A Work Project, presented as part of the requirements for the Award of a Master's degree in Economics from the Nova School of Business and Economics.

An Analysis of Ecuador's Real Effective Exchange Rate Under Dollarization

Philip Francis Lapeyre Jr.

Work project carried out under the supervision of:

Prof. Miguel Lebre de Freitas

20-12-2023

Abstract

A time-series ARDL model produced an estimated REER misalignment that was larger in its overvaluation than the estimated overvaluations of the EQCHANGE database and the IMF reports. All three estimates corroborated that movement of REER after the 2014-2016 decline in oil prices deviated from what the macroeconomic fundamentals would justify.

An analysis, rooted in separate evaluations by the IMF, of dollarization's role in Ecuador's overvalued REER through an appreciation of the dollar and unsynchronized business cycles. The implications of a persistently overvalued REER are varied, but its effect on competitiveness and productivity of tradables is noteworthy given Ecuador's low-complexity exports.

Keywords: real effective exchange rate, dollarization, monetary policy, cyclical synchronization

This work used infrastructure and resources funded by Funação para a Ciência e a Tecnologia (UID/ECO/00124/2013, UID/ECO/01124/2019 and Social Sciences DataLab, Project 22209), POR Lisboa (LISBOA-01-0145-FEDER-007722 and Social Sciences DataLab, Project 22209) and POR Norte (Social Sciences DataLab, Project 22209).

I. Introduction

In 1995, Ecuador's economic complexity level – a gauge of the diversity and advancement of an economy's export base – ranked 112th out of 132 countries; in 2019, Ecuador ranked 120th (Atlas of Economic Complexity). One of the least complex economies in the world, an economy reliant on oil export revenue, was buoyed by the commodity cycle of the 2000's (Oks and Williams 2022). Perhaps evident from its stagnation in complexity level, Ecuador has been unable to shift from low to high productivity sectors. Within South America, Ecuador is not anomalous in this sense; the productive structures of much of South America are rigidly tied to raw commodities (Valdecantos 2023; Oks and Williams 2022). There are complex global dynamics here that contribute to the Ecuador's inability to diversify its export base, but Ecuador's decision to fully dollarize in 2000 may be contributing to the rigidity of Ecuador's productive structure.

It is through the transmission mechanism of the real effective exchange rate (REER) that an analysis of Ecuador's dollar regime takes place. For this purpose, a time-series ARDL model, in line with the behavioral equilibrium exchange rate (BEER) approach from Clark and MacDonald (1998), is used to estimate a long-run equilibrium REER of Ecuador and to calculate potential REER misalignment.

II. Literature Review

The strain of literature that this analysis most squarely fits into is the behavioral equilibrium exchange rate (BEER) approach (Clark and MacDonald 1998, 2004) as applied to emerging and developing economies. Much of the methodology used here sought to replicate that of Vdovychenko (2021) who performed a single-country, BEER and FEER analysis on Ukraine. Loukoianova (2007) and Osoz et al. (2012) choice of long-run determinants and subsequent analyses of REER misalignment for Ghana and Nigeria, respectively, were also informative to the methodology. Specifically, it was Nigeria's status as a state deeply reliant on oil exports, as well as Ghana's reliance on commodities trading, that offered pertinent approaches.

In an analysis of Nigeria's REER, Osoz et al. (2012) used oil price as one of the long-run determinants. The authors justify this as a proxy of Nigeria's terms of trade given the extreme export share of oil. As Ecuador's reliance is not as dramatic, it is important to capture price movements in non-oil commodities.

However, given the absence in previous literature of the BEER approach being applied to fully dollarized sovereigns, there is uncertainty over which determinants may have a long-run effect on the REER. This uncertainty is amplified given a one-country analysis where country-specific idiosyncrasies should be addressed. The novel addition to the literature is the inclusion of the federal funds effective rate as a hypothesized determinant, the justification of which is discussed below. For emerging markets, the effect of interest rates are most typically captured as an interest rate differential between domestic rate and those of trade partners (Loukoianova 2007).

The selection of which macroeconomic fundamentals to include were mostly driven by previous literature. The inclusion of relative *productivity differential* between Ecuador and its

trade partners, *net foreign assets*, and *commodity terms of trade* are consensus determinants and have been used widely across previous literature.

III. Data

The data used comes from the years 2000-2019. The reasoning for that window is: Ecuador fully dollarized in 2000 and data availability issues bounded data selection to 2019. There was concern that pre-dollarization data might skew results, especially for the REER, given the currency crisis experienced in the lead up to dollarization.

REER

The observed REER data comes from an index by the think-tank Bruegel, as described in Darvas (2021). Specifically, it is annual CPI-based REER data as determined in relation to Ecuador's top 65 trade partners. The weights used to determine weighted average of consumer prices in trading partners are time-varying, geometrically averaged weights implying there is no base year (Darvas 2021).

Productivity differential

The productivity differential, as is typical with previous literature was proxied used real GDP data. Defined here as the ratio of Ecuador's output-side real GDP per capita to the weighted average of its trade partner's output-side real GDP per capita. Weights determined by respective annual revenue share of Ecuador's exports for the top 65 partners. These weights vary every

year. The output-side real GDP data is sourced from Penn World Table 10.01 (Feenstra et al. 2015) and the trade data from Harvard's Atlas of Economic Complexity.

The overwhelming consensus in the literature over the use of productivity differential as a long-run determinant of the REER stems from the need to account for the Balassa-Samuelson effect; which in part states that it is differences in the productivity level of tradable goods across countries that help to explain movements in exchange rates (Vdovychenko 2021). Use of output-side real GDP per capita data is helpful for observing the relative difference between Ecuador and its trade partners in the productivity of tradeable goods and services (Feenstra et al., 2015). An increase of the productivity differential would signify that Ecuador is becoming relatively more productive compared to its trade partners, thus it would be expected for the REER to appreciate.

