Exchange Rates and Economic Growth: Re-Evaluation of Undervaluation

Maria V. Sokolova*

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Abstract

We show that the regional trade integration through a Regional Trade Agreement (RTA) alters the transmission of a country's monetary policy towards its trading partners and results in a different impact on the country's economic growth. Using data dating back to 1965 for over 100 countries, we investigate the relationship between the economic growth of a country and its price competitiveness vis-à-vis its RTA and non-RTA partners.

First, we show that the increase in the growth rate through an undervaluation can be mostly attributed to the improvement through the non-RTA trading partners. We provide both theoretical and empirical evidence that the working channel is greater trade dependency between RTA members - along with the increase in trade flows, their exports become more dependent on imports from each other. Higher trade dependency leads to a lower (or negative) effect of competitive depreciation on growth, as the relative price gain on exports is partially (or fully) offset by the relative price loss on imports. Second, contrary to the conventional wisdom that developing countries grow more through an undervaluation, we find that this may not hold true depending on the composition of the trade flows vis-à-vis its RTA and non-RTA trading partners. An advanced economy may grow more through an undervaluation that is affecting the non-RTA trading partners more. This finding gives a new tool to analyse the efficacy and transmission of monetary policy in the context of the changing global trade patterns.

Keywords: regional integration, economic growth, trade agreements, exchange rates, price competitiveness, supply chains
JEL classification: F43, F63, F15, F36, O24, O47

*The Graduate Institute of International and Development Studies (maria.sokolova@graduateinstitute.ch).
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1 Introduction

The idea that a competitive real exchange rate[1] - the undervaluation of the currency - fosters economic growth has recieved a lot of attention both in academic and political circles. In particular, it has recieved a lot of attention with respect to the developing countries, and the availability of exchange rate depreciations as a monetary policy tool has been largely debated. This paper contributes to the discussion by combining the question of favorable effect of undervaluations of the currency with the trade linkages and integration of countries. We find that, the more trade enhancing an RTA is, the more the conductive effect of undervaluations is sourced from undervaluations towards the non-Regional Trade Agreement (non-RTA) trading partners.

Whereas there has been evidence that stable exchange rate favors the economic growth, the question of the effects of undervaluation has triggered many debates, but most of the research has found a positive effect of it on economic growth, as commonly measured by gross domestic product per capita. This has been found especially effective in developing countries (Dollar, 1992; Gala, 2008), while the majority of researchers agree that the developed countries would potentially benefit much less from the undervaluations. In contrast to the belief that developed countries are limited in their use of undervaluations, our results suggest that they still may benefit from undervaluation of their currencies, conditioned that these undervaluations are directed at their non-RTA trading partners.

There has been a number of studies concentrating on the effects of overvaluation and undervaluation of the exchange rates on economic growth (Rodrik, 2008; Rapetti *et al.* , 2012; MacDonald & Vieira, 2010a; Fernandez-Arias *et al.* , 2002; Razin & Collins, 1997). While there is no consensus in the methodology, and there have been differently sized effects documented, the conventional wisdom prevails that depreciation (appreciation) is beneficial (harmful) and less (more) developed countries are effected more (less).

In contrast to most of the literature in the field[2] we disregard the use of the bilateral exchange rates and use the effective exchange rates instead. This allows us to capture the effect of complex composition of international trade flows and their multi-country nature. Following a well-known framework of undervaluation assessment of Rodrik (2008) and an alternative measure of undervaluations using the Hodrick-Prescott filter (that imposes a less strict assumptions on the equilibrium REER) we look at the source of the positive effect of undervaluations.

By splitting the conventional REER index into two subsample-fixed measures based on the association of the trading partner to an RTA, we find that the positive effect of undervaluations on economic growth found in the literature (Rodrik, 2008; Di Nino *et al.* , 2011; Razin & Collins, 1997; Rapetti, 2013; Béreau *et al.* , 2012) is sourced from the undervaluations to the non-RTA trading partners for most of the countries. The result is robust for developed economies, whereas for developing we find evidence of the "beggar-thy-neighbor" policies as their participation in RTA is typically less trade integrative and triggers less the structural transformation of the economy[3]. We also find evidence that low income countries tend to also gain more on the undervaluations against their non-RTA trading partners, whereas the undervaluations against their RTA trading partners may impede their growth[4].

[1] Throughout the whole paper the real exchange rate is defined as units of domestic currency needed to acquire a unit of foreign currency; therefore, an increase is depreciation. Thus, the same applies to the real effective exchange rate and increase is associated with depreciation.

[2] See, for example Di Nino *et al.* (2011); Rodrik (2008); Razin & Collins (1997). The exceptions are, for example, Fernandez-Arias *et al.* (2002)

[3] Same result found in (Fernandez-Arias *et al.* , 2002)

[4] We see it explained through fragile nature of the RTAs that involve the low income countries and the fact

The main channel of the divergent effect of the undervaluations against RTA and non-RTA trading partners is the non-linear improvement of the aggregate trade balance: when a depreciation happens, not only the export is becoming relatively less expensive, but also imports become more expensive, therefore in the course of time the trade balance improves. The more a country's exports are dependent on the imported inputs, the more the relative decrease of the price of exports is compensated by the relative increase of the price of producing these exports, as the imports are getting more expensive. This finding relates to the well-known Marshal-Lerner condition that has been empirically challenging to find when looking at aggregate price indicesBahmani *et al.* (2013). This paper provides a new framework to assess the elasticity of trade flows by splitting them based on the RTA association.

We formulate a theoretical model that captures the intuition behind our findings. Using Obstfeld & Rogoff (2005) model we build a two-region four-countries model and show that when there is a greater dependency on the regional inputs, the increase of the aggregate trade balanced is sourced from the non-regional trade. Additionally, we show that the inflation will be more intercorrelated with regional trading partners when there is greater trade integration.

This paper provides evidence that expansion of the international trade and proliferation of the supply linkages though the emergence of the global value chains have altered the traditional understanding of the transmission of the monetary shock. Countries that are highly integrated into the global supply chains and are dependent on the imported inputs or perform unique tasks may not be adversely affected on average by an appreciation, and some industries can actually gain as in the case of Switzerland(Fauceglia *et al.* , 2015). It makes competitive depreciations not as efficient for such countries, while other countries, being not as strongly integrated or having the role of the upstream producers can still benefit from competitive depreciation to their RTA trading partners.

We use RTAs as a cut off for our estimations, as it is a useful and trackable policy dimension. We acknowledge the fact that there could be other agreements that enhance the economic linkages between the countries. Majority of the RTAs agreements ease the legal, financial or other type of burden of trading. At the same time, these other agreements take usually more specialized formulations, and therefore are hard to pin down in the aggregate study.

Not all RTAs have the enhancement of the supply linkages at their core. Moreover, the advanced economies were the first ones to start implementing RTAs; developing countries started signing them only in the end of 90s, which made the RTAs between advanced countries "deeper" than the rest. Nevertheless, an RTA, apart from reducing the overall trade barriers, is most likely to be aimed at structural transformation of the industry among participating countries to the most efficient sectors; this enables then to use their comparative advantage more and better finance more productive industry (Fox, 2004; Freund & Ornelas, 2010; Moser & Rose, 2014). There are many reasons, though, for some RTAs to be more efficient than others(Frankel & Wei, 1998b), and the features of the RTAs that increase the trade linkages, and therefore alter the transmission of the exchange rate shock, should be further studied. We provide the first step in assessing the impact of the emergence of the global value chains in the context of international tarde effecting the transmission of the monetary shock.

The rapid expansion of the global value chains may be partially attributed to the increasing ease of trading between countries, which in turn is linked to the trade agreements being adopted. Blyde *et al.* (2014) novel study has highlighted the link between trade agreements and global value chains on the basis of finding evidence that there are more vertical FDI links established when the countries integrate. In the article ,they find a highly robust link between the integration agreements and offshoring, which they proxy by the number of sub-

that they specialize mostly in the low value-added or resource extractive activities.

sidiaries used to produce inputs to parent companies in each foreign country. They find that the deeper form of agreements - FTA and Custom Unions - enhance even greater links.

Both academic and policy literature has been regarding the complexity of the relation between international trade and exchange rates, and there has been a number of contradictory findings in both empirical and theoretical literature (Auboin & Ruta, 2013). Our research sheds light on this intricate relationship by lookinbg at how trade linkages between the countries drive the effect of undervaluation on the economy differently.

While there has been number of empirical studies documenting positive link between the economic growth and real exchange rates(Rodrik, 2008; Rapetti *et al.* , 2012; Gala, 2008), most of the studies have indicated that the link is stronger for the developing economies (Di Nino *et al.* , 2011; Dollar, 1992) and the effect is indeterminate for developed economies (Easterly, 2005). This paper adds that along with estimating the positive (or negative) effects of the exchange rates, we need to take into account the non-linear transmission of shocks between the trading partners. Even as the standard macroeconomic literature postulates that advanced economies are constrained in the applicability of the competitive undervaluations, we show that due to the non-linear transmission of the exchange rate shocks they may still gain on some competitive depreciations (implying the depreciations designed to affect the non-RTA trading partners).

Our research also highlights an additional feature of an RTA: an RTA may have an additional feature of being an insurance against exchange rate shock from the fellow RTA members. When an RTA trading partner is using competitive depreciation, if the production of this exported goods is dependent on the inputs imported from other RTA members, the gain on the competitive depreciation on the expense of the other RTA members is lower (or even negative) since, to produce more exports, the depreciating country will need more imports and therefore fellow RTA countries gain too.

The paper is organized as follows: Section 2 describes the existing arguements on the relation between exchange rates, economic growth and international trade; Section 3 briefly describes the data we use; Section 4 describes the underlying the RTA and non-RTA undervaluation construction methods; Section 5 provides estimation specifications of the growth regressions on the RTA and non-RTA specification, and describes the robustness checks; Section 6 presents the results of the estimations of the growth resgressions. In section 7 the theoretical model and the additional supporting estimations and descriptions on trade balances are presented. Section 8 discusses the implications of the results of the paper and further possibilities for the research, Section 9 concludes.

2 Background

This paper shows that composition of the trade flows between a country and its trading partners alters the transmission of the exchange rate shock. More precisely, we highlight the fact that there will be different effect of undervaluation when we look into the subsample of RTA trading partners and non-RTA trading partners. The main link we are exploiting is the improvement of the country's economic growth as a result of the undervaluation of the currency is channeled through improvement of a country's trade balance. As RTA trading partners have higher trade dependency, the effect of undervaluation will be less. Therefore the transmission of monetary policy should be looked at taking into account the trade composition and integration of the country.

In this section we discuss the link between the exchange rates and economic growth and explain how recent developments in international trade altered the transmission of the monetary policy.

There are numerous policy channels that could be involved in enhancing the economic growth through undervaluation of the exchange rate that are used by the governments in order to operate this mechanism - including monetary and fiscal instruments, exchange rate target, capital management. We concern ourselves with the open economy aspect of the link - how the exchange rates can effect the economic growth through trade linkages. We show that because of the changing trade integration the transmission of the monetary policy has been altered, leading to dependency of of the monetary policy efficiency on the composition and integration of trade.

Traditional open economy interpretation of the exchange rates is that a depreciation of the real effective exchange rate makes the exports relatively cheaper, while making the imports relatively more expensive (as compared to the selected set of countries). This boost the net exports and therefore improves the income in the economy. We argue that in the current state of the complicated trade linkages between the countries the interpretation is no longer as intuitive, and we can identify that depreciation increases the economic growth of a country mostly on the account of the countries that do not have an RTA agreement.

When a country's currency depreciates, exports of this country are becoming cheaper in the real terms, but at the same time imports are becoming more expensive in the real terms. The biggest exporters are the biggest importers (as documented in (Amiti *et al.* , forthcoming) for the firms one can integrate this finding to an average exporter in the world), which are quite likely to be highly vertically integrated into the GVCs - therefore an increase in export value may be matched by the corresponding increase in import value. This implies that the aggregate reaction to the exchange rate change is ambiguos and should be estimated not with the change in exports or bilateral trade, but some other measure. One of this measures of the trade integration could be, as we propose, the existence of the regional trade agreement.

As Baldwin (2011b,a, 2012) discusses, the regionalism and global supply chain linkages should be looked at together - since mid-80s the world has moved from trying to cultivate internal production network in each country to using the cross-border supply links and production abilities. Supply chain trade changes the map and the scope of the world trade, RTAs foster the links and intensity, some are signed on the "deep" provisions - such as intellectual property, service provision, etc. (Baldwin & Lopez-Gonzalez, 2013; De Melo, 2011).

Using RTAs seem a valid proxy for trade integration, and also for policy design - every country knows its RTA trading partners, and it is an active notion not only in academic circles, but also in the policy institutions and business unions. Even though RTAs have sometimes created instability, the medium- and long-term gains from signing an RTA are undoubtful (Baldwin, 2012; Freund & Ornelas, 2010).

As mentioned above, we use real effective exchange rate (REER) which allows us to compare the relative changes over the subset of countries. For the question we are raising - the distinction of the effect of undervaluation of a country's currency against its trade partners with whom it has a trade agreement signed and not - we consequentially split the conventional REER calculation for two sub-samples of trading partners - regional trade agreement partners (RTA partners) and not regional trade agreement partners (no-RTA partners). By keeping the *third country market* calculation method of the weights, we do not isolate each of the two samples. The full calculation method is described further in "Methodology" section. Figure 4 presents the RTA, no-RTA and average REER of the selected economies (for the main sample).

In figures 8 and 9 we present the comparison between the RTA and no-RTA REERs for selected economies. We can see that for most of the countries the no-RTA REER is more volatile than the RTA REER. There are three factors that are seen contributing to this:

- There may exist self-selection into signing an RTA between trading partners with a relatively more stable bilateral exchange rates (Frankel & Wei, 1998a; Frankel *et al.* , 1996);

- There could be a higher risk of "beggar-thy-neighbor" policies from trading partners, and therefore the country may have a more competitive attitude towards the RTA trading partners Fernandez-Arias *et al.* (2002);

- As the conventional REER is calculated over the full sample of the trading partners, the no-RTA and RTA REERs are a non-linear[5] decomposition of the conventional REER.

We acknowledge the fact that there could be a self-selection of the countries that join an RTA, but this has no intrinsic effect on our results, as we do not ask the question of why and by whom should an RTA be signed, but deal with the ex ante changes in transmission of monetary policy. To put it simply, we leave out of scope of this paper the discussion of why Germany and Hungary decide to sign an RTA, but once the RTA takes place, we claim that the transmission of monetary shock will be altered between them. To assure the reader this is the case that RTAs are affecting the transmission due to the higher trade integration, we also test with the measures built on the lagged RTAs.

The approach of splitting the sample in "regionals" and "non-regionals" and calculating separate REERs is somehow similar to Fernandez-Arias *et al.* (2002), where they look at the effect of the exchange rate misalignments in the context of the regional integration agreements. They find that between regional trading partners exchange rate may be used as a policy tool to enhance their own country's exports when other policy tools are legally unreachable. This addresses the second factor we have listed above - the higher risk of "beggar-thy-neighbor" policies from RTA trading partners leads to on average more competitive REER against RTA trading partners. Unlike Fernandez-Arias *et al.* (2002) we assume that complicated nature of international trade makes looking at aggregate exports is not sufficient when drawing conclusions on the non-linearity of the effect of undervaluation. Looking at the economic growth of a country reflects better the impact of the competitive exchange rates, as compared to gross exports.

The third factor is a purely technical aspect of splitting an aggregate REER into two sub-samples. We split conventional REER into its geometric composition of the REERs calculated over a subset of countries. The geometric product is by composition will be between the values of the multipliers if one of them is greater than one and the other is less.

We split selected countries presentation in figures 8 and 9 into two groups based on their income group as defined by IMF. Noticeable distinction is that on average the develped countries are more competitive to their RTA-partners, while developing countries tend to have greater REER towards their non-RTA trading partners. This gives ground thinking that there are different types of RTA cooperation between the countries, and we need to look at the type of country having an RTA.

There are numerous observations that developing and developed countries have different roles in global value chains and their trade integration is of different type (Giuliani *et al.* , 2005; Baldwin, 2011b,a; Baldwin & Lopez-Gonzalez, 2013). China is the biggest exporter in the world, but it is at the same time second biggest importer.

Baldwin (2012) discusses the changing nature and increased complexity of the international trade over time, but highlights that there are different stages to the international trade

[5] Product of the two sub-sample fixed REERs will be equal to the conventional REER. In robustness we also introduce the $(J+1)^{th}$ market into calculations that describes the aggregate of the other subsample, as it is seen as common "out-of-sample" competitor and captures better the selective nature of the RTAs.

prolifiration, where the developing countries acted later than developed. The "North and South" relationship of international trade and the emergence of the "smile curve" effect implies exactly the separation between the different stages of developed and developing countries in international trade.

Freund & Ornelas (2010) provide the review of theoretical and empirical aspects of regional trade agreements and document that RTAs have different goals and impacts on trade for developed and developing countries. Specialisation of countries on different stages of the supply chain may also play a role.

The argument above provides the ground to separate the sample by the level of development of the country. We use the IMF classification of the countries - *Developed*, *Emerging and Developing Markets* and *Low Income Countries (LICs)* - presented in Table 1. In table **??** The different nature of RTAs in different countries may therefore channel the effect of undervaluations between RTA and non-RTA trading partners differently. We expect to have a greater difference between the RTA and the no-RTA effects in the more developed countries - they appear to be more integrated and more interdependent. At the same time RTA for the LICs sometimes have more a political nature rather than economic.

Of course, additional justification for splitting the countries by the level of development is that there is different scope of the monetary policy scope in developed and developing countries: price of non-tradables is lower relative to tradables in developing countries, whereas as country develops the tradables become relatively cheaper. Therefore, undervalation in developing countries has a relatively greater impact on the tradables sector (Rodrik, 2008; Woodford, 2009). Even as we perform the Balassa-Samuelson adjustment to the measure of undervaluation, it seems still intuitive to split the sample into different groups as the set of the monetary tools available to countries is different[6].

