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May 5, 2015

Approved By

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INVESTMENT DYNAMICS IN PERU[1]

Over the last decade, average growth in Peru exceeded 6 percent, anchored by a substantial contribution from investment. A series of structural reforms in the 1990s, growing political stability, and the implementation of a solid macroeconomic framework in the early 2000s set the stage for this investment boom, allowing the country to take advantage of a prolonged improvement in its terms of trade and historically low global interest rates. Actions were also taken to strengthen public investment implementation and to enhance the overall investment climate. Now that commodity prices have softened and interest rates are expected to rise, addressing the next generation of structural reforms will be crucial to sustain investment and growth.

A. Introduction

1. Many developing countries have focused on fostering and attracting investment as an engine of economic growth. Investment is a major component of aggregate demand for goods and services in an economy. An increase in investment expenditures directly affects the demand for the various factors of production and causes an acceleration in output. At the same time, given basic consumption smoothing behavior, changes in investment spending is also associated with more output volatility. If well placed, investments in infrastructure, technology, machinery and equipment, and human capital can increase an economy's productivity and it's long-term growth potential.

2. In Peru, robust investment growth has been one of the main driving forces behind the country's recent economic success. The economy contracted in the 1980s, due mostly to a marked fall off in investment. In the 1990s, growth averaged 4 percent, with investment contributing 1 percentage point. In the 2000s, the economy expanded by 5½ percent per year with investment adding slightly over 2 percentage points. However, looking at the most recent decade (2004–13), real GDP growth averaged 6.4 percent, with investment supplying a full 3 percentage points—a contribution that is close to half of total growth.

3. Four fundamental factors have underpinned this surge in Peruvian investment:

- Implementation of structural reforms—particularly in the 1990s. Between the mid-1980s and late 1990s, there was a sizeable improvement in structural policies in Peru. According to the IDB structural reform index, Peru has made substantial improvements in trade, financial, tax, privatization, and labor reforms. While Chile remains the regional leader in structural reforms, Peru has gone from last place among the six financially integrated Latin American (LA6) economies[2] in 1985 to second place by 2010 (Lora, 2012).

[1] Prepared by K. Ross and M. Tashu.

[2] Brazil, Chile, Colombia, Mexico, Peru, and Uruguay.

- Improved political stability. After a period of economic and political turmoil in the 1980s and 90s, Peru implemented a new market friendly constitution in 1993 and defeated an ongoing terrorism threat. Around the turn of the new century, the country entered an era of relative stability and reemerged as a stronger and more stable democracy.

- A solid macroeconomic framework and reduced policy uncertainty. As part of the 1990s macro-financial reform, Peru ushered central bank independence and fiscal transparency and responsibility Laws. The results have been dramatic, with low inflation amidst strong growth, fiscal surpluses, low debt, and declining real and nominal interest rates. Investment surveys and rating agencies have noted the improvement in macro policies and the investment environment, leading to successive credit rating upgrades.

- Very favorable external conditions, with significant increases in commodity prices and a sustained fall in real world interest rates. As noted in Adler and Magud (2013), Latin America has benefited from a commodity price boom in the last decade, which has been more persistent than previous booms, and associated with much higher income gains. For example, Peru has enjoyed a cumulative income windfall of around 85 percent of GDP since 2003, with a larger share of this windfall allocated to domestic investment than in previous episodes. The sustained fall in real world interest rates,[3] combined with Peru's improved credit rating, have also allowed Peruvian firms to have increased access to cheap external financing.

4. The strong export commodity price gains and favorable international financing conditions have started to reverse. Going forward, this development will impact expectations and investment in Peru, which the authorities will need to counterbalance via further structural reform measures and improvements in infrastructure and human capital. Well aware of these realities, the current Peruvian administration is implementing a number of measures that should help to streamline and speed up the investment process.

5. The objective of this chapter is to describe recent investment dynamics in Peru and to empirically assess the relationship between private investment and its fundamentals. The chapter is organized as follows: section B provides some stylized facts of Peruvian investment dynamics in the recent decades, while section C describes the empirical analysis. Section D concludes with policy implications.

[3] The 10 year U.S. Treasury real interest rate fell from about 5½ percent, on average, during the 1980s to about 1½ percent, on average, during the last decade (2004–13).

B. Stylized Facts of Peruvian Investment

6. The mining industry's need for capital equipment helped to drive the investment boom (Figure 1).

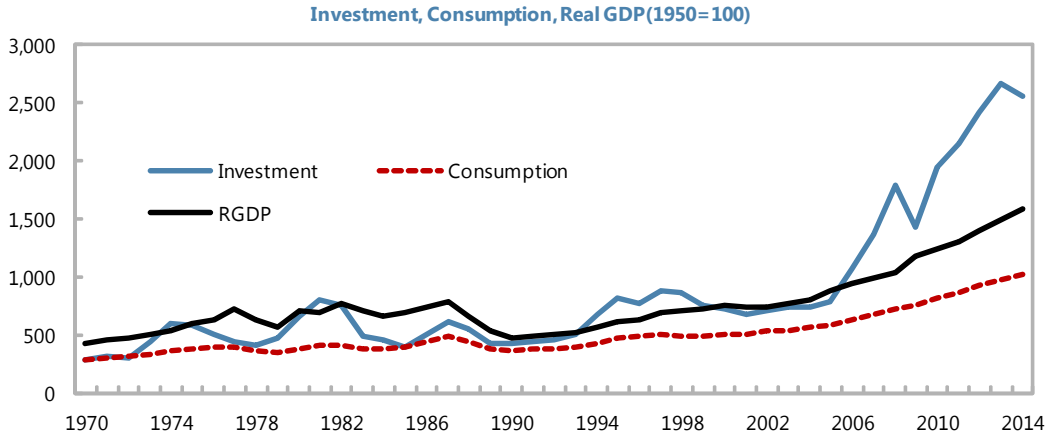
- *Private investment* growth was volatile during the 1970s and early 1980s. After declining throughout 1985–91, it gradually rebounded with the implementation of fundamental reforms during the first half of the 1990s, before moderating again by the end of the 1990s as external shocks lowered capital inflows. Investment swelled during 2004–13, far outpacing a relatively healthy rise in consumption. However, private investment growth started to slow in early 2013.

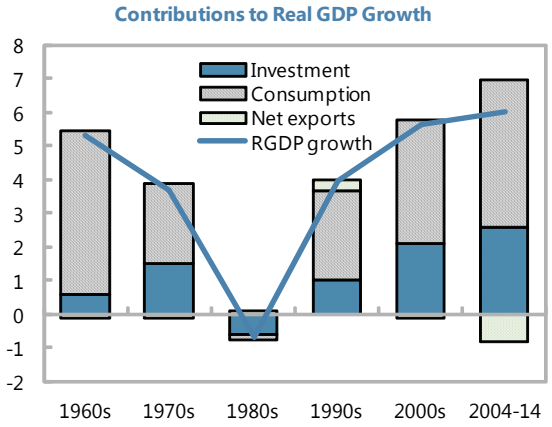
- *Equipment* and *construction* investment were key drivers of private investment over the last decade. Total private investment growth averaged about 15½ percent during 2003–08, with equipment investment contributing about 8¾ percentage points and construction contributing about 7 percentage points during this period. After a sharp drop during the height of the global financial crisis in 2009, private investment growth rebounded, averaging 13¼ percent in 2010–13. Equipment investment contributed the lion's share, particularly in 2010–11.

