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Working Paper

A simple model of internal and external balance for resource-rich developing countries

ADB Economics Working Paper Series, No. 660

Provided in Cooperation with:

Asian Development Bank (ADB), Manila

Suggested Citation: Davies, Martin; Schröder, Marcel (2022) : A simple model of internal and external balance for resource-rich developing countries, ADB Economics Working Paper Series, No. 660, Asian Development Bank (ADB), Manila, <https://doi.org/10.22617/WPS220222-2>

This Version is available at:

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A SIMPLE MODEL OF INTERNAL AND EXTERNAL BALANCE FOR RESOURCE-RICH DEVELOPING COUNTRIES

Martin H. Davies and Marcel Schröder

NO. 660

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May 2022

**ADB ECONOMICS
WORKING PAPER SERIES**

ADB Economics Working Paper Series

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Martin H. Davies and Marcel Schröder

No. 660 | May 2022

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We gratefully acknowledge Paul Barker for numerous discussions on exchange rate issues in Papua New Guinea. We would like to thank seminar participants at the Asian Development Bank and the International Monetary Fund for valuable comments and suggestions. We are grateful to Nedelyn Magtibay-Ramos for excellent research assistance.



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ISSN 2313-6537 (print), 2313-6545 (electronic)
Publication Stock No. WPS220222-2
DOI: <http://dx.doi.org/10.22617/WPS220222-2>

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ABSTRACT

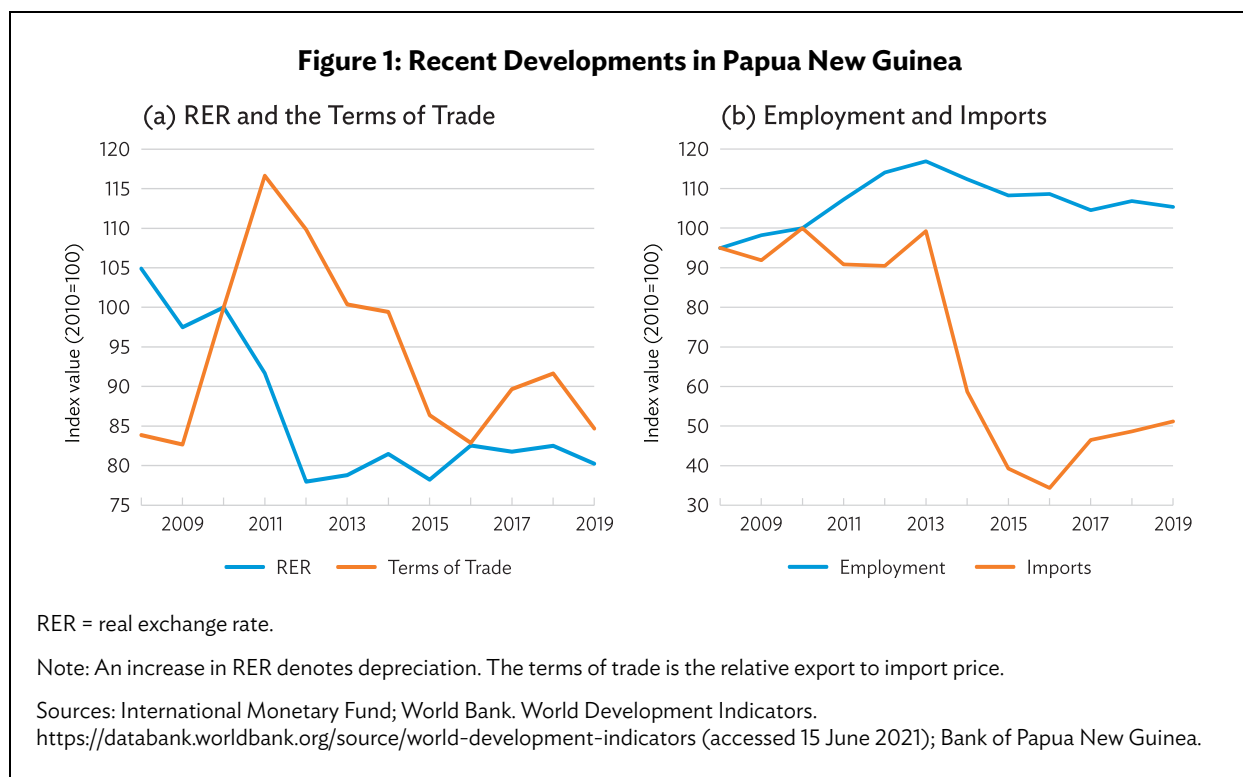
We present a simple model of internal and external balance that incorporates the key features of resource-rich developing countries (RRDCs). The main result is that “government take”, which is the ratio of fiscal resource revenue to resource output, is a key determinant of the equilibrium real exchange rate (RER) in RRDCs. In examining the case of Papua New Guinea, which has grappled with foreign exchange restrictions since 2015, we find that about half of the RER overvaluation estimated at 26% in 2019 would disappear if the current low level of government take was to be lifted to its long-term average. The analysis has two key takeaways for RRDCs. First, changes in the government take require adjustments to the RER and fiscal policy to maintain internal and external balance. Second, economic adjustments to falls in the take are difficult; therefore policies that seek to stabilize the take over time to promote macroeconomic stability are recommended.

Keywords: government take, internal and external balance, real exchange rate, resource-rich developing countries, resource taxation

JEL codes: F31, O11, Q32, Q33, Q38

I. INTRODUCTION

Resource-rich developing countries (RRDCs) have struggled to convert their vast natural resource wealth into sustainable economic development.¹ Among the chief reasons for this “resource curse” is the macroeconomic instability brought about by recurrent commodity boom-and-bust cycles. Papua New Guinea (PNG), a small RRDC located in the Pacific, is no exception. While the PNG economy adjusted well to a major boom in the 1970s, the one in the 1990s resulted in a large-scale economic crisis. Recently, in spite of the commencement of exports from a large liquefied natural gas (LNG) project and current account surpluses exceeding 25% of gross domestic product (GDP), the economy has struggled with foreign exchange shortages since the end of the commodities super cycle in 2014. Instead of allowing the real exchange rate (RER) to depreciate as the terms of trade deteriorated (Figure 1a), the Bank of Papua New Guinea (BPNG) has instead imposed foreign exchange rationing to protect declining foreign exchange reserves. This has led to significant backlogs in the processing of foreign exchange orders, import compression, and sharp falls in formal sector employment (Figure 1b). In the dependent economy model featuring internal and external balance targets (Salter 1959, Swan 1960, Corden 1960, Dornbusch 1974), this refers to a classical “deficit-unemployment” situation.²



¹ RRDCs are defined as low-income and lower middle-income countries (GDP per capita \leq \$4,000) with exhaustible natural resources exports comprising at least 20% of total exports (IMF 2012). The list of RRDCs is in the Online Appendix which can be accessed here: <https://www.adb.org/publications/internal-external-balance-resource-rich-developing-countries>.

² The dependent economy model is also known as the Australian model or Salter-Swan-Corden-Dornbusch model. Schmitt-Grohe and Uribe (2021) introduce micro foundations to this framework.

In this paper, we analyze the foreign exchange market in PNG to inform the ongoing policy debate on how to restore currency convertibility of the kina.³ To this end, we introduce a simple model of internal and external balance, which incorporates the key features of RRDCs. The model distinguishes between production in the resource and non-resource sectors, and is in the spirit of the dependent economy model in that it features the Salter-Swan policy framework. The model aids our understanding of the determination of the equilibrium real exchange rate (ERER)—defined as the value of the RER that results in the simultaneous attainment of both estimating the extent of RER overvaluation in PNG. On the basis of this analysis, we then propose a set of policy actions to achieve the currency convertibility objective. While the focus of this study is on PNG, our modified theoretical and empirical approach to analyzing internal and external balance is applicable to other RRDCs as well. This paper is related to a large literature on the macroeconomic impacts of natural resource boom-and-bust cycles in developing countries, e.g. the Dutch Disease (Corden and Neary 1982), the resource curse more generally (Frankel 2010, Van der Ploeg 2011, Venables 2016), and more specifically to recent studies developing macroeconomic policy frameworks (IMF 2012) and current account norms for RRDCs (Araujo et al. 2016).

We observe three key features that are common across RRDCs. First, the resource sector represents a large share—about one quarter on average—of the total economy in RRDCs. Second, the resource sector effectively operates as an “enclave” with virtually no linkages to the domestic economy’s non-resource sector. Because of limited local expertise and access to specialized inputs, the resource sector employs mostly foreign factors of production and most, if not, all of the output is exported.⁴ Third, the share of foreign ownership, in terms of equity interest in extractive projects and factors of production in the resource sector, is high.

These features imply that foreigners receive a sizable share of the resource sector’s output and that the net factor income (NFI) component in the current account balance is negative and large (in absolute value), driving a wedge between GDP and gross national income (GNI). Indeed, in RRDCs, the GNI to GDP ratio is low at 0.91 compared to 0.97 in other resource-rich countries (ORRCs), and 1.05 for the group of less-developed countries that are not classified as RRDCs.⁵ In the model, we modify the external balance condition as the presence of the large and negative NFI affects the sustainable level of the current account. And since domestic expenditure depends on national income, the NFI-channel also impacts the internal balance condition.

The government collects fiscal resource revenue through a combination of taxes on resource output (or sales) such as royalties or production levies, taxes on profits such as the corporate income tax, and its own equity interests in resource projects. Given their arguably low levels in RRDCs, we abstract away from domestic private ownership in the resource sector so that fiscal resource revenue is the mirror image of NFI in the model. We define the ratio of fiscal resource revenue to resource output as the “government take”, which serves as a proxy for domestic ownership in the resource sector. Empirically, about two thirds of the resource sector in RRDCs is foreign-owned by this measure, which compares to only one third in ORRCs.

