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Regional real exchange rates and growth: Evidence from resource-based regional economies

Kiril Tochkov

Department of Economics, Texas Christian University, Fort Worth, TX, USA

Correspondence
Kiril Tochkov, Department of Economics, Texas Christian University, Fort Worth, TX, USA.
Email: k.tochkov@tcu.edu

Abstract

Regional economies in emerging countries vary greatly in terms of their global integration. External shocks, therefore, require adjustment mechanisms that reflect local conditions. This paper focuses on the role of real exchange rates (RER) in the economic performance of regions. In particular, we use monthly data to construct RER for 77 Russian regions over the period 2000–2016. The results validate the adoption of a regional perspective by showing nontrivial differences across regions. Oil-producing and resource-based regional economies experienced much larger RER movements and higher volatility. Overall, RER appreciated steadily until a major drop in 2008, and then, again in 2014. Growth regressions show that RER depreciations have a stimulating effect on regional performance but only in the short run. These results confirm previous findings indicating that RER are a key facilitating factor but not a major determinant of growth and are thus unlikely to produce sustainable development.

JEL CLASSIFICATION
F31; O47; R11

1 | INTRODUCTION

Empirical studies on foreign trade of developing and emerging economies have traditionally focused on the flows of goods at the national level mainly due to lack of regional trade data.[1] Such type of analysis, however, tends to disregard regional disparities prevalent in most large emerging economies, making it difficult to gauge the effects of external shocks on growth and employment at the subnational level. For instance, four coastal provinces (out of a total of 31) account for about 70% of China's exports, while more than 40% of Russian exports originate from the city of Moscow (although only part of them are actually produced there). Accordingly, fluctuations in world prices, exchange rates,

and trade barriers will have different ramifications for growth across regions, calling for flexible region-specific responses.

This paper focuses on the role of regional real exchange rates, which have received little attention in the literature on emerging economies. In particular, we construct real exchange rates (RER) for 77 Russian regions and analyze their evolution and deviation from the national index over the period 2000–2016. The resulting patterns provide valuable insights into the impact of external and region-specific shocks on regional competitiveness. Moreover, we estimate the effects of RER on regional growth over the short, medium, and long run, allowing us to determine whether depreciation (appreciation) in real terms improves (harms) regional economic performance.

Russia is an interesting case because of its large number of diverse regions and the fact that its trade exhibits a significant export share of mineral products (around 60% in 2016), which influences growth at the national level. Rautava (2004) estimated that in the long run an increase in global oil prices by 10% resulted in a 2.2% increase in Russian GDP. An increasing export share of mineral fuels accompanied by a declining GDP share of manufacturing has led to the belief that Russia suffers from Dutch disease (Algieri, 2011; Oomes & Kalcheva, 2007; Tabata, 2013). But the extraction of oil and gas is concentrated in a few regions that are more likely than others to suffer from slow growth in manufacturing and from external shocks (Oomes & Ponomarenko, 2015). As our findings illustrate, RER movements tend to reflect global shocks to a higher extent for regions dependent on exports of raw materials than for economies exhibiting lower degrees of trade openness.

RER and its impact on growth have been the subject of a large number of empirical studies that almost exclusively employ national-level data (see Eichengreen (2008) for an overview). To the best of our knowledge, regional RER have been estimated only for U.S. states (Chen et al., 2006; Clark et al., 1999; Hervey & Strauss, 1998) and Chinese provinces (Yan et al., 2016).[2] These papers show significant variation in regional RER, underlining the importance of a regional perspective on trade. As for the link between RER and growth, the literature seems to agree that RER plays an important role in stimulating growth but only as a facilitating factor in conjunction with other determinants (Eichengreen, 2008). An undervalued RER is particularly effective in developing countries because it helps overcome prevalent institutional weakness and market failure (Rodrik, 2008). Similarly, an appreciation of the RER has a negative effect on growth in emerging economies, especially when driven by shocks on global financial markets (Bussiere et al., 2015). The volatility of RER has also been found to have adverse effects on growth, especially in countries with low levels of financial development (Aghion et al., 2009).

Studies on large emerging economies confirm the importance of a stable and competitive RER for growth. For instance, Rautava (2004) estimates that a 10% real appreciation is associated with a 2.4% decline in Russian output. However, others are skeptical that the recent real devaluation of the Russian currency will be able to promote growth in the face of structural problems (Mironov, 2015). In the case of China, Yan et al. (2016) who use regional RER find that a real depreciation stimulates growth in the less-developed inland provinces, while it has no effect on the wealthier coastal regions.

The rest of the paper is structured as follows. The next section describes the methodology of calculating regional RER and the regression model used to assess their impact on growth. Section 3 presents the results of the analysis, while Section 4 draws conclusions and discusses policy recommendations.