Net Foreign Assets

Net foreign assets as a percentage of GDP, both measured in current dollars. Net foreign assets being the sum of foreign assets held by monetary authorities and deposit banks, sourced from the World Bank's Word Development Indicators database.

A decline of NFA is the result of increased indebtedness, this debt will need to be serviced from an improved trade balance. Then, a decline in NFA should result in a decline in the REER through an increase in trade balance (Vdovychenko 2021).

Commodity Terms of Trade

This data is collected from the IMF's Commodity Terms of Trade database as described in Gruss and Kebhaj (2019). It is a country-specific commodity price index that accounts for 45 commodities. To account for changing export composition over time, time-varying weights are

used. Originally monthly data with June 2012 as base month, the data was averaged into annual data.

The CToT provides a variable that captures terms of trade shocks as the movement of the CToT can be abstracted as gain (loss) of aggregate disposable income from change in international prices of 45 listed commodities (Gruss & Kebhaj 2019). An appreciation in income would mean an appreciation in the REER given that Ecuador's export base – dominated by crude oil, bananas, and shrimp – is particularly sensitive to global commodity prices (Atlas of Economic Complexity).

Federal Funds Effective Rate

The federal funds effective rate, the key interest rate in the US, is guided by the actions of Federal Reserve and their appraisal of the state of the US economy (FRED 2023). This data was sourced from FRED and is measured as a percent. Previous literature does account for the interest rate, Clark and MacDonald (1998) incorporating the domestic real interest rate as a determinant for BEER. For emerging markets, the effect of interest rates are most typically captured as an interest rate differential between domestic rate and those of trade partners (Loukoianova 2007). The lack of independent monetary policy in Ecuador presents a unique situation as a fully dollarized economy has not undergone a BEER analysis.

In the IMF's first review (2019) of Ecuador under its recent involvement in the Extended Fund Facility, they cite the strong cyclical position and appreciation of the dollar as the leading causes for Ecuador's rising REER. The inclusion of a hypothesized determinant that is correlated with US business cycles might offer explanatory power to Ecuador's REER through its relation to the US NEER and thereby Ecuador's NEER. The effective federal funds rate, in line with

standard economic intuition, should be correlated with real economic activity in the US (King, 1996). Further, there is an explicit relationship between federal funds effective rate and nominal appreciation of the dollar (Alderman et al. 2023). A correlation with the movement of domestic Ecuadorian deposit rates is not what this variable seeks to capture. It is an alternative route to capture movement of Ecuador's NEER, through that of the US, that is of interest; explaining why a relative measure was not included.

VI. Methodology

There are three overarching camps for estimating the equilibrium REER: Fundamental Equilibrium Exchange Rate (FEER) (Williamson 1994), Natural Equilibrium Exchange Rate (NATREX) (Stein 1994), and Behavioral Equilibrium Exchange Rate (BEER) (Clark and MacDonald 1998). These arose as a result of the inadequacies of Purchasing Power Parity (PPP) as an equilibrium exchange rate. The FEER's assumption of internal (i.e. no output gap and full employment) and external balance (sustainable debt), does not align with Ecuador's reality over the sample period (2000-2019). On internal balance, there is a significant level of "inadequate employment", hovering around 55% of all employed from 2016 to 2018 (IMF 2019a). Ecuador entered into the IMF's Extended Fund Facility (EFF) in 2019, a clear sign that their debt was not sustainable in medium term. BEER, considered a direct approach, takes in fundamentals without the need for similar normative assumptions and while better capturing short-run and cyclical movements (Costa 2005). Given the nature of the fundamentals selected this is advantageous. The BEER approach can also be considered comparatively straight forward, Vdovychenko (2021) describes it as two-step approach 1) establish long-run relationship 2) use coefficients obtained to estimate equilibrium REER. It's a single equation reduced form model just as FEER.

The analytical usefulness of the BEER approach is two-fold: firstly, it allows for estimation of long-run equilibrium REER and thus for an estimation of REER misalignment, also referred to as the REER gap. Secondly, its use of macroeconomic fundamentals grants the identification of which fundamentals may be influencing the REER over time; which can be useful for implementing policy solutions to address a misaligned REER.

The methodological approach taken by Clark and MacDonald (1998, 2004) is followed, with a keen eye towards the single-country analysis of Ukraine's REER by Vdovychenko (2021). An autoregressive distributed lag (ARDL) model was used to establish the presence of long-run relationship between REER and fundamentals. Kripfgnaz and Schiender (2022) argue that the methodology laid out by Pesaran et al. (2001) is superior to Engle and Granger (1987) in confirming and estimating long-run relationships. Kripfgnaz and Schiender (2022) and others have suggested that the approach of Engle and Granger (1987) invites inaccuracy because of its need to pretest for stationarity and its inability to capture short-run dynamics (which may bias the accuracy of estimators). An advantage of the ARDL is that as long as no variables are of the second order of integration (i.e. I(2)) than the variables can be strictly I(0), I(1), or a combination (Kripfgnaz and Schiender 2022). Lastly, a vector error correction model to establish cointegration would not have been suitable given the small number of observations.
To specify an ARDL model and confirm the existence of a cointegrated (i.e. long-run relationship), the stages described by Kripfgnaz and Schiender (2022) were followed. The results of which are contained in Annex I.

First, fundamentals hypothesized to have a long-run effect on Ecuador's REER were chosen, the intuition for which has been reasoned above. Second, it was decided to leave the intercept unrestricted and to not include a time trend as an independent variable. Third, the

optimal lag order was obtained using the *maxlags()* command which algorithmically compares lag orders using Akaike information criteria, thus helping to reduce model uncertainty as it concerns lags. There is a technical requirement for the bounds testing where a minimum ratio of 2:1 between the number of observations and degrees of freedom is imposed. Given the small number of observations in the sample, a conservative approach was taken, the implications of which are elaborated on in *Limitations*.