This section has provided a discussion on the complicated nature of the contemporary production links and how it has changed the generally anticipated transmissions of monetary policy shocks. The expansion of the production chains first among developed countries and then after between less developed countries made the trade between most of the countries more interdependent, and made effect of depreciation ambiguous: if a country is highly dependant on the imports from its trading partners, the increase of the relative price of the necessary imported intermediates partially reduces the gains from the decrease in the relative price of exported final goods. We explained why using RTA is a good proxy for regional integration and production dependency by surveying the evidence of the RTAs signalling and/or promoting higher integration between the trading partners, especially among the developed countries. Therefore, the positive effect of the exchange rate undervaluation on economic growth is sourced more from the undervaluations towards the non-RTA trading partners, rather then RTAs. In the next section we provide the discription of methodology used to built the subsample-fixed REERs and the empirical specification.

3 Data

As the main data source we use the Direction of Trade bilateral trade statistics and International Financial Statistics of International Monetary Fund and World Bank database.

We aggregate the monthly exchange rates to tha yearly average, and use CPI yearly values to calculate the real exchange rate between countries.

[6]Woodford (2009) and Rapetti *et al.* (2012) discuss that the tradeoffs for using the depreciations in advanced economies are potentially larger than in the developing economies.

We have the maximum of 134 countries and maximum timespan between 1960 and 2009. The data on the contigency, classification of the countries is taken from the gravity dataset provided by CEPII.

Regional Trade Agreements and Customs Union data is from de Sousa (2012)[7]. We also use the World Governance Indicators dataset, World Bank and WEO data.

When looking at the Eurozone countries after the introduction of the Euro, we use the conversion rates set by the ECB to convert the Euro rate and use it for the uninterrupted time series of the exchange rates. Euro is split into the economies by conversion - robustness includes dropping the Euro area.

4 Methodology

As we are interested in estimating the effect of undervaluation versus certain group of trading partners, the main measure of undervaluation we use is the real effective exchange rate. We are interested in the measure that is calculated for each country over a subsample of trading partners that have and RTA in place and the ones that do not, which is possible to be done through calculating the REER over the subset of countries. Another advantage, apart from the ability of selecting certain subgroup of countries, is that REER is comparable between countries and years.[8]

Therefore, for any given country i in year t that has an RTA signed with the subset J_1 of its trading partners, we calculate the following measures:

$$REER_{i,t}^{RTA} = \prod^{j \in J_1} (brer_{i,j})^{\omega_j}$$

$$REER_{i,t}^{noRTA} = \prod^{j \in J_2} (brer_{i,j})^{\omega_j}$$

In the previous section we have explained the intuition that outlines the main reasoning for why having an RTA is a cutoff for J_1 and J_2. RTA represents a greater integration of the economies and higher trade dependency (Frankel *et al.* , 1996; Baldwin, 2011a; Frankel & Wei, 1998a; Moser & Rose, 2014) and therefore is a source for the different effect of undervaluation on economic growth. When a competitive depreciation is directed at the regional trade agreement partners, the decrease in the relative price of the exports imay be matched by the increase in relative price of imports from the RTA-partners. As between countries that have signed an RTA production links are more present, then the exporters will see an increase in price of imported inputs. Therefore there will be lower price elasticity with the RTA trading partners than with the no-RTA trading partners. This by-turn, implies that when a country undervalues its currency, it grows, but it grows more on the expense of its non-RTA trading partners, with who it has a greater trade imbalances.

For the main specification we calculate the yearly-weighted trade weights ω_j. We also run robustness with a five and ten year chain averages. In order to benefit from the data and have a vast country coverage we do not limit to a subset of countries, but we taking into account all existent trading partners at every year (as reported by DoTS trade flows). By doing so we aim to expand the country coverage from the conventional centralization on the developed countries. Using the broad timespan (from 1965 to 2013) when looking at RTAs may create bias to developed countries, as until 1990s the very few RTA among non-developed countries.

[7]http://jdesousa.univ.free.fr/data.htm#RegionalTradeAgreements

[8]The full process and data used in construction REERs is presented in the Appendix I.

We calculate a CPI-based REERs. Values of REER greater than 1 indicate that the value of the currency is lower then indicated by the purchasing power parity versus the given subset of the trading partners currencies. The currency is then more depreciated than others and makes it more competitive versus these trading partners. All REERs for all countries are indexed to 2010 for the estimation ease purposes[9].

As we are working in the panel setup, we estimate within-country time-variance controlling for all time-variant non-country specific shocks. As REER is a price competitiveness index, the decrease in REER is associated with appreciation and increase with depreciation of the currency[10].

Our main hypothesis deals with the fact that there is a different magnitude of the effects of undervaluations versus RTA and non-RTA trading partners due to different trade elasticities. In order to test that we are estimating the subsample-fixed REERs we estimate the coefficients of the REER undervaluation of two subsamples simultaneously.

An *"undervaluation"* in our definition implies a deviation from a certain equilibrium (or predicted) level, where the positive value indicates an index higher than prediction. We interchangeably use the term *"competitive depreciation"* and "undervaluation", as one should understand that a competitive depreciation is, by definition, a case of undervaluation of a currency. As there is no consensus among professionals on what the measure of undervaluation should be used, we use two different definitions - Rodrik measure of undervaluation, and less strict Hodrik-Prescott measure that is based on the time-series nature of the data.

As the main measure of undervaluation we use Rodrik measure of undervaluation (Rodrik, 2008) that is built controlling for the Balassa-Samuelson effect and has gained a wide-spread use(Glüzmann *et al.* , 2012; Di Nino *et al.* , 2011; MacDonald & Vieira, 2010b; Nicita, 2013; Berg & Miao, 2010). We recognise that there are some shortcomings to the methodology, but nevertheless we believe that until better mechanisms are developed, we provide a valid improvement on understanding of the exchange rate shock transmission when taking into account the complicated linkages of international trade.

The Rodrik measures of undervaluation $Underval_{it}^{Rod,RTA}$ and $Underval_{it}^{Rod,noRTA}$ represent the deviation from the equilibrium exchange rate, corrected for the Balassa-Samuelson effect[11]

$$Underval_t^{Rod,RTA} = \frac{lnREER_t^{RTA} - \widehat{lnREER}_t^{Rod,RTA}}{\widehat{lnREER}_t^{Rod,RTA}}$$

Where $\widehat{lnREER}_t^{Rod,RTA}$ is the predicted value of $lnREER^{RTA}$ from the regression that adjusts for the Balassa-Samuelson effect:

$$lnREER_{it}^{RTA} = lnGDPPC_{it} + f_t + \epsilon_{it}$$

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[9] Indexing to 1995 or 2005 does not change the general findings, but decreases the sample size as we lose countries that did not have an RTA in effect at that date.

[10] In figure 3 we present the comparison with BIS REER for selected economies with the inverse of our measure

[11] Calculations for no-RTA are analogous.

[12]

In contrast to Rodrik (2008) we operate with the real effective exchange rates in the main specifications, and moreover we split them, as was described above, in two measures of subsample competitiveness. To control for this split, we add the second measure of the competitiveness into the Balassa-Samuelson correction:

$$lnREER_{it}^{RTA} = lnGDPPC_{it} + lnREER_{it}^{noRTA} + f_t + \epsilon_{it}$$

At the equilibrium real effective exchange rate the goods in the home country are priced the same as in the trading partners' economies, weighted by the trade with them. Whenever the undervaluation measure is positive, it implies that the goods produced at home are relatively cheaper in real terms (controlling for inflation) than the goods produced at its trading partners: the currency is undervalued. Vice versa is true - when the undervaluation is lower than zero, the currency is overvalued and the goods are relatively more expensive in the real terms than at the trading partners' economies. In the robustness checks we presents results separately for the samples of the overall relative appreciations and depreciations of the currencies.

We calculate also an alternative coefficient of undervaluation through estimating the percentage deviations from the Hodrick-Prescott (HP) filter predicted values of the REERs. This approach is based on the time-series aspect of the data and has been used by other studies (Fernandez-Arias *et al.* , 2002) that consider it a plausible methodology to decrease the endogeneity of the estimations. We are interested in having different elasticities for RTA and no-RTA undervaluations and expecting the effect of the calculated deviations to be of the alike direction and magnitude as calculated elasticities.

The HP-filter is a measure of the undervaluation that represents the percentage deviation from the predicted trend, and is constructed in the following way:

$$underREER_t^{HP,RTA} = \frac{REER_t^{RTA} - \widehat{REER}_t^{HP,RTA}}{\widehat{REER}_t^{HP,RTA}}$$

Using HP filter makes the assumption of the equilibrium less distorting - undervaluation in HP sence will mean the deviation of the predicted trend in REER, which is therefore assumed to be the equilibrium path, different for each country. We will not be differentiating explicitly between the nature of the two different natures of the equilibriums.

Since the main measure of undervaluation represents the deviation from the equilibrium real effective exchange rate, when the price competitiveness of all countries remain the the same - equilibrium - state, this enforces the condition of existence of this equilibrium throughout the observed timeperiod. Therefore in robustness check we also include the different timespan by looking only at the periods 1990-1999 and 2000-2013.

Next subsections introduce the estimation strategy and then describe the robustness checks performed.

5 Estimation

We take close after Rodrik (2008) framework of assessing the impact of exchange rate undervaluation, and adapt it for the measure of undervaluation of subsample fixed real effective exchaneg rate. Because we are interested in capturing the changing trade pattern, we use yearly values. Therefore the dependent variable is the growth of the GDP per capita (income) in the next period. We run panel regressions with the fixed effects. Time dummies capture the common shocks such as global trade collapse, but as a robustness check we drop the global financial crisis times. We run on the full sample the conventional REER and also the

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Results presented in table 6. In this specification the correction corrects not only for the level of prices of non-tradables and for the competitiveness level in the other subsample. I expect it to be a better correction for the price ratio of the tradables to non-tradables, even though not conventional, as the level of the real effective exchange rate is by design aimed at measuring competitiveness. Earlier it was illustrated that there are distinct persistent differences in the RTA and no-RTA levels, so it seems plausible that the value of the *other* REER will be a good proxy for Balassa-Samuelson along with the GDPpc value.

subsample-fixed REERs, the construction and idea behind which are explain in the previous subsection. The conventional REER regression takes the following form:

$$growth_{it} = \alpha + \gamma_1 lnGDPPC_{i,t-1} + \gamma_2 Underval_{i,t} + f_i + f_t + u_{it}$$

where:
$growth_{it}$ - the growth of the gdp per capita in country i at time t;
$lnGDPPC_{i,t-1}$ - convergence term of initial level of income;
$Underval_{i,t}$ - Undervaluation of log of the calculated REER taking into account all trading partners, normalized to 2010;
$f_i \, and \, f_t$ - country- and time- (3 year periods) fixed effects.

Using the subsample-fixed REERs:

$$growth_{it} = \alpha + \beta_1 GDPPC_{i,t-1} + \beta_2 Underval_{i,t}^{RTA} + \beta_3 Underval_{i,t}^{noRTA} + f_i + f_t + u_{it}$$

where:
$lnREER_{i,t}^{RTA}$ - the log of the calculated undervaluation to the sample of RTA-trading partners;
$lnREER_{i,t}^{noRTA}$ - the log of the calculated undervaluation to the sample of non RTA-trading partners.

In the subsample-fixed REERs we restrict the regression sample to the countries that have got an RTA signed, and we incude them only when the RTA got encated (as according to de Sousa (2012) dataset).

The fixed effects serve to absorb any growth determinants that are time-invariant and country-specific, time-specific and country-invariant. We perform some already mentioned and some additional robustness checks, that are summarized below.

We do not descriminate between the appreciation/depreciation in our estimations looking at all changes of the price index. For the sake of completeness of our investigation and to support our findings, in the Appendix we present the main estimations for separately episodes of overall depreciation and appreciation.

5.1 Causality

Real effective exchange rate - in fact, any real exchange rate, - has the price of tradables to non-tradables as a basis and therefore is endogenous variable. We agree with the arguement of Rodrik (2008) who bases his logic on the fact that the governments are still concerned with the real exchange rate and do not let it float freely and that the policies directed at the nominal exchange rates also make its real "counterpart" co-move.

We also follow Rodrik (2008) footsteps in using the dynamic panel approach through generalized method of moments (GMM) to address the question of reverse causality through allowing for the endogeneity of the regressor. Tables 14 and 15 present both the two-step difference and two-step system estimator[13] for both of the undervaluation estimates. We also add the "usual" growth determinants to control for the other variables that might be effecting the relationship.

Even though there is yet to be determined the econometric procedure that will control for endogeneity of the undervaluation, we believe our results are still convincing for the message: there is differentiated effect on economic growth from undervaluation (or competitive

[13] Based on the Arellano & Bond (1991) and Blundell & Bond (1998) procedure

depreciation) to RTA trading partners and non-RTA trading partners. This is channeled through greater trade interdependency and therefore different price elasticity of output (and, therefore, trade balance). A monetary shock will have a dissimilar transmission and efficiency based on the composition of the trade flows.

After presenting the results on our "modified" Rodrik regression, we provide theoretical and empirical evidence of the different price elasticities of trade balance with respect to the RTA and no-RTA trading partners.

5.2 Robustness Checks

One could argue that selection into RTA may partually be based on the exchange rate and the exchange rate volatility(Frankel *et al.* , 1996), and therefore it is redundant that the undervaluation to the RTA-trading partners is less efficient as the movement is less frequent and is associated with lower volatility. We indeed find that, on average, undervaluation is lower for the RTA-trading partners and therefore $REER^{RTA}$ moves on with a more constant trend. Even though we believe there is no intrinsic point for our question, we check whether there is bias from this selection: we perform the robustness check by splitting the sample by the contingency of the countries. It should be noted that in this robustness check most (if not every) country has a different subsample of contingent countries, and the result then captures the lower trade costs based on the geographic proximity.

If there is no effect of the RTA being trade-integrating, trade-dependency increasing and therefore altering the transmission of the monetary policy shock, then an undervaluation to the closer countries should have a greater effect, as neighboring countries are usually having a similar consumer basket[14].

As greater trade dampens exchange rate volatiliy(Broda & Romalis, 2011), it may also dampen the effect of undervaluation. In this paper we do not address this question in detail, leaving it to the further research, but we split the sample based on the size of the bilateral trade imbalances: the presumption is that the greater net export to the destination allows for the greater effect of the undervaluation[15]. The trade imbalances split is performed in the following way: we assign the $REER^{over}$ to the REER calculated in the same manner as $REER^{noRTA}$ but among the sample of the countries which has trade imbalance above the median value of the trade imbalance for a given country. Analogous for the $REER^{below}$. The $REER^{over}$ would relate in the similar manner to $REER^{below}$ as $REER^{noRTA}$ to $REER^{RTA}$.

As discussed in the theoretical background, the source of the different magnitude of the undervaluation effect to RTA and non-RTA trading partners are different price elasticities due to the greater trade interdependence between the countries that have an RTA. As theory and empirical evidence below will further illustrate, the bilateral trade imbalances are indeed lower among RTA trading partners, as the RTA trading partners trade more with each other.

One of the concerns that the readers might have is to which extent our results are driven by the trade shares and redistribution of the countries between the RTA and non-RTA subsets. Accordingly we perform robustness checks with the five year chain-linked trade weights and ten-year averaged trade flows. We do not use these trade flows as the main specification, as through using the double-weighting in construction of REERs we believe to limit the composition effect from the weighting shares, but instead we impede the effect of the changing

[14] As discussed in Broda & Romalis (2011)

[15] In the companion paper I discuss how RTAs actually *deepen* the bilateral trade imbalances - on average a country lowers the trade imbalance by 3% 5 years after signing an RTA. I see this as an illustration of the trade integration of an RTA, while structural transformation leads to both trade creation 'within' the RTA and trade distruction 'outside' the RTA

trade map. Therefore, using weighting scheme from the averaged or smoothed trade flows biases our results downwards.

As we use very rich and broad dataset - over 100 countries over the timeperiod from 1965 to 2013, one of the possible problems we could be facing is the data quality coming from earlier years and from the countries with worse data quality. Assuming that the greater GDP per capita indicates better quality of institutions, we chose 80 countries whose average GDP per capita over 1995-2005 was the highest and generate their $REER^{noRTA}$ and $REER^{RTA}$ within them over the course of 1980 to 2005. We also drop the crisis years in order to limit other shocks.

Another interesting check is to see whether our results of different impact of undervaluations to RTA and non-RTA will be driven by only overall overvaluations or undervaluations. We split our estimated sample into the two subsamples:

- Undervaluation: in the year t the $REER$ is greater than in $t-1$, and the increase is greater than 25^{th} percentile of the average world increase in that year;
- Overvaluation: in the year t the $REER$ is lower than in $t-1$, and the decrease is greater than 25^{th} percentile of the average world decrease in that year

5.3 Additional controls

As in Rodrik (2008) we include the set of additional controls that may have a great effect on the elasticity between the REER and the economic growth:
$GovConsumption$ - is government consumption level as the percent of the GDP;
ToT - are the external terms of trade;
$Educ$ - average years of education;
$Inflation$ - inflation in the country;
$RuleOfLaw$ - is taken from the World Governance Indicators and is aimed at capturing the institutional quality in the country;
$Savings$ - gross savings (as a percent of GDP).
We report in regressions (1) - (5) the results of the regressions on each control separately and regression (6) reports the results of a regression with all the controls. Some of the data is not available for the big timespans, so it is useful to look at the regressions separately and in combination.

5.4 Income levels

Balassa-Samuelson effect postulates that as the level of income of the country grows, tradable goods become cheaper compared to the non-tradable goods. One could argue that Balassa-Samuelson is, in general, effect observed on the low frequency, and our estimation strategy, by having the time- and country- fixed effects should not suffer from it[16], as there are assumed to be no such huge shifts that will effect the estimations(Woodford, 2009), but we would argue the opposite, as there has been the cases both in developing and low-income countries of big shifts in the observed period. Some low-income countries has raised their GDP per capita by over 30%, Argentina has suffered a big shift in the relative income since the end of 90s. Therefore we believe that some sort of the Balassa-Samuelson correction is needed.

We implement the Balassa-Samuelson correction as Rodrik (2008), which is seen as an imperfect correction and raised some qestions that it might bias our results upwards(Woodford, 2009). We perform all the robustness checks with the alternative measure of undervaluation,

[16] Or we can look at the coefficient in the sample starting from 1990.

based on the Hodrick-Prescott filter, which therefore has to be adjusted for the income levels of the countries. Therefore, in order to further assure the robustness of our result, we also perform a robustness check with interaction of the HP-measure of undervaluation with the level of income of the country. This is meant to control for the average changes in the tradables-to-nontradables ratio of Balassa-Samuelson effect.