2 | METHODOLOGY AND DATA

2.1 | Calculating RER

RER is a widely used variable in the literature, but it is not directly observable and needs to be constructed. In the process, researchers have to make a series of choices, which contribute to differing

specifications across studies. At its most basic, RER is defined as the nominal bilateral exchange rate adjusted for the relative price between the home country and its trading partner. RER can be expressed as a bilateral exchange rate, but given that countries have numerous trading partners, their corresponding bilateral RERs are usually averaged to generate a weighted index. For that purpose, geometric averaging is the preferable method because it treats movements in the exchange rates symmetrically, whereas an index based on the arithmetic mean handles appreciating and depreciating currencies differently, varies depending on the choice of base period, and is extremely sensitive to changes in the definition of the nominal exchange rate (Brodsky, 1982; Rosensweig, 1987).

Another key issue involved in the construction of RER is the choice of weights, which can consist of the share of exports to a given partner country in overall trade, the corresponding share of imports, or a combination of the two. To an extent, the decision depends on the focus of the study with import shares capturing the competition between the trading partners on the domestic market of the home country and export shares representing the competition between the producers of the home country and of the trading partner on the latter's domestic market. Furthermore, these weights can be fixed over time, assuming that trade shares change only gradually, or they can be allowed to vary reflecting shifting trade patterns.

The selection of price indices is also of major importance for RER. Conceptually, Producer Price Index (PPI) is the preferable option given the focus on competitiveness of suppliers and the fact that the Consumer Price Index (CPI) contains a substantial number of nontraded goods and services, a large import component, and products with controlled or subsidies prices (Clark et al., 1999; Ellis, 2001; Rosensweig, 1987). At the same time, many central banks and international organizations employ the CPI as it is readily available over a long period and is comparable across a large number of countries (see Appendix II in Klau & Fung, 2006; Table 3 in Lauro & Schmitz, 2012; Ellis, 2001). Alternative deflators that have been used in the literature include unit labor costs and the GDP deflator, but their coverage across countries and time is limited.

In this paper, we follow Clark et al. (1999) and define the RER for Russian region i with respect to its trading partners j ($j = 1,…,N$) at time t as:

$$\text{RER}_{it} = 100 \prod_{j=1}^{N} \left[\left(\frac{E_t P_{it}}{P_{jt}} \right) \Big/ \left(\frac{E_b P_{ib}}{P_{jb}} \right) \right]^{w_j} \tag{1}$$

where E_t is the nominal exchange rate expressed in terms of currency units of country j per Russian ruble at time t, P_{it} and P_{jt} are the price indices for region i and country j at time t, respectively, w_j is the weight assigned to country j, and subscript b denotes the base period. The specification in Equation (1) ensures that the index is set equal to 100 in the base period.

In the baseline model, we employ PPI as the price index for Russian regions and their trading partners. Regional PPI is based on a survey of around 10,000 enterprises across Russia and is reported by the Federal State Statistics Service on a monthly basis. The sample period used in this study ranges from June 2000 to December 2016. The index includes factory-gate prices of more than 1,000 goods across three major sectors (Mining and quarrying, Manufacturing, and Production and distribution of electricity, gas, and water).[3] Monthly data on PPI for the other countries were obtained from IMF's *International Financial Statistics* database with a few exceptions.[4]

With regards to trading partners, we select 41 countries that jointly account on average for around 85% of annual exports and imports at the national level in Russia over the period 2000–2016. The sample can be broadly divided into member states of the European Union (EU), the Asia-Pacific Economic Cooperation (APEC), the Commonwealth of Independent States (CIS), and Turkey.[5] In the

baseline model, weights are based on the share of a given partner country in total trade of the region, whereby calculations are conducted separately for exports, imports, and their weighted sum as follows:

$$w_j^X = \frac{X_j}{\sum_{j=1}^{N} X_j} \quad (2)$$

$$w_j^M = \frac{M_j}{\sum_{j=1}^{N} M_j} \quad (3)$$

$$w_j = \left(\frac{\sum_{j=1}^{N} X_j}{\sum_{j=1}^{N} X_j + \sum_{j=1}^{N} M_j} \right) w_j^X + \left(\frac{\sum_{j=1}^{N} M_j}{\sum_{j=1}^{N} X_j + \sum_{j=1}^{N} M_j} \right) w_j^M \quad (4)$$

where X_j and M_j are region $i's$ exports to and imports from country j ($j = 1, \ldots, 41$), respectively. The weights are fixed for the entire sample period based on the trade levels in 2014, which is the earliest year with foreign trade data available for the complete set of Russian regions as reported by the Federal Customs Service.[6] Given that the customs data contains all categories of goods, while the PPI is based on manufacturing, we exclude trade in raw agricultural products (Harmonized System (HS) codes 1 through 15) when calculating the weights.

The nominal exchange rates of the ruble are reported on a monthly basis at period end by the Bank of Russia. Eight EU member states adopted the euro during the sample period but the calculations were conducted as if they continued using their national currencies under the Exchange Rate Mechanism (ERM II). In particular, for the period after joining the Eurozone, the exchange rate between the euro and the ruble for those eight countries was further converted to national currency units per ruble by employing the fixed conversion rate between the national currency and the euro at the time of accession to the European Monetary Union.