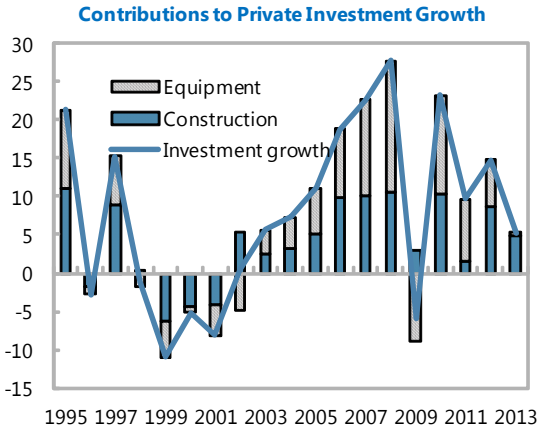
- The majority of *construction investment* had been non-residential investment. Non-residential and residential investment in percent of total investment averaged 32 and 24 percent, respectively, during 2007–11 (the most recent period with detailed breakdowns). Non-residential investment growth contributed 7½ percentage points to the 11 percent growth in construction investment during this period. Machinery and equipment (which included exploration and research) averaged 32 percent of total investment, while transport equipment was 9 percent. Other installations and software made up the remaining 3 percent.

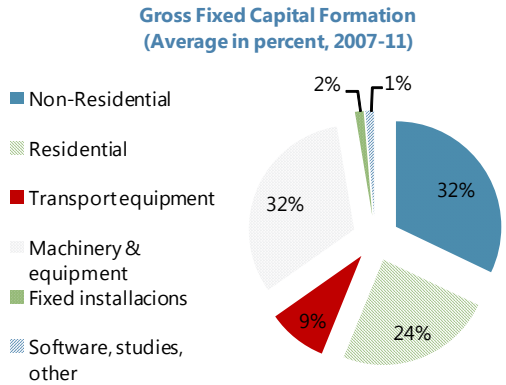
- *Investment in the minerals* sector boomed during 2003–12. Investment in the sector grew at an annual rate of 32 percent in real terms, over the period. As a share of total private investment, investment in the minerals sector increased from 3 percent to over 20 percent. Mineral commodity investments are concentrated in copper (68 percent), gold (13 percent), iron ore (13 percent), copper-zinc (4 percent), and other poly-metallic minerals (6 percent). About 70 percent of all foreign direct investment goes into the extractive industry sector. Peru, on par with Chile, was fifth in the global destination for exploration of nonferrous metals, behind Canada, Australia, the U.S., and Mexico. A number of copper mines are set to come on stream between 2015 and 2022, expected to expand copper production significantly.

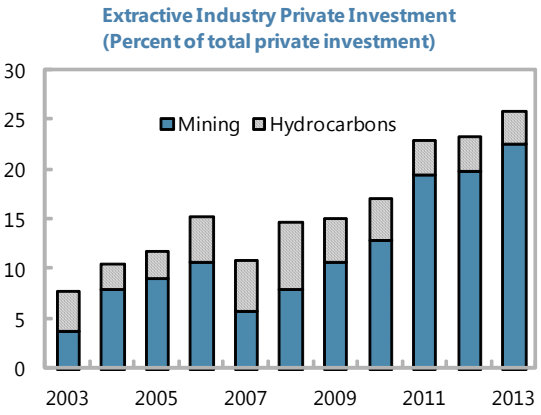
Figure 1. Investment Dynamics











Sources: World Economic Outlook; the Peruvian central bank (BCRP); official statistics institute (INEI); mining and energy ministry (MEM); and Fund staff estimates.

7. Public investment spending has increased in line with private investment, reflecting investment promotion initiatives and the need to fill large infrastructure gaps (Figure 2).

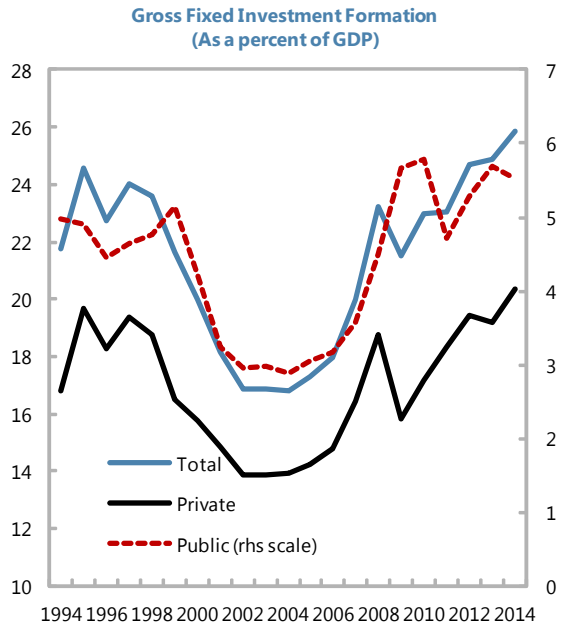
- As a percent of GDP, public investment spending increased from about 3 percent in the early 2000s to about 5.5 percent in 2014. In the same period, private investment jumped from about 14 percent to about 20 percent of GDP. Over the last decade, public investment contributed 2¾ percentage points (21 percent) to the average annual growth in total real fixed capital investment of 12¾ percent.

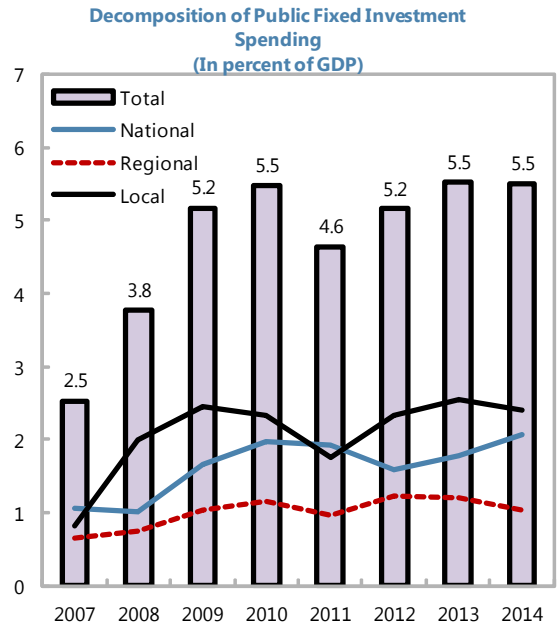
- *Local government* spending has been a major factor in the rise in public investment. Local investment spending has tripled, increasing from less than 1 percent of GDP in 2007 to 2½ percent of GDP by 2014. Taken together, national and regional fixed investment spending has gone from about 1½ percent to 3 percent of GDP. To some extent, these results are a reflection of the decentralization process and the government's efforts to bring investment projects to the local and municipality levels.

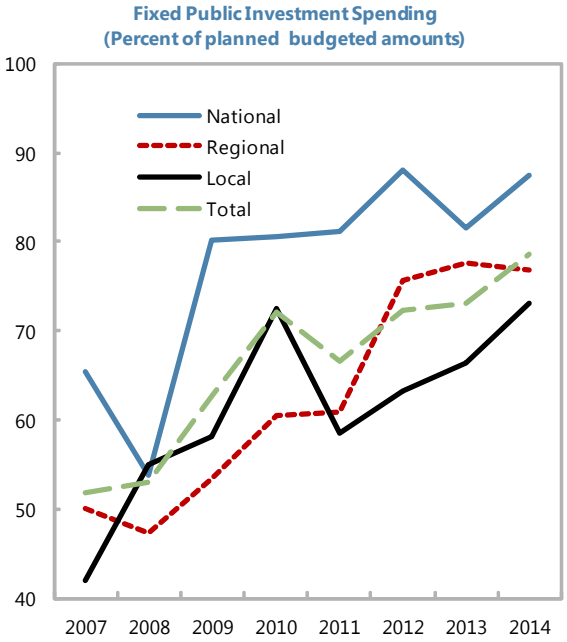
- *Implementation of planned public investment* spending has improved. The increase in metal prices and thus royalty and "canon" revenues have relaxed financial resource constraints at the national and at lower levels of government in specific mining regions. At the same time, the decentralization process has created a number of new jurisdictions with relatively inexperienced capital spending administrative units. Nevertheless, the public sector is getting much better at implementing capital spending budgets. Overall, fixed public investment spending is about 79 percent of budgeted amounts—up 27 percentage points from 2007.