³ The kina is the currency and legal tender of PNG.

⁴ The enclave nature of the resource sector has been noted early on in Singer (1950) and Corden (1984).

⁵ ORRCs is a group of resource-rich countries that have reached at least upper middle-income status: Australia, Botswana, Brazil, Canada, Chile, Kuwait, Norway, Oman, Qatar, Saudi Arabia, and United Arab Emirates.

Among the key results of the model is that an increase in government take appreciates the ERER in RRDCs. In practice, various factors introduce time-variation in government take. It tends to increase during periods of rising commodity prices because many of the government's tax instruments are profit-based such as the corporate income tax. However, changes in commodity prices are just part of the story. The take also changes over the life cycle of resource projects. For example, governments usually accrue a larger share of payments during the mature phase of a project which is after multinational firms (MNFs) have recovered their return on investment.

Based on the model, we empirically estimate the ERER for PNG as a function of government take, the terms of trade, and other macroeconomic fundamentals. The results suggest that the RER was overvalued by 14%–26% in 2019. We find that the extremely low government take totaling only 5% of resource output explains about half of this misalignment, taking the 20% long-run average as the benchmark. There is also evidence that the relevant channel through which the RER appreciates during resource booms in PNG is via the increase in government take and not the terms of trade. Fox and Schröder (2018) estimate PNG's RER overvaluation over 1980–2016, but do not control for government take. When we follow their approach, the results suggest a real overvaluation of 5% in 2019, which seems implausibly low given the ongoing large backlog in foreign exchange orders and import compression. Our conclusion is that government take is an important variable, which should be taken into account when analyzing internal and external balance in RRDCs such as PNG.

Two key policy implications for RRDCs follow. First, changes in government take require adjustment to the RER to maintain internal and external balance. Second, policies seeking to stabilize government take over time should be part of the tool kit to promote macroeconomic stability in these countries. One way for the Government of PNG to achieve this is to prioritize the frontloading of revenue from new resource projects by relying more on tax instruments that are less profit based such as production levies or royalties on sales. Among the key reasons for the low government take in recent years is the backload in revenues from the massive PNG LNG project because of profit-based provisions and various tax incentives in the investment agreement between the government and foreign investors. In addition, real depreciation and fiscal restraint are needed to effectively address PNG's deficit-unemployment condition.

The rest of the paper is organized as follows. Section II discusses the structure of PNG's foreign exchange market, recent developments, and the factors explaining the chronic foreign exchange shortages. Section III presents the internal-external balance model which then guides the estimation of PNG's ERER. Section IV outlines policy recommendations based on our analysis. Section V concludes.

II. THE FOREIGN EXCHANGE MARKET IN PAPUA NEW GUINEA

This section describes the structure of the foreign exchange market in PNG and recent developments, and analyzes the factors behind the chronic foreign exchange shortages.⁶

⁶ We conducted extensive interviews with both private and public sector market participants in PNG in 2020. Much of this section is based on a study of the foreign exchange market of PNG conducted in 2020 and 2021 (Davies 2021).

A. Market Structure

Given that PNG is a developing country with a small and relatively unsophisticated manufacturing sector, there is a high propensity to import a wide variety of manufactured capital goods; intermediate inputs; and final goods for households, firms, and government. In addition, foreign exchange demand also stems from businesses that want to repatriate profits or wealthy households that send funds abroad. Foreign exchange supply comes from sales of PNG commodity exports, particularly from the larger mining operators and agricultural exporters. Other sources are tax receipts, royalties, and other payments from resource companies such as Lihir, PNG LNG, Porgera, and Ok Tedi. At times, foreign direct investment (FDI) to the resource sector is a large contributor to foreign exchange inflows, as in 2010–2014 during the construction of the PNG LNG project which had an initial investment volume of \$19 billion. However, large-scale resource projects do not trigger much FDI flows to PNG’s non-resource sector—in contrast to other developing countries such as Ghana, Mozambique, Mongolia, or Tanzania (Toews and Vzina 2020, Sayour and Schröder 2021).⁷ Consequently, FDI inflows have come to a virtual halt since 2015 for lack of new extractive projects.⁸

B. Recent Foreign Exchange Market Conditions⁹

The start of the PNG LNG project’s production phase in mid-2014 coincided with the end of the commodities super cycle and a sharp drop in commodity prices. While LNG exports led to large current account surpluses of about 25% of GDP during 2014–2019, this did not translate to reserve accumulation because of offsetting financial account outflows associated with debt repayments for the PNG LNG project as well as offshore dividend payouts. Figure 1a shows the RER has not depreciated markedly despite the fall in commodity prices and the overall state of the economy resembling that in 2000–2003 (Howes et al. 2019). While the nominal exchange rate has depreciated by about 6% annually, this has been almost entirely offset by the inflation differential relative to PNG’s trading partners. Overall, these factors suggest that the RER is overvalued.

Consequently, there has been an ongoing foreign exchange shortage in PNG since around 2015. Although the International Monetary Fund (IMF) has officially classified PNG’s exchange rate regime as a de facto crawl-like arrangement since 2014, the BPNG has rationed the market’s access to foreign exchange instead of allowing further exchange rate depreciation. The BPNG has instructed foreign exchange dealers to prioritize certain types of transactions in the queue for foreign exchange, and to give lower priority to, or prevent, the execution of other transactions. For example, in 2015 and 2016, the remittance of business profits and dividends was prevented, while necessities such as rice and fuel took priority over other consumer goods (Fox et al. 2017). The processing time of foreign exchange orders has varied. While the wait was between 6 weeks and 16 weeks in 2017 (Fox et al.

⁷ This is based on data from the FDI markets database on greenfield FDI projects by the *Financial Times*.

⁸ International capital mobility for PNG is low. There are virtually no short-term flows that link interest rate changes to exchange rate changes. Evidence of the low capital mobility in PNG is the observation that the balance of payments deteriorates (reserves decline) whenever the government undertakes a fiscal expansion. That is, when the current account worsens, there is little offsetting response in the financial account despite the higher interest rates induced by the fiscal expansion. This immobility affords the BPNG the opportunity to set both the interest rate and the exchange rate, an option not available to (impossible trinity).

⁹ Unless otherwise attributed, the numbers in this section come from interviews conducted with domestic participants, including domestic commercial banks, in 2020.

2017), current delays are estimated in the 3–12 weeks range (James 2021). Unlike other developing countries that are facing foreign exchange shortages such as Egypt, Lebanon, or Nigeria, there is no well-established parallel market in PNG.¹⁰ This means that all approved transactions are conducted at the official exchange rate.

Yearly surveys of top executives report that foreign exchange access has been among PNG businesses' chief concerns since 2014, and has been on top of the list in 2016–2018 and again in 2020 (James 2021, Fox et al. 2018). Over this period, there has been a substantial backlog in outstanding foreign exchange orders within the banking system, although estimates of its extent have varied. In 2015, this figure was put at about \$1 billion (Business Advantage PNG 2015), \$1.5 billion during the Ok Tedi mine closure in 2016, and between \$300 million and \$1 billion in 2017 (Fox et al. 2017).

In 2018, the BPNG has reduced guidance to the banks on the allocation of foreign exchange. However, since the beginning of the coronavirus disease (COVID-19) pandemic, the backlog has risen against the backdrop of falling commodity prices and the closure of the Porgera gold mine in April 2020 after the government did not renew the license of the incumbent mining operator Barrick. The current account surplus declined to 14% of GDP in 2020, while financial outflows adjusted only partially. Loan support totaling \$700 million by the IMF, the Asian Development Bank, and the Government of Australia assisted partially in addressing the shortfall. In early 2021, outstanding foreign exchange orders are estimated at about \$650 million.¹¹

C. Factors Behind the Foreign Exchange Shortages

On the supply side, as mentioned, was a fall in commodity prices causing PNG's terms of trade to fall by 27% over 2011–2019. As a result, fiscal resource revenue has plummeted and almost dried up at times (Banks and Namorong 2018, Howes 2018). Figure 2 shows the variation in “government take” (the ratio of fiscal resource revenue to resource GDP) over 2000–2019.¹² The data on fiscal resource revenue come from IMF country reports compiled by the International Centre for Tax and Development, while resource GDP is sourced from the PNG budget database published by the Development Policy Centre at the Australian National University. The data are available over 1989–2019. The recent trend in government take is a precipitous fall from about 45% in 2006 to 30% in 2011, 2.5% in 2016, and 5% in 2019.