The sample of Russian regions consists of 77 administrative units (out of a total of 85) from across eight federal districts.[7] Three small regions were excluded either because of lack of data (Chechen Republic) or because the few countries they exported to were not well represented by the sample of trading partners chosen for the analysis (Republic of Ingushetia and Republic of Kalmykia).

2.2 | Growth regressions

The impact of the regional RER on growth is estimated in a dynamic panel-data regression framework with fixed effects as follows:

$$\Delta y_{it} = \beta_0 + \beta_1 \ln \text{RGDPPC}_{it-k} + \beta_2 \ln \text{RER}_{it} + \beta_3 \ln \text{INV}_{it} + \beta_2 \ln \text{OPEN}_{it} + \beta_2 \ln \text{OIL}_{it} + \eta_t + \upsilon_i + \varepsilon_{it} \quad (5)$$

where $\Delta y_{it} = \left(\ln Y_{it} - \ln Y_{i,t-k} \right) / k$ is the average annual growth of real output per capita in region i at time t. Region-specific and time-specific fixed effects are denoted by υ_i and η_t, respectively. The dynamic nature of the model is captured by the lagged value of the output variable (RGDPPC). The main variable of interest is the regional RER, but we also include control variables that can affect growth, such as fixed capital investment as a share of output (INV) and trade openness (OPEN)

defined as the output share of the sum of exports and imports. Finally, the price of Urals oil is added due to its importance for growth in Russia. All independent variables are expressed in natural logs.

In addition to the baseline specification which uses annual data ($k = 1$), we estimate the impact of RER on growth over 3-year ($k = 3$) and 5-year ($k = 5$) periods to explore medium and long-run effects.[8] To address potential endogeneity issues, the estimation is also conducted using System GMM (SGMM) (Arellano & Bover, 1995; Blundell & Bond, 1998), which uses suitable lagged levels and lagged first differences of the regressors as their instruments. To minimize the number of instruments, we restrict the maximum lags of dependent and predetermined variables for use as instruments to two. In accordance with GMM estimation techniques, we report the Sargan test of overidentifying restrictions and the Arellano–Bond test that the average autocovariance of residuals of order two is zero. Finally, we include year dummies in the model to control for universal time-related shocks.

3 | EMPIRICAL RESULTS

3.1 | Regional RERs

For comparison purposes, we construct a national RER for Russia using the same methodology as for regional RERs. The regional average and the national RER presented in Figure 1 exhibit many similarities. A long period of gradual appreciation over the 2000s ends abruptly in the aftermath of the global financial crisis in 2008. A relatively quick recovery leads to new heights, albeit at the cost of higher volatility. Another bout of severe depreciation is observed following the introduction of Western sanctions in 2014, with signs of a resurgence detectable only in 2016. Despite the shared trajectory, Figure 1 shows nontrivial differences between the national and regional RERs. In particular, the national RER appreciates more, and is therefore higher, than the regional RER in most periods except for the early 2000s.