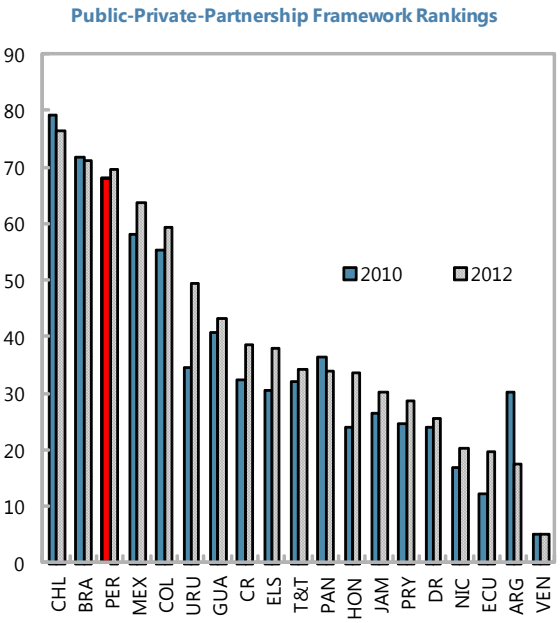
- *Infrastructure gaps* remain large. According to the World Economic Forum's 2014 measure of infrastructure quality Peru is ranked 105th out of 144 countries. The Peruvian Association National Infrastructure Investment (AFIN (2012)) has estimated that the national infrastructure gap for 2012–21 at a third of projected GDP). Deficit areas include energy, telecommunications, transport, health, and education. Clearly improved infrastructure would have a positive effect on productivity, investment, and growth.

Figure 2. Public Investment Dynamics









Sources: INEI; EIU 2012 Infrascope report; and Fund staff estimates.

8. Long-term capital flows have contributed to Peru's investment boom. During 2007–13, long-term capital inflows averaged about 8 percent of GDP, up from about 4 percent during 1994–2005. Foreign direct investment (FDI) comprised the lion's share of long-term inflows (about 5¼ percent of GDP on average during 2006–13). A substantial amount of FDI inflows emanate from profits that have been generated from current FDI stocks. About half of the profits generated from the FDI stocks (i.e., about 3 percent of GDP) during 2006–13 were re-invested in Peru.[4]

9. The commodity price boom and the favorable external financing that have underpinned vigorous private investment growth in the past decade have receded. Commodity prices have been falling since 2012 and the costs of external financing have increased following the U.S. Federal Reserve's announcement of tapering unconventional monetary policy in May 2013. As a result, growth of private investment has slowed down in Peru. The private investment to GDP ratio in Peru declined from about 21½ percent in the first quarter of 2013, when it was at its peak, to 20 percent at the end of 2014. Similarly, long-term capital inflows also weakened in 2014. Commodity prices are expected to fall further in the medium term due to the expected moderation and rebalancing of growth in China and global interest rates are expected to rise due to anticipated monetary policy tightening in the U.S.

C. The Empirical Framework

10. Most empirical studies on aggregate investment are based on a version of the neoclassical flexible-accelerator theory of capital. This theory shows that the desired level of capital is positively related to the level of expected output and negatively related to the expected user cost of capital (Jorgenson, 1963). For developing countries, the models are often applied with modifications since key assumptions such as perfect financial markets and little or no government investment are not applicable in developing economies (Greene and Villanueva, 1991).

11. One important modification to the neoclassical flexible-accelerator theory of capital is incorporating the role of uncertainty. Bernanke (1983) and Pindyck (1991) argue that investment is sensitive to uncertainty because expenditures on fixed capital are economically irreversible in the sense that they are mostly sunk costs that cannot be recovered. Since new information relevant for assessing the returns on long-run projects arrives over time, an uncertain environment increases the incentives for waiting and hence reduces investment. Le (2004) incorporates the role of uncertainty into an investment model based on the optimal condition for a representative agent maximizing his/her expected utility. In this model, the optimal level of investment depends positively on the expected value of the return and negatively on the variance (uncertainty) of the return on domestic investment.

[4] Reinvestment rates tend to be relatively high in extractive industry countries given sizable capital import requirements and high profitability. During 2004–13, reinvestment rates were around 25 percent for Mexico and Colombia, and close to 60 percent for Chile.

12. For empirical purposes, the modified neoclassical flexible-accelerator model is specified as:

$$y_t = \alpha + \boldsymbol{X}_t\beta + \varepsilon_t$$

Where, y_t is the log of private investment to GDP ratio; X_t represents logs of a set of variables that affect investment through their effects on the expected rate of return, the variance of the return, and the user cost of capital; ε_t is the stochastic error term; α is the constant term; β are the elasticities to be estimated; and 't' refers to time indices.

- GDP or growth of GDP is often used as a key determinant of expected rate of return in empirical studies.[5] The problem with this practice is that both output and investment are endogenously determined. Most studies attempt to address this problem by using lagged GDP/growth of GDP instead of contemporaneous levels. Nevertheless, investment decisions are made based on the expected rate of returns and the past levels of output may not be a good indicator of expected output, in particular in developing economies. To address the simultaneity problem in the investment-output relationship, this study specifies private investment as a function of underlying exogenous factors that determine expected output and investment. The factors include the real prices of major export commodities, structural reforms, and government investment in infrastructure and human capital. The Appendix shows that the explanatory variables have predictive value for private investment.

- In commodity dependent economies, in particular, the real prices of major export commodities are key determinants of output and the expected return on investment. Commodity price affects investment and output not only in the commodity sector, but also in the rest of the economy through its effect on income and the current account, the budget, and the profitability of sectors that are correlated with the commodity sector (Cardoso, 1993). There is a high correlation between the real commodity export price index and expected growth of the Peruvian economy. Structural reforms such as trade and financial openness, labor market reforms, and privatization can also affect the expected rate of return on investment through improving the productivity and efficiency of private investment. Similarly, government investment in complementary goods and services such as infrastructure, human capital, and improvements in the efficiency of public services can enhance the productivity of the private sector and encourage private investment.[6]

- Empirical studies show that macroeconomic volatility, resulting from policy and external shocks, and political instability are major sources of uncertainty in developing economies with significant negative impact on private investment.[7] A number variables including, real exchange rate volatility, inflation volatility, output volatility, terms of trade volatility, and external debt

[5] See Greene and Villanueva (1991), Le (2004), Jongwanich and Kohpainboon (2008), and Ang (2010).

[6] If involved directly in the productive sector of the economy, government investment may also affect private investment negatively by competing for limited physical and financial resources (Greene and Villanueva, 1991).

[7] See Greene and Villanueva (1991), Le (2004), Jongwanich and Kohpainboon (2008), and Ang (2010).

burden are often used as indictors of macroeconomic uncertainty. For the sake of parsimony, however, this study relies on real exchange rate volatility, which could reflect the uncertainty resulting from both macroeconomic policy and external shocks. A measure of political risk is also included to control for the role of political uncertainty.

- For financially open economies, the world interest rate is a key determinant of the user cost of capital. An increase in the world real interest rate leads to an increase in the user cost of capital and is expected to have a negative impact on private investment in financially open developing economies. World interest rates can also be a proxy for availability of external finance (capital flows) as lower world interest rates could push capital to emerging economies as international investors search for better yields.