Because many of the tax instruments through which the government generates resource revenue are profit-based such as the corporate income tax, government take tends to be positively correlated with commodity prices. A decline in the take following the fall in commodity prices was thus expected, but not to the extent observed. Also part of the story are the various tax incentives granted to foreign investors of new resource projects such as PNG LNG or Ramu Nickel.¹³ These incentives have significantly delayed payments to the Government of PNG. At the same time, it should be noted

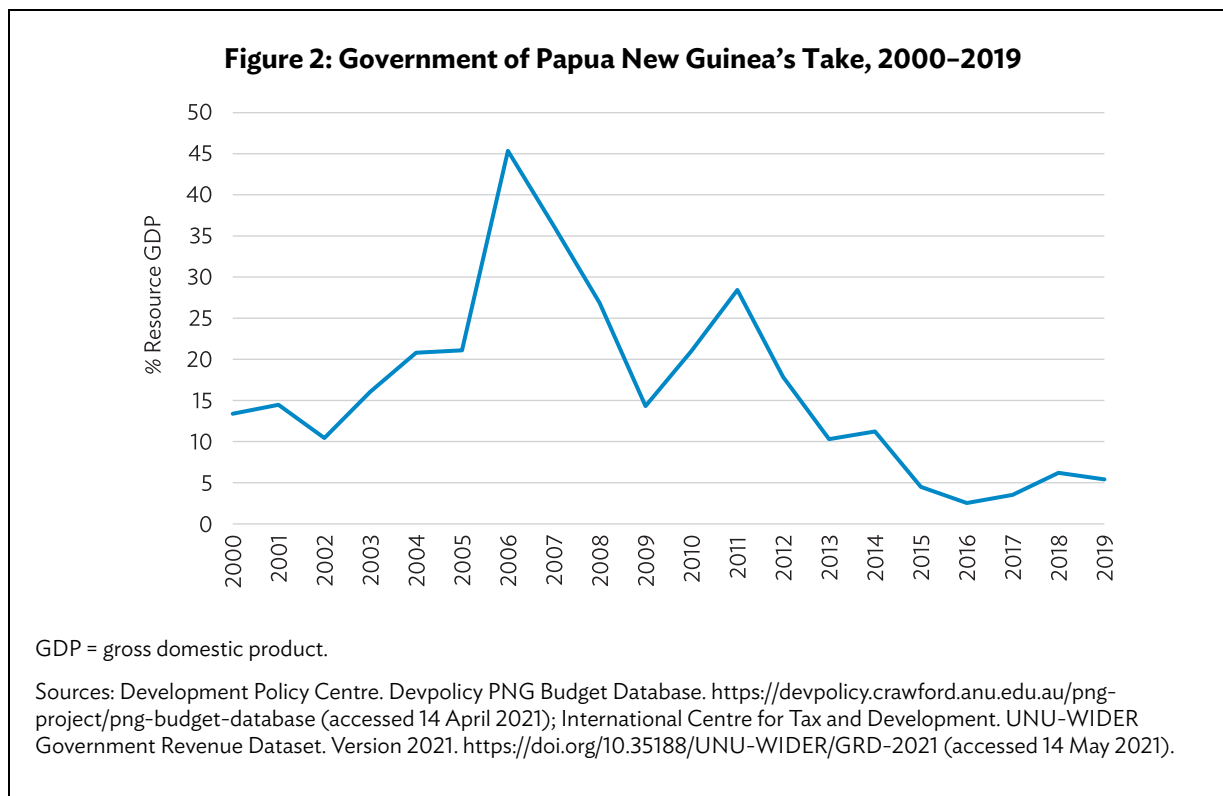
¹⁰ Fox et al. (2017) report unverified rumors of a small-scale parallel market in which the Australian dollar trades at a premium of 15%. We did not hear about any parallel market activity during our interviews with domestic market participants.

¹¹ Domestic importers have adjusted to the rationing of foreign exchange by relying on the support of foreign parent companies and managing the expectations of their overseas suppliers around delays in payments. Firms have also delayed payments of dividend and remittances and, in some cases, have reinvested them in onshore projects rather than wait to send them on shore.

¹² The preferred measure of government take would be the ratio of total resource revenue to resource rents. However, there are no reliable data on the latter. Thus, we proxy government take using resource GDP throughout this paper.

¹³ These incentives include tax holidays, accelerated depreciation, loss carry forward arrangements, tax deductible development levies, or treating royalty payments as advance corporate income tax.

that these projects are still in their early stages, during which revenue accrual to the government is naturally lower than in the mature project phase since investors are still recovering their initial outlays.



Another key factor that explains the foreign exchange shortages is the government's high and rising salary bill of which a large share falls on foreign durable and nondurable goods.¹⁴ Adjusted for inflation, this component has grown by 43% since 2013, while government revenue stagnated. As a ratio to the latter, the PNG wage bill rose from 31% in 2013 to 45% in 2019 despite the government's pledges to the World Bank at the end of 2017 not to increase the salary bill until 2020 as part of its Medium-Term Fiscal Strategy (Howes 2020).

III. DETERMINATION OF THE EQUILIBRIUM REAL EXCHANGE RATE

For long-run currency convertibility, three conditions must be satisfied (Guitan 1996). First, the RER must be at an appropriate level, i.e., consistent with external balance. Second, international reserves must be at an adequate level to cushion against shocks. Third, macroeconomic policy should be prudent, particularly along fiscal and monetary dimensions. In this section, we determine the RER that leads to the simultaneous attainment of both external balance and internal balance; that is, the ERER (Nurkse 1945). External balance is defined as the current account deficit that can be financed through sustainable levels of capital inflows. Since RRDCs, like PNG, have a large informal sector, the definition

¹⁴ Unofficial estimates suggest a share of about 60%–70%.

for internal balance requires some modification. We follow Garnaut and Baxter (1983) who define internal balance as “the state in which the number of people who prefer wage employment to village life, given the wage level and other factors affecting non-village life and village standards of living, roughly balances the number of wage and other non-village jobs available.”

We present a simple model of internal and external balance, which incorporates three key features of RRDCs and shows that their inclusion has implications for the internal and external balance conditions and thus the ERER in these countries. We then use this model as a guide to estimate the extent of RER overvaluation in PNG.

Table 1: Country Characteristics

	RRDCs	ORRCs	G7	OLDCs	PNG
GNI/GDP	0.91	0.97	1.01	1.05	0.90
Resource GDP/GDP	0.26	0.25	0.01	0.03	0.23

G7 = Group of Seven, GDP = gross domestic product, GNI = gross national income, OLDC = other least-developed country, ORRC = other resource-rich country, PNG = Papua New Guinea, RRDC = resource-rich developing country.

Notes: ORRCs include Australia, Botswana, Brazil, Canada, Chile, Kuwait, Norway, Oman, Qatar, Saudi Arabia, and United Arab Emirates. Government take is calculated as the ratio of total fiscal resource revenue to resource GDP. Cameroon is excluded from the RRDC group because of its unreliable resource GDP data. OLDCs belong to the group of least-developed countries that are not at the same time classified as RRDCs. A list of OLDCs is in the Online Appendix. Sample period: 2000–2019.

Sources: National accounts data; World Bank. World Bank. World Development Indicators. <https://databank.worldbank.org/source/world-development-indicators> (accessed 15 June 2021).

A. Key Characteristics of Resource-Rich Developing Countries

The first feature is that the resource sector is large relative to the overall economy, which is 26% on average over 2000–2019 in RRDCs (Table 1). Second, the resource sector effectively operates as an “enclave” in RRDCs, which is documented by Singer (1950), in the early Dutch Disease literature by Corden (1984), and more recently by Ackah-Baidoo (2012). The enclave nature stems from the lack of local firms’ access to specialized inputs and expertise to extract resources through complex processes. As Halland, Lokanc, and Nair (2015) note, extractive industries bring skilled labor, goods, and services from abroad. In addition, firms and consumers in the domestic economy consume little, if any, of the resource sector’s output. Further, given the low levels of worker skill in RRDCs, there is little demand for domestic workers by the foreign MNFs. Overall, the resource sector thus employs mainly foreign factors of production, and there are virtually no linkages to the rest of the economy. PNG is an illuminating illustration of this. The resource sector contributes about 23% to total output (Table 1), but only employs about 20,000 national workers out of a total labor force of 2.7 million. Further, at the time that the PNG LNG project commenced exporting in 2014 and 2015, the country was ranked in the top five fastest growing in the world with real GDP growth of 7.4% and 6.8% respectively (World Bank 2017), while the economy was grappling with foreign exchange shortages and falling formal sector employment (Figure 1b).

Table 2: Government Take Comparison

	RRDCs	ORRCs	PNG
Government take ($\tilde{\alpha}$)	0.37	0.66 ^a	0.20

ORRC = other resource-rich country, PNG = Papua New Guinea, RRDC = resource-rich developing country.

Notes: Government take is calculated as the ratio of total fiscal resource revenue to resource gross domestic product. Cameroon is excluded from the RRDC group because of its unreliable resource gross domestic product data. ORRCs include Australia, Botswana, Brazil, Canada, Chile, Kuwait, Norway, Oman, Qatar, Saudi Arabia, and United Arab Emirates. Sample period: 2000–2018.

^a Calculated based on available data from Botswana, Chile, Kuwait, Norway, Qatar, and Saudi Arabia.

Sources: National accounts data; World Bank. World Development Indicators. <https://databank.worldbank.org/source/world-development-indicators> (accessed 15 June 2021); International Centre for Tax and Development. UNU-WIDER Government Revenue Dataset. Version 2021. <https://doi.org/10.35188/UNU-WIDER/GRD-2021> (accessed 14 May 2021).

The third characteristic is that the resource sector has a high degree of foreign ownership, both in terms of factors of production and equity interests in resource projects. This implies that foreigners receive a sizable share of the resource sector's output and, given its large relative size, RRDCs' current account balances include a negative and large (in absolute value) NFI term. This is indeed observed in the data as the average GNI to GDP ratio is 0.91 for RRDCs, compared to 0.97 for ORRCs, 1.01 for the Group of Seven (G7), and 1.05 for the group of least-developed countries that are not classified as RRDCs (other least-developed countries), while PNG's ratio is near the RRDC-average at 0.90 (Table 1).

Further evidence of a high degree of foreign ownership provides a look at the government take, which is the share of resource output left after payments to foreign equity holders and foreign factors of production are made. Government take thus serves as a good proxy for domestic ownership in the resource sector (Table 2).¹⁵

The RRDC average of government take is low at 0.37, meaning that about two thirds of the resource sector is foreign-owned in these countries. This compares to an average government take of 0.66 in ORRCs, or that only one third of the resource sector is foreign-owned in this country group.