6 Results

In this section we present the results of the empirical specification. As described above, we expect to get the main effect of undervaluation being sourced from the non-RTA trading partners. As country wary a lot by income levels, we split the sample into their income level as according to the IMF classification.

In the table 3 we present the results of the main specification. The regressions (2)-(5) present the results over different subsamples with undervaluation constructed following Rodrik (2008), and in (6) - (9) we present the results with HP filter measure of undervaluation.

When we run our aggregate regression based on the yearly data with the conventional REER, we estimate that on average 10% undervaluation is associated with $0.11 * 0.1 = 0.011$ or 1.1% higher growth of the real per capita GDP. Traditional measure in such regressions is the bilateral real exchange rate to the USD, with the effect of a 10% undervaluation varying from 0.1% to 2%. Therefore our estimates are consistent with the literature, even as we are using areduced form growth regression with the real effective exchange rate. A 10% undervaluation of the real effective exchange rate requires the effective nominal exchange rate adjustment of a number of currencies. As explained above, we assume the policies exist which can alow for that.

For all the further results it should be noted again that we are estimating elasticities to the certain subsample fixed real effective exchange rates - a weighted basket of bilateral exchange rates. These exchange rates are grouped based on the association to any RTA, and therefore for each country it may represent different share of total trade. Therefore, even though we do report the magnitudes, it should be noted that the main purpose of our study is to highlight the finding that the positive effect of undervaluation on economic growth is channeled mostly through the undervaluations to the non-RTA trading partners. And the more trade facilitating an RTA is - as in the case of developed countries - the more it is likely that there is greater difference in elasticities between the undervaluation to non-RTA and RTA trading partners.

In table 3 across all samples with both measures of undervaluation we get significant positive effect of undervaluations against the non-RTA subsample of trading partners. We see that for developed countries a 10% undervaluation is associated with 2.4% higher economic growth, and among the emerging and developed countries (EMs) 2.5%. When we make the assumption of the existence of the equilibrium level of REER less stringent by using HP filter-constructed undervaluation, this value goes up to 6.8% for developed countries and goes down for EMs to 0.4%, while the RTA-undervaluation for EMs goes up to 3.2%. Low Income Countries (LICs) get from 5% to 6.5% increase in growth rate from a 10% undervaluation in REER to their non-RTA trading partners.

These results support our story about different elasticities and dissimilar effect (and nature) of effect of trade integration through RTAs for countries with different income level. Developed countries are highly integrated in their production networks between themseleves and their RTA trading partners, therefore when undervalying their currency, they gain mostly on the undervaluations against their non-RTA trading partners. The well-known implementation of the "beggar-thy-neighbor" policies is a tool for EMs, as they are not very integrated vertically in the production chains (according to our estimates, this policy is losing its efficiency over the timespan - which talks in favor of trade integrative nature of RTAs). EMs see the exchange rate as a tool for export enhancing when bounded by an RTA - the result consistent with Fernandez-Arias *et al.* (2002). Concerning LICs - LICs are usually seen as a source of resources, or a intermediate step of supply chain specializing in either low value-added or highly labor intensive skill-scarce activitiesHolmes *et al.* (n.d.); Fox (2004). Therefore undervaluation of these countries against their non-RTA trading partners does not have as sizeble impact on the partner economies, while boosting their economic growth. At the same time, one should notice the fragile state of some RTA structures of LICs - the undervaluation to their RTA trading partners may hurt their own economy through what we see two channels - the political fragility as RTAs is seen as a source of political leverage for LICs and through inelastic demand for their own goods - their tradable goods are more expensive relative the non-tradables, and even though the undervaluation enhances production of the tradables, the income in the RTA-bounded cannot be sufficiently released to buy the goods.

One worry could be that the advanced countries result is being effected by the Eurozone countries. Table 4 shows that results remain stark for when we omit all Euro-denominated countries (since the fixed their exchange rate to Euro). In fact, the effect is

In the table 5 the results are presented when we smooth all the bilateral trade flows over 5 years. The absence of significance of the undervaluation over non-RTA partners among the sample of developed countries can be explained by the fact that there has been many new entries into the RTAs that have changed the map of trade. The elasticities are still different as devised when we look at the HP-measure. Overall we still get the similar result.

The estimates are quite high than traditionally estimated in the growth regressions on th exchange rates, but are anticipated if we take into consideration the fact that we are using the real effective exchange rate, and taking into consideration all existent trading partners.

In general our results confirm the hypothesis that the growth enhancing effect of undervaluations is actually coming from the undervaluations against the trading partners with whom there is lower integration of production processes. We use RTA as a proxy for the trade dependency between countries. Conditioning on the type of RTA (as we have explained earlier the most trade integrative RTAs will be signed by the developed countries).

The underlying channel of the different elasticities between undervaluations is the improvement of the trade balance of a country. In table 8 we present results over the median split of the bilateral trade imbalance. We code the lowest bilateral trade imbalance as $RTA = 1$ since the most trade integrative RTAs will also be lowering the trade imbalance[17]. The results confirm that advanced countries are improving their economic growth mostly on the base of the non-RTA trading partners. The result on the "beggar-thy-neighbor" policies of the EMs is also holding - 2.3% growth on 10% undervaluations against the countries that have low trade imbalance with the emerging countries. The result for LICs is somewhat different. The LIC countries grow by 6.4% when they undervalue 10% against countries that have trade imbalance lower than median. This captures the import-dependence of the LICs: they import a lot of tradables, and the lower are the prices or the more they are able to substitute their imports, the more funds are available for other means of growth enhancement. This argues against the "export-led"[18] theories and advocates for the need of the LICs to climb the ladder of the supply chains.

Table 9 supports the "geography" of the trade integration - the countries are most inte-

[17]See the companion paper (forthcoming) for the discriptions and statistics.

[18]These theories (Adelman, 1984) claim that we can sustain the low-developed countries by exporting the resources from them, outsourcing the labor-intensive activities and importing into them "other" needed goods under preferential rates.

grated with the neigbours, and the undervaluations against the neighbors hurts the domestic economy.

6.1 Causality tests

In tables 11 and 10 we present the results with the usual growth determinants, alike the ones in (Rodrik, 2008). We find the positive effect of the undervaluations being mostly sourced from the effect on the non-RTA trading members robust to all controls. As different controls are available for the different time periods, we present the separate regressions and the regression with all controls simultaneously.

When we lax the strictness of REER equilibrium by looking at the HP filter undervaluation, we still get the positive overall effect of the undervaluations against non-RTA trading partners. Though when we control for givernment consumption (column (2)), for inflation (3) and for savings rate (6) we get greater effect of the undervaluations against RTA-trading partners. This discrepancy in fact is driven by certain subsamples of the countries: as EMs engage a lot into "beggar-thy-neighbor" policies when bounded by RTA, increase in the givernment consumption is seen as insurance against the exchange rate shock. Same applies for inflation - because of the risk of "beggar-thy-neighbor", inflation rate appears to be a better indicator for the trade.

Tables 14 and 15 report the results of the Arellano-Bond estimations, where we treat our measures of undervaluations as endogenous regressors. The instrumental variable approach is ruled out due to a impossibility of finding an exogenous variable that is correlated with the exchange rates but does not effect the growth (Rodrik, 2008; Glüzmann *et al.* , 2012). We follow the guidance of Roodman (2009) and apply the Arellano & Bond (1991) technique in using the generalized method of moments as an estimation method. The results of the GMM estimations as earlier perform the positive and significant effect of the undervaluations over the non-RTA trading partners. In table 15, where we use more laxed definition of the real exchange rate equilibrium by using HP filter, in column (2) and (6) with the two-step sestem GMM we observe that the undervaluations against RTA trading partners are driving the positive effect on economic growth. One could dedact that subsample of developing and emerging countries in (6) is leading the result in (2); the result in (6) illustrates our finding about possible efficiency of the "beggar-thy-neighbor" monetary policies between the developing countries[19].

7 Channel of the effect

Previous sections discussed the complex nature of economic growth - regional agreements - undervaluation relationship. The results of the estimations based on the Rodrik (2008) indicated effect of undervaluation has significantly different magnitudes conditioning on whether it is channeled through RTA or non-RTA trading partners. Moreover, among different types of countries there might be different directions of the effect of undervaluation against these subgroups of trading partners. This paper argues that the effect of undervaluation is non-linear between the RTA and non-RTA trading partners due to the, on average, greater trade integration between the RTA trading partners. The result is ambigous with respect to the emerging economies, but we assert that this is due to little trade integration that follows an RTA for emerging economies and higher risks of "beggar thy neighbor" policies.

Another important point we are touching upon is the existence of the J-curve effect. Our findings are consistent with the J-curve theory, as our main finding is that the slope of the

[19] As, for example, in case of Brazil in 1999 which provoked reallocation of Argentinian producers to Brazil.

J-curve will be different when looking at the RTA trade and non-RTA trade. The relapse to the positive side of the J-curve will be much faster with respect to the non-RTA trading partners, and much longer with respect to RTA trading partners because of importance of the imports from RTA-partners in a country's exports, which may deem in some cases very long periods of sustaned undervaluation. Therefore, the composition and integration of trade will matter for the speed of the J-curve effect, and we will observe two separate patterns in J-curves built with respect to subset of RTA and non-RTA trading partners.

The greater is interdependency between the RTA trading partners, the less efficient (and possibly harmful) depreciation may be, as the production of the depreciating country is more dependant on the imported inputs which increase their price. In this section we illustrate this channel by building an extension to Obstfeld & Rogoff (2005) model and then provide some statistical evidence on the trade imbalances in the RTAs[20].

7.1 Analytical framework

The section above presented the result of running the economic growth equation as set up by Rodrik (2008) on measures of undervaluation that are fixed to the regional and non-regional trade agreement partners. The result talk to the fact that there are different elasticities to RTA and non-RTA trading partners, which is motivated by different level of trade integration between the country in question and its trading partners. This section presents the theoretical basis for observed result. By taking the standard three-country model of Obstfeld & Rogoff (2005) and expanding it to still static, but more complicated regional form of the world and allowing dependency of output on the goods produced in the other countries, we model the improvement of the trade balance with respect to the regional and non-regional trading partners. The result indicates that the higher is the trade integration between the regional trading partners, the more the improvement of the trade balance is sourced from the greater trade with the non-regional trading partners. The simulation results also indicate that greater trade integration in the presence of the regional and domestic bias in consumption and production creates greater aggregate trade balance improvement. Full derivations and steps of the presented motivations are in the Appendix II.

It is plausible to assume that countries that sign an RTA are more likely to prefer the goods and components from their RTA partners: as discussed in Freund & Ornelas (2010) it has been believed to be one of the main reasons of RTA emergence,

Research of Moser & Rose (2014) indicates that there is a significant rise in the investor activity when the RTA is announced, and the effect is greater when an RTA is signed between the countries that already trade a lot - the finding is true throughout the sample of countries on the different level of development. This could be seen as Empirical firm-level investigation of Blyde *et al.* (2014) in Latin American countries shows that signing an integration agreement makes the production links more spread between the countries. Another fact that supports our assumption of existence of bias in trade between the RTA partners is that the trade imbalances are lower between the countries that have an RTA in place, as illustrated in the figure 7.1 below [21].

We split the world into "North" and "South"regions with A and B, C and D countries respectively. Countries in the North have an RTA between them, and the countries in the South too. We aim to capture how the dependency between the countries alters the transmission of the exchange rate shock. As described in section theoretical background, signing an RTA conventionally implies greater integration - both consumption and production. The

[20] For a more sophisticated description and analysis, please refer to the companion paper "Trade Re(Im)Balanced"

[21] This result is provided in fuller and discussed in the companion paper "Trade Re(Im)Balanced"

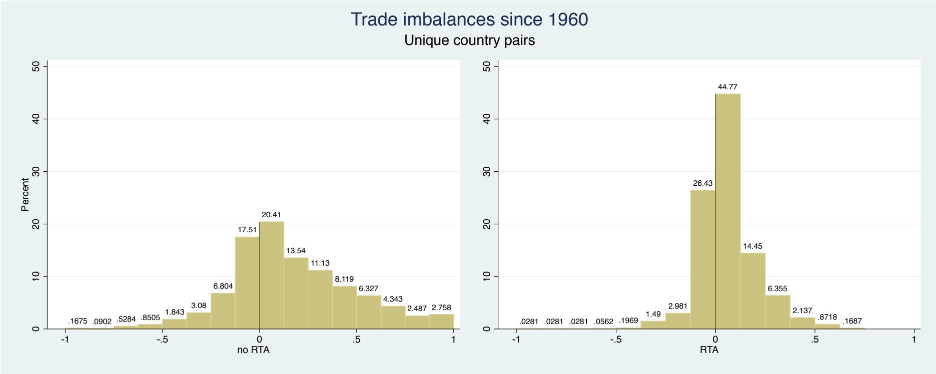

Figure 1: Distribution of the bilateral trade imbalances between RTA and non-RTA trading partners

more efficient an RTA is, the more it triggers structural transformation of the economy. We can differentiate between two types of RTA integration - in goods consumption (referring to parameter "a" further) and in production (parameter "b").

The evidence above allows us to assume that there will be higher preference for the goods produced in home region; there is also domestic bias in consumption and production. The consumption basket of country A then looks like the following:

$$C_A = \left[\left((1+\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \right)^{\frac{1}{\lambda}} (C_{AA})^{\frac{\lambda-1}{\lambda}} + \left((1-\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \right)^{\frac{1}{\lambda}} (C_{AB})^{\frac{\lambda-1}{\lambda}} + \right.$$
$$\left. + \left(\frac{1}{4} - \frac{a}{2} \right)^{\frac{1}{\lambda}} \left((C_{AC})^{\frac{\lambda-1}{\lambda}} + (C_{AD})^{\frac{\lambda-1}{\lambda}} \right) \right]^{\frac{\lambda}{\lambda-1}}$$

C_{ij} represents the good of country j consumed in country i, a is regional bias and α is domestic bias. It is redundant to assume within southern domestic bias when talking about country A from the North.

There is a k mass of firms in each country, and they produce final good of variety k by using their own domestic produced good as intermediate input and the goods of other countries. To incorporate the regional bias we use a two-level production function.The total otput has the Cobb-Douglas functional form for the simplicity. The production function of a firm k in country A uses labor and a composite input:

$$Y_{A,k} = \frac{1}{\eta^{\eta} (1-\eta)^{1-\eta}} A_A (L_{A,k})^{\eta} (V_{A,k})^{1-\eta}$$

where V is a composite intermediate input with price Q. The composite input is a nested CES from the products produced in the 4 countries, and has similar structure as to the consumption basket of the final good, encorporating the regional and domestic biases in the use of the intermediate inputs:

$$V_{A,k} = \left[(1+\beta) \left(\frac{1}{4} + \frac{b}{2} \right)^{\frac{1}{\lambda}} (V_{AA,k})^{\frac{\lambda-1}{\lambda}} + (1-\beta) \left(\frac{1}{4} + \frac{b}{2} \right)^{\frac{1}{\lambda}} (V_{AB,k})^{\frac{\lambda-1}{\lambda}} + \right.$$
$$\left. + \left(\frac{1}{3} - \frac{b}{2} \right)^{\frac{1}{\lambda}} \left((V_{AC,k})^{\frac{\lambda-1}{\lambda}} + (V_{AD,k})^{\frac{\lambda-1}{\lambda}} \right) \right]^{\frac{\lambda}{\lambda-1}}$$

Solving this model for the evolution of the prices, provides us with the link between the exchange rates and the terms of trade (see Appendix II for the derivations and discussion). The presence of the regional and domestic biases in the consumption and production functions makes the link between depreciation and terms of trade between different country-pairs assymmetric. Depreciation against non-regional trading partner improves the terms of trade with the regional trading partner - since you need more regionally imported inputs and goods to satisfy the production and consumption function parameters.

Translating it into the changes of the aggregate trade balance of A after a depreciation:

$$\widehat{TB_A} = 2\left[1-\lambda\left[1-a-b\right]\right]\widehat{\tau_{A,C}} + \left[1-\lambda\left[(1-\alpha)\left(\frac{1}{2}+a\right)+(1-\beta)\left(\frac{1}{2}+b\right)\right]\right]\widehat{\tau_{A,B}} \quad (1)$$

The higher are the regional preferences, the greater will be the increase in trade with non-regionals (since the first term increases on a,b), and the lower will be the change in the trade with the regional trading partner. Therefore when production integration between the regional trading agreement members is more intensive, upon depreciation trade balance improves more on the account of the non-RTA trading partners. In figure 7.1 the simulation results of the model with different levels of regional bias in final goods and intermediate inputs are presented. The lambda is assumed standard to the literature and is equal to 2. We assume domestic preference in final goods consumption $\alpha = 0.675$ and in intermediate goods consumption $\beta = 0.75$. The figure presents the simulation of the 10 results of a 20 % depreciation in country A. The results are normalised to the steady state of the model, and are consistent with the general macroeconomic theory. A depreciation leads to the overall improvement of the trade balance, but including heterogeneous biases between regional and non-regional trading partners allows us to see that there is a greater improvement following the depreciation in a more regionally integrated economy.

Our findings are to some content a direct consequence of the Marshall-Lerner condition: we find lower improvement of trade balance with the RTA trading partners, which suggests that their trade flows are indeed less elastic. The improvement of the trade balance, which channels the effect on economic growth, will be mostly achieved on the expense of the the non-RTA trading partners, as they have a greater trade flows elasticity. In the next subsection we provide further evidence that illustrates our finding: we run dynamic regressions to determine if there are indeed different elasticities of trade balance with respect to the RTA and no-RTA trading partners.

8 Further

8.1 Policy implications

In the modern macroeconomics, the most thought-after dominant goal is the inflation targeting, which leaves the exchange rates a subject to the general FX interventions that are aiming at the lower volatility of the exchange rate. At the same time, changing pattern of the world trade has made the monetary policy shock transmission more complicated.