D. Data and Sources

13. Data on private and government investment are obtained from the central bank, while the structural reform index is obtained from Lora (2012). The structural reform index measures improvements in trade, financial, tax, privatization, and labor policies. The total structural reform index (standardized from 0 to 1) is a simple average of sub-indices in these 5 policy areas. Lora's data from 2010–13 was extended using similar indicators from the World Economic Forum's Global Competitiveness index (GCI) database.

14. The rest of the variables are constructed as follows:

- The real commodity export price index is constructed as the weighted average of world price indices of copper, gold, lead, and zinc (Peru' major export metals) deflated by the manufacturing export unit value index of advanced economies

- Real exchange rate volatility is measured by the variance of a generalized autoregressive conditional heteroskedasticity process of order 1 (GARCH(1,1)) specification. Specifically, the real exchange rate volatility is constructed as follows. First, the log of the real effective exchange rate is specified as an AR (1) process on monthly data for the period 1980–2013. Second, the estimated variance of the error term from this model is specified as a function of its first lag and the first lag of the square of the error term. The predicted value from the dependent variable (the variance of the error term), expressed in percent, is taken as a measure of real exchange rate volatility. The quarterly figures are obtained by averaging corresponding monthly data. The GARCH-based variance is considered a better measure of uncertainty than alternatives such as the sample standard deviation because it specifically reflects the unpredictable innovations in a variable instead of simply showing the overall variability from past outcomes.

- Political uncertainty is constructed from the Political Risk Service Group (PRSG)'s political risk rating indictor. PRSG's political risk rating evaluates the political stability of a country on a comparable basis with other countries. It assesses risk points for each of the component factors of government stability, socioeconomic conditions, investment profile, internal conflict, external conflict, corruption, military in politics, religious tensions, law and order, ethnic tensions,

democratic accountability, and bureaucracy quality. The ratings range from a high of 100 (least risk) to a low of 0 (highest risk). The political uncertainty variable used in this study is the reverse of PRSG's risk rating, calculated as 100-'PRSG's risk rating', so that higher values reflect higher political risk/uncertainty.

- Real world interest rate is the real interest rate on U.S. Treasury 10-year bond, calculated as the difference between the nominal interest rate and the Cleveland Fed's 10-Year expected U.S. inflation rate. Data source is Haver.

E. Estimation Methods and Results

15. The sample covers quarterly data during 1984–2013 based on data availability for all of the main variables. Unit root test results show that all of the variables have unit root. Hence, the baseline results are based on an Error Correction Model (ECM). Since the structural reform index is available at the annual level, it is assumed that all quarters of a year have similar values.[8]

16. The estimation results are broadly in line with expectations (Table).[9] The baseline results, column (1), are estimated using the ECM. With the exception of the real exchange rate volatility, which becomes statistically significant with unexpected positive sign, all of the explanatory variables have statistically significant coefficients with expected signs.[10] The unexpected sign on the coefficient of real exchange rate volatility appears to be due to the high co-linearity between political uncertainty and the real exchange rate volatility, with a correlation coefficient of about 0.8. When the political risk indicator is dropped from the model, (column (2)), the sign of the real exchange rate volatility coefficient becomes negative but statistically insignificant. According to the baseline results, a 10 percent increase in commodity prices or in the structural reform index or in the government investment to GDP ratio could lead to a 4.8 percent or a 3¼ percent or a 4½ percent, respectively, increase in the private investment to GDP ratio. On the other hand, a 10 percent increase in the political risk index could lead to a 16¾ percent drop in the private investment to GDP ratio. Similarly, a percentage point (100 bps) increase in the U.S. real interest rate would lead to a ¼ percent decrease in private investment to GDP ratio.

[8] Although this is an arbitrary assumption, it may not affect the analysis significantly since the structural reform index is a slow changing variable except during the early 1990s, when it jumped significantly following the constitutional reform.

[9] Johansen cointegration tests (both the Trace and Maximum Eigenvalue cointegration tests) show evidence for a statistically significant cointegration vector between private investment and the dependent variables.

[10] Constant terms, trend, and seasonality dummies are included as exogenous variables in the cointegration specification.

Table 1. Long-Run Determinants of Private Investment in Peru 1/

	(1)	(2)	(3)	(4)
Real export commodity price index	0.481	0.448	0.394	0.444
	*(6.306)***	*(4.279)***	*(5.065)***	*(4.712)***
REER volatility	0.055	-0.007	0.065	0.004
	*(4.434)***	*(-0.378)*	*(4.504)***	*(0.264)*
Structural reform index	0.320	0.667	…	0.133
	*(2.347)***	*(3.178)***	…	*(0.769)*
U.S. real interest rate	-0.189	-0.250	-0.151	-0.158
	*(-6.137)***	*(-6.115)***	*(-4.210)***	*(-4.440)***
Political uncertainty	-1.683	…	-1.935	-1.103
	*(-7.606)***	…	*(-7.507)***	*(-4.335)***
Government investment	0.464	0.215	0.494	0.169
	*(8.574)***	*(2.496)***	*(8.011)***	*(3.724)***

Source: Staff estimates.

1/ All variables except the U.S. real interest rate are expressed in natural logarithm form. Constant terms, trends, and seasonal dummies are included in all specifications, but the results are not reported. Lag length for the ECM specifications is 2.

(1) Baseline regression estimated by ECM method.

(2) Baseline regression without the political risk indicator.

(3) Baseline regression without the structural reform index.

(4) Results estimated by the FMOLS method.

Numbers in parenthesis are t-values. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectivelly.

17. The estimated results are robust to specification changes. The baseline regression was re-estimated without the structural reform index to see if the results are affected by our ad-hoc assignment of quarterly values in this variable. As shown in column (3) of the Table, the results of the remaining variables are not sensitive to the exclusion of the structural reform index. Finally, column (4) shows the cointegration relationship re-estimated using the FMOLS method to test the robustness of the baseline results to changes in specification/methodology. With the exception of the structural reform index, which becomes statistically insignificant, the rest of the results remain broadly unchanged.

F. Concluding Remarks

18. This chapter investigated the dynamics and determinants of private investment in Peru using both descriptive and empirical analyses. The results show that external factors (commodity prices and U.S. real interest rate), political stability, and structural reforms are key

factors driving private investment in Peru. There is also strong statistical evidence that public investment is complementary to private investment.

19. Given the less favorable external conditions going forward, policy makers in Peru need to redouble structural reform efforts to support investment and growth. Maintaining macroeconomic and political stability and rebooting structural reform measures are crucial to enhancing private investment in Peru. Compared to the 1980s and 1990s, macroeconomic and political institutions are now much more developed. Consequently, the room for further improvement in this area is somewhat narrower and the marginal contribution to private investment growth will most likely be smaller. Nonetheless, reversals of these progresses could derail confidence and private investment and need to be avoided at any cost. This leaves second round structural reforms and public investment in complementary goods and services as the main policy tools for jumpstarting private investment in Peru. In this regard, ongoing efforts to diversify exports, increase education and R&D spending, and to reduce red-tape and the overly complicated system of permits are most welcome.

Appendix. Granger Causality Tests

Tests confirm that the explanatory variables granger cause private investment. The interpretation of the regression results as causal effects of the explanatory variables on private investment was based on the assumption that causality runs from the explanatory variables to private investment, but not in the reverse direction. The assumption was made in part because most of the variables are exogenous by choice. Granger causality tests confirm that the explanatory variables have predictive value for private investment. The null hypothesis that 'X does not Granger Cause private investment' is rejected for all explanatory variables 'X', whereas the reverse null hypothesis could not be rejected at conventional levels of significance.