B. Model

The framework is that of a small open RRDC that produces goods in a resource (R) and non-resource sector (NR). Total GDP of the economy is the sum of the economic activity in the non-resource (Y_{NR}) and resource sectors (Y_R) and thus $Y_{GDP} = Y_{NR} + Y_R$. The non-resource sector produces agricultural goods, basic manufactures, and nontradables using domestic capital (K_{NR}) and labor (L_{NR}). The output of the resource sector is given by:

¹⁵ As we elaborate on in the next section, this is true when there is no domestic private ownership in the resource sector.

$$Y_R = F_R(K_R, L_R, R)$$

where K_R and L_R are capital and labor in the resource sector and R is the resource which can be thought of as copper, crude oil, gold, LNG, nickel, silver, and others. Following our discussion above, we assume that the resource sector is majority foreign-owned, employs only foreign workers, L_R , and that capital in the resource sector, K_R , is entirely foreign-owned. The resource, R , belongs to the home country. However, through mutual agreement between the MNFs and the home government, MNFs have the right to exploit it. The foreign factors of production L_R and K_R , are paid out of the resource sector output, Y_R , with the remainder, which is attributable to the resource R , being resource rents. Resource rents, ρ , are thus defined as:

$$\rho = Y_R - (wL_R + rK_R)$$

where w and r and the factor prices for L_R and K_R which are determined internationally and thus taken as exogenous.¹⁶

We also assume that the domestic economy does not consume any of the resource sector's output so that $EX_R = Y_R$, where EX_R denotes resource sector exports. For simplicity of exposition, we model EX_R as being invariant to changes in the real exchange rate.¹⁷ We assume that foreigners do not own any capital in the non-resource sector, and the home country, PNG in our example, does not own capital in any foreign country. Further, foreigners do not work in the non-resource sector, and Papua New Guineans do not work overseas. These assumptions simplify the setup of the model, in particular the derivation of NFI, but they are not key to the results.

The government owns share $\alpha \in [0, 1)$ of the resource sector, and is hence entitled to a share α of resource rents, $\alpha\rho$ in total. The domestic private sector may also own a share $\alpha_\rho \in [0, 1)$ of the resource sector. However, in most RRDCs this is low. We assume that the domestic private sector has no ownership and $\alpha_\rho = 0$. The remaining share of the resource sector, $(1 - \alpha)$, belongs to foreign MNFs entitling them to a share of the resource rents of $(1 - \alpha)\rho$.

The government taxes the foreign share of resource rents at rate t_R , which generates additional revenue of $t_R(1 - \alpha)\rho$.¹⁸ Additionally, MNFs make royalty payments at rate t_L per unit of resource sector output in exchange for the right to extract the resource, $t_L Y_R R$ in total. Given that the ratio of resource rents, ρ , to resource sector output, Y_R , is $Y = \frac{\rho}{Y_R}$ we calculate the government's total revenue from the resource sector as:

$$(t_L + (\alpha + (1 - \alpha)t_R)Y)Y_R.$$

This allows us to determine the government take, $\tilde{\alpha}$, as:

$$\tilde{\alpha} = \frac{\text{Total resource revenue}}{Y_R} = t_L + (\alpha + (1 - \alpha)t_R)Y \quad (1)$$

¹⁶ Because resource output, Y_R , is measured in real terms, an increase in the price of the extracted resource, *ceteris paribus*, will lead to a corresponding increase in Y_R . The rental rate, r ; incorporates normal returns to capital.

¹⁷ The key point here is that the resource exports are less responsive to changes in the RER, Θ , than non-resource exports, EX_{NR} , which in RRDCs tend to be primary products, such as agriculture, and simple manufactures. Modelling EX_R as dependent on Θ , but less sensitive to changes in than EX_{NR} , would not qualitatively change the model.

¹⁸ In practice, this would correspond to instruments such as corporate income tax or dividend withholding tax.

As discussed in the previous section, the government take can vary substantially over time as commodity prices fluctuate, or because resource projects are at their initial stages during which governments reap a small share of rents, ρ , especially when an extraction agreement includes tax incentives for MNFs. Conversely, when projects approach the end of their life cycles, yields fall as costs to achieve a given level of output rise which has the effect of lowering rents. Shocks or fluctuations in extraction costs are also an important determinant of Y and therefore government take. For simplicity, we do not model such effects explicitly and instead capture these through (exogenous) changes in Y .¹⁹ We assume that the government returns the resource revenue, $\tilde{\alpha}Y_R$, to domestic factors of production. Since the marginal propensity to consume is the same for both domestic capital and labor, the distribution of resource revenue does not matter.

Given our assumption above that there are no foreign factors of production employed in the non-resource sector and no nationals working overseas, then this setup allows us to simply represent net payments to foreign factors of production (including the foreign share of resource rents), or NFI , as:²⁰

$$NFI = -(1 - \tilde{\alpha})Y_R \quad (2)$$

In RRDCs, since the resource sector is a large share of GDP (Y_R/Y_{GDP} is large) and $\tilde{\alpha}$ is small, then from (2) it follows that $\frac{NFI}{GDP}$ is strongly negative and the difference between GNI and GDP is large. Since GNI is defined as $Y_{GNI} = Y_{GDP} + NFI$; under our assumptions GNI simplifies to the sum of non-resource GDP and the government take:²¹

$$Y_{GNI} = Y_{NR} + \tilde{\alpha}Y_R$$

Whereas private sector investment, I , is exogenously determined, consumption, C , imports, IM , and domestic taxes, T , all depend on national income, Y_{GNI} . Specifically, $C = a + c(1 - t)Y_{GNI}$, $IM = m(\theta)(1 - t)Y_{GNI}$ and $T = tY_{GNI}$, where a is the autonomous component of consumption, c is the marginal propensity to consume, and t is the average tax rate. The government uses the total tax revenue raised on national income, T , to finance its spending, G .²² Finally, $m(\theta)$ is the marginal propensity to import which depends on the RER, with $m'(\theta) < 0$. The RER is defined as:

$$RER = \theta = \frac{eP^*}{P}$$

where e is the nominal exchange rate (domestic currency per unit of foreign currency), P is home's price of consumption, and P^* is foreign's consumption price.²³ An increase in θ refers to a real depreciation.

Given that L_{NR}^* and K_{NR}^* are the full employment levels of labor and capital in the domestic economy, then the level of non-resource output that ensures full employment of domestic factors of

¹⁹ For example, changes in tax rate, t_R , would also affect government take, but such scenarios are not the focus of our study.

²⁰ We derive this in the Online Appendix.

²¹ Since $Y_{GNI} = Y_{GDP} + NFI$ then $Y_{GNI} = Y_{NR} + Y_R - (1 - \tilde{\alpha})Y_R = Y_{NR} + \tilde{\alpha}Y_R$.

²² The government returning the take of $\tilde{\alpha}Y_R$ to domestic factors of production and levying taxes on gross national income of $T = tY_{GNI}$ is equivalent to the government returning only $(1 - t)\tilde{\alpha}Y_R$ of the take to domestic factors of production, retaining the remainder $(t\tilde{\alpha}Y_R)$, which is the amount they would tax back, and then taxing non-resource income at rate t . That is, $tY_{GNI} = tY_{NR} + t\tilde{\alpha}Y_R$.

²³ Conceptually, this is an expenditure-based "external RER" (Hinkle and Nsengiyumva 1999). The price of consumption includes both tradables and nontradables.

production is $Y_{NR}^f = F_{NR}(K_{NR}^*, L_{NR}^*)$, where $F_{NR}(\cdot)$, is the non-resource sector production function. Non-resource exports are determined by $EX_{NR}(\theta)$ with $EX'_{NR}(\theta) > 0$. This leads to the internal balance condition.

Definition 1. *The internal balance condition for a RRDC is given by:*

$$Y_{NR}^f = \mu(A + EX_{NR}(\theta)) + (\mu - 1)\tilde{\alpha}EX_R \quad (3)$$

where $\mu = (1 - (c - m)(1 - t))^{-1}$ is the multiplier and $A = a + I + G$ is absorption (footnote 20).

The enclave nature of the resource sector can be seen in this expression with resource sector exports, EX_R , having a lower multiplier $(\mu - 1)$ than the other components of aggregate expenditure (μ) . This is because EX_R only influences domestic expenditure through the fraction of resource sector output that is returned to the domestic economy (the government take), and is therefore part of GNI and which is spent on consumption and imports. To relate this to Corden and Neary (1982), because the resource sector is an enclave and employs no domestic factors of production, any change in EX_R leads to a spending effect but no resource movement effect.²⁴

The external balance condition is defined as the sustainable level of the current account. In deriving an expression for the current account here, we must account for non-zero NFI.

The current account balance is the trade balance plus NFI given by $EX_{NR} + EX_R - IM - (1 - \tilde{\alpha})Y_R$, which simplifies to $EX_{NR} + \tilde{\alpha}EX_R - m(\theta)(1 - t)Y_{GNI}$. Substituting for Y_{GNI} gives the expression below.²⁵

Definition 2. *The external balance condition for a RRDC is defined by:*

$$(1 - c(1 - t))(EX_{NR}(\theta) + \tilde{\alpha}EX_R) - m(\theta)(1 - t)A = 0 \quad (4)$$

Solving the system of equations 3 and 4 allows the determination of the solution for the ERER, $\hat{\theta}$, and the equilibrium level of absorption, \hat{A} ,

$$EX_{NR}(\hat{\theta}) = m(\hat{\theta})(1 - t)(Y_{NR}^f + \tilde{\alpha}EX_R) - \tilde{\alpha}EX_R \quad (5)$$

$$\hat{A} = (1 - c(1 - t))[Y_{NR}^f + \tilde{\alpha}EX_R] \quad (6)$$

Since $EX'_{NR}(\theta) > 0$, the LHS of equation 5 is increasing in θ , and since $m'(\theta) < 0$ the RHS of equation 5 is decreasing in θ . This ensures that equation 5 yields a unique solution for $\hat{\theta}$.