Fourth, once the optimal ARDL specification was estimated (as shown in equation (2)), the Ljung-Box test was performed on the lags of residuals to ensure there is no autocorrelation present – an important step for eliminating bias. Next, the ARDL model is reparametrized into an error correction model in order to estimate long-run and short-run effects, this is represented as equation (3). Lastly, in order to confirm the existence of a long-run relationship, the bounds testing of Pesaran et al. (2001) was conducted. This entails three tests that account for different scenarios and whether variables are I(0) or I(1). Importantly, the Kripfgnaz and Schiender (2020) critical values are used, which adjust to small sample sizes. All three null hypotheses were rejected meaning there exists cointegration between the REER and fundamentals.

With the existence of a long-run relationship corroborated by the bounds testing, the next step was to take the long-run coefficients and apply them to the equilibrium values of the respective fundamentals. The equilibrium values were estimated by obtaining the trend component of the fundamentals using the Hodrick-Prescott filter as has been done by Clark and MacDonald (1998) Vdovychenko (2021) and others. These equilibriums values were then placed into equation (4), which provided the estimation of the equilibrium REER (EREER) in natural log. The REER misalignment can then calculated as shown in equation (5).

(1) $\widehat{EREER} = f(pd, ctot, nfa, fedr)$

The specification of the ARDL(1, 1, 0, 1, 0) model, in ARDL(p, q, …, q) notation, can be represented as:

(2) $$REER_t = c_0 + \phi_0 REER_{t-1} + \beta_0 pd_t + \beta_1 pd_{t-1} + \beta_2 ctot_t + \beta_3 fedr_t + \beta_4 fedr_{t-1} + \beta_5 nfa_t + u_t$$

(3) ARDL(1, 1, 0, 1, 0) represented in error correction form:

$$\Delta REER_t = c_0 - \alpha(REER_{t-1} - \theta_0 pd_t - \theta_1 ctot_t - \theta_2 fedr_t - \theta_3 nfa_t) + \psi_0 \Delta pd_t + \psi_1 \Delta fedr_t + u_t$$

Where α is the speed-of-adjustment coefficient, θ_i is the respective long-run coefficient (reproduced as θ_x in eq. 4), and ψ_i is the respective short-run coefficient. Reparameterization of coefficients, as shown in Kripfgnaz and Schiender (2022), is provided in Annex _.

(4) $$\widehat{EREER} = c_0 + \theta_{pd} pd_E + \theta_{ctot} ctot_E + \theta_{nfa} nfa_E + \theta_{fedr} fedr_E + u_t$$

Where θ_x is representative of long-run coefficients and x_E is representative of equilibrium of respective fundamental.

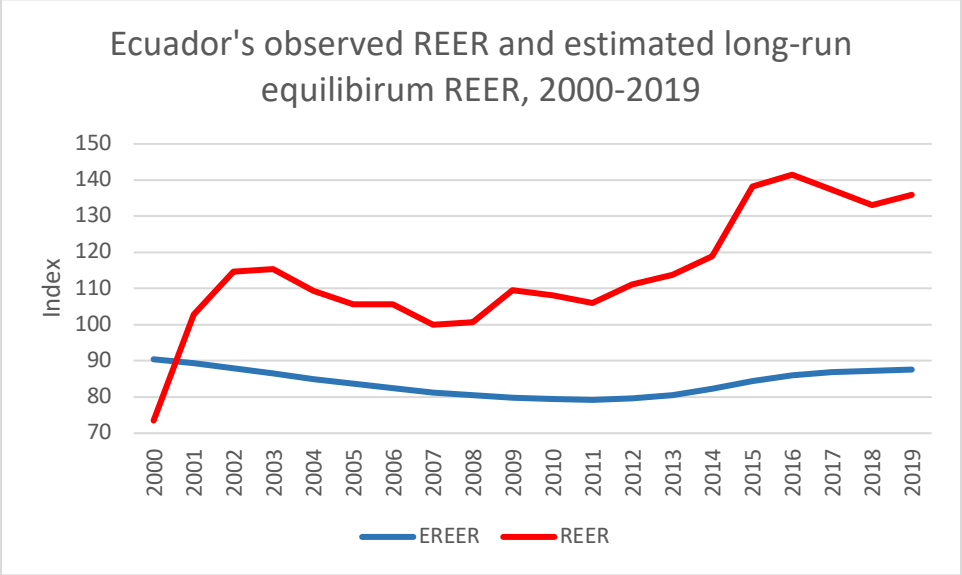
(5) $$MIS_t = REER_t - EREER_t$$

V. Findings

It was found that the long-run coefficients of the following determinants were statistically significant at a significance level below 1%: productivity differential, CToT, and NFA. These coefficients can be interpreted just as the coefficients in a typical OLS regression model (Kripfgnaz and Schiender 2020). We can then say that a one-unit increase in productivity differential, CToT, or NFA would have the respective approximate effects on the REER of: a 1.00% increase, a 7.68% decline, and a 6.73% decline. The signs on the CToT and NFA are both negative, running counter to the consensus economic intuition, this is discussed further in *Limitations*.

The long-run effect of the federal funds effective rate was found to be not statistically different from zero, but interestingly the short-run coefficient for federal funds effective rate was, at a significance level below 1%. With that interpretation being that a one unit increase in the federal funds effective rate (a seemingly implausible rate increase in interest rates over the short-run) would result in a decline in the REER of 1.76%.