Granger Causality Tests

	P-Values for Lag length:	
Null Hypothesis	1	2
Commodity price does not Granger Cause private investment	0.0023	0.0657
Private investment does not Granger Cause terms of trade	*0.7632*	*0.7771*
REER volatility does not Granger Cause private investment	0.0020	0.0223
Private investment does not Granger Cause REER volatility	*0.3555*	*0.2128*
Structural reform does not Granger Cause private investment	0.0021	0.0449
Private investment does not Granger Cause structural reform	*0.7791*	*0.8562*
U.S. real interest rate does not Granger Cause private investment	0.0021	0.0629
Private investment does not Granger Cause U.S. real interest rate	*0.4654*	*0.2099*
Political uncertainty does not Granger Cause private investment	0.0020	0.0998
Private investment does not Granger Cause political uncertainty	*0.9523*	*0.4276*
Government investment does not Granger Cause private investment	0.0582	0.0001
Private investment does not Granger Cause government investment	*0.2025*	*0.1221*

Source: Staff estimates.

1/ Based on quarterly data from Peru. All variables except the U.S. real interest rate are expressed in natural logarithm form.

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FORECASTING PERUVIAN GROWTH USING A DSGE MODEL[1]

A dynamic stochastic general equilibrium (DSGE) model was constructed based on the characteristics of the Peruvian economy. The model goes beyond the standard open economy construct by including a separate export sector and adding a channel for export demand to impact fixed investment, particularly in the mining sector. The model is then used to examine shocks that have impacted output and to forecast growth. The results suggest that shocks to total factor productivity in the export sector (TFP) and overall confidence were main drivers of real GDP fluctuations. Moreover, the forecasts are in line with other standard empirical models used by staff, offering additional support to the Fund's baseline forecast. A key takeaway is that potential growth has declined with lower commodity prices and efforts to raise TFP should focus on increasing investment.

A. Introduction

1. Forecasting growth rates of emerging market commodity exporters like Peru can be a challenging exercise. These economies are heavily exposed to large external shocks and tend to have high and volatile growth rates related in part to volatile capital inflows. In addition, many have gone through substantial structural reforms and other economic improvements that have attracted sizeable amounts of foreign direct investment (FDI)—much of it in their commodity producing export sector. In addition, a large part of this investment is in infrastructure and capital goods, and is closely aligned with movements in commodity prices. Peru is precisely such an economy. Unfortunately, these factors can make it difficult to construct a well designed theoretical model that fully captures the main trade, investment, and output channels.

2. Various techniques have been used by staff to forecast Peru's growth (see Box). They include (i) financial programming (staff's baseline scenario),[2] (ii) empirical forecasting methods, and (iii) theoretical model-based forecasting. In this paper, a theoretical DSGE model was applied to forecast growth and analyze the importance of the various shocks that drive real GDP movements in Peru. DSGE models use modern macroeconomic theory to explain and predict co-movements of aggregate time series over the business cycle and to perform policy analysis. The DSGE model complements existing methods by including all components of real GDP jointly and considering endogenous movements between variables. The model also takes into account the macroeconomic policy stance, such as changes in monetary policy rates and in public spending.

[1] Prepared by F. Lipinsky and S. Vtyurina.

[2] This is arguably the most common technique used by Fund teams and central banks to forecast GDP growth.

3. This chapter is organized as follows. Section B examines traditional growth channels for Peru. Section C describes the structure of the economy and theoretical framework. Section D describes and discusses briefly the results of the model for year 2015. The final section concludes. The Appendix presents a detailed description of the model.

Box 1. Benchmarking Growth Forecasts

A variety of modeling devices are used to cross check baseline forecasts. A few are mentioned below:

The Global Projection Model (GPM) project has developed a series of multi-country models designed to generate coherent global forecasts and conduct policy analysis in a comprehensive manner. The underlying model-building strategy seeks to strike a balance between two popular approaches to macro modeling: highly structured DSGE models whose primary focus is theoretical consistency (often at the cost of empirical accuracy), and purely statistical models, whose primary focus is accuracy (often at the cost of theoretical consistency). The GPM modeling strategy features a core macro structure consisting of a few behavioral equations, based on conventional linkages familiar to most macro modelers and policy makers. This ensures some theoretical consistency and desirable model properties. The estimation/calibration methodology for the GPM's parameters is implemented in a manner that ensures the simulation properties are sensible and broadly consistent with modelers' priors and the data. This facilitates interpretation of forecasts and policy-analysis exercises.

STFS is the Short-Term Forecasting System, which is a suite of models focused on the first two monitoring quarters. The "headline" number is the inverse-MSE weighted sum of all STFS model estimates. The STFS growth number controls for the impact of model change. Thus, this number reflects the pure impact of new data on the monitoring.

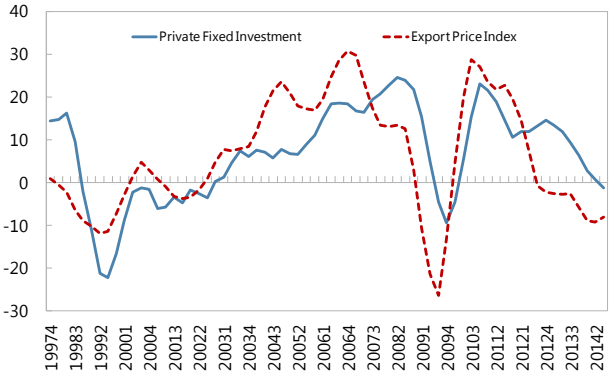
Nowcasting produces forecasts that make use of high frequency indictors such as country level industrial production and PMIs. This improves the quality of the forecast by linking it directly to the latest economic indicators, and by making it consistent with country-level developments.

A Vector Error Correction Model (VECM) estimated staff forecasts growth conditioned only on external variables: a Peru-specific real commodity price index, an export-weighted GDP of main trading partners, and the U.S. real 10-year Treasury bond rate.

B. Growth Channels[3]

4. Growth in Peru is strongly affected by external factors. One of the main channels by which Peruvian activity is impacted is through trade given that the Peruvian economy is highly open, with exports ranging between 40–45 percent of GDP. The lion's share of these exports is in metals, with machinery imports linked to their extraction. A second channel has been through marked increases in gross domestic income. Large and persistent positive

Peru: Private Investment and Exports
(In percent, 12-months quarterly rolling growth rate)



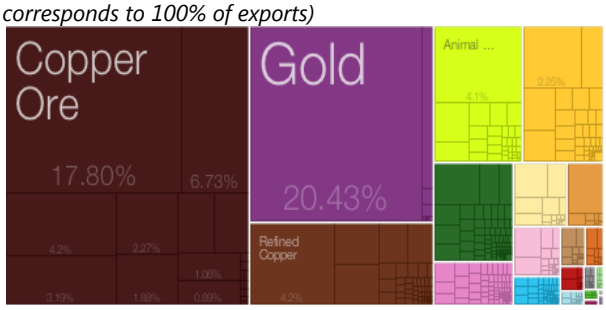
Sources: National authorities and Fund staff calculations.

[3] See Ross and Peschiera-Salmon (2015).

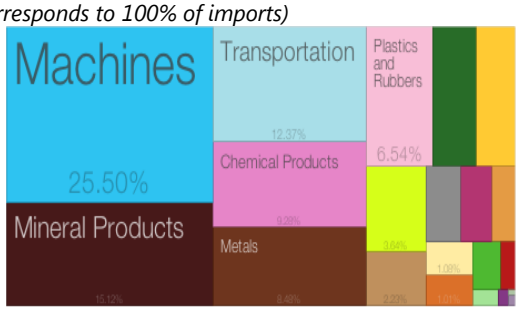
terms of trade shocks have increased income and led to an increase in consumption. Another key growth channel has been investment, especially in the mining sector, which responds strongly to changes in external market conditions. Moreover, there are spillovers from mining investment to total investment.