We now derive the main propositions.

²⁴ If the resource sector was fully integrated with the rest of the economy, domestic factors of production employed in the resource sector, and no foreign ownership, then the internal balance condition would be $Y_{GDP}^f = \mu(a + I + G + EX_{NR}(\theta) + EX_R)$.

²⁵ In the standard model where $NFI = 0$; the external balance condition would simply be $EX_{NR} + EX_R - IM = 0$. The sustainable long-run net foreign asset position may be negative in which case the external balance condition would be $CA = X < 0$, where X is the sustainable level of long-run borrowing. However, following convention, we set $CA = 0$ for external balance.

Proposition 1. *Following an increase in the government take, $\tilde{\alpha}$, the ERER, $\hat{\theta}$, must appreciate to maintain internal and external balance, where:*

$$\frac{d\hat{\theta}}{d\tilde{\alpha}} = -\frac{1}{\frac{EX_{NR}}{\theta} \left(\varepsilon_{EX_{NR},\theta}(\hat{\theta}) + \frac{1}{s_{NR}(\hat{\theta})} \varepsilon_{m,\theta}(\hat{\theta}) \right)} EX_R [1 - m(\hat{\theta})(1 - t)] < 0$$

Proof. The proof is in the Online Appendix.

An increase in the government take, $\tilde{\alpha}$, leads to an increase in the share of resource sector export revenues being returned to the home country improving the current account as NFI increases (becomes less negative). A higher $\tilde{\alpha}$ also increases Y_{GNI} , which provides stimulus to the domestic economy (the non-resource sector) by driving up domestic expenditure. Consumption and imports expenditures both rise and this has a net positive effect as $c > m(\hat{\theta})$.

Thus, an appreciation of the real exchange rate, which reduces non-resource exports, $EX_{NR}(\theta)$, is required to return the economy to internal and external balance. As can be seen in the expression above, the magnitude of the response of the ERER, $\hat{\theta}$, to a change in the government take, $\tilde{\alpha}$, depends on the elasticity of non-resource exports with respect to the RER, $\varepsilon_{EX_{NR},\theta}(\hat{\theta})$, the elasticity of the marginal propensity to import with respect to the RER, $\varepsilon_{m,\theta}(\hat{\theta})$, and the share of non-resource exports in total export receipts, $s_{NR}(\hat{\theta}) = \frac{EX_{NR}(\hat{\theta})}{EX_{NR}(\hat{\theta}) + \tilde{\alpha} EX_R}$. The lower the elasticities the greater is the response of the ERER to a change in government take.

Proposition 2. *Following an increase in the government take, $\tilde{\alpha}$, the equilibrium level of absorption, \hat{A} , must increase to maintain internal and external balance, where:*

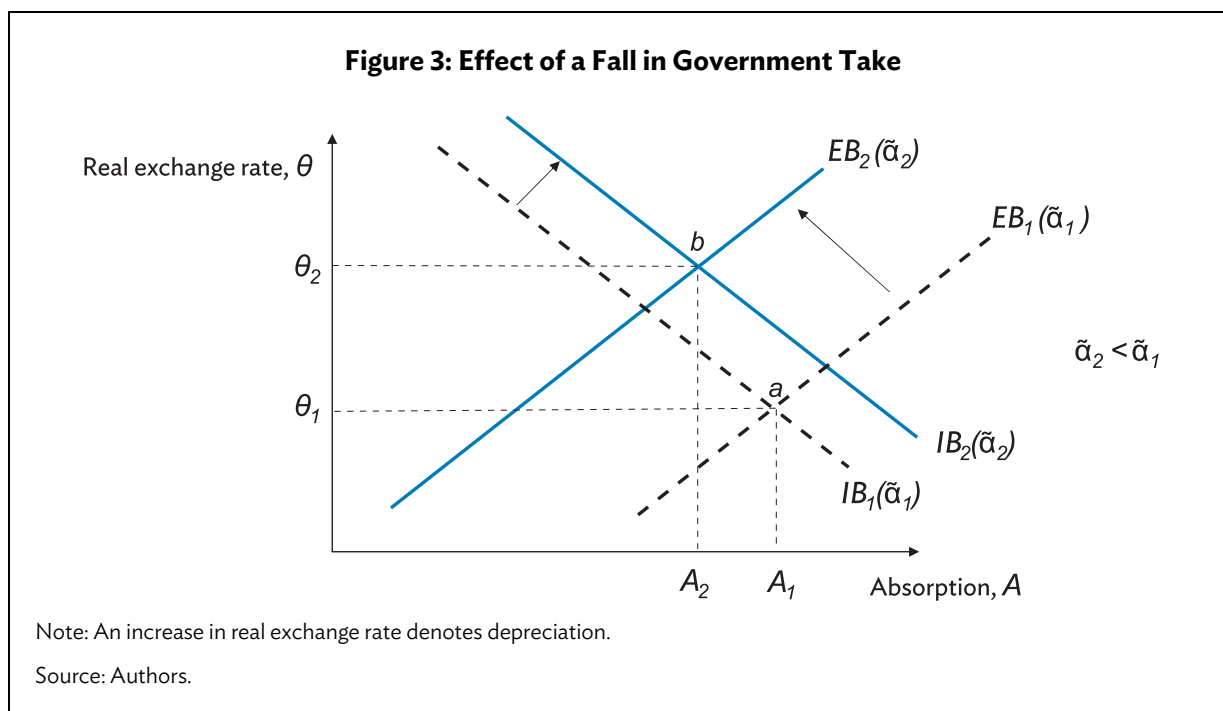
$$\frac{d\hat{A}}{d\tilde{\alpha}} = \frac{EX_R}{\frac{EX_{NR}}{\theta} \left(\varepsilon_{EX_{NR},\theta}(\hat{\theta}) + \frac{1}{s_{NR}(\hat{\theta})} \varepsilon_{m,\theta}(\hat{\theta}) \right)} \left[(1 - c(1 - t)) \frac{dEX_{NR}(\hat{\theta})}{d\theta} - \hat{A}(1 - t) \frac{dm(\hat{\theta})}{d\theta} \right] > 0$$

Proof. The proof is in the Online Appendix.

An increase in government take improves the current account which requires RER appreciation to restore external balance. While the NFI-channel also boosts domestic expenditure, this is offset by the fall in EX_R driving non-resource output below the internal equilibrium. Thus, in addition to an appreciation of the RER, an increase in absorption is needed to ensure internal and external balance.²⁶ Similar to Proposition 1, the magnitude of $\frac{d\hat{A}}{d\tilde{\alpha}}$ depends on the elasticities $\varepsilon_{EX_{NR},\theta}(\hat{\theta})$ and $\varepsilon_{m,\theta}(\hat{\theta})$ and the non-resource export share, $s_{NR}(\hat{\theta})$.

Figure 3 is a Swan diagram illustrating the impact of a fall in government take on the economy, as experienced by PNG since 2011. The worsening of the current account requires real depreciation to restore external equilibrium, as illustrated by the leftward shift of external balance. The fall in government take also lowers GNI, but the impact is relatively smaller than on the current account as shown by the comparably small rightward shift of internal balance in the diagram.

²⁶ While a change in government take also affects the current account, the result here is in contrast to that of a net export shock since the economy adjusts to these via the RER only.



This means that the increase in non-resource exports triggered by the real depreciation pushes non-resource output above Y_{NR}^f so that a reduction in absorption is needed for internal equilibrium to hold. The economy moves from the initial equilibrium at point a to point b . The current position of the PNG economy is likely to be somewhere below point b and to the right of A_2 .

C. Estimating the Equilibrium Real Exchange Rate

In this section, we estimate PNG's ERER to calculate the degree of RER misalignment. The ERER definition implies that it is a function of a set of macroeconomic variables evaluated at their sustainable values. The internal-external balance model in the previous section suggests that government take from resource projects is an important determinant of equilibrium in a RRDC such as PNG. Based on Edwards (1989), Montiel (1999), and Faruqee (1995), the complete list of the ERER fundamentals is as follows:

- The terms of trade [+/-]
- Trade openness [+]
- Productivity differentials between PNG and its trading partners (Balassa-Samuelson effect) [-]
- Government consumption of tradables [+] and nontradables [-]
- Net international indebtedness [+/-]
- Government take from resource projects [-]

where the signs of the partial derivative with respect to the RER are parenthesized. For example, an improvement in the terms of trade has an ambiguous impact on the ERER (Edwards 1989), while increased trade openness—through the removal of tariffs for example—results in a real depreciation (Edwards 1989, Montiel 1999). As shown in the previous section, a higher government take appreciates the ERER.

To estimate the ERER, we use the single-equation approach which is widely used in the empirical literature on RERs following Edwards (1989); Elbadawi (1994); and Baffes, Elbadawi, and O’Connell (1999). The analysis proceeds in two steps. The first estimates the long-run relationship between the RER and the fundamentals listed above:

$$RER_t = \beta F_t + u_t$$

where F_t refers to the fundamentals, vector β contains the long-run parameters, and u_t is a stationary error term with mean zero. The second step derives the sustainable values of the fundamentals, F_t^S , through trend-cycle decomposition to calculate the ERER:

$$ERER_t = \beta F_t^S.$$

The degree of misalignment (in %) can then be determined by applying the following formula:

$$RER \text{ misalignment}_t = 100\% \times \left(1 - \frac{RER_t}{ERER_t}\right)$$

where positive (negative) values denote RER overvaluation (undervaluation).