The regional dynamics of RER averaged by federal district and displayed in Figure 2 further highlight the variation at the subnational level in Russia. The RERs of the five districts west of the Urals (Central, Northwest, South, Volga, and North Caucasus) initially overlap with the national index but since 2004 they deviate from it, exhibiting markedly lower levels of appreciation. By contrast, the RERs of Ural and Siberia track the national index much closer and in most periods exceed it. This can be explained by the fact that the key natural resources constituting a major share of Russian exports are
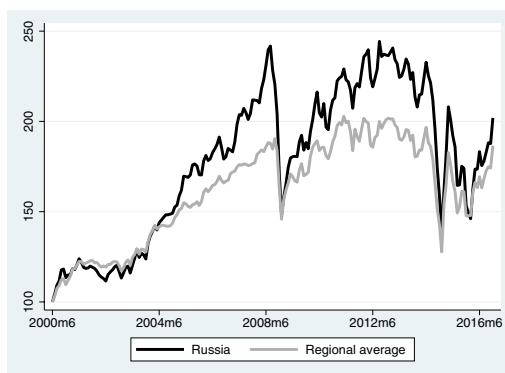
FIGURE 1 Average regional RER and national RER, monthly data, 2000–2016 [Colour figure can be viewed at wileyonlinelibrary.com]
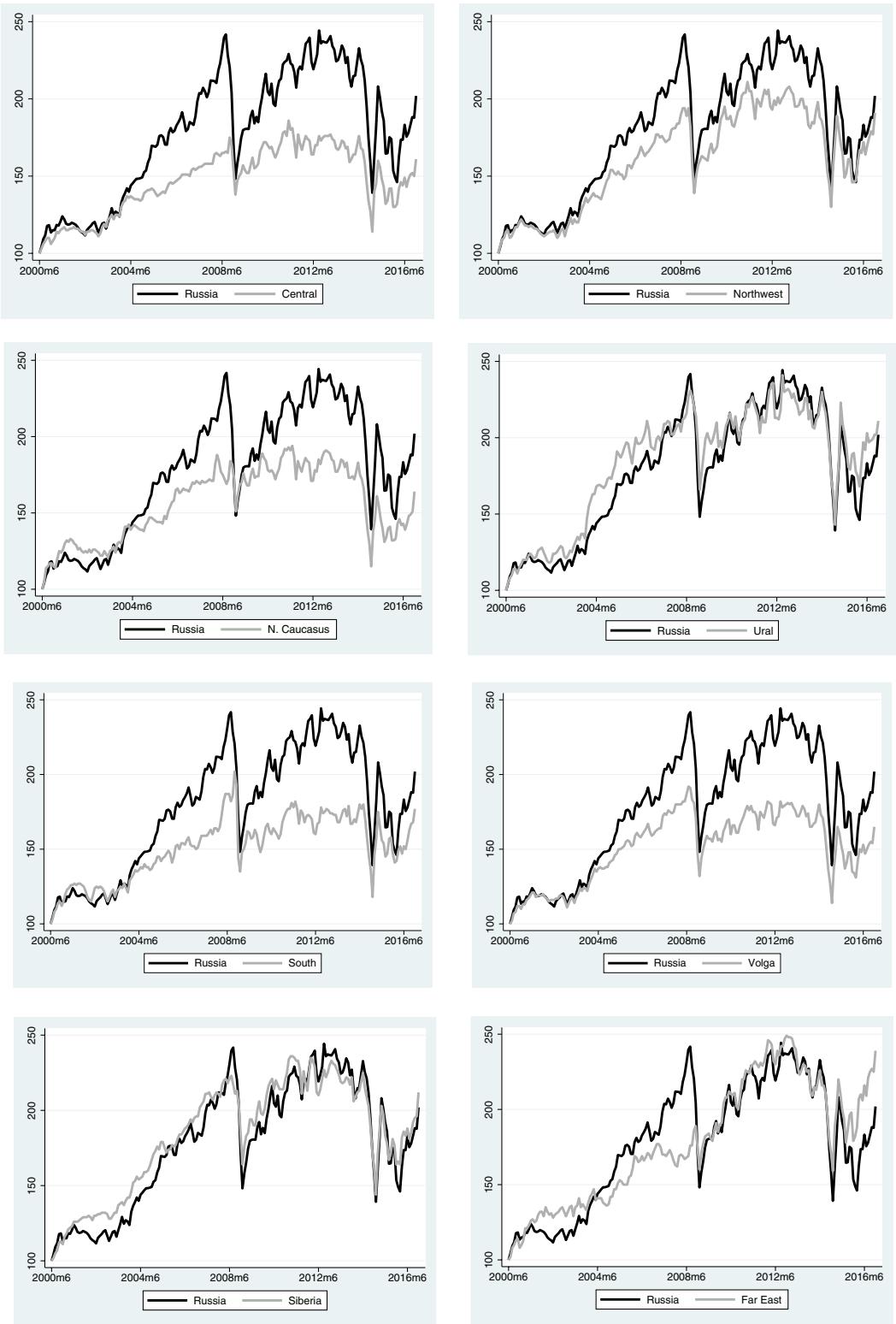
FIGURE 2 Monthly regional RER averaged by federal district versus national RER, 2000–2016 [Colour figure can be viewed at wileyonlinelibrary.com]
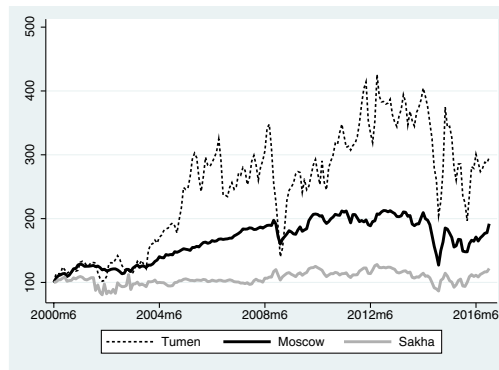
FIGURE 3 Monthly RER of three Russian regions, 2000–2016 [Colour figure can be viewed at wileyonlinelibrary.com]

TABLE 1 Descriptive statistics of regional RER by federal district, 2000–2016

	Mean	*SD*	**Max**	**Correlation**
Central	146.87	21.51	185.69	0.921 (0.059)
Northwest	160.78	30.82	211.21	0.925 (0.037)
South	151.27	21.20	201.55	0.849 (0.172)
N Caucasus	155.98	23.62	193.87	0.828 (0.196)
Volga	151.44	23.26	191.67	0.872 (0.106)
Ural	184.21	37.02	240.82	0.826 (0.178)
Siberia	183.18	36.65	236.02	0.887 (0.080)
Far East	178.33	39.86	249.23	0.850 (0.106)
National average	161.66	27.66	202.84	1.000
Russia	177.94	40.84	244.31	0.985

Note: The reported mean is first averaged across regions in a given district, and then, across the sample period. The standard deviation is across time. The Pearson correlation coefficient is calculated first between each region and the national mean, and then, averaged across regions in a given district. The standard deviation in parenthesis is across regions in the district.

extracted in these two federal districts. The Far East region is unique in that its RER dynamics are initially similar to those in the five districts west of the Urals but after 2008 their pattern resembles those of Ural and Siberia. Indeed, the extraction of oil and gas in the Far East, and especially in Sakhalin, has gathered pace since the second half of the 2000s.