Figure 1. Peru: Structure of Exports and Imports

Complexity map of Peru's exports (the whole surface corresponds to 100% of exports)



Complexity map of Peru's imports (the whole surface corresponds to 100% of imports)

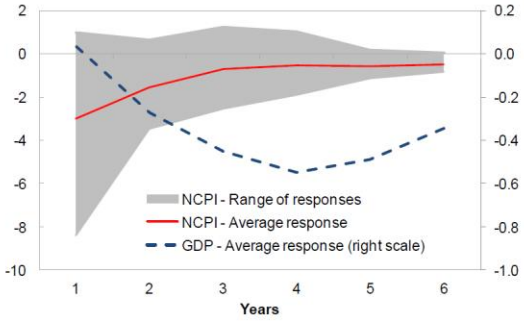


Source: The observatory of economic complexity.

5. Changes in import demand of large trading partners play a crucial role. Movements in the pace of growth in the Chinese economy have had an impact on growth in Peru and in the region. The figure shows the response of export prices and GDP of a large set of Latin American countries, including Peru, to changes in China's GDP.[4] With respect to the growth forecasts of two largest importers from Peru, the U.S. and China, while a solid recovery is expected to continue in the United States, growth forecasts for China point to a deceleration in the years ahead. This should create a more challenging environment for the Peruvian economy going forward. Finally, two other important growth drivers, supply and confidence shocks had a significant impact on growth in Peru in the past (see below).

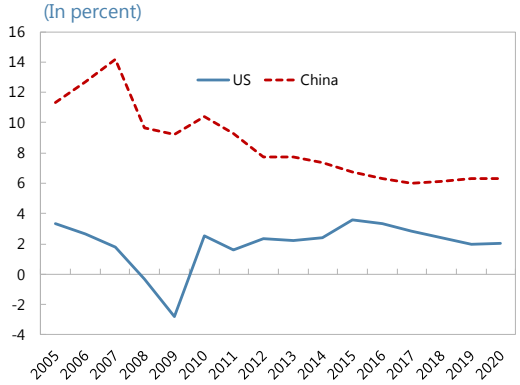
[4] Peru sold 17 percent of its total exports to China in 2012 (about 4 percent of GDP), of which 81 percent are metals (Han and Peschiera-Salmon, 2014).

Latin America: Impact from China 1/



Source: Gruss, 2014.
1/ Response of net commodity price indexes (NCPI) and GDP of Latin American countries to a 1 percent decrease in China's GDP (relative to trend).

Real GDP growth for China and U.S.
(In percent)



Source: World Economic Outlook.

C. The Model and Empirical Framework

6. The main objective of the DSGE theoretical modeling exercise was to capture and understand specific characteristics of the Peruvian economy (Appendix). The model features a separate commodity-exporting sector so that export prices may differ from domestic prices beyond mark-up shocks. The export sector produces its output with infrastructure, machines and equipment to capture the feedback effect from export demand and export prices to domestic investment. Machines and equipment are partly sourced from Peruvian producers, and partly imported from abroad, reflecting the dominance of imported capital goods versus domestically-produced capital goods.[5] The incorporation of these characteristics is one of the main contributions of this chapter.

7. The DSGE model is relatively small utilizing only seven macroeconomic variables. Quarterly data from 1996Q1 to 2014Q4 are taken from the central bank database and are used to estimate the model. These variables include real GDP, real private consumption, and real total fixed investment, real exports, real imports, export prices, and import prices. The model also matches real government consumption, implicitly through the economy wide resource constraint.

8. The model included eight different shocks that allowed replicating the Peruvian data. The included shocks are shocks to the long-run TFP-growth rate, government consumption, confidence/uncertainty[6], monetary policy, export and domestic sectors' TFP, as well as export and import prices. Consequently, the shocks capture a variety of domestic and external influences that are important for the Peruvian economy.[7]

[5] Around 80 percent of Peru's capital goods are imported and a large part of imports are machines and transportation vehicles used in the mining industry.

[6] The confidence shock is conducted by perturbing the discount factor within the household utility function.

[7] An interesting extension of the model would be to include financial frictions and additional shocks in the model.

9. The model fit was optimized by estimating the shock variances with Bayesian estimation techniques. The performance of general equilibrium models is highly dependent on parameter values, in particular the magnitude of the various shocks. The variances of the eight shocks determine the shock magnitudes and are critical for the model's fit. Bayesian estimation techniques were used to "let the data speak" in determining parameter estimates (the "posteriors") that optimally fit the data, based on some initial values (the "priors"). As a starting point, standard advanced economy values were used as priors for the shock variances. Then, the Peruvian data set was applied to the model, and allowed to pin down posteriors for the shock variances that optimally fit the Peruvian data.[8] The determined posteriors where then used for the real GDP variance decomposition and the forecasting exercise, which are the main outputs of the paper.

D. Results

10. The model is able to identify the main determinants to real GDP movements in Peru over the last 20 years. Seventy one percent of the variance in real GDP is explained by changes in total factor productivity (40 percent) and by changes in confidence (31 percent).[9] The remaining 29 percent is explained by monetary policy, government consumption, export price, import price, and long-run growth shocks together.

RGDP Variance Decomposition

(In percent)

Total TFP	40.1
Domestic	1.8
Export	38.3
Confidence	30.8
Other shocks	29.1
Total	100

Source: Fund staff calculations.

- **Variance in TFP:** Thirty eight percent of the variance in GDP is explained by supply shocks in the exporting industry. Only 2 percent of GDP movements are explained by shocks to firms that produce domestically consumed consumption and capital goods. An examination of the supply side shows that export production has not been growing in line with export demand; neither did export growth catch up with growth in export prices. At the same time, investment has been growing in line with export prices, especially in mining. This suggests there is untapped growth potential once supply shocks unwind and export production reaches its potential. In 2014, there was a one–off shock to production due to maintenance work at the largest mine and start-up operating difficulties at a new mine, which are expected to dissipate in the short term. The large capital investment that took place over the past decade is expected to pay off over the medium term (which is accounted for in staff's medium-term baseline scenario).

[8] Another interesting extension would be to compare in greater detail the model's forecasts with empirical forecasts of vector autoregression models.

[9] The variance of the different macro economic variables is attributed to the various exogenous shocks that govern the dynamics of the model. Estimation results in general are very sensitive to changes in parameters and assumptions, but provide a good approximation of the neighborhood, in which the true values reside. The percentages of the GDP variance decomposition can be viewed as mean estimates.

- **Confidence shocks:** Confidence shocks explain almost one third of GDP variation alone. While confidence is a significant driver in general, it has also played an important role more recently. Business confidence in Peru was weak due to several factors in 2014. The election of new local governments and legal proceedings against some local officials led to contracting uncertainty among businesses that were involved in local public projects. Simultaneously, the elections led to turnover of some local civil servants and local temporary hiring freezes until the new local governments take office and start executing public spending. Moreover, lower job creation rates reduced private consumption spending, weighing further on confidence. The presidential elections in 2016 bring some uncertainly to the outlook and some businesses are in a wait and see mode.

Peru: Market Sentiment

Sources: National Authorities and Fund staff calculations.

11. For 2015, the DSGE model predicts GDP growth close to the staff baseline. Financial programming forecasts by staff, which factors in policy stimulus, places GDP growth at 3.8 percent. Taking changes in the external environment as well as domestic supply and confidence shocks into account, the DSGE model predicts GDP growth slightly lower, at 3.7 percent in 2015, and somewhat above the recent GPM and STSF estimates. "Nowcasting," which does not capture planned fiscal stimulus, places growth closer to 3 percent. Accounting solely for exogenous external factors, the VECM forecast is 2.6 percent.

Peru: Growth Forecasts

Vector Error Correction (VECM)	2.6
Nowcasting 1/	3.2
Global Projection Model (GPM) 1/	3.4
Short-term Forecasting System (STSF) 1/	3.5
DSGE	3.7
Financial Programming (FP)	3.8

Source: IMF staff calculations.

