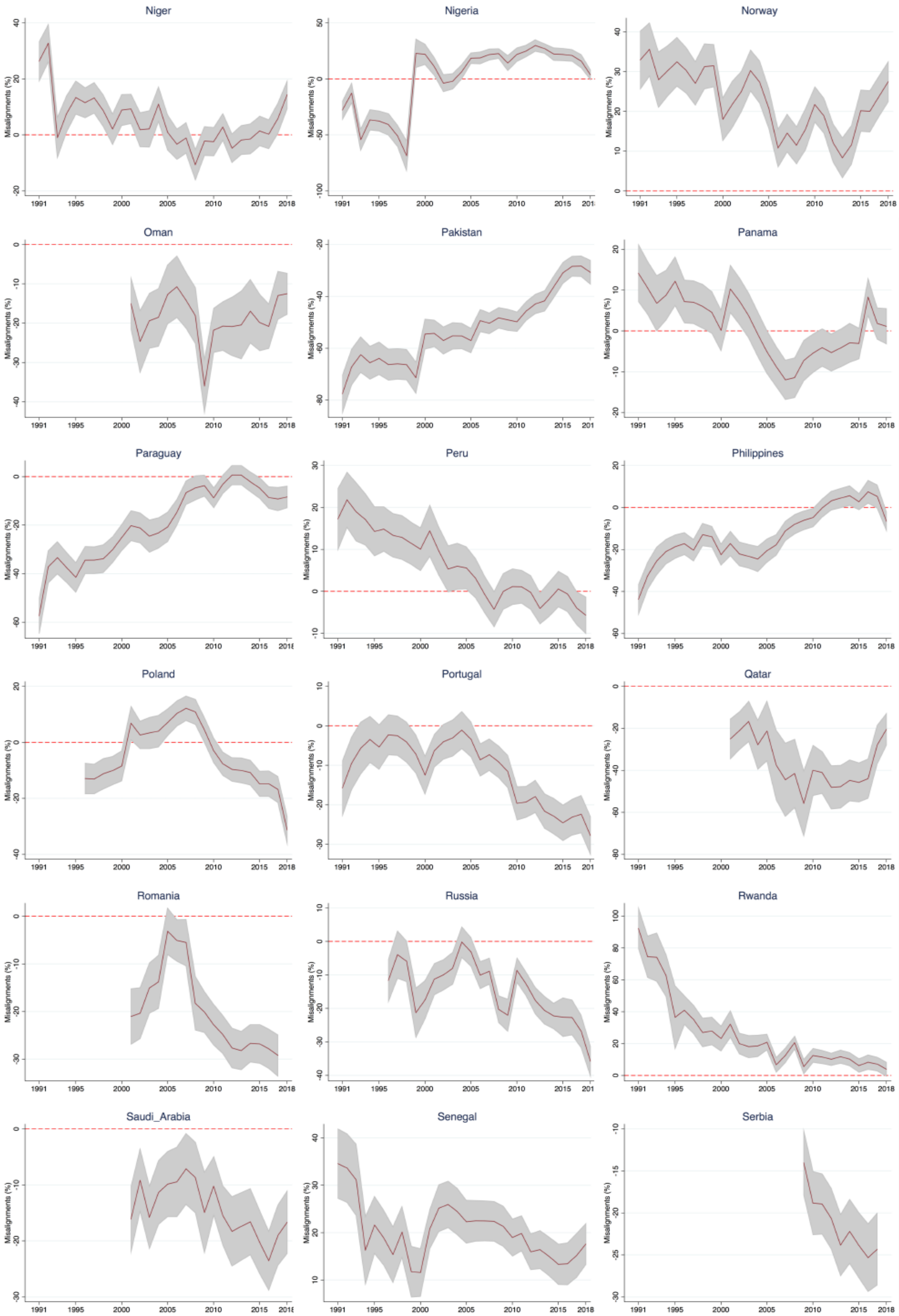

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