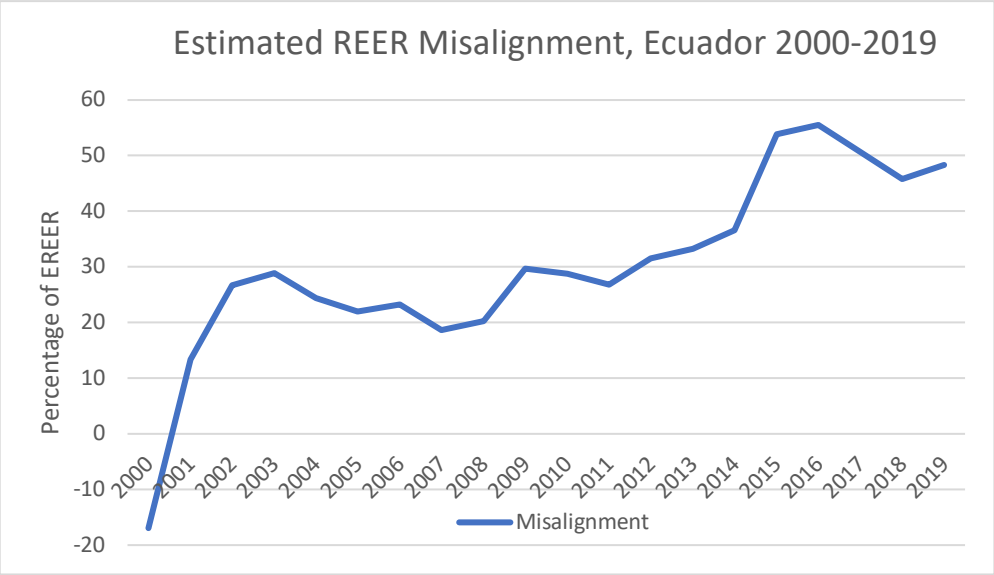
Figure 1. Observed REER and estimated long-run equilibrium measured in REER index (Darvas 2021)



REER data sourced from Darvas 2021. EREER calculated by author as described here.

It was found that the observed REER was significantly overvalued when compared to the estimated long-run equilibrium REER (EREER) obtained from the methodology outlined above. Figure _ depicts the EREER as rather steady in comparison, with little co-movement between the two. The misalignment is remarkably persistent, in part because of the relative stability of the EREER.

Figure 2. MIS as percentage of the estimated long-run equilibrium REER (EREER)



The calculated misalignment (MIS_t) is shown here as a percentage of the estimated EREER, calculations by author. Observed REER data sourced from Darvas 2021.

VI. Discussion

Before a discussion on the reasoning and implications of a sizable and persistent REER misalignment, it is crucial to ground the empirical findings here with those from the IMF and the French research center, CEPII.

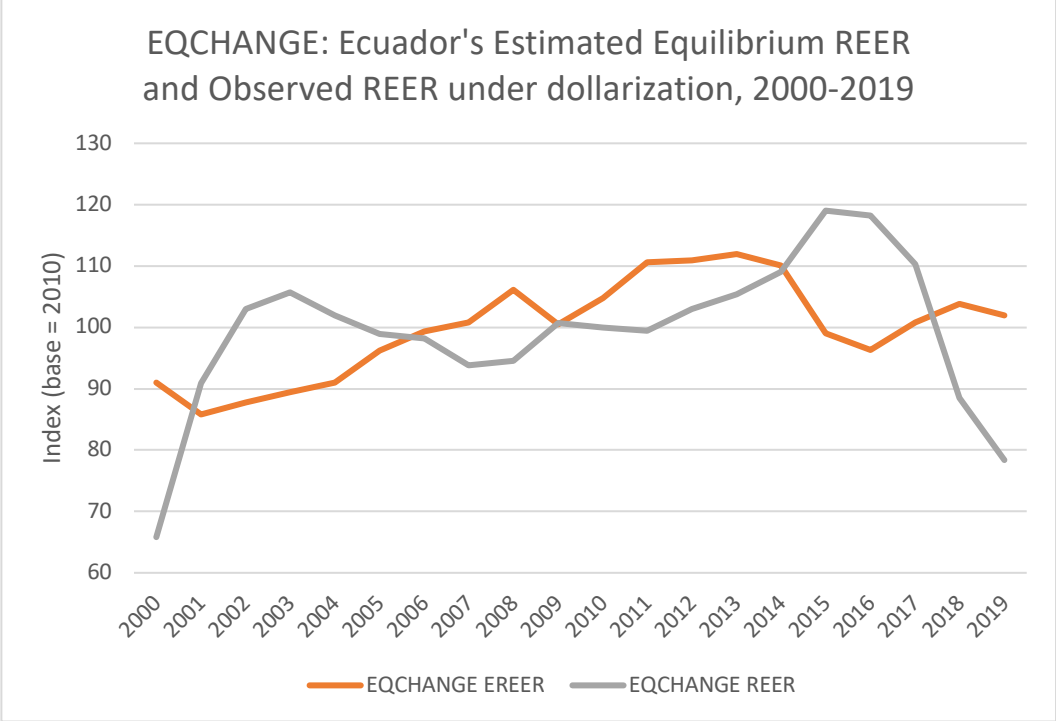
EQCHANGE, developed by CEPII, is a database that using BEER methodology calculates an equilibrium REER and misalignment of REER. In their estimation, they take as determinants sectoral productivity relative to trade partners, net foreign assets as a percent of GDP, and terms of trade. The estimates shown in Figures _ and _ are those derived from time-varying five-year weighted averages and 30 trade partners (Couharde 2018).

To get a sense of the IMF's analysis, data had to be cobbled together across a few different reports on Ecuador. A methodology was used that adheres to an external balance assessment approach and appears to slightly change from report to report, but is nonetheless a valuable comparison. A 2016 IMF *Article IV* report, finds that in 2015 Ecuador's REER was overvalued by 25% (IMF, 2016, p.40). A 2019 *Staff Report* evaluates the REER to be overvalued

by 31 percent (IMF, 2019a, p.62). Another report published a few months later would seem to revise that overvaluation to 34 percent (IMF, 2019b, p.8).