1/ IMF Research department.

12. The projected path of the other macro variables included in the model also follow baseline forecasts. Figure 2 shows quarter on quarter percentage growth rates of seven selected variables: real GDP, total fixed investment, private consumption, exports, imports, export price inflation, and import price inflation. Results for exports and export price inflation demonstrate that recent declines in exports prices are likely to trigger a slow-down in exports at the beginning of 2015, which in turn negatively affects output. As exports recover and negative supply shocks phase out, the economy is expected to recover throughout the second to the fourth quarter of 2015. Over the medium-term, the DSGE model also suggests a moderation of potential growth, in line with expected lower export prices and investment in the staff's baseline scenario.

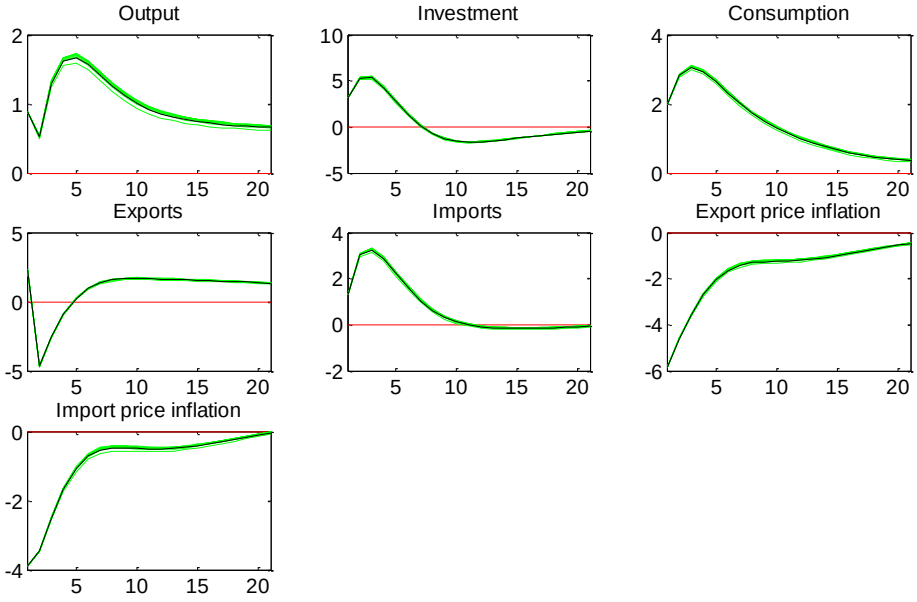
E. Conclusions

13. The preliminary results from the estimated DSGE model of the Peruvian economy were in line with staff's benchmark models. The model provided interesting insights into the main growth drivers and its forecasts fit well with staff's projections from other methodologies. The forecasted trajectory of key variables also followed plausible paths. Most importantly, the model

served to motivate discussions on the interactions between export production and demand, commodity prices, and fixed investment.

14. Policy advice from the exercise centers on raising total factor productivity through accelerating investment, reducing red tape, and improving infrastructure. The model clearly indicates that lower commodity prices and a less favorable external environment will have a negative impact on growth. Thus efforts should be redoubled to implement planned infrastructure projects, structural reforms, and a variety of measures announced in 2014 to accelerate investment by reducing bureaucratic procedures. These efforts should boost productivity and growth, as well as the economy's long-term potential output.

Figure 2. Peru: Forecasts 1/



Source: Fund staff calculations.

1/ Forecasts for 21 quarters; the zero point refers to 2014Q4.

15. Focus should also be on working with local governments to restore local public investment spending and strengthening overall confidence through social inclusion. The "Public Works in Lieu of Taxes" projects, where a private entity constructs a public project in a local region in lieu of paying taxes, offers a pragmatic solution to local infrastructure gaps, but needs to be monitored closely and follow appropriate safeguards. The initiatives to promote social inclusion, poverty reduction, and financial deepening should also continue help reduce inequality and contribute to social stability.

Appendix. Dynamic Stochastic General Equilibrium Model[1]

Model Setup

1. The DSGE model of the Peruvian economy is based on the structure of exports and imports. A large part of Peru's exports are commodities, such as copper ore, gold and refined copper (Figure 1). Accordingly, there are two sectors in the model, an exporting sector and a domestic sector, which produces domestic consumption and capital goods. In the following equation, the subscript "X" refers to the exporting sector, the subscript "D" refers to the domestic good producing sector. The production functions of both sectors are of the standard Cobb Douglas forms, where e_t denotes exports and $y_{D,t}$ denotes output of domestically produced consumption and capital goods:

$$p_{X,t}e_t = p_{X,t}\left(z_{X,t}k_{X,t-1}^{\alpha}\left(Z_t l_{X,t}\right)^{1-\alpha}\right)$$

$$p_{D,t}y_{D,t} = p_{D,t}\left(z_{D,t}k_{D,t-1}^{\alpha}\left(Z_t l_{D,t}\right)^{1-\alpha}\right)$$

Exporting and domestic firms hire workers ($l_{X,t}$ and $l_{D,t}$) and rent capital ($k_{X,t}$ and $k_{D,t}$) for production, until marginal costs of labor (wages $w_{X,t}$ and $w_{D,t}$) and capital (capital rental rates $r_{X,t}$ and $r_{D,t}$) reach marginal products. The shocks $z_{X,t}$ and $z_{D,t}$ denote temporary TFP shocks, while Z_t captures stochastic long-run growth. The steady state value of $z_{X,t}$ in comparison to $z_{D,t}$ is calibrated such that the export share in total GDP fits the Peruvian data.

2. Around eighty percent of invested capital goods are imported in Peru. As can been seen from the complexity map, a large part of these imports are machines and transportation vehicles (Figure 1), of which a significant part is devoted to commodity extraction. Accordingly, in the model, investment in both sectors is a composite of domestically produced capital goods and imported capital goods:

$$i_{X,t} = \left(v_d^{\frac{1}{\eta_i}}\left(i_{X,t}^{d}\right)^{\frac{\eta_i-1}{\eta_i}} + v_m^{\frac{1}{\eta_i}}\left(i_{X,t}^{m}\right)^{\frac{\eta_i-1}{\eta_i}}\right)^{\frac{\eta_i}{\eta_i-1}}$$

$$i_{D,t} = \left(v_d^{\frac{1}{\eta_i}}\left(i_{D,t}^{d}\right)^{\frac{\eta_i-1}{\eta_i}} + v_m^{\frac{1}{\eta_i}}\left(i_{D,t}^{m}\right)^{\frac{\eta_i-1}{\eta_i}}\right)^{\frac{\eta_i}{\eta_i-1}}$$

The parameter η_i denotes the elasticity of substitution between domestically produced and imported investment goods, and the parameters v_d and v_m denote the relative bias between goods. Investment also comprises infrastructure investment. Taking capital goods and infrastructure

[1] For a detailed derivation see Vukotic (2007) and Dib (2008). Vukotic (2007) explains in detail the derivation of a New Keynesian Small Open Economy model. Dib (2008) adds an exporting commodity sector but doesn't estimate the model. The incorporation of financial frictions in the model may further improve the forecasting results and is left for future work. However, financial shocks *are* absorbed in the model by the seven existing shocks. Finally, there is a large body of literature, which compares the forecasting accuracy of DSGE models versus empirical models. This paper offers a theoretical model; it would be interesting to perform a horse race between the two types of models and to compare for example the root mean squared errors (RMSEs).

together, we set $v_d = 0.65$ and $v_m = 0.35$ to match the Peruvian characteristics. Investment and capital are related through standard capital accumulation equations, where the function $S(.)$ introduces capital adjustment costs that smooth the response of investment and capital.