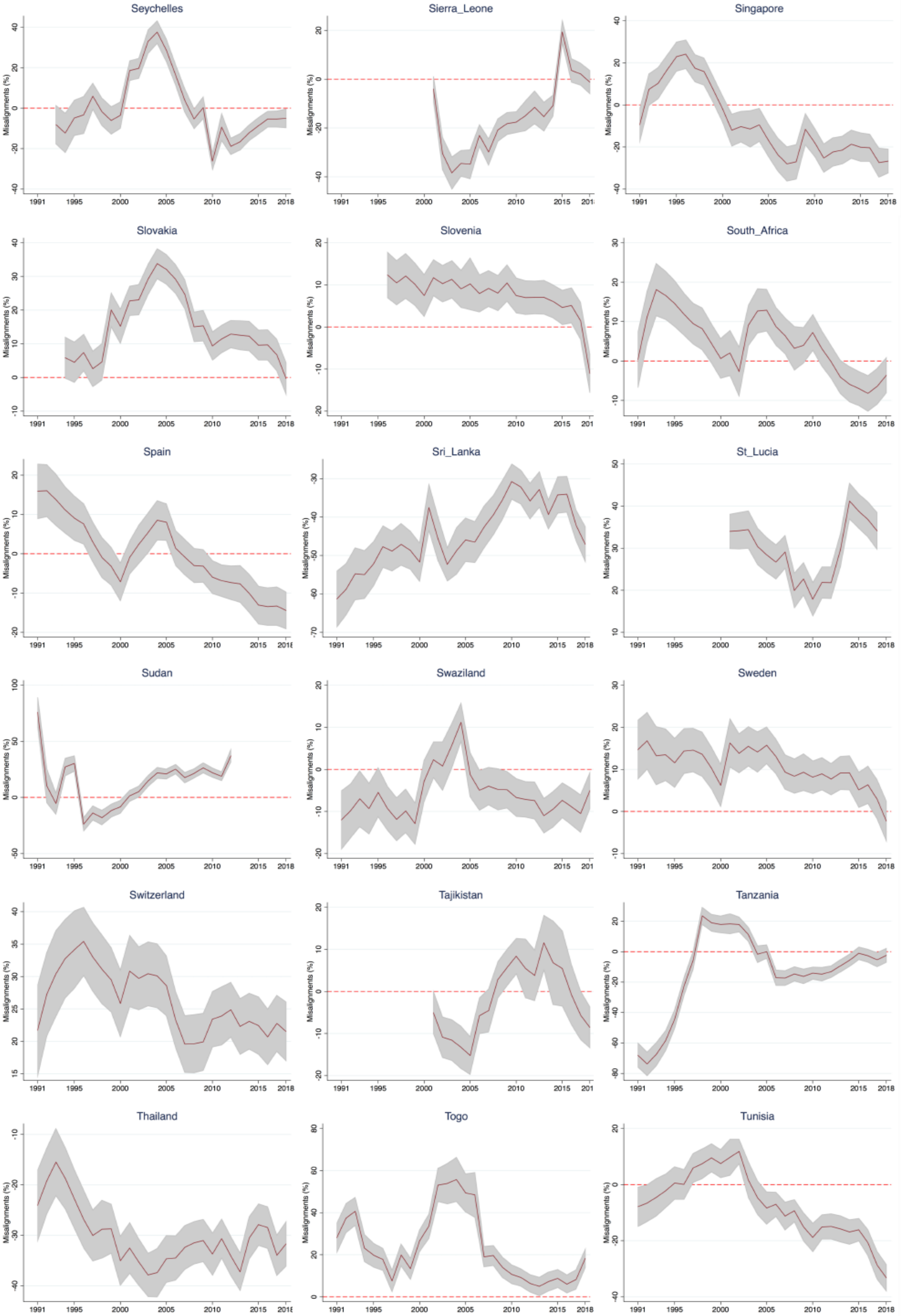

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