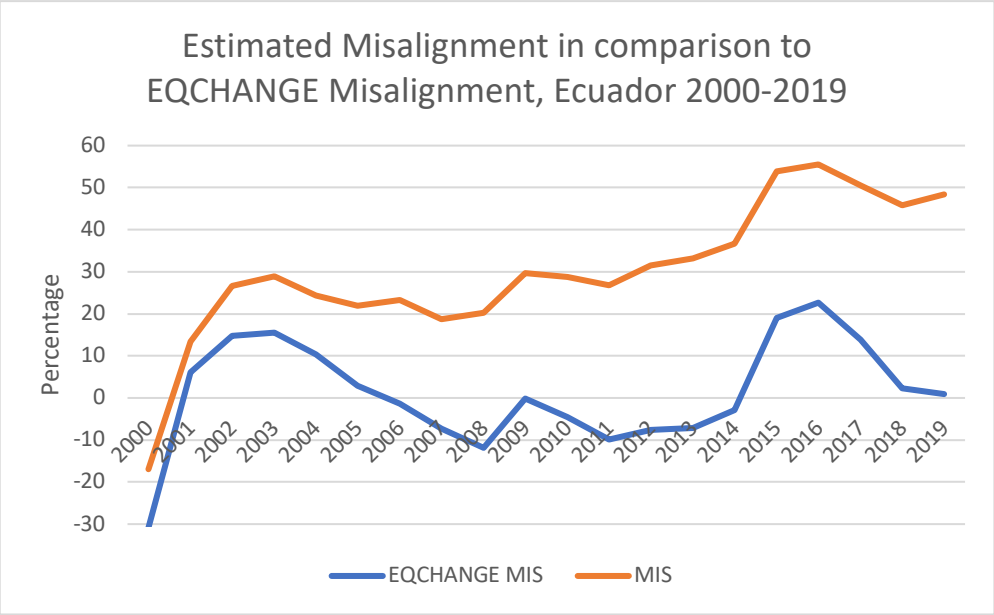
A comparison of *Figure 1* and *Figure 3* reveals that the findings presented here are of an order of magnitude and persistence well above that of EQCHANGE, but importantly – for the sake of the credibility of the results and model – the estimated misalignment (MIS) does move with the misalignment calculated by EQCHANGE. The available IMF statistics, that are not plotted, of overvaluation fit between and support the findings of significant overvaluation. It should be noted that all three analyses used differing methodology.

Figure 3. From EQCHANGE Ecuador's observed REER and long-run estimated REER (EREER)



Data sourced from EQCHANGE as described in Couharde et al. (2018).

Figure 4. Comparison of Ecuador's estimated REER misalignment (MIS) between author and EQCHANGE database



MIS is calculated by the author following the methodology described. EQCHANGE *MIS* comes from EQCHANGE.

What is true across the findings is that there is a disconnect between the macroeconomic fundamentals and Ecuador's REER. Dollarization's complicity in the documented misalignment can offer an analysis where the consensus long-run determinants cannot; in examining the impact of dollarization on the REER, the influence of the nominal effective exchange rate (NEER) on the REER is a useful starting place.

Differing in notation, equation (7) shows the equation used in Darvas (2021) and exhibits the relationship between the NEER and REER. The NEER is composed of the nominal exchange rate (NER) in the form of the weighted average of bilateral nominal exchange rates, as shown in equation (6); from Couharde (2018), again with differing notation.

(6) $$NEER_{i,t} = \prod_{w=1}^{N} NER_{iw,t}$$

Representative of the product of bilateral exchange rates between country i and trade partner w at time t with N trading partners

(7) $$REER_{i,t} = NEER_{i,t} \cdot \frac{P_{i,t}}{P_{W,t}}$$

Where $\frac{P_{i,t}}{P_{W,t}}$ is the consumer price ratio between country i and its trade partners W

Log transformation of equation (7):

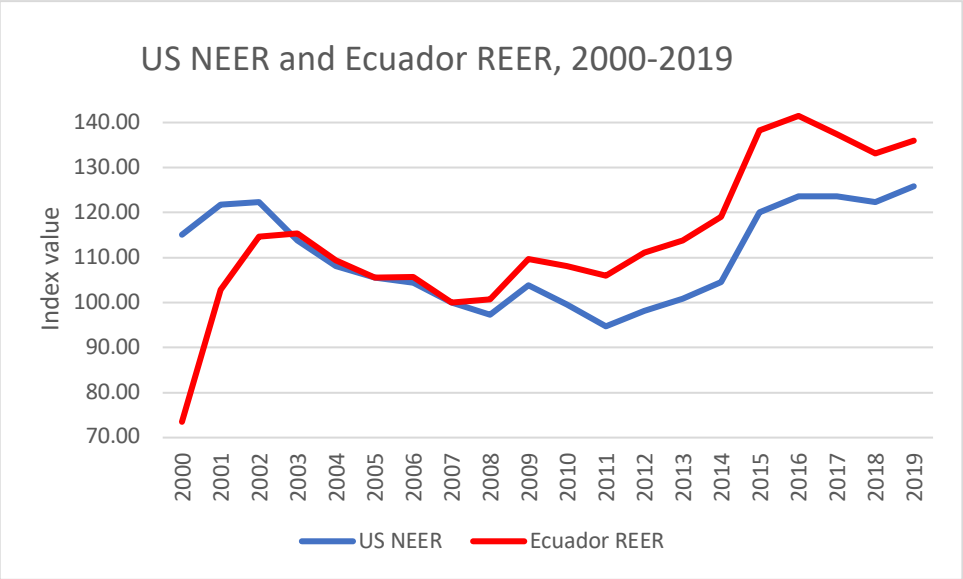
(8) $$\ln REER_{i,t} = \ln NEER_{i,t} + \ln P_{i,t} - \ln P_{W,t}$$