Figure 3 uses the main oil-producing region of Tumen in Siberia, the capital city of Moscow, and the remote and sparsely populated region of Sakha in the Far East to illustrate the disparities in RER dynamics at the regional level. Sakha's RER barely changes over the sample period, even during times of crisis and trade sanctions. Moscow's RER doubles over the 2000s but remains relatively constant thereafter despite higher volatility. Tumen's RER appreciates rapidly reaching four times its initial level within a decade but at the same time it experiences extremely high levels of volatility. These divergent patterns indicate yet again major regional differences in RER across Russia.

The descriptive statistics in Table 1 confirm this picture. The three resource-dependent federal districts of Ural, Siberia, and the Far East have higher average and maximum RERs than other districts and record volatility levels that in some cases are almost twice as high as for their counterparts west

of the Urals. As observed in the graphs, the national RER follows more closely the pattern of the re-source-rich regions, while the regional average reflects the features of the other districts.

In addition to the visual and descriptive evidence, we explore the differences between regional and national RERs in a more formal way by employing cointegration techniques. For this purpose, we first test for the stationarity of the series. The results of the Augmented Dickey–Fuller Test presented in the first two columns of Table 2 suggest that all series averaged at the federal district level are nonstationary in levels but stationary in first differences. At the regional level (not reported), only three out of the 77 regions are stationary in levels (Mari-El, Omsk, and Rostov). Next, we conduct the Johansen test for cointegration between the national and each of the regional RERs. The findings in the last three columns of Table 2 imply that while the regional average and national RER are cointegrated, at the subnational level this is true only for one of the eight federal districts. At the level of individual regions, a cointegration with the national RER is detected for only nine of the 74 regions.[9] Accordingly, the majority of regional RERs do not share a common trend with the national index, meaning that the two series are not driven by the same factors and are thus independent of each other in the long run. The broader implications of this finding are that the national RER cannot be employed as a proxy for its regional counterpart in regressions using macroeconomic variables at the subnational level.

3.2 | Robustness tests

To test the sensitivity of our results, we first compare the averaged regional RER with the national-level RER calculated by the IMF and the Bank of International Settlements (BIS) using different methods (e.g., CPI instead of PPI) over the same period. Figure 4 shows deviations between the three estimates to be minimal. Our index appears slightly lower than the other two, suggesting that when regional RER are taken into account, the resulting appreciation is lower than when national-level data are used. Figure 5 displays the regional RER calculated by using export, import, and total trade shares

**TABLE 2** Unit root and cointegration tests

	Unit root test[a]		Cointegration test[b]		
	Level	**First difference**	**Eigenvalue**	**Trace statistic**	**# of regions[c]**
Central	−1.932	−8.151***	0.064	18.052	1 (18)
Northwest	−1.602	−7.930***	0.055	14.516	3 (10)
South	−2.164	−8.282***	0.078	18.236	0 (4)
N Caucasus	−1.977	−7.607***	0.044	13.478	0 (5)
Volga	−2.014	−7.905***	0.044	12.867	4 (13)
Ural	−2.027	−8.604***	0.050	18.089	0 (4)
Siberia	−2.015	−7.194***	0.089	28.329**	0 (11)
Far East	−1.162	−7.862***	0.037	10.061	1 (9)
Regional average	−1.867	−7.949***	0.078	23.307**	–
Russia	−1.718	−7.755***	–	–	–

[a]Test statistic of the Augmented Dickey–Fuller Test containing a constant and four lags.

[b]Johansen test for cointegration between the national and each of the regional RERs containing a constant and four lags.

[c]Number of regions within a federal district for which the null hypothesis of no cointegration with the national RER was rejected at the 5% significance level. Total number of regions in parenthesis. The three regions with RER stationary in levels were excluded.