We show that, as signing an RTA increases the trade integration between the trading partners and strengthens trade linkages between countries, it also alters transmission of the monetary shock, making it less efficient. Therefore, if a country is bound by RTAs to its major trading partners impliments competitive depreciation, the efficiency of it will be much lower than a country which has no RTAs with its trading partners. Of course, different RTAs

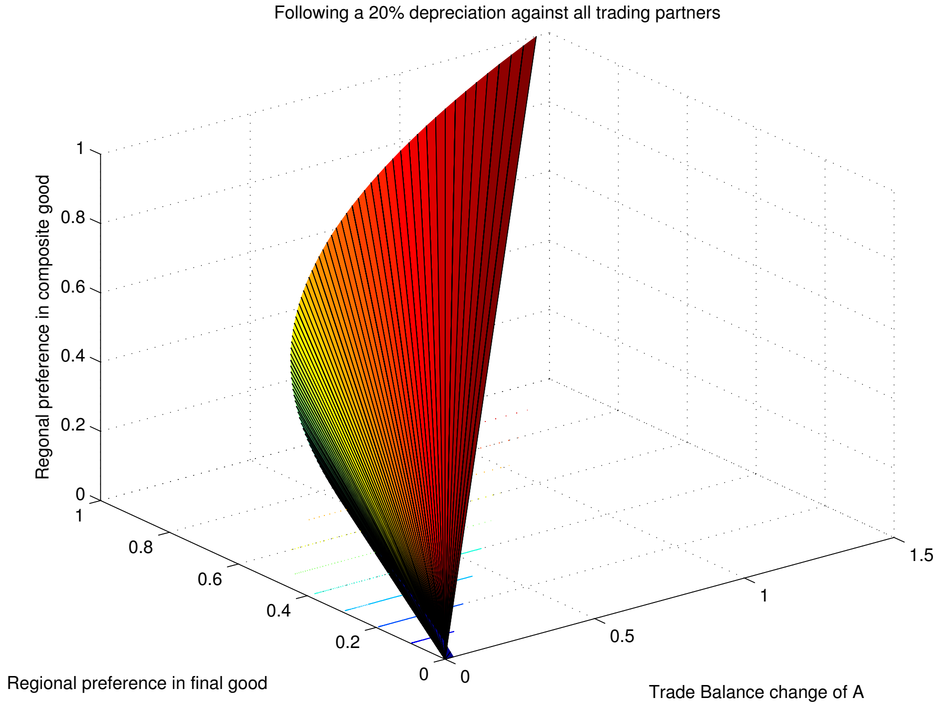

Figure 2: Simulation of the model prediction

will result in different integration levels, but on average every RTA leads to some structural transformation of the economy that leads to re-allocation to the sectors of the comparative advantage and, therefore, promotes trade creation.

The result is more relevant for the developed economies, as they have started implementing RTAs earlier which lead to greater and broader integration(Freund & Ornelas, 2010). They are also more likely to specialize in the more unique production stages, while outsourcing more upstream tasks to the less developed countries.

At the same time least developed countries benefit more from what is known as "beggar-thy-neighbor" policies: they get higher effect from depreciating their currency against their RTA trading partners. This is contributed to the fact that RTAs increase trade integration less among the least developed countries (LIC), acting more like a geographic political tool.

In our policy implication we assume that such policy tools exist that can maintain an undervalued currency. This is also an assumption of Rodrik (2008), and it has been discussed by Woodford (2009).

Another critique of Rodrik's result is that undervaluation among the developed countries may not have the same definition due to the ratio of tradables to non-tradables prices and we should take into account policies of developed countries that increase both the exchange rates and growth (in his argument - savings, as a measure that increases growth and effects exchange rates)[22]. By using a more aggregate index and concentrating on the non-linearity of transmission of the monetary policy shock between the subsets of trading partners we believe to step away from this constraint. We believe that in our framework we show that even though developed countries are more constrained in their monetary policies, they still can exploit the gains of competitive depreciation.

Another important critique that we can step through is that the (small) size of the tradables sector in the developing countries can lead to a mechanic association between exchange

[22]See Woodford (2009)

rate and growth, that does not necessary lead to causation. If we assume (which is a plausible assumption according to some trade economists) that RTAs are signed by the countries with a relatively similar consumption basket, then we show that the effect of undervaluation is more than a pure mechanics as it has a non-linear effect. If the undervaluation was not causing growth, but this was a pure mechanical correlation, we would not have observed systematically greater effect of undervaluation against non-RTA trading partners. This provides an important tool for the monetary design and policy analysis: exchange rate policies that are directed at different tradables sectors will be growth-enhancing, no matter the size of the tradables sector, if the effect of this policy is directed more to the trading partners that do not have an RTA in place.

Our research also contributes to the debate on the negative balance-sheet effect of undervaluation. If the debt is issued in the foreign currency, than depreciation worsens the balance and may lead to contraction. Using Russian Customs dataset from Sokolova (2013) we may state that the trade with the RTA partners is more likely to be priced in domestic currency and the trade with non-RTA members is more likely to be priced in foreign currency. As we observe the greater effect of undervaluation against the non-RTA trading members, we may conclude that the "real" effect of the undervaluation on the economy on average outweights the balance-sheet effect.

8.2 Competitive Depreciations and Undervaluation of the Currencies

In the previous sections we have indicated that that the commonly known positive effect of undervaluation on economic growth is actually sourced from the undervaluations - or competitive depreciations - against countries which are not bounded by the RTA. The result is highly robust to various specifications.

We broke down the price competitiveness index into two parts based on the RTA participation, and showed in the fixed effect panel estimation that competitive depreciation will have a different effect depending on the composition of the trade flows of the country that is implementing it. If a country is participating actively in RTAs, there will be high intensity of trade between the RTA trading partners, and the effect of undervaluation will be low as the enhancement of exports will be conditioned on the greater price of the imported inputs which are harder to be substituted when an RTA is signed between two countries. If with the majority of its trading partners there is an RTA signed, then an undervaluation may not benefit the host economy.

Our findings also explain why there is a diverse response to overvaluations - some overvaluations may be less harmful if they are directed against the RTA-trading partners that supply the imported inputs: the decrease in the relative price of imports may actually increase the exports[23].

The analysis tool we are providing indicates another important finding: signing an RTA may be an important tool in securing the adverse effects on the monetary policy spillovers of a country's trading partners. Of course, one should differenciate between the different type of RTAs - we will leave this question open till further research - but if an RTA has trade facilitating features, then competitive depreciation of one of the RTA members may not harm its other RTA members as to boost its exports the depreciating country will need more - more expensive - imports. It is undoubtedly conditioned on the type of the industries that one could be looking at, but this is an important addition i the analysis of the design and transmission of the monetary policy.

[23]On the diverse effects of the overvaluation the reader can regard Bussiére *et al.* (2014)

8.3 Further research

Our reserch so far is concerned with only the undervaluations based on the conventional measure of the REER. We base our REER, as commonly and wide acceptedly done, on the CPIs and gross trade flows. This provokes two shortcomings: the price iindexes may take into account the capital in- and out-flows, and the gross trade may be unrepresentative of the economy in question. In the current decade majority of the scholars have agreed that due to the complicated supply linkages and improved ease of trade between countries, looking at the gross trade flows might be misleading. The better measurement of trade integration is provided by the value added trade flows(Baldwin, 2011b; Johnson & Noguera, 2012). Value added indicates the actual contribution of the country into its exports, leaving outside the doublecounting of intermediate imported inputs.

The research of Blyde *et al.* (2014) illustrates that RTAs indeed facilitate a structural shift for the countries by showing on the Latin American example that entering an RTA signifies higher number of cross-border mergers and acquisitions, implying that it leads to a greater supply chain integration. This shows that

Therefore one could infer that it will be more appropriate instead of the price competitiveness to look at the competitiveness that is linked to the value-added activities.

The theory and method of Bems & Johnson (2012) formulates a VAREER measure of the real effective exchange rate that is more accomodative of the supply chain framework. In contrast to conventional REER, VAREER uses GDP deflator and value-added weights in its construction. This measure performs better than conventional REER when we take into account the global supply linkages.

Using VAREER to study the variegated effect of undervaluations vis-a-vis the RTA and no-RTA trading partners could be an important step in understanding the real effects of global value chains on economic growth of a country.

In the companion paper I investigate the trends of the bilateral trade imbalances between the RTA trading partners. The key result is that an average bilateral trade imbalance deepens by at least 5% within 10 years after the RTA taking place. The effect becomes much at least 3 times greater if only pairs of similar countries[24] are concerned. Average pair of countries that has signed an RTA improves the aggregate trade imbalance with the "rest of the world" - implying the countries outside the RTA by 4%/ This implies that signing an RTA indeed leads to the structural transformation concerned and increases the trade dependency between the trading partners.

9 Conclusions

This paper studied the effects of undervaluations on the economic growth in the context of new developments of international trade. Using existing methodologies we study the effects of undervaluations against RTA and non-RTA trading partners and find that for the majority of the countries the effect is sourced from the undervaluations against non-RTA trading partners.

Our findings of the general relationship between economic growth and real exchange rate are close to the study of Rodrik (2008) who finds that an undervalued currency could be a source of economic growth and that it is more present for the developing rather than developed countries. In contrast to his research, we are not looking into a bilateral real exchange rate to the USD, but at the aggregated measure of real effective exchange rate, which allows us to break the undervaluation by the groups trading partners, capturing the non-linear dispersion of the monetary policy efficiency. We show that trade integration through signing an RTA

[24] As defined through the level of development

channels the monetary shock differently, and the higher effect of undervaluation is sourced from the non-RTA trading partners, as with the RTA partners there is greater dependency on imported inputs which are becoming more expensive after a depreciation.

Developed countries, that are more likely to participate in the production sharing type of RTAs , grow least on undervaluations that are directed against its RTA trading partners[25] as compared to the undervaluations against the non-RTA trading partners, where a 10% undervaluation of the real effective exchange rate increases growth by 2.4% - 6.8%. Developed countries have historically started implementing RTAs earlier and their RTAs are "deeper" than the ones of the emerging economies and low-income countries. These countries have integrated more and are very dependant on the inputs from their RTA trading partners, therefore competitive depreciations that are directed at their RTA partners may result in the "beggar thyself" policies.

The results on the emerging economies show mixed evidence. When we impose a less strict assumption on the estimation technics, the effect of undervaluations against non-RTA trading partners drops from 2.4% on 10% undervaluation to 0.4%, while the effect of the RTA undervaluation becomes significant 3%. We assume that this is a sign of the less stable treatment of RTA by emerging economies - there has been cases of "beggar-thy-neighbor" policies when an RTA was signed. Having lower level of specialization and lower integration among the RTA partners of the emerging economies there exist a greater risk of this policies.

Low income countries, that traditionally have less production sharing resulting from RTAs and specialize more on the upstream activities, benefit more from undervaluations directed at their non-RTA trading partners. Due to fragility of the nature of their RTAs and relatively more easy substitutability of the products and services of the low income countries along the supply chain, they effect of a 10% undervaluation against RTA trading partners can result in shrinkage of the economy by 2.1%.

The effect is channeled through the different elasticities of the trade balance with respect to the terms of trade with its regional and non-regional trading partners. To illustrate that we have built on the basis of Obstfeld & Rogoff (2005) model a four country model that shows the altering effect of the presence of the imported inputs on the improvement of the trade balance. Assuming in our model that RTA is accompanied with a greater dependence on the imported inputs from the other RTA countries, we show that the greater is the trade integration between the regional partners, the less they are exposed to the worsening of the terms of trade with respect to each other economy, and the more they grow on the improvement of the trade balance with the non-RTA trading partners. To support the assumption that RTA "deepens" the relationship between the countries, we show that an enactment of RTA results in the lowering of trade imbalances. The decrease in the size of trade imbalance is true for most of the average country pair, and the more similar are the countries, the greater is the decrease. The result is highest (about on average across *all* pairs) at 4% between the advanced economies, which supports our finding that RTAs brings highest degree of trade integration for developed economies.

We show that not all currency undervaluations will have a similar effect. A country that is tied by many RTAs and is an active participant in the global value chains - implying that it uses imported inputs and specializes in a a certain stage of the good production - will grow less on undervaluation, whereas a country that has fewer RTAs in place can be more successful in implementing "beggar thy neighbor" monetary policy. Signing an RTA signifies the structural transformations in the economy that are aimed (and in most of the cases result) at reallocation of resources from low-productive to high-productive activities in tradable sector. This reallocation increases trade itself and trade dependency between the countries. This

[25] In most of the cases we get insignificant estimates

reallocation changes the production dependency and plays an important role in transmission of the monetary policy and alters the efficiency of competitive depreciations. The results that we have presented illustrate that monetary policy will have a different efficiency depending on the composition and direction of trade flows and the degree of economic integration of the country. Exchange rate policies are usually not included in the RTAs clauses, and frequently are thought as an available policy tool for the export enhancement. We formulate a new argument which shows that implementation of these policies can have be less effecient than traditionally thought off on the economic growth.

Future research on the topic is needed, since not all RTAs will instigate structural transfomation in the participating economies, and, more importantly, it will be different across different industries. This paper has highlighted the non-linear effect of undervaluations on the economic growth due to complicated structure of the current international trade linkages.

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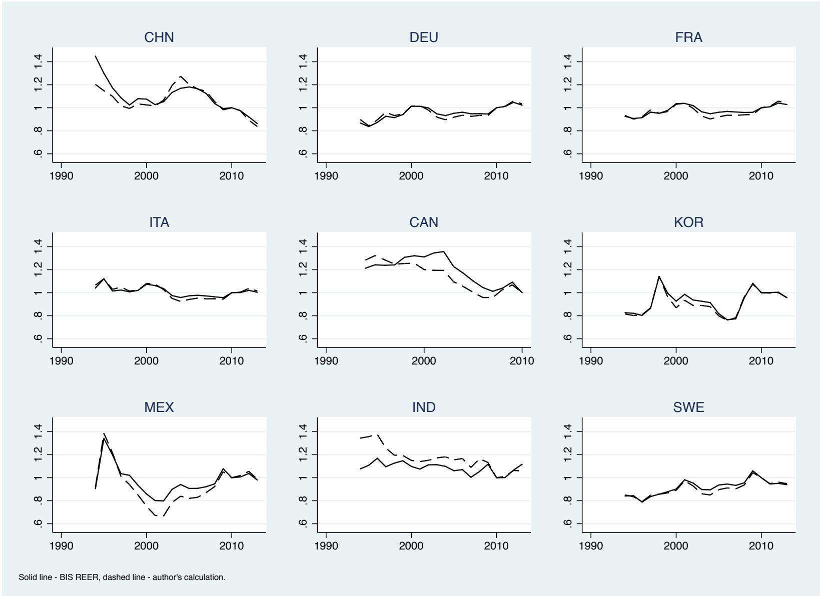

Figure 3: Comparison between BIS REERs and Athor's calculations (for selected economies)

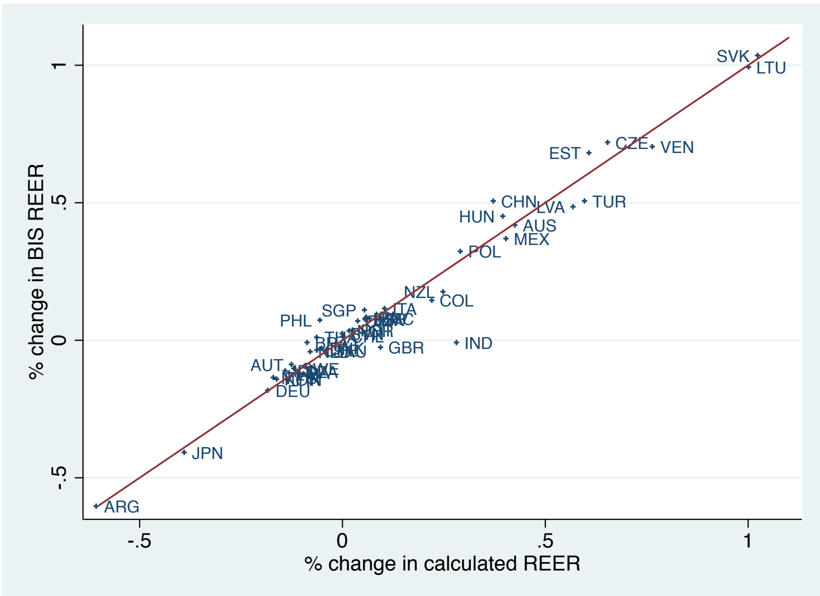

Figure 4: Comparison between changes in REERs

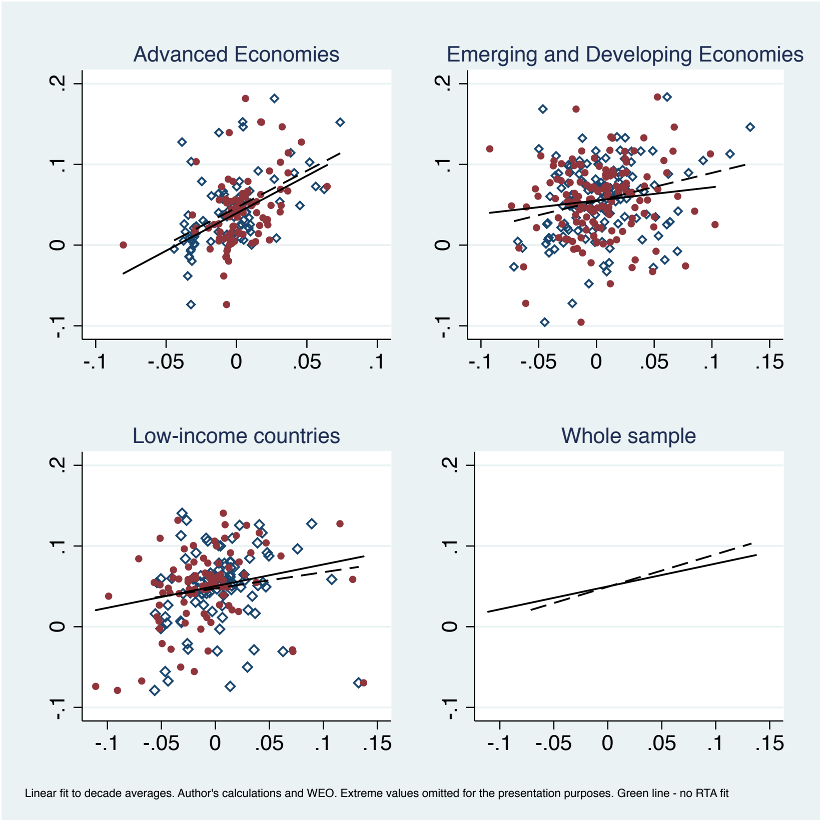

Figure 5: Linear fit of the decade averages of economic growth on subsample-fixed REERs