(9) $$\sigma(\Delta reer_{i,t}) = \sigma(\Delta neer_{i,t}) + \sigma(\Delta p_{i,t}) + \sigma(p_{W,t}) + 2 \cdot \sigma(\Delta neer_{i,t}, \Delta p_{i,t}) - 2 \cdot \sigma(\Delta neer_{i,t}, p_{W,t}) - 2 \cdot \sigma(\Delta p_{i,t}, p_{W,t})$$

Where $reer_{i,t} = \ln REER_{i,t}$; $neer_{i,t} = \ln NEER_{i,t}$; $p_{i,t} = \ln P_{i,t}$; $p_{W,t} = \ln P_{W,t}$

Using the data of 170 countries from 2016-2021, and equations (7)-(9), Darvas (2021) demonstrates that short-run changes in REER are principally determined by changes in NEER. This would suggest that the nominal exchange rate (NER) may have a short-run effect on the REER. Ecuador being a fully dollarized economy, their NER appreciates just as that of the US. As the IMF (2016, 2019ab, 2021, 2022) cites across its reports, what drives Ecuador's short-term REER movements are nominal movements of the dollar. However, the plotting of Ecuador's observed REER and the US's NEER, in Figure 5, would seem to suggest a persistent effect.

Figure 5. Nominal Appreciation of dollar and Ecuador REER appreciation



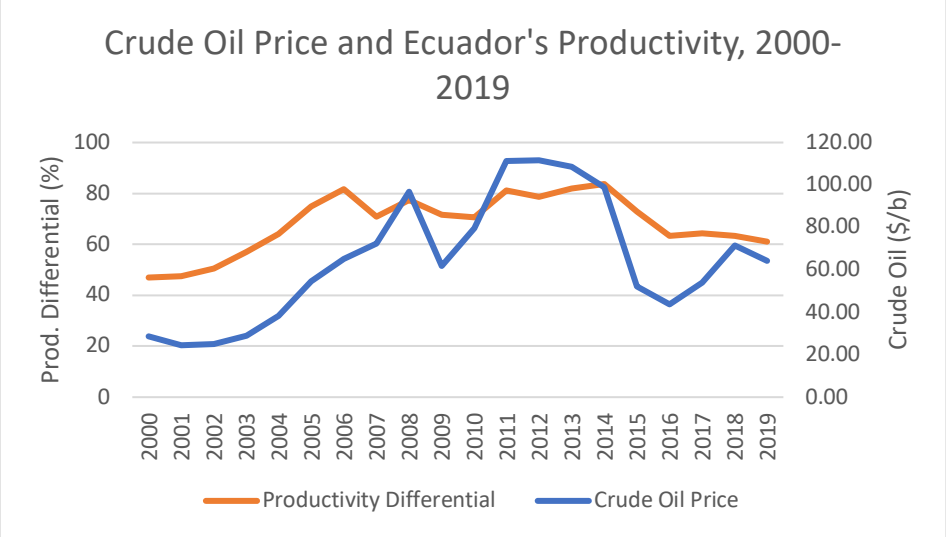
NEER and REER data sourced from Darvas (2021).

A stylized fact may be that it is the relative strong cyclical position of the US economy, in conjunction with US monetary policy, that led to an appreciation of the dollar over the second half of the sample period (Alderman et al. 2023). Consequently, it is US business cycles, which can reasonably be labeled an exogenous force, that are causing the appreciation of Ecuador's NEER and thus Ecuador's REER.

A theorized and empirically supported cost of dollarization is the potential for little cyclical synchronization between the dollarized sovereign and the US (Swiston 2011, Berg and Borenzstein 2000). This coincides with, and is reinforced by, a lack of monetary policy in the dollarized state – US monetary policy is shaped in accordance with US conditions, and not Ecuadorian. These two processes – unsynchronized business cycles and only suboptimal policy tools to smooth the subsequent increase in output volatility – are what has occurred in Ecuador (Swiston 2011, Koráb 2023). Confronted with an output shock, Ecuador's REER is unable to adjust and stabilize output, with stabilization falling to an indifferent US monetary policy regime (Swiston 2011).

The 2014 fall in oil prices, given Ecuador's reliance on oil exports, provides an episode of the impact that cyclical disconnect between Ecuador and the US can have on Ecuador's REER. Grigoli et al. (2017), in an analysis of the 2014-2016 price drop, found that, out of a group of prominent oil exporting countries (which included Ecuador), the countries that fared better had the ability to conduct counter-cyclical policies (fiscal and monetary) and had a flexible exchange rate – allowing relative prices to adjust, to some degree, to handle the shock. Ecuador's REER was unable to adjust to the country's fall in real GDP. So, while its productivity and terms of trade fell, signaling that the REER should also fall, its REER following the US NEER, increased. The business cycles of Ecuador, abstractly rendered by fundamentals, would not dictate a rise in the REER; dollarization, which can be deemed an exchange rate policy, presents itself as an institutional rigidity preventing the adjustment of the REER towards its equilibrium.

Figure 6. Annual Crude Oil Price (Brent – Europe) and Ecuador's relative productivity



Crude Oil Price data sourced from FRED. Productivity Differential calculated by author using data from World Penn Table and Atlas of Economic Complexity.

This episode, leaving Ecuador's REER persistently overvalued, can additionally be rendered as a shock to Ecuador's international competitiveness. Staehr and Vermeulen (2016)

use a CPI-based REER index as a proxy for competitiveness, finding that among Euro area members a short-term shock to REER hurts GDP growth, with this effect lasting approximately two years. It is well established that an overvalued REER hurts the competitiveness of tradable goods (Rodrik 2008). Rodrik (2008) stresses that an overvalued REER hurts growth and reports that an undervalued REER is a necessary component to rapid growth (i.e. development) for low- to middle-income countries as it allows the relative profitability of tradables to increase. There is a path dependency to economic development that requires a country, unless the country is a supremely well-managed petrostate, to cultivate a manufacturing sector; this a necessity largely because of the scale in productivity gains that only manufacturing can facilitate (Oks and Williams 2023). Therefore, a persistently overvalued REER can restrain growth through a drag on the productivity of tradables.