***$p < .01$; **$p < .05$.
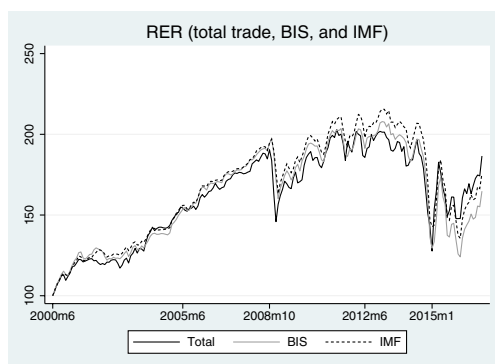
FIGURE 4 Averaged regional RER versus BIS and IMF calculations [Colour figure can be viewed at wileyonlinelibrary.com]
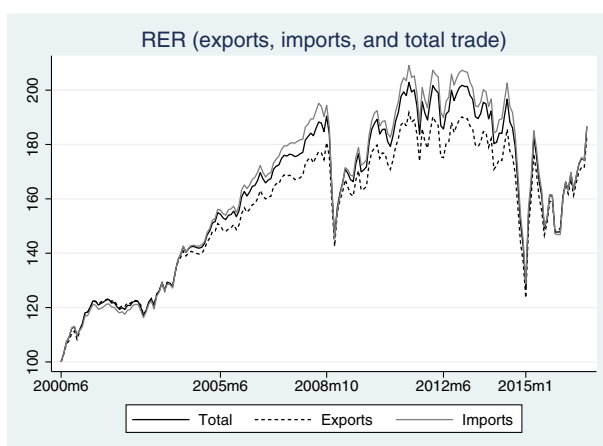
FIGURE 5 Regional RER calculated by using exports, imports, and total trade shares as weights [Colour figure can be viewed at wileyonlinelibrary.com]

as weights (see Equations (2)–(4)). The choice of shares does not seem to matter much, except for the period 2005–2010 when the import-weight method results in slightly higher levels of regional RER than the export-weight specification.

In our calculation of regional RERs, the trade weight assigned to country j (w_j) is constant over the sample period and relies on the trade shares for 2014. This assumption is necessitated by the lack of detailed trade statistics by region for earlier years but it is likely to affect the resulting RER indices. Given the limited data, we employ a twofold approach to test the potential implications for our estimates. First, we focus on broadness of cross-sectional coverage and calculate regional RERs for all regions in the sample over a 3-year period (2014–2016). Specifically, we employ the shares of each trading partner for the corresponding year, which would be the optimal method of calculation, if data were available in such detail for all years and regions. The second approach emphasizes the length of the sample period at the expense of broadness by using again annual weights on a subsample of nine regions over the years 2002–2016.

The results of the robustness tests for the broader sample are presented in Table 3. At first, we use a fixed weight based on total trade shares in the year 2015 and 2016 (rather than 2014 for the baseline model). The resulting RERs record correlations with the initial estimates in Table 1 of at least 0.99,

suggesting that fixed weights applied to the entire sample period do not have a significant impact on the calculations. Next, we restrict the analysis to the years 2014–2016 and apply the corresponding total trade shares for each year. The correlations reported in the last column of Table 3 are slightly lower but do not drop below 0.95. At the level of individual regions (not reported), the correlations for the variable trade weights exceed 0.78 with very few exceptions, such as Murmansk, which as the home of one of the largest nickel producers in the world was affected by the crash in metal prices in 2015–2016.

The results for the extended sample period in Table 4 are also encouraging. Using variable weights for total trade over the years 2002–2016 produces correlations with the baseline estimates that are statistically significant and vary between 0.71 and 0.96 with an average of 0.85. Overall, we view the outcomes of these tests as a confirmation that, even in the absence of detailed data for the trade shares across all years of the sample, our findings presented in the previous section remain relatively robust.

3.3 | Determinants of regional RERs

Figures 2 and 3 suggest that commodity prices are likely to affect regional RERs in Russia. To test this proposition formally, we conduct a regression analysis of the RER's potential determinants. The literature on the topic identifies several key factors, but many of them apply to the national level only (e.g., foreign reserve holdings, government budget).[10] To make it relevant to the regional setting of our paper, we focus on three variables: productivity, labor costs, and commodity prices. According to the Balassa–Samuelson hypothesis, faster productivity growth in the tradable sector relative to the trading partner can boost RER. Lower labor costs can have a similar effect by increasing competitiveness, while a surge in commodity prices would also lead to a resource-based economy experiencing an appreciation in real terms.

We measure labor productivty as the ratio of regional GDP and the number of employed persons. Unit labor costs are calculated as the ratio of average annual wages and labor productivity. Commodity

TABLE 3 Robustness tests (full sample, weights based on period 2014–2016)

	Weight specifications					
	2015	**Corr.**	**2016**	**Corr.**	**2014–16**	**Corr.**
	Fixed		**Fixed**		**Variable**	
Central	146.78 (21.29)	0.999	147.18 (21.62)	0.999	147.47 (14.11)	0.999
Northwest	213.42 (66.92)	0.994	159.02 (29.77)	0.999	188.73 (33.73)	0.953
South	148.67 (20.72)	0.997	151.40 (22.81)	0.993	153.78 (15.32)	0.983
N Caucasus	152.16 (21.62)	0.998	153.64 (22.65)	0.998	147.58 (17.83)	0.995
Volga	151.59 (23.63)	0.999	151.23 (23.95)	0.999	150.34 (15.16)	0.997
Ural	173.66 (34.76)	0.996	176.04 (36.33)	0.999	185.83 (22.47)	0.959
Siberia	182.91 (35.70)	0.999	181.08 (34.94)	0.999	189.08 (18.66)	0.999
Far East	178.02 (39.62)	0.999	175.16 (37.58)	0.999	201.30 (17.13)	0.984

Note: Regional RERs averaged across regions by federal district and their standard deviations across time reported in parenthesis. Columns (1) and (3) use fixed weights for total trade in the years 2015 and 2016, respectively. Column (5) employs variable weights for total trade based on current year. Pearson correlation coefficients are for correlations with baseline RERs and are averaged across regions by federal district.