(1) Data

We use the dataset of Fox and Schröder (2018) who estimate misalignment in PNG’s RER over 1980–2016, and extend it until 2019. Observations on the RER are retrieved from the IMF’s International Financial Statistics database. The IMF proxies the RER by using consumer price indexes and trade weights, which are essentially an expenditure-based external RER and, as such, closely related to the theoretical counterpart in our model. The terms of trade are the relative price of exports to imports (in natural logarithm), which is compiled from the World Bank’s World Development Indicators database, World Development Reports, and the BPNG. Trade openness is proxied through the trade ratio (exports plus imports relative to GDP) and sourced from the World Development Indicators and BPNG.²⁷ Since there are no separate data on government consumption of tradables and nontradables, we include total government consumption in the RER equation instead.²⁸ We update the latter based on BPNG’s Quarterly Economic Bulletin Statistical Table 7.1. We proxy productivity differentials by taking the ratio of PNG’s non-resource GDP per capita to the unweighted average GDP per capita of the five largest trading partners, i.e., Australia, Japan, Malaysia, the People’s Republic of China, and Singapore.²⁹

Data on net international indebtedness for the years 1980–2015 come from the updated Wealth of Nations database (Lane and Milesi-Ferretti 2007). For subsequent years, we approximate changes in this variable by the current account balance. We obtain the latter from BPNG’s Quarterly Economic Bulletin Statistical Table 8.1-B. For those variables that are measured as a ratio to GDP (trade openness, government consumption, net international indebtedness, and productivity), we source the latter from Devpolicy PNG Budget Database. Government take is the same series as in Figure 2. The sample period is 1989–2019, and is dictated by the availability of government take.

²⁷ The idea is that a country with a more liberal trade regime exchanges more goods and services with the rest of the world, all else being equal.

²⁸ This is akin to imposing an equality restriction on the coefficients attached to government spending on tradables and nontradables.

²⁹ Since the resource sector is highly dependent on imported labor and capital, changes in non-resource GDP are better suited to approximate changes in productivity.

(2) Method

For estimating β , we use the procedure of Fox and Schröder (2018). Dickey-Fuller generalized least squares (DF-GLS) test statistics based on Elliott, Rothenberg, and Stock (1996) suggest that the data are a mixture of $I(0)$ and $I(1)$ series. To estimate the long-run relationship between the ERES and fundamentals we use the fully-modified ordinary least squares (FM-OLS) estimator, which is suitable for small samples and when regressors are mixed stationary and non-stationary.³⁰ To test for parameter stability over the sample period and co-integration among the variables, we use the L_c test of Hansen (1992). Finally, the sustainable values are based on the trend component derived through the Hodrick-Prescott filter.

The estimation process typically involves finding various subsets of the fundamentals that form a long-run relationship with the RER. Our decision rule is to choose the specification that contains the largest number of fundamentals and minimizes the information criteria, provided that the coefficients are co-integrated, stable, and their signs are in line with economic theory (Montiel 2007, Fox and Schröder 2018).

D. Results

Table 3 presents the results. There are five specifications explaining long-run RER behavior. Based on the above selection criteria, we take a closer look at columns 1–3 since these are the most inclusive ones containing five ERES fundamentals. Of these, we select column 2 because the adjusted R-squared

Table 3: The Long-Run Relationship Between Real Exchange Rate and Fundamentals

Independent Variable	(1)	(2)	(3)	(4)	(5)
Terms of trade	0.21 (0.07)***	0.21 (0.05)***	0.16 (0.05)***		-0.11 (0.03)***
Trade openness	0.66 (0.05)***		-0.16 (0.09)*	0.78(0.06)***	0.71 (0.05)***
Productivity differentials		-0.42 (0.05)***	-0.43 (0.04)***		
Government consumption	-1.89 (0.29)***	-1.34 (0.2)***	-1.12 (0.25)***	-2.15 (0.39)***	-2.45 (0.33)***
Net international indebtedness	0.10 (0.04)**	0.09 (0.03)***	0.07 (0.03)**		
Government take	-0.64 (0.11)***	-0.23 (0.08)***		-0.46 (0.13)***	
L_c	0.59	0.67	0.76	0.42	0.34
R^2	0.86	0.91	0.90	0.86	0.86

Notes: ***, **, * denote the level of statistical significance at 1%, 5%, and 10%. Standard errors in parentheses. The dependent variable is the real exchange rate (natural logarithm). An increase in real exchange rate denotes depreciation. L_c refers to the test statistic for parameter stability and cointegration due to Hansen (1992). Specifications in columns 1–4 include a trend; column 5 includes a constant. The sample period is 1989–2019.

Source: Authors' calculations.

³⁰ FM-OLS uses a semi-parametric procedure which accounts for long-run endogeneities and serial correlation in the independent variables (Phillips and Hansen 1990, Phillips 1995).

is higher than in column 1, while the negative coefficient on trade openness in column 3 is inconsistent with theory.

However, the resulting misalignment estimates are highly implausible. They suggest that the RER was overvalued by only 2% in 2015 when BPNG first introduced foreign exchange rationing and even a moderate real undervaluation in subsequent years. The other specifications in Table 3 yield similar unrealistic misalignment estimates. An explanation for this is that the single-equation approach by construction generates misalignment estimates of average zero over the sample period (Baffes, Elbadawi, and O’Connell 1999; Edwards and Savastano 1999). In PNG’s case, foreign exchange rationing—a distortionary policy that sustains disequilibrium in the foreign exchange market—has persisted for a significant proportion of time over a relatively small sample period. These circumstances hinder the uncovering of the true long-run parameters that reflect the RER behavior consistent with internal and external balance. The practical solution used here is to disregard the rationing years and estimate the long-run relationship over the trimmed 1989–2014 sample period, and then use the estimated parameters to calculate the ERES over the entire 1989–2019 span.³¹

Table 4, column 1 reports the results of the main specification given the above decision rule. Consistent with the model in the previous section, government take explains long-run behavior in PNG’s RER. The point estimate is -0.81 and significant at the 1% level, which suggests that a 10-percentage point increase in the government take appreciates the ERES on average by about 8.5%, all else being equal. The signs and magnitudes of the coefficients on the other fundamentals are consistent with economic theory.

Figure 4 shows the degree of RER misalignment over 2000–2019. The estimates suggest that the RER was overvalued by about 15%–20% during 2012–2018 and 26% in 2019. The main driving force behind these results is the historically low government take of only 5% in 2019 (and even lower in

Table 4: The Long-Run Relationship Between Real Exchange Rate and Fundamentals, Trimmed Sample Period

Independent Variable	(1)	(2)	(3)
Terms of trade	0.09 (0.03) ***	-0.07 (0.03) **	
Trade openness	0.69 (0.08) ***		
Productivity differentials		-0.41 (0.03) ***	-0.38 (0.04) ***
Government consumption		-1.21 (0.40) ***	
Net international indebtedness	0.27 (0.08) ***		0.13 (0.06) **
Government take	-0.81 (0.23) ***		
L_c	0.40	0.65	0.59**
R^2	0.68	0.85	0.80

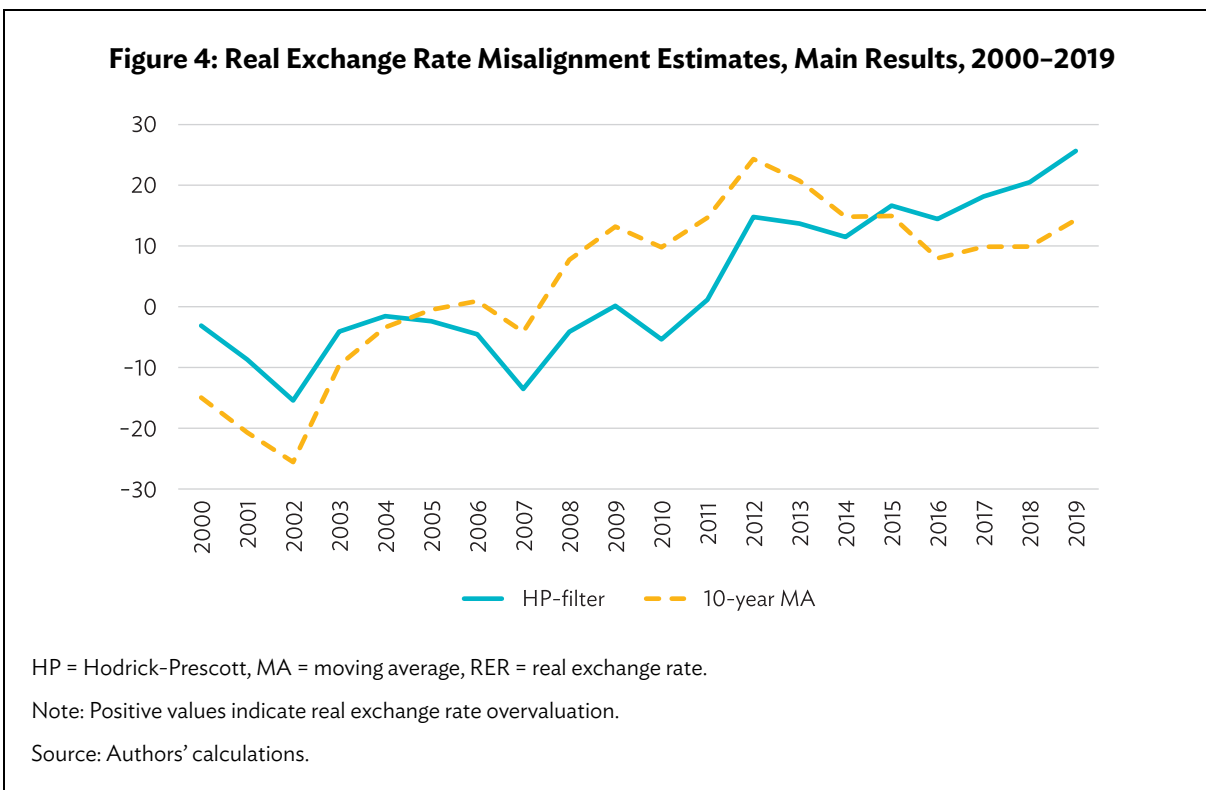
Notes: ***, **, * denote the level of statistical significance at 1%, 5%, and 10%. Standard errors in parentheses. The dependent variable is the real exchange rate (natural logarithm). An increase in real exchange rate denotes depreciation. L_c refers to the test statistic for parameter stability and co-integration due to Hansen (1992). All specifications include a constant. The sample period is 1989–2014.