During sustained periods of a relatively strong dollar, dollarization, through its role in sustaining an overvalued REER, harms the development of Ecuador and perpetuates an export base that is low in complexity and undiversified. This fits with the critique of dollarization that there is a trade-off between growth and price stability (Koráb 2023).

VII. Limitations

The most notable limitation to the results obtained is the relatively small number of observations used. Issues surrounding data availability, specifically for output-side real GDP data, led to the use of annual data; this and Ecuador's relatively short experience with dollarization, contributed to the small sample size. There are a few limitations stemming from this, none more important than the prospect that inference of results cannot be considered reliable. The outcome of such a small number of observations, especially in combination with the

relatively large number of variables used, is unprecise estimators and thereby an unprecise model (Kripfgnaz and Schnieder, 2022). However, it should be noted that when establishing cointegration (i.e. a long-run relationship) what is important is the time span covering observations (Giles, 2014).

Another, more technical, consequence of the small number of observations concerns the number of lags that could be taken. The bounds test, used to confirm the existence of cointegration, associated with the ARDL model requires at least twice as many observations as coefficients (Kripfgnaz and Schnieder, 2022). This forced a conservative approach to selecting lags. While 19 observations imposes a technical limitation, having observations covering 19 years is beneficial and aligns with much of the empirical literature on developing market exchange rates [see Edwards and Savastano (1999), p.47 for a comprehensive list].

A lack of lags taken for some of the independent variables does not allow the error correction model to separately estimate short-run effects for variables with no lags, it only allows for the estimation of long-run effects. This is another limitation of a lack of observations, as it is not technically possible to take additional lags. Taking too few lags can lead to misspecification of the model and may have contributed to the negative coefficients on long-run effects of the CToT and NFA.

Model uncertainty is another significant limitation that must be noted. There are many variables that could be considered a determinant for estimating Ecuador's equilibrium REER. Specification of a model that reasonably accounts for all feedback mechanisms is very difficult. The approach to specify a model with the same determinants employed by Vdovychenko (2021) is not exhaustive in attempting to limit model uncertainty. An approach where several models are

used in aggregation to estimate the equilibrium REER, like the one taken by Vdovychenko (2021), better controls for model uncertainty.

VIII. Conclusion

A time-series ARDL model, with significant limitations, produced an estimated REER misalignment that was notably larger in its overvaluation than the estimated overvaluations of the EQCHANGE database and the IMF reports. All three independent estimates corroborated the notion that movement of the REER after the 2014-2016 decline in oil prices deviated from what the macroeconomic fundamentals would justify.

An analysis, rooted in separate evaluations by the IMF, of dollarization's role in Ecuador's overvalued REER through an appreciation of the dollar and unsynchronized business cycles. The implications of a persistently overvalued REER are varied, but its effect on the competitiveness and productivity of tradables is noteworthy given Ecuador's low-complexity exports. Then, dollarization will not only reduce growth and increase output volatility, but may materially pile on to complex global dynamics that have brought Ecuador to a place with no substantive manufacturing base.

There are various paths that tangential further research could go. One would be a replication of the methodology presented here, but instead using quarterly data and better specifying of the model using different combinations of long-run determinants. Another option might entail a comparison of BEER between the fully dollarized states of Ecuador, El Salvador, and Panama, with Ecuador's non-dollarized regional neighbors Chile, Colombia, and Peru. These two options could lend credence to the idea that dollarization may contribute to the overvalued REER. A distinctively separate strand of research might focus on the implications of an overvalued REER, relying on granular sector-specific productivity data, an analysis of how

the REER influences sectoral productivity and resource allocation across both tradables and non-tradables. An analysis of this kind may be able better able to quantify dollarization's impact on the complexity level of Ecuador's export base.

References

Alderman, Andrew; Camp, Kevin M.; and Mandiak, Erin. "How currency appreciation can impact prices: the rise of the U.S. dollar," *Beyond the Numbers: Prices & Spending*, vol. 12, no. 6 (U.S. Bureau of Labor Statistics, March 2023), https://www.bls.gov/opub/btn/volume-12/how-currency-appreciation-can-impact-prices-the-rise-of-the-us-dollar.htm

Berg, Andrew, and Eduardo R. Borensztein. "The Pros and Cons of Full Dollarization." *Finance and Development*, March 2000, 38–41. https://www.imf.org/external/pubs/ft/fandd/2000/03/pdf/berg.pdf.

Costa, Sonia. "A Survey Of Literature On The Equilibrium Real Exchange Rate An Application To The Euro Exchange Rate." *Banco de Portugal*, Economic Bulletin, no. Winter 2005 (2005). https://www.bportugal.pt/sites/default/files/anexos/papers/ab200514_e.pdf.

Clark, Peter, & MacDonald, Ronald (1998). Exchange rates and economic fundamentals: A methodological comparison of BEERs and FEERs. IMF working paper no. 67, November.10.1007/978-94-011-4411-7_10

Couharde, C., Delatte, A-L, Grekou, C., Mignon, V. and Morvillier, F. (2018), "EQCHANGE: A World Database on Actual and Equilibrium Effective Exchange Rates", International Economics, Vol. 156, Q4 2018.
https://www.sciencedirect.com/science/article/pii/S2110701717302457#sec2

Darvas, Z. (2021) 'Timely measurement of real effective exchange rates', Working Paper 15/2021, Bruegel. https://www.bruegel.org/2021/12/timely-measurement-of-real-effective-exchange-rates/

"Ecuador: Article IV Consultation Staff Report." *IMF Country Reports* 2016, no. 19/81 (2019): https://www.imf.org/en/Publications/CR/Issues/2019/03/21/Ecuador-2016-Article-IV-Consultation-Press-Release-and-Staff-Report-46689.