TABLE 4 Robustness tests (reduced sample, weights based on period 2002–2016)

	Fixed 2014 weight	Variable 2002–2016 weight	Corr.
Sakha	106.60 (10.06)	103.27 (8.75)	0.714
Kamchatka	174.79 (18.29)	235.05 (33.02)	0.817
Primorsky	167.33 (19.38)	207.07 (29.97)	0.800
Khabarovsk	174.07 (26.04)	205.78 (34.23)	0.842
Amur	211.31 (41.37)	245.56 (44.82)	0.815
Magadan	214.75 (87.94)	243.76 (95.95)	0.838
Sakhalin	196.42 (48.32)	269.61 (73.17)	0.963
Jewish Auton. Region	233.13 (50.11)	246.82 (51.83)	0.908
Chukotka	184.00 (58.86)	201.60 (69.59)	0.964

Note: Regional RERs with standard deviations in parenthesis. Column (1) reports the baseline estimates using a fixed weight for total trade shares in 2014. Column (2) employs variable weights for total trade based on current year (2002–2016). All Pearson correlation coefficients are statistically significant at 1%.

prices are based on Urals oil, Russian natural gas, and an index of the global prices of metals, all reported by the IMF. The annual data were analyzed in a dynamic panel model with fixed effects (by region and year) and the results are presented in Table 5. As expected, the three commodity prices exhibit positive and significant coefficients. Unit labor costs also have the predicted sign, indicating a negative relationship with RER. Productivity initially emerges with a negative sign but switches to the expected positive sign when unit labor costs are excluded from the model. This result suggests that productivity can explain RER movements that are unrelated to labor costs.

3.4 | Regional growth and RER

The next part of the analysis involves assessing the impact of regional RER on growth. According to the results of the baseline estimation with fixed effects in Table 6, all coefficients exhibit the expected signs across all three specifications and attain statistical significance with the exception of openness. RER has a negative effect on growth meaning that an appreciation hurts the economic performance of regions, which concurs with the findings of previous studies on developing and emerging economies. The magnitude of the RER coefficient declines as the time horizon of growth is extended. At annual intervals, a 10% RER appreciation would cause real per-capita output of Russian regions to fall by 0.37%. For 3-year periods, growth would decline by 0.19%, while at 5-year intervals the drop by 0.003% is not statistically significant anymore.

The results reveal some interesting insights. A depreciation of RER can help regional economies stimulate economic growth but only in the short run. Long-run growth depends on factors other than a competitive RER, such as fixed capital investment. This finding fits well with the argument promoted by Eichengreen (2008) that RER is a facilitating factor rather than a key determinant of growth.

We address endogeneity issues by conducting the estimation using SGMM. The results in the last three columns of Table 6 confirm largely the robustness of our results. The coefficient of the RER variable exhibits the negative sign and is not significant for 5-year growth intervals. The only difference is that the magnitude of the coefficients is slightly lower than in the fixed-effects estimation.

TABLE 5 Determinants of regional RERs (2000–2016)

	(1)	(2)	(3)	(4)	(5)
Labor productivity	−0.131*** (0.035)	−0.131*** (0.035)	−0.131*** (0.035)		0.132*** (0.021)
Unit labor cost	−0.334*** (0.036)	−0.334*** (0.036)	−0.334*** (0.036)	−0.223*** (0.021)	
Oil price	0.603*** (0.056)				
Gas price		0.575*** (0.049)			
Metal price			0.643*** (0.060)		
Lag RER	0.603*** (0.016)	0.603*** (0.016)	0.603*** (0.016)	0.609*** (0.016)	0.621*** (0.017)
Constant	0.480** (0.205)	0.329 (0.207)	−0.182 (0.158)	1.638*** (0.091)	0.123 (0.327)
Obs.	1,308	1,308	1,308	1,308	1,308
R^2	0.93	0.93	0.93	0.93	0.93

Note: Dependent variable is the log of regional RER. Robust standard errors in parenthesis. All variables are annual values in natural logs. All regressions include region- and time-fixed effects.