Source: Authors’ calculations.

³¹ Implicit in this approach is the assumption that the average misalignment was zero (or any distortionary exchange rate policy short-lived) during 1989–2014 and that the estimated long-run parameters have remained stable during the years of foreign exchange rationing. While verifying the latter would require knowing the counterfactual of no foreign exchange shortages, the former seems reasonable given that authorities allowed the RER to adjust to various shocks during this period; for example, during the Asian financial crisis and severe drought in 1997.

the years before) compared to the 20% long-run average. The estimates suggest that, just by closing that gap, about half of the RER misalignment would disappear.

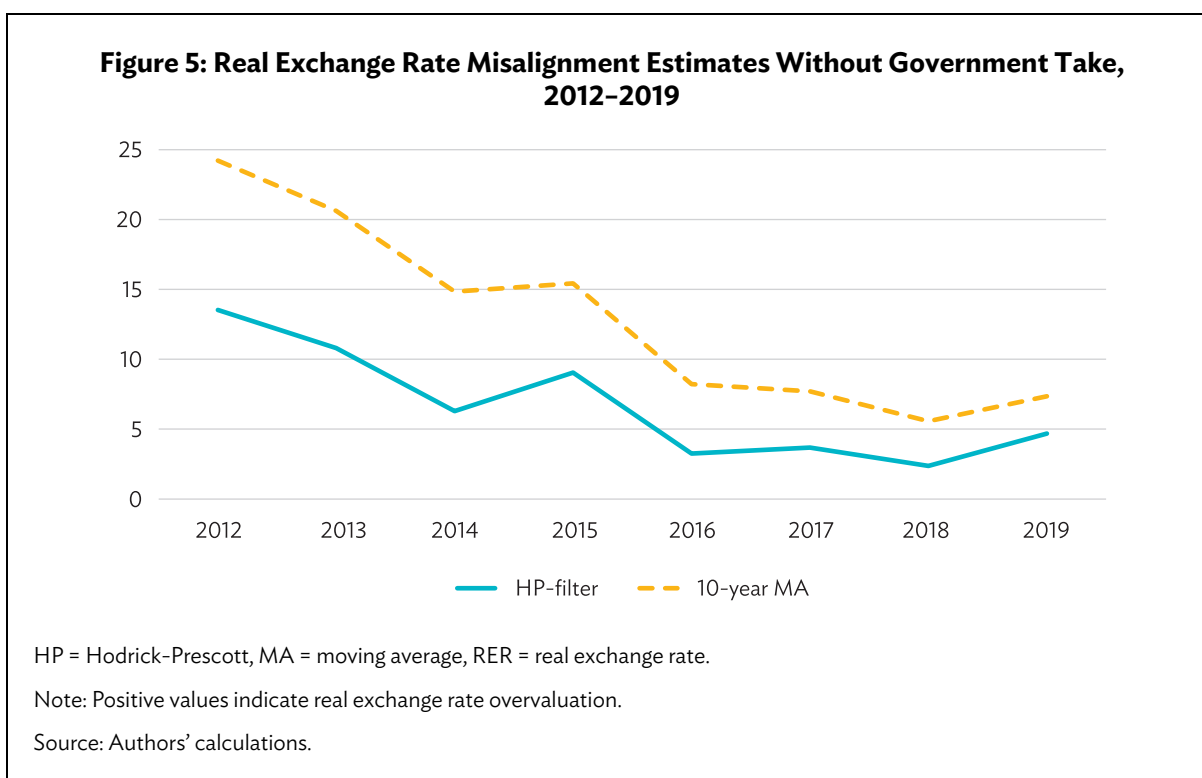
For robustness, we derive sustainable values using a 10-year moving average (Fox and Schröder 2018). In this case, the results differ slightly in that the period of real overvaluation already began in 2008, while the magnitude in 2019 is lower at 14%. Either way, both results suggest that a substantial degree of RER misalignment persists and that government take explains a significant proportion of it.



For comparison, we estimate the degree of real overvaluation without controlling for government take as in Fox and Schröder (2018). We find two possible specifications as reported in columns 2–3 in Table 4. Since the Hansen test suggests that the parameters in column 3 are unstable, we go ahead with column 2. The RER overvaluation estimates are similar to Fox and Schröder (2018) until 2015 (near the end of their sample period), but they are significantly lower than the main results in the years after (Figure 5). Especially in 2019 the estimated degree of RER overvaluation appears implausibly low at just 5% (Hodrick-Prescott filter sustainable values) in light of the sustained large backlog in foreign exchange orders. A further interesting difference between the main results and column 2 is that the sign of the coefficient on the terms of trade switches. In the main specification with government take, an improvement in the terms of trade, all else being equal, depreciates the EER, which implies that the substitution effect dominates the income effect (Edwards 1989). One interpretation of this is that the EER appreciates via the government take channel during resource booms, and not the terms of trade. Another is that, as discussed, since government take encapsulates changes in commodity prices, holding this variable constant means that the terms of trade only captures changes in the ratio of non-resource export prices to import prices. Either way, our conclusion is that government take should be part of internal and external balance analyses in RRDCs such as PNG.

IV. POLICY RECOMMENDATIONS

Based on the analysis in this paper, the key factors explaining the chronic foreign exchange shortages in PNG are the government's rising salary bill and the sharp decline in government take in recent years. The latter happened because of a combination of falling commodity prices, resource projects still being in their early phases, and various tax incentives granted to foreign investors in the resource sector. We make the following three policy recommendations for fiscal and exchange rate policy in PNG, which should be undertaken in concert.



- (i) **Allow sufficient RER depreciation.** The internal-external balance model presented in the previous section suggests that the RER should depreciate in response to a fall in government take to maintain both internal and external balance. This has not happened in PNG, which implies that the RER is overvalued. The empirical results of this paper suggest this to be 14%–26% in 2019. Hence, there must be a greater willingness by policy makers to accept real depreciation to restore kina convertibility. This will also provide a stimulus to the non-resource sector, especially in agriculture, which would result in a boost for jobs and incomes. Allen et al. (2008) show that smallholders in PNG are responsive to market opportunities and that food production increased significantly because of the kina devaluation in the 1990s. We recommend an immediate real depreciation of about 20%.
- (ii) **Reduce absorption.** As discussed in Proposition 2, a fall in government take requires a reduction in absorption to restore equilibrium. In PNG's case, the government's rising salary bill has substantially contributed to the large fiscal deficits and foreign exchange

shortages in recent years, as salary and interest payments have reached almost 60% of the government's revenue. This is a major problem that needs to be addressed. A good starting point is to adhere to the Medium-Term Fiscal Strategy pledged to the World Bank in 2017, i.e., keeping the salary bill constant in nominal terms over the next 2 years. Such a move would promote kina convertibility and reestablish PNG's reputation in implementing prudent fiscal policy. The latter will allow PNG to borrow under better terms and conditions in the future, and can assist the government in managing divergences that arise between revenue and expenditure, particularly because of the volatility in government take.

- (iii) **Aim to stabilize government take from the resource sector.** Precipitous falls in the government take, as have occurred in the past decade in PNG, require difficult adjustments for the economy and the government's budget. Given the borrowing constraints that the Government of PNG faces, it is difficult to smooth out the effects of the large variations in government take on revenues when they have been back-loaded for many years, as in the case of the PNG LNG project. While it is not possible to avoid all volatility, aiming for more stability in government take is desirable nonetheless. One way to achieve this is through greater frontloading of revenue streams from new projects by relying on tax instruments that are less profit based, such as production levies or royalties on sales. Generous tax incentives such as loss carry forward provisions or considering royalties as advance income tax payments may attract foreign investment in the resource sector, but they lead to significant delays in the government receiving much-needed revenues. Such incentives should thus be used more sparingly in the future.

V. CONCLUSION

We present a theoretical model that proposes government take—the ratio of fiscal resource revenue to resource output—to be an important determinant of internal and external balance in RRDCs. The model predicts that a fall in government take depreciates the EREER and lowers equilibrium absorption. Empirically, government take has a strong impact on the EREER in PNG. The results suggest that, if the gap between the current low level of government take (5% of resource output) was to be lifted to its long-term average (20% of resource GDP), about half of the RER overvaluation estimated at 26% in 2019 would disappear.

From a policy perspective in PNG, we recommend an immediate real depreciation of about 20% to address the overvaluation in the RER. In addition, absorption should be constrained through fiscal restraint, in particular with respect to the government's salary bill.

There are two key takeaway messages from our analysis for policy makers in RRDCs beyond PNG. First, changes in the government take necessitate adjustments to the RER. Second, falls in the take require difficult adjustments to the exchange rate and the government's budget. Policies, which stabilize government take over time, are thus desirable to promote macroeconomic stability. These include, for example, greater reliance on tax instruments that are output-based or sales-based and a less generous use of tax incentives to foreign investors.