"Ecuador: First Review under the Extended Arrangement under the Extended Fund Facility Arrangement." *IMF Country Reports* 2019, no. 2019/210 (2019): https://www.imf.org/en/Publications/CR/Issues/2019/07/03/Ecuador-First-Review-under-the-Extended-Fund-Facility-Arrangement-Requests-for-Waiver-of-47087

"Ecuador: Sixth Review under the Extended Arrangement under the Extended Fund Facility and Financing Assurances Staff Report." *IMF Country Reports* 2022, no. 22/378 (2022): https://www.imf.org/en/Publications/CR/Issues/2022/12/16/Ecuador-Sixth-Review-under-the-Extended-Arrangement-under-the-Extended-Fund-Facility-and-527064

"Ecuador: Staff Report for the 2019 Article IV Consultation and Request for an Extended Arrangement under the Extended Fund Facility." *IMF Country Reports* 2019, no. 19/72 (2019): https://www.imf.org/en/Publications/CR/Issues/2019/03/20/Ecuador-Staff-Report-for-the-2019-Article-IV-Consultation-and-Request-for-an-Extended-46682.

Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review, 105(10), 3150-3182, www.ggdc.net/pwt.

Giles, Dave. 2014. "Unit Root Testing: Sample Size vs Sample Span." *Econometrics Beat: Dave Giles' Blog* (blog). *Blog Spot*. May 26, 2014. https://davegiles.blogspot.com/2014/05/unit-root-testing-sample-size-vs-sample.html.

Grigoli, Francesco & Herman, Alexander & Swiston, Andrew. (2017). A Crude Shock: Explaining the Impact of the 2014-16 Oil Price Decline Across Exporters. IMF Working Papers. https://www.researchgate.net/publication/319198522_A_Crude_Shock_Explaining_the_Impact_of_the_2014-16_Oil_Price_Decline_Across_Exporters

Gruss, Bertrand, and Suhaib Kebhaj. "Commodity Terms of Trade: A New Database." *IMF Working Papers*, 2019/021, January 24, 2019. https://doi.org/10.2139/ssrn.3333745.

King, Robert G., and Mark W. Watson. "Money, Prices, Interest Rates and the Business Cycle." *The Review of Economics and Statistics* 78, no. 1 (1996): 35. https://doi.org/10.2307/2109846.

Kripfganz, Sebastian, and Daniel Schneider. "Ardl: Estimating Autoregressive Distributed Lag and Equilibrium Correction Models." Tohoku University Research Center for Policy Design, April 1, 2022. https://www2.econ.tohoku.ac.jp/~PDesign/dp/TUPD-2022-006.pdf.

Loukoianova, Elena, and Plamen Iossifov. "Estimation of a Behavioral Equilibrium Exchange Rate Model for Ghana." *IMF Working Papers* 07, no. 155 (July 1, 2007). https://doi.org/10.5089/9781451867190.001.

Oks, David, and Henry Williams. "The Long, Slow Death of Global Development." *American Affairs*, 122-50, VI, no. Number 4 (Winter 2022) (2022). https://americanaffairsjournal.org/2022/11/the-long-slow-death-of-global-development/#notes.

Ozsoz, Emre & Akinkunmi, Mustapha. (2012). Real Exchange Rate Assessment for Nigeria: An Evaluation of Determinants, Strategies for Identification and Correction of Misalignments. OPEC Energy Review. 36. https://onlinelibrary.wiley.com/doi/full/10.1111/j.1753-0237.2011.00206.x

Ramos-Herrera, María del Carmen. "How Equilibrium Exchange Rate Misalignments Influence on Economic Growth? Evidence for European Countries" *Economics* 16, no. 1 (2022): 199-211. https://doi.org/10.1515/econ-2022-0027

Ravn, M. O., and H. Uhlig. 2002. On adjusting the Hodrick–Prescott filter for the frequency of observations. Review of Economics and Statistics 84: 371–376. https://doi.org/10.1162/003465302317411604.

Rodrik, Dani (2008). The real exchange and economic growth. Brookings Papers on Economic Activity, Economic Studies Program, The Brookings Institution, 39, 365–412.10.1353/eca.0.0020

Sebastian Edwards & Miguel A. Savastano, 1999. "Exchange Rates in Emerging Economies: What Do We Know? What Do We Need to Know?," NBER Working Papers 7228, National Bureau of Economic Research, Inc. https://ideas.repec.org/p/nbr/nberwo/7228.html.

Staehr, Karsten and Vermeulen, Robert, How Competitiveness Shocks Affect Macroeconomic Performance Across Euro Area Countries (August 24, 2016). ECB Working Paper No. 1940, https://ssrn.com/abstract=2828602

Swiston, Andrew. "Official Dollarization as a Monetary Regime: Its Effectson El Salvador." *IMF Working Papers* 11, no. 129 (2011). https://doi.org/10.5089/9781455258390.001.

The Growth Lab at Harvard University. The Atlas of Economic Complexity. http://www.atlas.cid.harvard.edu.

The World Bank. 2023. World Development Indicators. Washington, D.C.: The World Bank (producer and distributor). https://databank.worldbank.org/source/world-development-indicators

U.S. Energy Information Administration, Crude Oil Prices: Brent - Europe [ACOILBRENTEU], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/ACOILBRENTEU, December 10, 2023.

Valdecantos, Sebastian. (2023), "The Green Transition Dilemma: The Impossible (?) Quest for Prosperity of South American Economies." AFD Research Papers No. 271. Paris: Agence Française de Développement. https://ideas.repec.org/p/avg/wpaper/en15195.html.

Vdovychenko 2021 – BEER on Ukraine, lays out analytical usefulness of BEER, essentially replicating their econometric methodology (same fundamentals, same approach) https://repec.graduateinstitute.ch/pdfs/Working_papers/HEIDWP06-2021.pdf