***$p < .01$; **$p < .05$.

TABLE 6 Growth regressions, fixed effects and GMM (2001–2015)

	Fixed effects			System GMM		
	1-year	3-years	5-years	1-year	3-years	5-years
RER	−0.037***	−0.019**	−0.0003	−0.028***	−0.016*	−0.006
	(0.011)	(0.010)	(0.011)	(0.009)	(0.009)	(0.023)
Investment	0.021***	0.008	0.017***	0.029***	0.065***	0.040**
	(0.005)	(0.005)	(0.006)	(0.003)	(0.009)	(0.021)
Openness	0.004	0.002	−0.002	−0.015***	−0.012***	−0.006
	(0.003)	(0.003)	(0.003)	(0.002)	(0.004)	(0.011)
Oil price	0.046***	0.037***	0.003	0.030***	0.046***	−0.018
	(0.008)	(0.006)	(0.008)	(0.003)	(0.015)	(0.239)
Lag RGDPPC	−0.171***	−0.117***	−0.081***	0.109***	0.854***	0.065
	(0.015)	(0.012)	(0.012)	(0.016)	(0.018)	(0.161)
Constant	1.889***	1.230***	0.897***	0.317***	0.749***	0.242*
	(0.146)	(0.116)	(0.114)	(0.033)	(0.058)	(0.129)
Obs.	1,155	385	231	1,001	308	154
Within R^2	0.52	0.62	0.71			
AR(2) (Pr > z)				0.215	0.475	0.421
Sargan test (Pr > χ^2)				0.368	0.350	0.343

Note: Dependent variable is the annual growth of real regional GDP per capita. Robust standard errors in parenthesis. All independent variables in natural logs. All regressions include region- and time-fixed effects. Two-step system GMM estimation with Windmeijer (2005) small sample robust correction.

***$p < .01$; **$p < .05$; *$p < .1$.

4 | CONCLUSIONS

Regional economies in emerging countries have a different extent of exposure to external shocks making RER an important factor in their economic performance. This paper uses Russia as an example of a large emerging economy and constructs regional RER over the period 2000–2016. The results validate the adoption of regional perspective on trade and exchange rates by showing a significant variation of RER across regions in Russia. Oil-producing and resource-dependent regions have experienced a rapid appreciation of their RER in the years leading up to 2008 when commodity prices were surging. Other regions that were less integrated in global trade went through a more moderate appreciation. Furthermore, the volatility of RER in resource-based regional economies was markedly higher. The global financial crisis in 2008 and the aftermath of the Ukrainian crisis have led to major depreciations of regional RER and to a stronger tendency for exchange rates to diverge across regions.

The literature has shown RER to be an important facilitating factor for growth, especially in developing countries. Our results support this notion by showing that RER depreciation stimulates growth; however, this is true only in the short and medium run. In the long run, RER depreciations lose their effectiveness and cannot improve regional economic performance.The major conclusions that can be derived from the analysis are twofold. First, regional variation needs to be taken into account when investigating trade and exchange rate issues. Policies based on analysis of a single national real exchange

rate are likely to produce adverse effects for certain regions. Second, exchange rate depreciations are unlikely to help regions in emerging economies promote sustainable growth. National governments concerned with regional development and regional governments seeking an appropriate response to external or region-specific shocks need to focus on adjustment mechanisms that might be facilitated by but not driven by real exchange rates.

ENDNOTES

[1] In fact, some major emerging countries like India still do not report trade statistics at the subnational level. By contrast, U.S. trade data at the state level goes back to the mid-1980s.

[2] A group of papers explored regional exchange rates in the context of optimal currency areas by comparing the variance of RER among regions of a country with the one between countries. Such studies typically contrasted European Union member states with U.S. states and Canadian provinces in the run-up to the creation of the European Monetary Union in the 1990s (Eichengreen, 1990; Obstfeld & Peri, 1998; Poloz, 1990; Von Hagen & Neumann, 1994).

[3] Data on PPI for each of these sectors and their subindustries is available at the national level but at the regional-level coverage across time and regions is limited, preventing us from adjusting, for instance, for the effect of administered prices that might be involved in the production and distribution of electricity, gas, and water.

[4] In a couple of cases, missing data for years at the beginning or the end of the sample period were gathered from the CEIC database. For Moldova and Azerbaijan, additional data on PPI was gathered from the national statistical agency and from the Interstate Statistical Committee of CIS, respectively.

[5] The sample includes all current 28 EU member states, eight of the 10 CIS countries (Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, and Ukraine), and four APEC members (China, Japan, South Korea, and the United States). Turkmenistan and Uzbekistan were excluded from the CIS sample due to lack of data.

[6] The year 2014 marks the deepening of the Ukrainian crisis and the imposition of Western economic sanctions against Russia in the aftermath of the annexation of the Crimea. These sanctions targeted mostly the energy, defense, and financial sectors, while Russia's countersanctions restricted imports of agricultural products. Moreover, the impact of these sanctions on the trade shares (and, thus, on the weights used to calculate RER) of various countries became evident only in the years following 2014.

[7] Three autonomous areas (Nenets, Yamalo-Nenets, and Khanty-Mansi) were counted as parts of the larger regions they are subordinated to due to lack of data. Also excluded were the City of Sevastopol and the Republic of Crimea which were annexed by Russia in 2014.

[8] For this purpose, the sample period is reduced to 2001–2015 to ensure that the number of years is divisible by 3 and 5.

[9] The three aforementioned regions of Mari-El, Omsk, and Rostov were excluded from the cointegration analysis because their RERs are stationary in levels.

[10] See, for instance, Algieri (2013) who analyzed RER's determinants at the national level in Russia.

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