Figure 6: Linear fit of economic growth on the lagged change of subsample-fixed REERs (decade averages)

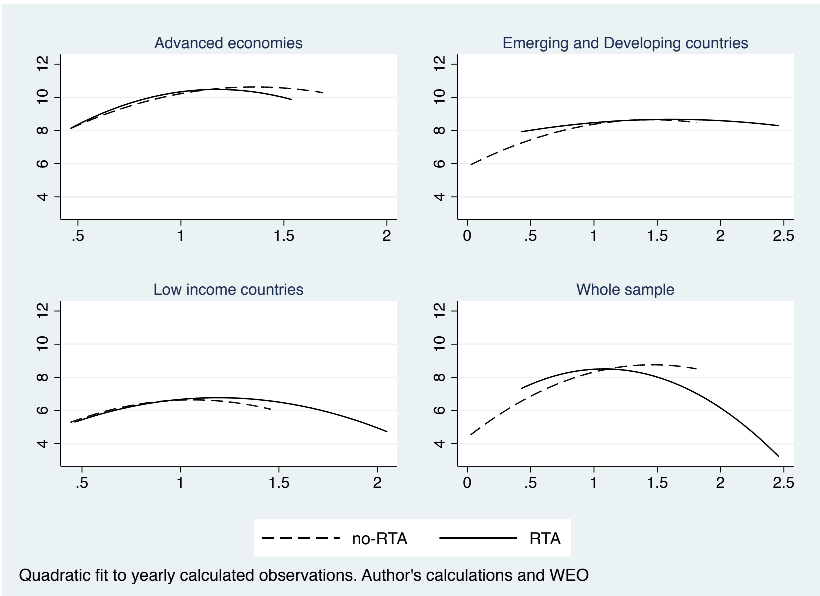

Figure 7: Quadratic fit of the yearly data on subsample-fixed REERs and country GDP per capita

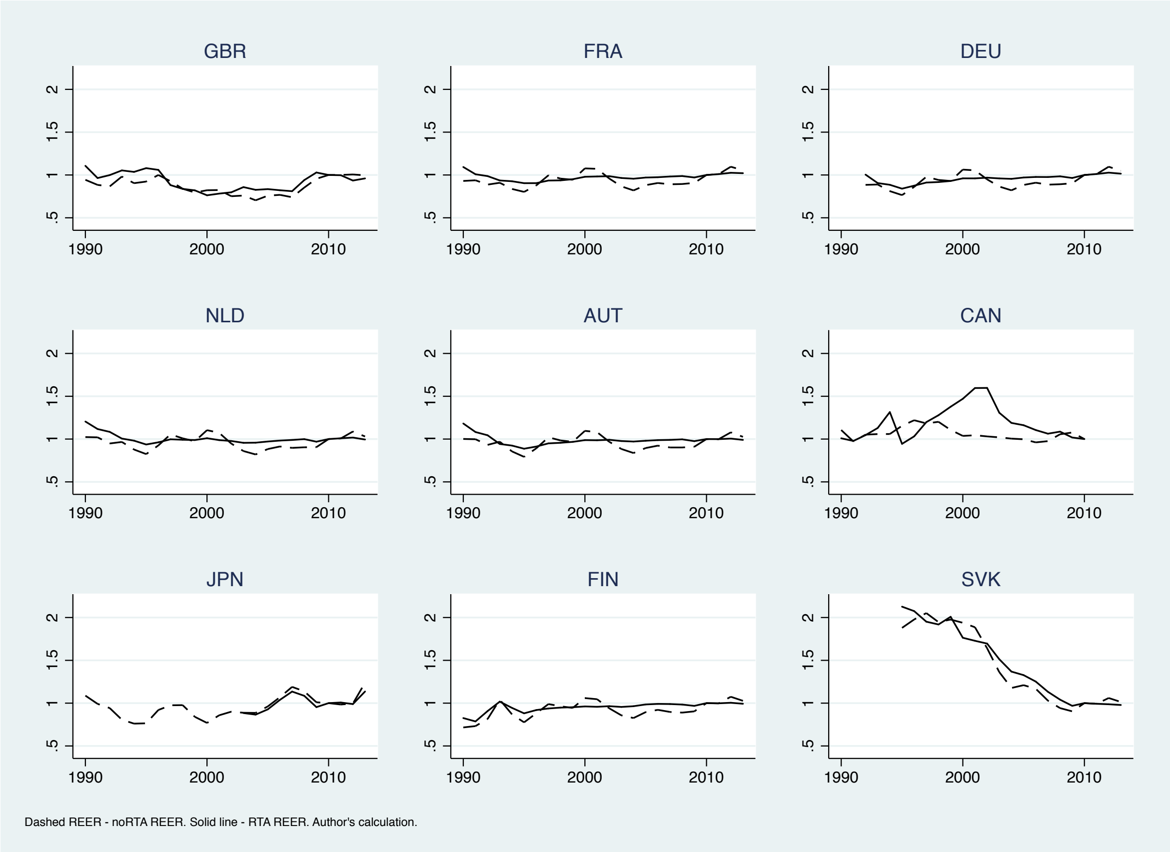

Figure 8: DOTs data: Subsample-fixed REER for selected developed countries

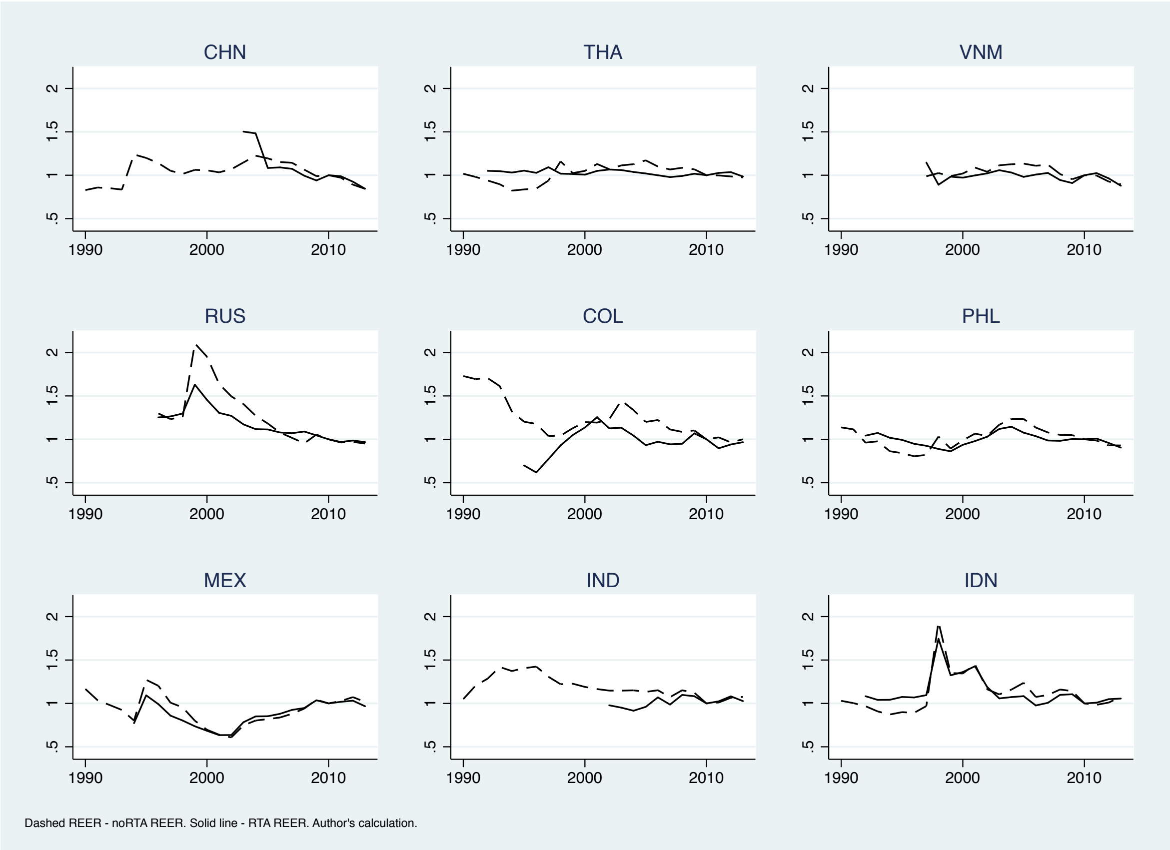

Figure 9: DOTs data: Subsample-fixed REER for selected developing countries

Table 1: Country List of the subsamples by income

Advanced Economies	Emerging Market and Developing Economies		Low-income countries	
Belgium	Albania	Lithuania	Armenia	Sierra Leone
Luxembourg	Algeria	Macedonia, FYR	Maldives	Nepal
Portugal	Argentina	Malaysia	Nicaragua	Kyrgyz Republic
Singapore	Bahamas, The	Mauritius	Sudan	Mongolia
Finland	Barbados	Mexico	Burkina Faso	Cambodia
France	Belize	Morocco	Ghana	Georgia
Ireland	Brazil	Oman	Bangladesh	Niger
Slovak Republic	Brunei Darussalam	Pakistan	Rwanda	Tanzania
Sweden	Bulgaria	Panama	Mauritania	Mali
Spain	Chile	Paraguay	Togo	Senegal
Austria	Colombia	Peru	Chad	St. Lucia
Iceland	Costa Rica	Philippines	Guinea	Bolivia
Germany	Croatia	Poland	Grenada	Vietnam
Slovenia	Dominican Republic	Qatar	Uganda	
Czech Republic	El Salvador	Russian Federation	Nigeria	
Australia	Fiji	Saudi Arabia	Guyana	
New Zealand	Gabon	Seychelles	Tonga	
Norway	Guatemala	South Africa	Dominica	
Switzerland	Hungary	Sri Lanka	Kenya	
Estonia	India	St. Kitts and Nevis	Burundi	
Italy	Indonesia	Suriname	Honduras	
Malta	Jamaica	Syrian Arab Republic	Mozambique	
Netherlands	Jordan	Thailand	Cameroon	
Denmark	Kazakhstan	Trinidad and Tobago	Madagascar	
Japan	Kuwait	Tunisia	Zambia	
Greece	Latvia	Turkey	Ethiopia	
Cyprus	Lebanon	Ukraine	Malawi	
Canada	Libya	Uruguay	Benin	

Table 2: Correlations between the undervaluations measures

	$Rod, noRTA$	Rod, RTA	$HP, noRTA$	HP, RTA
$Rod, noRTA$	1			
Rod, RTA	0.74	1		
$HP, noRTA$	0.05	0.02	1	
HP, RTA	0.22	0.34	0.08	1

Table 3: Main regression: results on the three-year averages

	Dependent variable - GDPpc growth								
	Rodrik measure of undervaluation					HP measure of undervaluation			
	Full Sample		Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
ln Initial Income	-0.31***	-0.27***	-0.24***	-0.34***	-0.28***	-0.37***	-0.28***	-0.41***	-0.31***
	(0.03)	(0.04)	(0.08)	(0.07)	(0.07)	(0.03)	(0.05)	(0.05)	(0.07)
$underREER^{Rod}$	0.11**								
	(0.05)								
$underREER^{Rod,noRTA}$		0.28***	0.24*	0.25**	0.50***				
		(0.08)	(0.14)	(0.10)	(0.11)				
$underREER^{Rod,RTA}$		-0.04	0.04	-0.07	-0.21**				
		(0.05)	(0.16)	(0.06)	(0.09)				
$underREER^{HP,noRTA}$						0.05***	0.68***	0.04***	0.65***
						(0.02)	(0.12)	(0.01)	(0.15)
$underREER^{HP,RTA}$						0.36***	0.25*	0.32*	-0.08
						(0.13)	(0.14)	(0.17)	(0.15)
Constant	2.19***	1.97***	2.20***	2.35***	1.42***	2.57***	2.53***	2.85***	1.79***
	(0.16)	(0.24)	(0.63)	(0.45)	(0.33)	(0.19)	(0.38)	(0.28)	(0.33)
Observations	906	664	208	280	176	661	208	280	173
R-squared	0.58	0.63	0.83	0.61	0.68	0.64	0.87	0.63	0.69
Number of countries	123	117	30	52	35	117	30	52	35

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

Table 4: Robustness check: no Eurozone

	Dependent variable - GDPpc growth							
	HP measure of undervaluation				Rodrik measure of undervaluation			
	Full Sample	Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Initial Income	-0.28***	-0.28***	-0.35***	-0.28***	-0.37***	-0.30***	-0.43***	-0.31***
	(0.04)	(0.10)	(0.07)	(0.07)	(0.04)	(0.06)	(0.05)	(0.07)
$underREER_t^{Rod,noRTA}$	0.28***	0.27**	0.24**	0.50***				
	(0.07)	(0.13)	(0.10)	(0.11)				
$underREER_t^{Rod,RTA}$	-0.05	-0.02	-0.07	-0.21**				
	(0.05)	(0.16)	(0.06)	(0.09)				
$underREER_t^{HP,noRTA}$					0.04***	0.74***	0.04***	0.65***
					(0.01)	(0.12)	(0.01)	(0.15)
$underREER_t^{HP,RTA}$					0.33***	0.19	0.30*	-0.08
					(0.13)	(0.12)	(0.17)	(0.15)
Constant	1.91***	2.60***	2.42***	1.44***	2.69***	2.84***	2.93***	1.79***
	(0.27)	(0.78)	(0.47)	(0.34)	(0.20)	(0.43)	(0.30)	(0.33)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	597	151	270	176	594	151	270	173
R-squared	0.62	0.80	0.61	0.68	0.63	0.85	0.63	0.69
Number of countries	113	28	50	35	113	28	50	35

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Robustness check: Smoothed 5-year trade flows in weights

	Dependent variable - GDPpc growth							
	HP measure of undervaluation				Rodrik measure of undervaluation			
	Full Sample	Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Initial Income	-0.28***	-0.27***	-0.33***	-0.28***	-0.37***	-0.30***	-0.41***	-0.31***
	(0.04)	(0.08)	(0.07)	(0.07)	(0.03)	(0.05)	(0.05)	(0.08)
$underREER^{Rod,noRTA}$	0.26***	0.24	0.25**	0.48***				
	(0.08)	(0.14)	(0.10)	(0.12)				
$underREER^{Rod,RTA}$	-0.01	0.09	-0.07	-0.18**				
	(0.05)	(0.17)	(0.06)	(0.09)				
$underREER^{HP,noRTA}$					0.05***	0.65***	0.04***	0.62***
					(0.02)	(0.11)	(0.01)	(0.16)
$underREER^{HP,RTA}$					0.38***	0.27*	0.32*	-0.00
					(0.14)	(0.15)	(0.17)	(0.18)
Constant	2.05***	2.39***	2.34***	1.58***	2.58***	2.71***	2.85***	1.78***
	(0.24)	(0.62)	(0.44)	(0.33)	(0.20)	(0.41)	(0.28)	(0.33)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	659	206	280	173	659	206	280	173
R-squared	0.63	0.83	0.61	0.67	0.64	0.87	0.63	0.69
Number of panel_id	117	30	52	35	117	30	52	35

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Smoothed trade flows are generated with the chain-averaged 5year trade flows.

Table 6: Robustness check: Correction for Balassa-Samuelson taking into account the split of REER

	Dependent variable - GDPpc growth							
	HP measure of undervaluation				Rodrik measure of undervaluation			
	Full Sample	Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Initial Income	-0.27***	-0.24***	-0.34***	-0.28***	-0.37***	-0.28***	-0.41***	-0.31***
	(0.04)	(0.08)	(0.07)	(0.07)	(0.03)	(0.05)	(0.05)	(0.07)
$underREER^{Rod,noRTA}$	0.25***	0.27**	0.19**	0.33***				
	(0.07)	(0.12)	(0.09)	(0.12)				
$underREER^{Rod,RTA}$	-0.04	0.04	-0.07	-0.21**				
	(0.05)	(0.16)	(0.06)	(0.09)				
$underREER^{HP,noRTA}$					0.05***	0.68***	0.04***	0.65***
					(0.02)	(0.12)	(0.01)	(0.15)
$underREER^{HP,RTA}$					0.36***	0.25*	0.32*	-0.08
					(0.13)	(0.14)	(0.17)	(0.15)
Constant	1.98***	2.20***	2.36***	1.46***	2.57***	2.53***	2.85***	1.79***
	(0.25)	(0.65)	(0.45)	(0.34)	(0.19)	(0.38)	(0.28)	(0.33)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	664	208	280	176	661	208	280	173
R-squared	0.63	0.83	0.61	0.68	0.64	0.87	0.63	0.69
Number of panel_id	117	30	52	35	117	30	52	35

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Smoothed trade flows are generated with the chain-averaged 5year trade flows.