REFERENCES

- Ackah-Baidoo, Abigail 2012. "Enclave Development and Offshore Corporate Social Responsibility: Implications for Oil-Rich Sub-Saharan Africa." *Resources Policy* 37 (2): 152–59.
- Allen, Matthew, R. Michael Bourke, and Andrew McGregor. 2008. "Cash Income from Agriculture." In *Food and Agriculture in Papua New Guinea*, edited by R. Michael Bourke and Tracy Harwood, 284–424. Canberra: ANU E Press.
- Araujo, Juliana D., Bin Grace Li, Marcos Poplawski-Ribeiro, and Luis-Felipe Zanna. 2016. "Current Account Norms in Natural Resource Rich and Capital Scarce Economies." *Journal of Development Economics* 120: 144–56.
- Baffes, John, Ibrahim A. Elbadawi, and Stephen A. O'Connell. 1999. "Single-Equation Estimation of the Equilibrium Exchange Rate." In *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, edited by Lawrence E. Hinkle and Peter J. Montiel, 405–64. Oxford, UK: Oxford University Press.
- Banks, Glenn, and Martyn Namorong. 2018. "Papua New Guinea's Disappearing Resource Revenues." *Devpolicy Blog*, August 15. <https://devpolicy.org/papua-new-guineas-disappearing-resource-revenues-20180815/>.
- Business Advantage PNG. 2015. "Foreign Exchange Controls Affect Papua New Guinea Business as ANZ Calls for Changes to Kina Trading Range." *Business Advantage*, October 6. <https://www.businessadvantagepng.com/foreign-exchange-controls-affect-papua-new-guinea-business-as-anz-calls-for-changes-to-kina-trading-range/>.
- Corden, Warner M. 1984. "Booming Sector and Dutch Disease Economics: Survey and Consolidation." *Oxford Economic Papers* 36 (3): 359–80.
- . 1960. "The Geometric Representation of Policies to Attain Internal and External Balance." *The Review of Economic Studies* 28 (1): 1–22.
- Corden, Warner M., and J. Peter Neary. 1982. "Booming Sector and De-industrialisation in a Small Open Economy." *Economic Journal* 92 (368): 825–48.
- Davies, Martin 2021. "The Path to Kina Convertibility: Study of the Foreign Exchange Market of Papua New Guinea." Discussion Paper No. 120. Institute of National Affairs, Port Moresby.
- Dornbusch, Rudiger 1974. "Real and Monetary Aspects of the Effects of Exchange Rate Changes." In *National Monetary Policies and the International Financial System*, edited by Robert Z. Aliber. Chicago, IL: University of Chicago Press.
- Edwards, Sebastian 1989. *Real Exchange Rates, Devaluation, and Adjustment*. Cambridge, MA: The MIT Press.

- Edwards, Sebastian and Miguel A. Savastano. 1999. "Exchange Rates in Emerging Economies: What Do We Know? What Do We Need to Know?" NBER Working Paper No. 7228. National Bureau of Economic Research, Cambridge, MA.
- Elbadawi, Ibrahim A. 1994. "Estimating Long-Run Equilibrium Exchange Rates." In *Estimating Equilibrium Exchange Rates*, edited by John Williamson, 99–132. Washington, DC: Institute for International Economics.
- Elliott, Graham, Thomas J. Rothenberg, and James H. Stock. 1996. "Efficient Tests for an Autoregressive Unit Root." *Econometrica* 64 (4): 813–36.
- Faruqee, Hamid 1995. "Long-Run Determinants of the Real Exchange Rate: A Stock-Flow Perspective." *IMF Staff Papers* 42 (1): 80–107.
- Fox, Rohan, Stephen Howes, Nelson Atip Nema, and Marcel Schröder. 2017. "2017 PNG Economic Survey." Discussion Paper 66. Development Policy Centre, Australian National University.
- Fox, Rohan, and Marcel Schröder 2018. "After Papua New Guinea's Resource Boom: Is the Kina Overvalued?" *Asia & the Pacific Policy Studies* 5 (1): 65–76.
- Fox, Rohan, Stephen Howes, Nelson Atip Nema, Hoai Bao Nguyen, and Dek Joe Sum. 2018. "2018 PNG Economic Survey." In *2018 PNG Update: PNG in the Year of APEC*, edited by Stephen Howes and LN Pillai, 21–50. Canberra: The Australian National University.
- Frankel, Jeffrey Alexander 2010. "The Natural Resource Curse: A Survey." NBER Working Paper No. 15836. National Bureau of Economic Research, Cambridge, MA.
- Garnaut, Ross and Paul Baxter. 1983. "Exchange Rate and Macro-Economic Policy in Independent Papua New Guinea." Technical Report. Institute of National Affairs.
- Guitán, Manuel 1996. "Concepts and Degrees of Currency Convertibility." In *Currency Convertibility in the Middle East and North Africa*, edited by Saleh M. Nsouli and Manuel Guitián, 21–23. Washington, DC: International Monetary Fund.
- Halland, Håvard, Martin Lokanc, Arvind Nair, and Sridar P. Kannan. 2015. *The Extractive Industries Sector: Essentials for Economists, Public Finance Professionals, and Policy makers*. Washington, DC: World Bank.
- Hansen, Bruce E. 1992. "Tests for Parameter Instability in Regressions with I(1) Processes." *Journal of Business & Economic Statistics* 10 (3): 321–35.
- Hinkle, Lawrence E. and Fabien Nsengiyumva. 1999. "The Two-Good Internal RER for Tradables and Nontradables." In *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, edited by Lawrence E. Hinkle and Peter J. Montiel, 113–73. Oxford, UK: Oxford University Press.
- Howes, Stephen 2018. "Why is PNG's Government Resource Revenue So Low?" Presented at 2018 PNG Update. University of Papua New Guinea's School of Business and Public Policy and the Australian National University's Development Policy Centre, June 14–15. Port Moresby.

- Howes, Stephen 2020. "PNG's Salary Bill Problem." *Devpolicy Blog*, September 8. <https://devpolicy.org/pngs-salary-bill-problem-20200908/>.
- Howes, Stephen , Rohan Fox, Maholopa Laveil, Hoai Bao Nguyen, and Dek Joe Sum. 2019. "2019 Papua New Guinea Economic Survey." *Asia & the Pacific Policy Studies* 6 (3): 271–89.
- IMF. 2012. "Macroeconomic Policy Frameworks for Resource-Rich Developing Countries." Policy Paper. International Monetary Fund, Washington, DC.
- James, David. 2021. "Foreign Exchange the Number One Concern for Papua New Guinea Business, Says Chamber Hear." *Business Advantage*, February 8. <https://www.businessadvantagepng.com/unpredictable-papua-new-guineas-resources-sector-still-adapting-the-niupela-pasin/>.
- Lane, Philip R. and Gian Maria Milesi-Ferretti. 2007. "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and liabilities, 1970–2004." *Journal of International Economics* 73 (2): 223–50.
- Montiel, Peter J. 1999. "Determinants of the Long-Run Equilibrium Real Exchange Rate." In *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*, edited by Lawrence E. Hinkle and Peter J. Montiel, 264–90. Oxford, UK: Oxford University Press.
- . 2007. *Equilibrium Real Exchange Rates, Misalignment and Competitiveness in the Southern Cone*. Santiago de Chile: CEPAL, Economic Development Division, United Nations.
- Nurkse, Ragnar 1945. *Conditions on International Monetary Equilibrium. Essays in International Finance*. Princeton, NJ: Princeton University Press.
- Phillips, Peter C. B. 1995. "Fully Modified Least Squares and Vector Autoregression." *Econometrica* 63 (5): 1023–78.
- Phillips, Peter C. B. and Bruce E. Hansen. 1990. "Statistical Inference in Instrumental Variables Regression with I(1) Processes." *The Review of Economic Studies* 57 (1): 99–125.
- Salter, Wilfred E. 1959. "Internal and External Balance: The Role of Price and Expenditure Effects." *Economic Record* 35 (71): 226–38.
- Sayour, Nagham and Marcel Schröder. 2021. *The FDI Job Multiplier During a Resource Boom: Evidence from Mongolia*. ADB Economics Working Paper No. 642. Asian Development Bank, Manila
- Schmitt-Grohe, Stephanie and Martín Uribe. 2021. "Reviving the Salter-Swan Small Open Economy Model." *Journal of International Economics* 130: 103441.
- Singer, H. W. 1950. "The Distribution of Gains Between Investing and Borrowing Countries." *American Economic Review* 40: 473485.
- Swan, T. 1960. "Economic Control in a Dependent Economy." *Economic Record* 36 (73): 51–66.
- Toews, Gerhard and Pierre-Louis Vzina. 2020. "Resource Discoveries, FDI Bonanzas, and Local Multipliers: Evidence from Mozambique." *The Review of Economics and Statistics* 1–36.

Van der Ploeg, Rick 2011. "Natural Resources: Curse or Blessing?" *Journal of Economic Literature* 49 (2): 366–420.

Venables, Anthony J. 2016. "Using Natural Resources for Development: Why Has It Proven So Difficult?" *Journal of Economic Perspectives* 30 (1): 161–84.

World Bank. 2017. *Global Economic Prospects, June 2017: A Fragile Recovery*. Washington, DC.

A Simple Model of Internal and External Balance for Resource-Rich Developing Countries

Resource-rich developing countries (RRDCs) have been struggling to convert their vast natural resource wealth into sustainable economic development, which is negatively affected by macroeconomic instability brought about by recurrent commodity boom-and-bust cycles. The working paper presents a simple theoretical model of internal and external balance that incorporates the key features of RRDCs and predicts that a fall in government take depreciates the equilibrium real exchange rate and lowers equilibrium absorption. The model proposes government take, which is the ratio of fiscal resource revenue to resource output, to be an important determinant of internal and external balance in RRDCs.

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