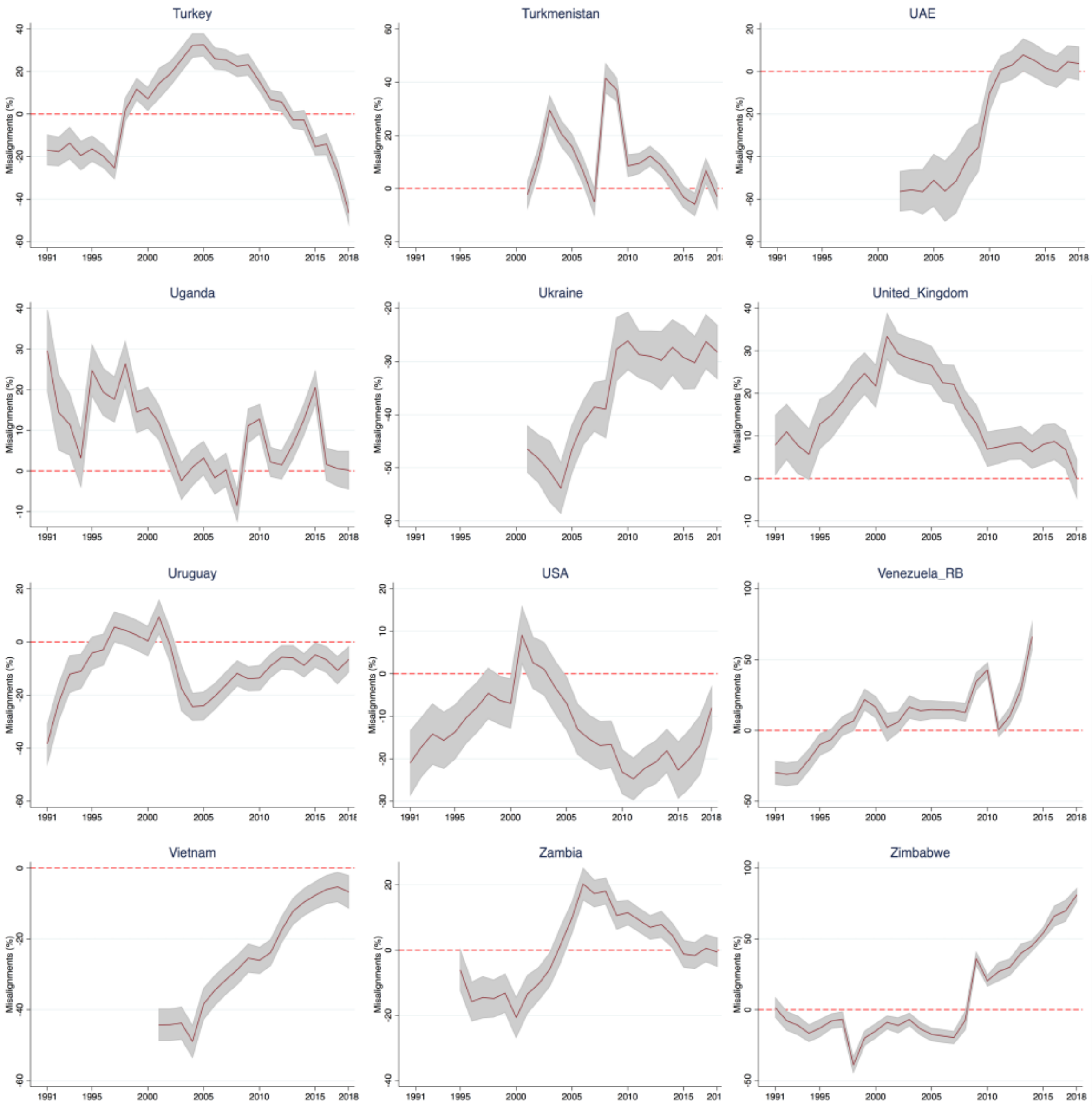

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