Table 7: Robustness check: Quality of information on trade

	Dependent variable - GDPpc growth							
	HP measure of undervaluation				Rodrik measure of undervaluation			
	Full Sample	Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Initial Income	-0.29***	-0.29***	-0.34***	-0.28***	-0.38***	-0.33***	-0.42***	-0.31***
	(0.04)	(0.08)	(0.07)	(0.07)	(0.03)	(0.05)	(0.05)	(0.08)
$underREER^{Rod,noRTA}$	0.30***	0.27*	0.29***	0.51***				
	(0.07)	(0.15)	(0.10)	(0.12)				
$underREER^{Rod,RTA}$	-0.04	0.04	-0.09	-0.20**				
	(0.04)	(0.18)	(0.06)	(0.09)				
$underREER^{HP,noRTA}$					0.05***	0.65***	0.04***	0.64***
					(0.02)	(0.12)	(0.01)	(0.15)
$underREER^{HP,RTA}$					0.37***	0.28*	0.31*	-0.02
					(0.13)	(0.16)	(0.16)	(0.17)
Constant	2.08***	2.42***	2.69***	1.57***	2.72***	2.83***	3.19***	1.67***
	(0.29)	(0.74)	(0.54)	(0.32)	(0.23)	(0.49)	(0.36)	(0.33)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	645	195	277	173	645	195	277	173
R-squared	0.63	0.82	0.61	0.67	0.64	0.86	0.63	0.69
Number of countries	117	30	52	35	117	30	52	35

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Only tradeflows with the 50 main countries (as defined by GDP from 1990-2005)

Table 8: Robustness: Results on Bilateral median trade imbalance split

	Dependent variable - GDPpc growth							
	Contingency				Median trade imbalance			
	Full Sample	Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Initial Income	-0.31***	-0.25***	-0.34***	-0.30***	-0.35***	-0.28***	-0.37***	-0.31***
	(0.03)	(0.04)	(0.03)	(0.05)	(0.02)	(0.03)	(0.03)	(0.04)
$Underval^{Rod,noRTA}$	0.01	0.30***	0.02	-0.08				
	(0.07)	(0.10)	(0.10)	(0.08)				
$Underval^{Rod,RTA}$	0.10*	0.23***	0.05	0.34***				
	(0.06)	(0.06)	(0.10)	(0.10)				
$Underval^{HP,noRTA}$					-0.13**	0.50**	-0.19***	-0.05
					(0.05)	(0.21)	(0.06)	(0.11)
$Underval^{HP,RTA}$					0.17***	0.14**	0.23***	0.64***
					(0.06)	(0.06)	(0.07)	(0.13)
Constant	2.18***	2.11***	2.31***	2.11***	2.38***	2.51***	2.48***	2.10***
	(0.16)	(0.35)	(0.19)	(0.21)	(0.13)	(0.21)	(0.18)	(0.18)
Observations	898	247	431	220	898	247	431	220
R-squared	0.59	0.81	0.57	0.68	0.59	0.83	0.58	0.71
Number of panel_id	123	30	53	40	123	30	53	40

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

Table 9: Robustness: Results on Contingent countries split

	Dependent variable - GDPpc growth							
	Undervaluation - Rodrik				Undervaluation - HP filter			
	Full Sample	Advanced countries	Emerging and Developing	Low Income	Full Sample	Advanced countries	Emerging and Developing	Low Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Initial Income	-0.31***	-0.21***	-0.35***	-0.25***	-0.36***	-0.26***	-0.38***	-0.30***
	(0.03)	(0.07)	(0.03)	(0.06)	(0.02)	(0.03)	(0.03)	(0.07)
$Underval^{Rod,noRTA}$[26]	0.17***	0.55***	0.09*	0.30***				
	(0.05)	(0.14)	(0.05)	(0.09)				
$Underval^{Rod,RTA}$[27]	-0.05*	-0.26**	-0.02	-0.04				
	(0.03)	(0.11)	(0.03)	(0.06)				
$Underval^{HP,noRTA}$[28]					0.13***	0.96***	0.08**	0.62***
					(0.04)	(0.14)	(0.04)	(0.12)
$Underval^{HP,RTA}$[29]					-0.10***	-0.14	-0.06*	-0.08**
					(0.03)	(0.11)	(0.03)	(0.04)
Constant	2.16***	1.84***	2.33***	1.77***	2.43***	2.36***	2.50***	1.95***
	(0.19)	(0.54)	(0.21)	(0.30)	(0.15)	(0.25)	(0.20)	(0.31)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	
Observations	708	186	343	179	707	186	342	179
R-squared	0.61	0.86	0.58	0.75	0.60	0.89	0.58	0.77
Number of panel_id	101	24	43	34	100	24	42	34

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Robustness check: Economic growth and Other Covariates (Rodrik measure)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable - GDPpc growth						
lag_gdppc	-0.28***	-0.28***	-0.26***	-0.28***	-0.28***	-0.27***	-0.28***
	(0.05)	(0.04)	(0.03)	(0.05)	(0.05)	(0.04)	(0.05)
$REER^{Rod,noRTA}$	0.53***	0.28***	0.32***	0.56***	0.24***	0.29***	0.60***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.08)	(0.10)
$REER^{Rod,noRTA}$	-0.17**	-0.04	-0.07	-0.17*	-0.00	-0.05	-0.24**
	(0.07)	(0.05)	(0.06)	(0.09)	(0.05)	(0.05)	(0.10)
Rule Of Law	0.04						0.01
	(0.04)						(0.06)
Gov. Consumption		-0.00					-0.01
		(0.00)					(0.01)
Inflation			0.16***				0.30
			(0.04)				(0.29)
Education Spending				0.00			0.00
				(0.00)			(0.00)
Terms Of Trade					0.04		-0.09
					(0.09)		(0.17)
Savings						0.00***	0.00
						(0.00)	(0.00)
Constant	2.23***	2.01***	1.85***	1.86***	2.03***	2.06***	2.26***
	(0.37)	(0.29)	(0.21)	(0.36)	(0.31)	(0.25)	(0.44)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Observations	563	658	663	466	586	646	380
R-squared	0.68	0.63	0.65	0.70	0.65	0.63	0.75
Number of panel_id	117	117	117	109	107	117	99

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

Table 11: Robustness check: Economic growth and Other Covariates (HP measure)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable - GDPpc growth						
lag_gdppc	-0.41***	-0.37***	-0.36***	-0.36***	-0.34***	-0.36***	-0.37***
	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
$REER^{HP,noRTA}$	0.05***	0.06**	0.05***	0.72***	0.44***	0.06***	0.71***
	(0.01)	(0.02)	(0.02)	(0.06)	(0.09)	(0.02)	(0.07)
$REER^{HP,RTA}$	0.47***	0.35***	0.37***	0.13	0.19*	0.37***	0.07
	(0.12)	(0.13)	(0.12)	(0.14)	(0.11)	(0.14)	(0.15)
Rule Of Law	0.02						-0.01
	(0.04)						(0.05)
Gov. Consumption		-0.00					-0.00
		(0.00)					(0.01)
Inflation			0.16***				0.31
			(0.03)				(0.27)
Education Spending				0.00			0.01
				(0.00)			(0.01)
Terms Of Trade					0.12		0.11
					(0.11)		(0.18)
Savings						0.00***	0.00*
						(0.00)	(0.00)
Constant	3.27***	2.59***	2.49***	2.51***	2.43***	2.60***	2.90***
	(0.32)	(0.22)	(0.19)	(0.30)	(0.22)	(0.21)	(0.39)
Country FE	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES
Observations	563	655	660	466	583	645	380
R-squared	0.67	0.64	0.66	0.74	0.69	0.65	0.78
Number of countries	117	117	117	109	107	117	99

Robust standard errors in parentheses

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

Table 12: Growth rates on growth rates regression

	Dependent variable - GDPpc growth							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
lagged GDPpc growth	0.26**	0.30**	0.27**	0.30***	0.37**	0.18	0.24**	0.58***
	(0.11)	(0.13)	(0.12)	(0.10)	(0.15)	(0.14)	(0.11)	(0.20)
$\Delta\ Underval^{Rod,noRTA}$	0.22*	0.22	0.22*	0.25**	0.37**	0.11	0.21*	0.54**
	(0.12)	(0.17)	(0.12)	(0.10)	(0.16)	(0.16)	(0.12)	(0.24)
$\Delta\ Underval^{Rod,RTA}$	0.08	0.17	0.08	0.09	0.26	0.13	0.08	0.40*
	(0.09)	(0.13)	(0.09)	(0.09)	(0.16)	(0.10)	(0.10)	(0.21)
Δ Rule of Law		-0.03						0.04
		(0.07)						(0.14)
Δ Gov. Consumption			-0.00					-0.01
			(0.00)					(0.01)
Δ Inflation				0.11				-0.57**
				(0.07)				(0.27)
Δ Education Spending					0.00			0.00
					(0.00)			(0.00)
Δ Terms Of Trade						0.33		-0.30
						(0.31)		(0.49)
Δ Savings							0.00	0.00
							(0.00)	(0.00)
Constant	0.25*	0.04	0.25*	0.25*	0.45***	0.23*	0.50***	-0.13*
	(0.14)	(0.04)	(0.14)	(0.14)	(0.05)	(0.14)	(0.05)	(0.07)
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Time FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	617	485	610	615	366	538	588	285
R-squared	0.58	0.64	0.58	0.59	0.67	0.61	0.58	0.72

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Results by regions (random effects regression, from 1998)

	Dependent variable - GDPpc growth						
Region		CIS	Europe	LAC	MENA	SSA	Asia
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln Initial Income	-0.02***	-0.01	-0.05*	-0.09***	-0.02	0.00	-0.03**
	(0.00)	(0.04)	(0.03)	(0.02)	(0.02)	(0.01)	(0.01)
$Underval^{Rod,noRTA}$	1.23***	4.38***	0.54*	1.52***	0.75***	0.87***	1.49***
	(0.11)	(0.83)	(0.30)	(0.21)	(0.13)	(0.25)	(0.48)
$Underval^{Rod,RTA}$	0.69***	0.45	0.48*	0.35*	-0.05	0.81***	0.31
	(0.12)	(0.37)	(0.25)	(0.20)	(0.23)	(0.22)	(0.25)
Constant	0.25***	-0.59***	0.57**	0.83***	0.31**	0.03	0.33***
	(0.04)	(0.20)	(0.29)	(0.16)	(0.14)	(0.07)	(0.10)
Time FE	YES	YES	YES	YES	YES	YES	YES
Observations	509	30	78	107	36	99	53
Number of countries	117	6	17	25	10	24	13

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

Random effects model chosen over the fixed effects model due to the very small sample size (starting from 1998). Hausman test satisfyed. Selecting into such regions takes care for the unimportant time-invariant countries specific characteristics.

Table 14: GMM estimations (Rodrik measure)

	Dependent variable - GDPpc growth							
	Full sample		Developed countries		Developing and Emerging		LICs	
	two-step difference	two-step system	two-step difference	two-step system	two-step difference	two-step system	two-step difference	two-step system
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged growth	0.32***	0.47***	0.27*	0.32*	0.19	0.42**	0.20	0.52***
	(0.10)	(0.10)	(0.15)	(0.17)	(0.16)	(0.17)	(0.16)	(0.12)
ln Initial income	-0.27***	-0.03***	-0.21	0.02	-0.33*	-0.05***	-0.56***	0.00
	(0.10)	(0.01)	(0.15)	(0.03)	(0.17)	(0.02)	(0.11)	(0.01)
$Underval^{Rod,noRTA}$	0.88***	0.85***	0.65***	0.58***	0.64***	0.74***	0.98***	1.05***
	(0.13)	(0.15)	(0.19)	(0.20)	(0.20)	(0.24)	(0.20)	(0.17)
$Underval^{Rod,RTA}$	0.10	0.07	0.25	0.26	0.03	-0.03	-0.19	-0.04
	(0.08)	(0.08)	(0.21)	(0.18)	(0.11)	(0.10)	(0.16)	(0.15)
Constant		0.01		0.00		0.00		0.05*
		(0.02)		(0.02)		(0.03)		(0.03)
Observations	500	617	171	201	198	250	131	166
Number of countries	113	116	30	30	50	52	33	34
P-value Hansen test	1.000	0.998	1	1	1.000	1.000	1.000	1

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

The results are achieved through application of the `xtabond2` of stata, with all usual assumptions as according to (?). We estimate all regressions with time and country dummies. We use only the first lag as suggested by the appropriate test for the Arellano-Bond type of estimators. We use three-year averages for all variables.

Table 15: GMM estimations (HP filter measure)

	Dependent variable - GDPpc growth							
	Full sample		Developed countries		Developing and Emerging		LICs	
	two-step difference	two-step system	two-step difference	two-step system	two-step difference	two-step system	two-step difference	two-step system
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged growth	0.13	0.12	0.16	0.38**	0.02	0.17**	-0.21	0.54***
	(0.18)	(0.10)	(0.15)	(0.18)	(0.22)	(0.08)	(0.22)	(0.09)
ln Initial income	-0.43***	-0.03***	-0.17*	-0.01	-0.48***	-0.02	-0.46***	-0.00
	(0.10)	(0.01)	(0.09)	(0.03)	(0.11)	(0.02)	(0.11)	(0.01)
$Underval^{HP,noRTA}$	0.58***	0.24	1.00***	1.11***	0.44*	0.14	0.63**	1.41***
	(0.16)	(0.15)	(0.16)	(0.18)	(0.24)	(0.09)	(0.27)	(0.20)
$Underval^{HP,RTA}$	0.32***	0.45**	0.20*	0.27*	0.14	0.47**	-0.10	-0.03
	(0.12)	(0.18)	(0.11)	(0.14)	(0.14)	(0.21)	(0.15)	(0.14)
Constant		0.33***		0.10		0.23		0.02
		(0.08)		(0.33)		(0.17)		(0.07)
Observations	498	614	171	201	198	250	129	163
Number of countries	113	116	30	30	50	52	33	34
P-value Hansen test	1.000	0.990	1	1	1.000	1.000	1.000	1.000

Robust standard errors in parentheses

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

The results are achieved through application of the xtabond2 of stata, with all usual assumptions as according to (?). We estimate all regressions with time and country dummies. We use only the first lag as suggested by the appropriate test for the Arellano-Bond type of estimators. We use three-year averages for all variables.

Table 16: Marshall-Lerner condition test (fixed effects panel)

	Full sample		Advanced		Emerging		LICs	
	$\delta lnIMP$	$\delta lnEXP$	$\delta lnIMP$	$\delta lnEXP$	$\delta lnIMP$	$\delta lnEXP$	$\delta lnIMP$	$\delta lnEXP$
$\sum \delta REER^{noRTA}$	-0.75***	0.69***	-0.94***	0.67***	-0.51***	0.42***	-1.14***	0.45***
	(0.013)	(0.15)	(0.07)	(0.08)	(0.09)	(0.12)	(0.33)	(0.17)
$\sum \delta REER^{RTA}$	-0.07***	-0.16***	-0.26***	-0.21*	-0.00	-0.00	0.05**	-0.35**
	(0.01)	(0.07)	(0.07)	(0.12)	(0.00)	(0.00)	(0.02)	(0.14)
$\sum \delta lnIMP$	-0.09*		-0.34***		0.00		0.00	
	(0.05)		(0.10)		(0.00)		(0.00)	
$\sum \delta lnEXP$		-0.15***		-0.00		-0.04***		-0.15***
		(0.03)		(0.00)		(0.01)		(0.06)
$\sum \delta lnY$	1.37***		1.65***		1.10***		1.48***	
	(0.04)		(0.12)		(0.12)		(0.11)	
$\sum \delta lnY^{w}$		0.42***		0.33***		0.04***		-0.37***
		(0.05)		(0.05)		(0.02)		(0.13)
$lnREER^{noRTA}_{t-1}$	-0.10***	0.02	-0.11*	0.18*	-0.17***	0.00	-0.00	-0.45***
	(0.05)	(0.06)	(0.06)	(0.10)	(0.06)	0.08)	(0.16)	(0.21)
$lnREER^{RTA}_{t-1}$	0.05	0.11*	0.09	0.06	0.04	0.17*	-0.22*	0.43**
	(0.04)	(0.07)	(0.06)	(0.011)	(0.06)	(0.09)	(0.13)	(0.19)
$lnIMP_{t-1}$	-0.26***		-0.18***		-0.29***		-0.32***	
	(0.02)		(0.03)		(0.03)		(0.05)	
$lnEXP_{t-1}$		-0.26***		-0.20***		-0.27***		-0.34***
		(0.02)		(0.04)		(0.03)		(0.05)
lnY_{t-1}	0.31***		0.18***		0.33***		0.40***	
	(0.03)		(0.04)		(0.04)		(0.07)	
lnY^{w}_{t-1}		0.48***		0.28***		0.52***		0.79***
		(0.02)		(0.06)		(0.07)		(0.10)
Constant	1.33***	-2.55***	1.09***	-0.69***	1.56***	-2.93***	1.72***	
	(0.11)	(0.26)	(0.13)	(0.23)	(0.17)	(0.45)	(0.27)	(0.84)
Observations	1626	1626	494	494	676	676	456	456
R-squared	0.54	0.28	0.79	0.39	0.62	0.30	0.38	0.31
Countries	117	117	30	30	53	53	34	34

Robust standard errors in parentheses

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

When there were no significance on any of the lags we just report the direction of the estimates and assign value ”0.00”

A Appendix I

A.1 REER construction

Nominal exchange rate $ner_{i,j}$ and consumer price indices $cpi_{i,j}$ are taken from the IFS database and aggregated to yearly values (simple average) across the available data. Competitiveness weight ω_{ij} is calculated in accordance to what is called "third market effect" as opposed to simple trade weights.
Therefore, assume that country i and j can compete in k markets (including their own). Define T_l^k as the sales of country l in country k's market. Then s_j^k is country's j market share in country k and w_i^k share of country i's output sold in country k. s_i^i is the domestic supply of country i to country i. We proxy for domestic supply on the basis of the original Turner & dack (1993) methodology and the WEO data[30].

$$s_j^k = \frac{T_j^k}{\sum_l T_l^k}$$

$$w_i^k = \frac{T_l^k}{\sum_n T_l^n}$$

Then the weight attached to country j by coutry i is:

$$\omega_{ij} = \frac{\sum_k w_i^k s_j^k}{\sum_k w_i^k (1 - s_i^k)}$$

This weight could be understood as the sum over all possible markets of the magnitude of the degrees of competition between producers of the ij country pair over the magnitude of competition of the producers of the country i over all possible markets.
This construction of the competitiveness weight is a convex combination of the bilateral import weight and a double export weights, and can be represented in a following way:

$$\omega_{ij} = \lambda_i^{IMP} \omega_{ij}^{IMP} + \lambda_i^{EXP} \omega_{ij}^{EXP}$$

Where:
$\omega_{ij}^{IMP} = \dfrac{s_i^j}{\sum_{l \neq i} s_l^i}$ - simple import weight;

$\omega_{ij}^{EXP} = \dfrac{\sum_{k \neq i} w_i^k s_j^k}{\sum_{k \neq i} w_i^k (1 - s_i^k)}$ - ratio of the intensity of competition between the producers of i and j markets, taking into account the competition of the other possible markets;

$\lambda_i^{IMP} = \dfrac{w_i^k (1 - s_i^i)}{\sum_k w_i^k (1 - s_i^k)}$ - is the measure of relative importance of competition of the domestic producers of country i and all other producers;

$\lambda_i^{EXP} = \dfrac{\sum_{k \neq i} w_i^k (1 - s_i^k)}{\sum_k w_i^k (1 - s_i^k)}$ - the measure of relative importance of competition of the exporters of country i and other producers in all export markets.

[30] We calculate the following expression: *[(Percent GDP of manufactured VA)*GDP+(Manufactured Imports as Percent of Merchandise Imports)*(Merchandise Imports)]* All values are in a common denomination.

To construct the REERs we use the IMF data on nominal exchange rates[31] and CPIs and calculate bilateral real exchange rates (bRER) between all pairs of trading partners. We normalize all RERs to 2010, therefore each value of bilateral RER is a relative measure to the value of bilateral competitiveness in 2010. For the full sample estimation we calculate the commonly used corresponding conventional REER:

$$REER_{i,t} = \prod^{j \in J} (brer_{i,j})^{\omega_j}$$

where ω_j is calculated over the set of all trading partners J. We calculate share ω_j, as described in the Appendix using the double-weighting scheme - meaning taking into the account the *third market effect* - the competition the trading partners are facing from the third parties. The weight ω_j can be percieved as the sum of magnitudes of degrees of competition of the ij producers over the magnitude of the competition faced by i producers over all possible markets. This methodology of calculating ω_j shares are applied by such institutions as BIS, ECB and IMF (See for example Schmitz *et al.* (2012)).
It is intuitive that the set of trading partners J could be predetermined - as it is done in, for example, BIS where their REER measure is being constructed agains weights of 62 major economies. Figure 4 shows the comparison between the available BIS yearly REER for the major economies and the aggregate REER calculated with our framework. The correlation between the changes is 94%, and the deviations are for some countries (Indonesia, China, Singapore, Estonia, Phillipines, Turkey) could be explained by the fact that these countries assign greater weights to the trading partners that are not included into the 62-countries sample of the BIS[32]. The countries that have the share of trade within the 62-countries close to the actual share of these countries in the countries' trade, lie closer to the 45 degrees line. Figure 4 indicates that we use a technic that is suited for both developed and developing countries, capturing indeed the competitiveness measure as defined by the REER.
As the compound measure of REER is bounded to the chosen set of trading partners J, the resulting measure is discribing the competitiveness index also against the J set. The novelty of our approach is that we use the methodology behind construction of the aggregate measure of competitiveness REER with the ω_j weights to split the REER measure into two competitiveness measures against the subsets J_1 and J_2, where $J_1 + J_2 = J$.
We use the conventional formula used by many international institutions and central banks that includes the double-weighting of exports so that to account for the competition in the third markets. The full methodology with explanation is presented in the Appendix. The double weighting in the construction of the REER allows us to calculate appropriate measures of REERs to J_1 and J_2 without isolating the trading partners within each subset. This is done through keeping the other subset in the weights calculation, but calculating the geometric average over just a subset. [33]
When constructing REER over the set of RTA trading partners J_1 we treat all non-trading partners as competitive destinations in computing the trade weights, but calculate the REER as a geometric average over the J_1 subset of countries. This way the weights reflect the importance of the competition being faced by the trading partners, but the constructed

[31] We take the period averages based on monthly data.

[32] Additional distortions are coming via the third market effect: when the sample of countries is limited to lower number of countries it is transated into lower number of potential competitors and competition markets, and the total competitiveness in the world is also lower.

[33] We also do calculations of the weights with the $(J+1)^{th}$ market which is the composite market of all possible markets in the other subset. Such calculation, in my opinion, captures better the selective nature fo RTAs and the fact that trading partners with an RTA should be seen in most of the cases as a common market by the countries outside an RTA.

REER reflects the competitiveness index of the given country to the certain subset of the countries.
For the construction of the aggregate REER we use the common system of CPI-based REER construction, that goes back to Armington (1969) and McGuirk (1987) theoretical foundations. This construction technic is used by BIS, IMF, OECD and other institutions. The CPI-based REER of country i is then give by the geometric average of the real exchange rates across the j trading partners:

$$REER_{i,t} = \prod_{j=1}^{j=n} \left(\frac{cpi_j ner_j}{cpi_i ner_i} \right)^{\omega_{ij}}$$

As one of the robustness checks we represent all countries outside the sample as a single competeing country. For example, when we are calculating the competitiveness weights attached to the Germany-France trade flows in 2005 as they have an RTA signed, we treat Russia and China as a part of a joint non-RTA market where both of the countries compete. This allows us to estimate the competitiveness weights with respect to the RTA (or non-RTA) trading partners without isolating them from the existence of the non-RTA (RTA) markets. Then $REER^{RTA}$ and $REER^{noRTA}$ become the rempresentative measure of price competitiveness with respect to the given group.

B Appendix II

Until the laws of thermodynamics are repealed, I shall continue to relate outputs to inputs - i.e. to believe in production functions.
Samuelson (1972) (p. 174)

B.1 Consumption

There are 4 countries, A and B, C and D. A and B has an RTA signed (can be seen as "Northern" countries), C and D have a separate RTA (and can be seen as "Southern" countries). Consumption is a nested CES with regional (if $a > 0$) and domestic (if $\alpha > \frac{1}{2}$) bias.
Consumption in country A is:

$$C_A = \left[\left((1+\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \right)^{\frac{1}{\lambda}} (C_{AA})^{\frac{\lambda-1}{\lambda}} + \left((1-\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \right)^{\frac{1}{\lambda}} (C_{AB})^{\frac{\lambda-1}{\lambda}} + \right.$$
$$\left. + \left(\frac{1}{4} - \frac{a}{2} \right)^{\frac{1}{\lambda}} \left((C_{AC})^{\frac{\lambda-1}{\lambda}} + (C_{AD})^{\frac{\lambda-1}{\lambda}} \right) \right]^{\frac{\lambda}{\lambda-1}}$$

The allocation of consumption is:

$$\begin{aligned} C_{AA} &= (1+\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \left(\frac{P_{AA}}{P_A} \right)^{-\lambda} C_A \\ C_{AB} &= (1-\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \left(\frac{P_{AB}}{P_A} \right)^{-\lambda} C_A \\ C_{AC} &= \left(\frac{1}{4} - \frac{a}{2} \right) \left(\frac{P_{AC}}{P_A} \right)^{-\lambda} C_A \\ C_{AD} &= \left(\frac{1}{4} - \frac{a}{2} \right) \left(\frac{P_{AC}}{P_A} \right)^{-\lambda} C_A \end{aligned}$$

where:

$$P_A = \left[(1+\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) (P_{AA})^{1-\lambda} + (1-\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) (P_{AB})^{1-\lambda} + \right.$$
$$\left. + \left(\frac{1}{4} - \frac{a}{2} \right) \left((P_{AC})^{1-\lambda} + (P_{AD})^{1-\lambda} \right) \right]^{\frac{1}{1-\lambda}}$$

Each C_{Ai} basket is of the form:

$$C_{Ai} = \left[\int_0^1 (C_{Ai}(z))^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}}$$

which implies:

$$C_{Ai}(z) = \left(\frac{P_{Ai}(z)}{P_{Ai}} \right)^{-\theta} C_{Ai} \quad ; \quad P_{Ai} = \left[\int_0^1 (P_{Ai}(z))^{1-\theta} dz \right]^{\frac{1}{1-\theta}}$$

Comibning the two levels we get:

$$\begin{aligned}
C_{AA}(z) &= \left(\frac{P_{AA}(z)}{P_{AA}} \right)^{-\theta} (1+\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \left(\frac{P_{AA}}{P_A} \right)^{-\lambda} C_A \\
C_{AB}(z) &= \left(\frac{P_{AB}(z)}{P_{AB}} \right)^{-\theta} (1-\alpha) \left(\frac{1}{4} + \frac{a}{2} \right) \left(\frac{P_{AB}}{P_A} \right)^{-\lambda} C_A \\
C_{AC}(z) &= \left(\frac{P_{AC}(z)}{P_{AC}} \right)^{-\theta} \left(\frac{1}{4} - \frac{a}{2} \right) \left(\frac{P_{AC}}{P_A} \right)^{-\lambda} C_A \\
C_{AD}(z) &= \left(\frac{P_{AD}(z)}{P_{AD}} \right)^{-\theta} \left(\frac{1}{4} - \frac{a}{2} \right) \left(\frac{P_{AD}}{P_A} \right)^{-\lambda} C_A
\end{aligned} \tag{2}$$

Labor supply. If we consider a log utility of consumption and a linear cost of effort, the labor supply is:

$$W_A = P_A C_A \tag{3}$$

B.2 Production

The output of firm k in country A uses labor and a composite input (assume a Cobb-Douglas for simplicity):

$$Y_{A,k} = \frac{1}{\eta^\eta (1-\eta)^{1-\eta}} A_A (L_{A,k})^\eta (V_{A,k})^{1-\eta}$$

where V is an intermediate input with price Q. The demand for labor and intermediate input is:

$$\begin{aligned}
L_{A,k} &= \eta \left(\frac{W_A}{Q_A} \right)^{-(1-\eta)} \frac{Y_{A,k}}{A_A} \\
V_{A,k} &= (1-\eta) \left(\frac{W_A}{Q_A} \right)^{\eta} \frac{Y_{A,k}}{A_A}
\end{aligned}$$

Composite good V as a thought exercise can be seen as a composite capital good, for which you need to use some of the stock of your own capital good, but you also relate to the capital goods of other trading partners.

V is structured in the same way as the consumption basket, with possibly a different regional and domestic bias:

$$V_{A,k} = \left[(1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)^{\frac{1}{\lambda}} (V_{AA,k})^{\frac{\lambda-1}{\lambda}} + (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)^{\frac{1}{\lambda}} (V_{AB,k})^{\frac{\lambda-1}{\lambda}} + \right.$$
$$\left. + \left(\frac{1}{3}-\frac{b}{2}\right)^{\frac{1}{\lambda}} \left((V_{AC,k})^{\frac{\lambda-1}{\lambda}} + (V_{AD,k})^{\frac{\lambda-1}{\lambda}} \right) \right]^{\frac{\lambda}{\lambda-1}}$$

$$V_{Ai,k} = \left[\int_0^1 \left(V_{Ai,k}(z)\right)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}}$$

The allocation and price indexes are (the overall price index Q only differ from the consumption price index because a and b can differ):

$$V_{AA,k}(z) = \left(\frac{P_{AA}(z)}{P_{AA}}\right)^{-\theta} (1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_A}\right)^{-\lambda} V_{A,k}$$
$$V_{AB,k}(z) = \left(\frac{P_{AB}(z)}{P_{AB}}\right)^{-\theta} (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left(\frac{P_{AB}}{Q_A}\right)^{-\lambda} V_{A,k}$$
$$V_{AC,k}(z) = \left(\frac{P_{AC}(z)}{P_{AC}}\right)^{-\theta} \left(\frac{1}{4}-\frac{b}{2}\right)\left(\frac{P_{AC}}{Q_A}\right)^{-\lambda} V_{A,k}$$
$$V_{AD,k}(z) = \left(\frac{P_{AD}(z)}{P_{AD}}\right)^{-\theta} \left(\frac{1}{4}-\frac{b}{2}\right)\left(\frac{P_{AD}}{Q_A}\right)^{-\lambda} V_{A,k}$$

$$Q_A = \left[(1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)(P_{AA})^{1-\lambda} + (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)(P_{AB})^{1-\lambda} + \right.$$
$$\left. + \left(\frac{1}{4}-\frac{b}{2}\right)\left((P_{AB})^{1-\lambda} + (P_{AC})^{1-\lambda} \right) \right]^{\frac{1}{1-\lambda}}$$

B.3 Price setting

The demand faced by firm k in country A is:

$$
\begin{aligned}
Y_{A,k} &= C_{AA}(k) + C_{BA}(k) + C_{CA}(k) + C_{DA}(k) \\
&\quad + V_{AA}(k) + V_{BA}(k) + V_{CA}(k) + V_{DA}(k) \\
&= \left(\frac{P_{AA}(k)}{P_{AA}}\right)^{-\theta} (1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left(\frac{P_{AA}}{P_A}\right)^{-\lambda} C_A \\
&\quad + \left(\frac{P_{BA}(k)}{P_{BA}}\right)^{-\theta} (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left(\frac{P_{BA}}{P_B}\right)^{-\lambda} C_B \\
&\quad + \left(\frac{P_{CA}(k)}{P_{CA}}\right)^{-\theta} \left(\frac{1}{4}-\frac{a}{2}\right)\left(\frac{P_{CA}}{P_C}\right)^{-\lambda} C_C \\
&\quad + \left(\frac{P_{DA}(k)}{P_{DA}}\right)^{-\theta} \left(\frac{1}{4}-\frac{a}{2}\right)\left(\frac{P_{DA}}{P_D}\right)^{-\lambda} C_D \\
&\quad + \left(\frac{P_{AA}(k)}{P_{AA}}\right)^{-\theta} (1+\beta)\left(\frac{1}{3}+b\right)\left(\frac{P_{AA}}{Q_A}\right)^{-\lambda} (1-\eta)\left(\frac{W_A}{Q_A}\right)^{\eta} \frac{Y_A}{A_A} \\
&\quad + \left(\frac{P_{BA}(k)}{P_{BA}}\right)^{-\theta} (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left(\frac{P_{BA}}{Q_B}\right)^{-\lambda} (1-\eta)\left(\frac{W_B}{Q_B}\right)^{\eta} \frac{Y_B}{A_B} \\
&\quad + \left(\frac{P_{CA}(k)}{P_{CA}}\right)^{-\theta} \left(\frac{1}{3}-\frac{b}{2}\right)\left(\frac{P_{CA}}{Q_C}\right)^{-\lambda} (1-\eta)\left(\frac{W_C}{Q_C}\right)^{\eta} \frac{Y_C}{A_C} \\
&\quad + \left(\frac{P_{DA}(k)}{P_{DA}}\right)^{-\theta} \left(\frac{1}{3}-\frac{b}{2}\right)\left(\frac{P_{DA}}{Q_D}\right)^{-\lambda} (1-\eta)\left(\frac{W_D}{Q_D}\right)^{\eta} \frac{Y_D}{A_D}
\end{aligned}
$$

The profits of a firm k are:

$$
\begin{aligned}
\Pi_{A,k} &= \left[(P_{AA}(k))^{1-\theta} - \frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{AA}(k))^{-\theta}\right]\left[\begin{array}{c} (P_{AA})^{\theta-\lambda}(P_A)^{\lambda}(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)C_A \\ +(1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right) * \\ * (P_{AA})^{\theta-\lambda}(1-\eta)(Q_A)^{\lambda-\eta}(W_A)^{\eta}\frac{Y_A}{A_A} \end{array}\right] \\
&\quad + \left[(P_{BA}(k))^{1-\theta} - \frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{BA}(k))^{-\theta}\right]\left[\begin{array}{c} (P_{BA})^{\theta-\lambda}(P_B)^{\lambda}(1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)C_B+ \\ +(1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right) * \\ * (P_{BA})^{\theta-\lambda}(1-\eta)(Q_B)^{\lambda-\eta}(W_B)^{\eta}\frac{Y_B}{A_B} \end{array}\right] \\
&\quad + \left[(P_{CA}(k))^{1-\theta} - \frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{CA}(k))^{-\theta}\right]\left[\begin{array}{c} (P_{CA})^{\theta-\lambda}(P_C)^{\lambda}\left(\frac{1}{4}-\frac{a}{2}\right)C_C \\ +\left(\frac{1}{4}-\frac{b}{2}\right) * \\ * (P_{CA})^{\theta-\lambda}(1-\eta)(Q_C)^{\lambda-\eta}(W_C)^{\eta}\frac{Y_C}{A_C} \end{array}\right] \\
&\quad + \left[(P_{DA}(k))^{1-\theta} - \frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{DA}(k))^{-\theta}\right]\left[\begin{array}{c} (P_{DA})^{\theta-\lambda}(P_D)^{\lambda}\left(\frac{1}{4}-\frac{a}{2}\right)C_D \\ +\left(\frac{1}{4}-\frac{b}{2}\right) * \\ * (P_{DA})^{\theta-\lambda}(1-\eta)(Q_D)^{\lambda-\eta}(W_D)^{\eta}\frac{Y_D}{A_D} \end{array}\right]
\end{aligned}
$$

The optimal prices are then:

$$
P_{AA}(k) = P_{BA}(k) = P_{CA}(k) = P_{DA}(k) = \frac{\theta}{\theta-1}\frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A} \tag{4}
$$

We can then simplify output as:

$$
\begin{aligned}
Y_{A,k} \;=\;& (1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left(\frac{P_{AA}}{P_A}\right)^{-\lambda} C_A + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left(\frac{P_{AA}}{P_B}\right)^{-\lambda} C_B \\
& + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\frac{P_{AA}}{P_C}\right)^{-\lambda} C_C + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\frac{P_{AA}}{P_D}\right)^{-\lambda} C_D \qquad (5) \\
& +(1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_A}\right)^{-\lambda}(1-\eta)\left(\frac{W_A}{Q_A}\right)^{\eta}\frac{Y_A}{A_A} \\
& +(1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_B}\right)^{-\lambda}(1-\eta)\left(\frac{W_B}{Q_B}\right)^{\eta}\frac{Y_B}{A_B} \\
& + \left(\frac{1}{4}-\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_C}\right)^{-\lambda}(1-\eta)\left(\frac{W_C}{Q_C}\right)^{\eta}\frac{Y_C}{A_C} \\
& + \left(\frac{1}{4}-\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_D}\right)^{-\lambda}(1-\eta)\left(\frac{W_D}{Q_D}\right)^{\eta}\frac{Y_D}{A_D}
\end{aligned}
$$

and profits as:

$$
\begin{aligned}
\Pi_{A,k} \;=\;& \frac{1}{\theta-1}\frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{AA})^{-\lambda}\left[\begin{array}{c} (P_A)^{\lambda}(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)C_A \\ +(1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)(1-\eta)(Q_A)^{\lambda-\eta}(W_A)^{\eta}\frac{Y_A}{A_A} \end{array}\right] \\
& +\frac{1}{\theta-1}\frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{AA})^{-\lambda}\left[\begin{array}{c} (P_B)^{\lambda}(1-\alpha)\left(\frac{1}{3}-\frac{a}{2}\right)C_B \\ +(1-\beta)\left(\frac{1}{4}-\frac{b}{2}\right)(1-\eta)(Q_B)^{\lambda-\eta}(W_B)^{\eta}\frac{Y_B}{A_B} \end{array}\right] \\
& +\frac{1}{\theta-1}\frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{AA})^{-\lambda}\left[\begin{array}{c} (P_C)^{\lambda}\left(\frac{1}{4}-\frac{a}{2}\right)C_C \\ +\left(\frac{1}{4}-\frac{b}{2}\right)(1-\eta)(Q_C)^{\lambda-\eta}(W_C)^{\eta}\frac{Y_C}{A_C} \end{array}\right] \\
& +\frac{1}{\theta-1}\frac{(W_A)^{\eta}(Q_A)^{(1-\eta)}}{A_A}(P_{AA})^{-\lambda}\left[\begin{array}{c} (P_D)^{\lambda}\left(\frac{1}{4}-\frac{a}{2}\right)C_D \\ +\left(\frac{1}{4}-\frac{b}{2}\right)(1-\eta)(Q_D)^{\lambda-\eta}(W_D)^{\eta}\frac{Y_D}{A_D} \end{array}\right]
\end{aligned}
$$

There are of course one output and one profit equation per country.

B.4 Steady state

Consider that all countries are identical with productivity A_0. All prices (including Q's) are then identical at P_0. (4) implies:

$$
P_0 = \frac{\theta}{\theta-1}\frac{(W_0)^{\eta}(P_0)^{(1-\eta)}}{A_0}
$$

Use (3) to write this as:

$$
\begin{aligned}
P_0 &= P_0\frac{\theta}{\theta-1}\frac{(C_0)^{\eta}}{A_0} \\
C_0 &= \left(A_0\frac{\theta-1}{\theta}\right)^{\frac{1}{\eta}}
\end{aligned}
$$

which gives consumption. (5) gives output:

$$\begin{aligned} Y_0 &= C_0 + (1-\eta)\left(\frac{W_0}{P_0}\right)^{\eta}\frac{Y_0}{A_0} \\ Y_0 &= C_0 + (1-\eta)(C_0)^{\eta}\frac{Y_0}{A_0} \\ Y_0 &= \frac{C_0}{1-(1-\eta)(C_0)^{\eta}\frac{1}{A_0}} \\ Y_0 &= \frac{C_0}{1-(1-\eta)\frac{\theta-1}{\theta}} > C_0 \end{aligned}$$

The model can be expressed as log linear approximations around this. Use the definitions of the various price indexes, (4) (or that the deviation of the price from the steady state is zero under sticky price), (3) and (5). You can also use balanced trade conditions, but these should be redundant with (5) I think. Of course the balanced trade conditions help thinking about the linkages between output and the terms of trade.
Linearizing around the steady-state output (Y_0):

$$\hat{Y_0} = \frac{1}{\eta^{\eta}(1-\eta)^{1-\eta}}A_0(L_0)^{\eta}(V_0)^{1-\eta}\left[\hat{A} + \eta\hat{L} + (1-\eta)\hat{V}\right]$$

$\hat{V}$ is the log deviation from the steady-state V_0. In the equilibrium all the inputs V are the same, but deviations due to the presence of the regional- and home-bias will have a different impact. For country A that has a regional agreement with country B:

$$\hat{V_A} = (1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\hat{V_{AA}} + (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\hat{V_{AB}} + \left(\frac{1}{4}-\frac{b}{2}\right)\left(\hat{V_{AC}}+\hat{V_{AD}}\right)$$

Depending on the degree of b the regional trade agreement partners will be more exposed to the shocks of their partners economy. The dissemination of the shocks to wage (through production of V will be different between the home, regional partner, and the rest of the world.

$$\begin{aligned} \hat{Y_0} = & \frac{1}{\eta^{\eta}(1-\eta)^{1-\eta}}A_0(L_0)^{\eta}(V_0)^{1-\eta}\Big[\hat{A} + \eta\hat{L} + \\ & +(1-\eta)\left[(1+\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\hat{V_{AA}} + (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\hat{V_{AB}} + \left(\frac{1}{4}-\frac{b}{2}\right)\left(\hat{V_{AC}}+\hat{V_{AD}}\right)\right]\Big] \end{aligned}$$

The shock on wages to the home economy has a direct impact and impact through the $\hat{V_{AA}}$. Similar shock to the regional trading partner will have a smaller impact, but it will still be greater than when the same shock is done on the non-regional trading partners through the regional preference b and within-regional preference β.
Steady-state profits (deriv. on paper):

$$\pi_0 = \frac{1}{\theta}P_0Y_0$$

Price indexes (optimality requires all markets have the same price (in home currency)):

$$\begin{aligned} P_{AA} = P_{BA} = P_{CA} = P_{DA} = \rho_A \\ P_{AB} = P_{BB} = P_{CB} = P_{DB} = \rho_B \\ P_{AC} = P_{BC} = P_{CC} = P_{DC} = \rho_C \\ P_{AD} = P_{BD} = P_{CD} = P_{DD} = \rho_D \end{aligned}$$

B.5 Terms of trade / Exchange Rates

$$\tau_{B,A} = \frac{\rho_A}{\rho_B} \;\; \tau_{C,A} = \frac{\rho_A}{\rho_C} \;\; \tau_{D,A} = \frac{\rho_A}{\rho_D}$$

Increase in $\tau_{B,A}$ implies that the B's good became more expensive compared to the A's produced good - therefore deterioration in the A's terms of trade.
Exchange rates (no non-tradables, but regional and home bias creates non-unit rates, even when prices are the same between different markets). For simplicity we assume no home bias in "Southern" region of C and D.

$$P_A = \left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_A^{1-\lambda} + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_B^{1-\lambda} + \right. \\ \left. + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_C^{1-\lambda}+\rho_D^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}$$

$$P_B = \left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_B^{1-\lambda} + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_A^{1-\lambda} + \right. \\ \left. + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_C^{1-\lambda}+\rho_D^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}$$

$$P_C = \left[\left(\frac{1}{4}+\frac{a}{2}\right)\rho_C^{1-\lambda} + \left(\frac{1}{4}+\frac{a}{2}\right)\rho_D^{1-\lambda} + \right. \\ \left. + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_A^{1-\lambda}+\rho_B^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}$$

$$\frac{P_B}{P_A} = \frac{\left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_B^{1-\lambda} + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_A^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_C^{1-\lambda}+\rho_D^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}}{\left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_A^{1-\lambda} + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_B^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_C^{1-\lambda}+\rho_D^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}} =$$

$$= \frac{\left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\tau_{A,B}^{1-\lambda} + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right) + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\tau_{A,C}^{1-\lambda}+\tau_{A,D}^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}}{\left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right) + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\tau_{A,B}^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\tau_{A,C}^{1-\lambda}+\tau_{A,D}^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}}$$

$$\frac{P_C}{P_A} = \frac{\left[\left(\frac{1}{4}+\frac{a}{2}\right)\rho_C^{1-\lambda} + \left(\frac{1}{4}+\frac{a}{2}\right)\rho_D^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_A^{1-\lambda}+\rho_B^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}}{\left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_A^{1-\lambda} + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\rho_B^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\rho_C^{1-\lambda}+\rho_D^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}} =$$

$$= \frac{\left[\left(\frac{1}{4}+\frac{a}{2}\right)\tau_{A,C}^{1-\lambda} + \left(\frac{1}{4}+\frac{a}{2}\right)\tau_{A,D}^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(1+\tau_{A,B}^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}}{\left[(1+\alpha)\left(\frac{1}{4}+\frac{a}{2}\right) + (1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\tau_{A,B}^{1-\lambda} + \left(\frac{1}{4}-\frac{a}{2}\right)\left(\tau_{A,C}^{1-\lambda}+\tau_{A,D}^{1-\lambda}\right)\right]^{\frac{1}{1-\lambda}}}$$

Price Indexes Evolution:

$$\widehat{P_B} - \widehat{P_A} = \widehat{\tau_{A,B}}\left((1+\alpha)(\frac{1}{4}+\frac{a}{2}) - (1-\alpha)(\frac{1}{4}+\frac{a}{2})\right) + (\widehat{\tau_{A,C}}+\widehat{\tau_{A,D}})\left(\frac{1}{4}-\frac{a}{2}-\frac{1}{4}+\frac{a}{2}\right)$$
$$= \widehat{\tau_{A,B}}2\alpha\left(\frac{1}{4}+\frac{a}{2}\right)$$
$$\widehat{P_C} - \widehat{P_A} = \widehat{\tau_{A,B}}\left((\frac{1}{4}-\frac{a}{2}) - (1-\alpha)(\frac{1}{4}+\frac{a}{2})\right) + (\widehat{\tau_{A,C}}+\widehat{\tau_{A,D}})\left(\frac{1}{4}+\frac{a}{2}-\frac{1}{4}+\frac{a}{2}\right)$$
$$= \widehat{\tau_{A,B}}\left(\alpha(\frac{1}{4}+\frac{a}{2}) - a\right) + a(\widehat{\tau_{A,C}}+\widehat{\tau_{A,D}})$$

Evolution of price inflation within the Nothern RTA is equal to the consumption weight of the country's home goods α less the regional partner's weight on the imports ($1-\alpha$, as we have symmetric domestic preference) from the regional partner, magnified by the regional bias, and multiplied by the percentage improvement of the home's terms of trade.
Whereas the "outside of the RTA" evolution of prices indexes is effected by the non-regional term-of-trade changes but that is effected now also by the within regional price movements. Therefore an improvement of the terms of trade within the RTA effects the terms-of-trade of the outside the RTA[34]
The presence of the home- and regional- biases allows us to have various exchange rates between the countries even when the nominal price is the same and there is no non-traded goods sector(Backus *et al.* , 1994). Thus the shifts in the bilateral exchange rates reflect the shifts in the relative prices of exports and imports, and are indicated through the Obstfeld & Rogoff (2005) the evolution of price indeces derivations.

$$\widehat{P_B} - \widehat{P_A} = \widehat{\tau_{A,B}}2\alpha\left(\frac{1}{4}+\frac{a}{2}\right) \tag{6}$$

$$\widehat{P_C} - \widehat{P_A} = \widehat{\tau_{A,B}}\left(\alpha(\frac{1}{4}+\frac{a}{2}) - a\right) + a(\widehat{\tau_{A,C}}+\widehat{\tau_{A,D}}) \tag{7}$$

(8)

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[34]For simplicity we assume no within the region bias for the Sothern RTA, as we are merely aimed at making the point that when we have trade integration, there is a positive spillover onto the total regional trade. The results remain the same when we include within region bias for South or when we lax the symmetries between the countries.

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The two equations above indicate that the exchange rate (being a function of the terms of trade between the trading partners) between the regional partners will be influenced by the domestic and regional bias, whereas the exchange rate with the non-regional trading partners will be determined by the regional terms of trade and the preferences parameters. Therefore the increase in $\widehat{\tau_{A,B}}$ (worsening of A's terms of trade against B) will not only trigger appreciation of the exchange rate between A and B, magnified by the domestic and regional bias; but also improves the exchange rate between A and C (and also D since C and D are symmetric).
The presence of terms of trade with the regional partner in the exchange rate with non-regional trading partners and its opposite effect drives the main predictive result of the theoretical part, which is formulated in the next subsection. We can also use the market clearing conditions to derive the total demand functions, and define the bilateral trade flows between the regional and non-regional partners.
Total demand of country A (D_A):

$$
\begin{aligned}
D_A = C_{AA} + C_{AB} + C_{AC} + V_{AA} + V_{AB} + V_{AC} = \\
= \left(\frac{1}{3}+a\right)\left(\frac{P_{AA}}{P_A}\right)^{-\lambda} C_A + \left(\frac{1}{3}-\frac{a}{2}\right)\left(\frac{P_{BB}}{P_A}\right)^{-\lambda} C_A + \left(\frac{1}{3}-\frac{a}{2}\right)\left(\frac{P_{CC}}{P_A}\right)^{-\lambda} C_A + \\
+\left(\frac{1}{3}+b\right)\left(\frac{P_{AA}}{Q_A}\right)^{-\lambda}(1-\eta)\left(\frac{W_A}{Q_A}\right)^{\eta}\frac{Y_A}{A_A} + \\
+\left(\frac{1}{3}-\frac{b}{2}\right)\left(\frac{P_{BB}}{Q_A}\right)^{-\lambda}(1-\eta)\left(\frac{W_A}{Q_A}\right)^{\eta}\frac{Y_A}{A_A} + \\
+\left(\frac{1}{3}-\frac{b}{2}\right)\left(\frac{P_{CC}}{Q_A}\right)^{-\lambda}(1-\eta)\left(\frac{W_A}{Q_A}\right)^{\eta}\frac{Y_A}{A_A}
\end{aligned}
$$

Looking at equation 5, the revenue from the production is:

$$
\begin{aligned}
P_A Y_A &= \left(\frac{1}{3}+a\right)\left(\frac{P_{AA}}{P_A}\right)^{-\lambda} C_A P_A + \left(\frac{1}{3}-\frac{a}{2}\right)\left(\frac{P_{AA}}{P_B}\right)^{-\lambda} C_B P_B \\
&+ \left(\frac{1}{3}-\frac{a}{2}\right)\left(\frac{P_{AA}}{P_C}\right)^{-\lambda} C_C P_C \\
&+ \left(\frac{1}{3}+b\right)\left(\frac{P_{AA}}{Q_A}\right)^{-\lambda}(1-\eta)\left(\frac{W_A}{Q_A}\right)^{\eta}\frac{Y_A}{A_A}P_A \\
&+ \left(\frac{1}{3}-\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_B}\right)^{-\lambda}(1-\eta)\left(\frac{W_B}{Q_B}\right)^{\eta}\frac{Y_B}{A_B}P_B \\
&+ \left(\frac{1}{3}-\frac{b}{2}\right)\left(\frac{P_{AA}}{Q_C}\right)^{-\lambda}(1-\eta)\left(\frac{W_C}{Q_C}\right)^{\eta}\frac{Y_C}{A_C}P_C
\end{aligned} \tag{9}
$$

Bilateral Trade Flows

The revenue is being used for acquisition of tradable good, we have balanced trade for the whole model, but bilateral trade will not be similar:
To country A from regional trade partner B:

$$TB_{AB} = C_{AB} + V_{AB} - C_{BA} - V_{BA}$$

Assuming the same home bias within the region for simplicity and divide by the terms of trade between the countries to make it comparable across different destinations:

$$TB'_{AB} = \left[(1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left[\left(\frac{\rho_B}{P_A}\right)^{-\lambda} C_A - \left(\frac{\rho_A}{P_B}\right)^{-\lambda} C_B\right] + \right.$$
$$\left. + (1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left[\left(\frac{\rho_B}{Q_A}\right)^{-\lambda} V_A - \left(\frac{\rho_A}{Q_B}\right)^{-\lambda} V_B\right]\right] \tau_{A,B}$$

The evolution of bilateral trade balance within the two regional trading partners AB is then:

$$TB'_{AB} = \left[-\lambda(1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left[\widehat{\tau_{A,B}}\widehat{C_A} - \widehat{\tau_{B,A}}\widehat{C_B}\right] \right.$$
$$\left. -\lambda(1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left[\widehat{\tau_{A,B}}\widehat{V_A} - \widehat{\tau_{B,A}}\widehat{V_B}\right]\right] + \widehat{\tau_{A,B}}$$

We can without the loss of generality assume that country sizes are in the steady state and do not change.

$$\widehat{TB_{AB}} = -\lambda(1-\alpha)\left(\frac{1}{4}+\frac{a}{2}\right)\left[\widehat{\tau_{A,B}} - \widehat{\tau_{B,A}}\right] - \lambda(1-\beta)\left(\frac{1}{4}+\frac{b}{2}\right)\left[\widehat{\tau_{A,B}} - \widehat{\tau_{B,A}}\right] + \widehat{\tau_{A,B}} =$$
$$= \left[1 - \lambda\left[(1-\alpha)\left(\frac{1}{2}+a\right) + (1-\beta)\left(\frac{1}{2}+b\right)\right]\right]\widehat{\tau_{A,B}}$$

To country A from non-regional trade partner C:

$$TB_{AC} = C_{AC} + V_{AC} - C_{CA} - V_{CA}$$

$$TB'_{AC} = \left[\left(\frac{1}{4}-\frac{a}{2}\right)\left[\left(\frac{\rho_C}{P_A}\right)^{-\lambda} C_A - \left(\frac{\rho_A}{P_C}\right)^{-\lambda} C_C\right] + \right.$$
$$\left. + \left(\frac{1}{4}-\frac{b}{2}\right)\left[\left(\frac{\rho_C}{Q_A}\right)^{-\lambda} V_A - \left(\frac{\rho_A}{Q_C}\right)^{-\lambda} V_C\right]\right] \tau_{A,C}$$

$$\widehat{TB_{AC}} = \left[-\lambda\left(\frac{1}{4}-\frac{a}{2}\right)\left[\widehat{\tau_{A,C}} - \widehat{\tau_{C,A}}\right] - \lambda\left(\frac{1}{4}-\frac{b}{2}\right)\left[\widehat{\tau_{A,C}} - \widehat{\tau_{C,A}}\right]\right] + \widehat{\tau_{A,C}} =$$
$$= \left[1 - \lambda\left[\left(\frac{1}{2}-a\right) + \left(\frac{1}{2}-b\right)\right]\right]\widehat{\tau_{A,C}}$$

Assume that prices in A fall - A faces a depreciation - the aggregate result on the trade balance of A will be:

$$\widehat{TB_A} = 2\left[1 - \lambda\left[1 - a - b\right]\right]\widehat{\tau_{A,C}} \tag{10}$$
$$+ \left[1 - \lambda\left[(1-\alpha)\left(\frac{1}{2}+a\right) + (1-\beta)\left(\frac{1}{2}+b\right)\right]\right]\widehat{\tau_{A,B}}$$

The higher are the regional preferences, the greater will be the increase in trade with non-regionals (since the first term increases on a,b), and the lower will be the change in the trade with the regional trading partner. Equations 6 and 7 link the terms of trade and the exchange rate in the presence of regionalism and domestic bias. The depreciation of A will improve the terms of trade with all trading partners, but much more so with the non-regional (see equation 7).

Therefore when production integration between the regional trading agreement members is more intensive, upon depreciation trade balance improves more on the account of the non-RTA trading partners.