$$k_{X,t} = (1-\delta)k_{X,t-1} + i_{X,t}\left(1 - S\left(\frac{i_{X,t}}{i_{X,t-1}}\right)\right)$$
$$k_{D,t} = (1-\delta)k_{D,t-1} + i_{D,t}\left(1 - S\left(\frac{i_{D,t}}{i_{D,t-1}}\right)\right)$$

3. There is a representative household that maximizes lifetime utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t z_{\beta,t}\left(\frac{(c_t - hc_{t-1})^{1-\gamma} - 1}{1-\gamma} - \theta_m \frac{L_t^{1+\chi}}{1+\chi} Z_t^{1-\gamma}\right)$$

In the utility function, c_t denotes the household's level of consumption, L_t total labor, and $z_{\beta,t}$ a shock to the discount factor, such that $\gamma_{t+1} = \frac{z_{\beta,t+1}}{z_{\beta,t}}$ resembles a risk shock. In Peru, the majority of consumption goods are produced in Peru, with the rest being imported. To capture this fact, consumption is a composite of domestically produced and imported consumption goods:

$$c_t = \left(v_{cd}^{\frac{1}{\eta_c}}(c_t^d)^{\frac{\eta_c-1}{\eta_c}} + v_{cm}^{\frac{1}{\eta_c}}(c_t^m)^{\frac{\eta_c-1}{\eta_c}}\right)^{\frac{\eta_c}{\eta_c-1}}$$

The parameter η_c denotes the elasticity of substitution between domestically produced and imported consumption goods, and the parameters v_{cd} and v_{cm} denote the relative bias between goods. To match the Peruvian characteristics, we set $v_{cd} = 0.7$ and $v_{cm} = 0.3$. With respect to labor, the members of the household work either in the commodity exporting sector or in the domestic sector. Accordingly, total labor, is a composite of labor in both sectors:

$$L_t = \left(l_{X,t}^{1+\phi} + l_{D,t}^{1+\phi}\right)^{\frac{1}{1+\phi}}$$

The household maximizes utility, subject to a budget constraint; expenses cannot exceed the household's income. Expenses are equal to:

$$c_t^d + i_{X,t}^d + i_{D,t}^d + p_{m,t}\left(c_t^m + i_{X,t}^m + i_{D,t}^m\right) + b_t + \epsilon_t b_t^* + T_t$$

In addition to consuming and investing, the household can also invest in domestic bonds b_t and foreign bonds b_t^*, where ϵ_t denotes the nominal exchange rate. Its income comprises returns on invested capital, labor, bonds holdings and firms' profits. The foreign interest rate also depends positively on foreign bonds holdings. The household's income is equal to:

$$r_{X,t}k_{X,t-1} + r_{D,t}k_{D,t-1} + w_{X,t}l_{X,t} + w_{D,t}l_{D,t} + \frac{R_{t-1}}{\pi_t}b_{t-1} + \epsilon_t \frac{R_{t-1}^*}{\pi_t}b_{t-1}^* + P_t$$

4. In addition to exporters, domestics firms, and households, there is a continuum of intermediate goods producers, who purchase goods from the domestic firms, and sell them to a final good producer[2], conscious of its demand function. As a result of the maximization problem of intermediate goods producers, inflation $\pi_t = \frac{p_t}{p_{t-1}}$ results as a mark-up over marginal costs $p_{D,t}$, an equation commonly referred to as the New Keynesian Phillips Curve: $\pi_t = \big(1 + X(.)\big)p_{D,t}$.

5. Government spending is assumed to be exogenous, and follows a stochastic autoregressive progress. The government finances government spending through lump-sum taxation. The monetary authority sets interest rates according to a Taylor rule.

6. Demand for the final good is equal to production of the final good producer:

$$c_t^d + i_{X,t}^d + i_{D,t}^d + g_t = y_{F,t}$$

The final good producer makes zero profits:

$$p_t y_{F,t} - \int_0^1 p_{i,t} y_{i,t} di = 0$$

The production function of the final good producer follows Dixit and Stiglitz (1997), where ϵ is the elasticity of substitution between intermediate goods.

$$y_{F,t} = \left(\int_0^1 y_{i,t}^{\frac{\epsilon-1}{\epsilon}} \, di \right)^{\frac{\epsilon}{\epsilon-1}}$$

Net exports are equal to:

$$NX_t = p_{X,t} e_t - p_{m,t}\big(c_t^m + i_{X,t}^m + i_{D,t}^m\big)$$

Finally, GDP is equal to:

$$c_t^d + i_{X,t}^d + i_{D,t}^d + p_{m,t}\big(c_t^m + i_{X,t}^m + i_{D,t}^m\big) + g_t + NX_t = GDP_t$$

This gives us the standard accounting identity:

$$c_t + i_t + g_t + ex_t - im_t = GDP_t$$

[2] Output of the final good producer is denoted with $y_{F,t}$.

Time Series and Forecasting

7. The model is estimated with Bayesian estimation techniques as in Ann and Schorfheide (2007). The estimation is based on seven data series, as shown in Figure 1. The observation equations, which link the stationary model to the data are:

$$Output = ln\left(\frac{GDP_{obs,t}}{GDP_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{GDP_{stat,t}}{GDP_{stat,t-1}}\right) + ln\left(\frac{Z_t}{Z_{t-1}}\right)\right) * 100$$

$$Investment = ln\left(\frac{i_{obs,t}}{i_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{i_{stat,t}}{i_{stat,t-1}}\right) + ln\left(\frac{Z_t}{Z_{t-1}}\right)\right) * 100$$

$$consumption = ln\left(\frac{c_{obs,t}}{c_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{c_{stat,t}}{c_{stat,t-1}}\right) + ln\left(\frac{Z_t}{Z_{t-1}}\right)\right) * 100$$

$$exports = ln\left(\frac{ex_{obs,t}}{ex_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{e_{stat,t}}{e_{stat,t-1}}\right) + ln\left(\frac{Z_t}{Z_{t-1}}\right)\right) * 100$$

$$imports = ln\left(\frac{im_{obs,t}}{im_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{c^m_{stat,t} + i^m_{stat,X,t} + i^m_{stat,D,t}}{c^m_{stat,t-1} + i^m_{stat,X,t-1} + i^m_{stat,D,t-1}}\right) + ln\left(\frac{Z_t}{Z_{t-1}}\right)\right) * 100$$

$$export\ price\ inflation = ln\left(\frac{Pex_{obs,t}}{Pex_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{p_{X,t}}{p_{X,t-1}}\right) + ln(\pi_t)\right) * 100$$

$$import\ price\ inflation = ln\left(\frac{Pim_{obs,t}}{Pim_{obs,t-1}}\right) * 100 = \left(ln\left(\frac{p_{m,t}}{p_{m,t-1}}\right) + ln(\pi_t)\right) * 100$$

The forecasts of the model are obtained by iterating forward on the state-space system, which is obtained as a solution of the first-order condition of the agents' maximization.

Long-run growth is stochastic, and follows the following process:

$$ln\left(\frac{Z_t}{Z_{t-1}}\right) = ln(\Lambda_Z) + \sigma_Z \epsilon_{Z,t}$$

The quarterly growth $\Lambda_Z$is set to 1.01, matching the quarterly average growth of GDP during the sample period (1996Q1−2014Q4).

Estimation Results

8. Figure 2 shows the prior and the posterior distributions for the shock variances of the eight shocks.[3] The divergence between the prior and posterior distributions is not surprising, given that priors were based on low values common for the US economy. Encouragingly, the data appears to be very informative in pinning down distinct posterior distributions that optimally fit the data.

[3] The acceptance rate of the Metropolis Hastings algorithm is 0.21, which is close to the "optimal" rate of 0.234 that is cited in the literature.

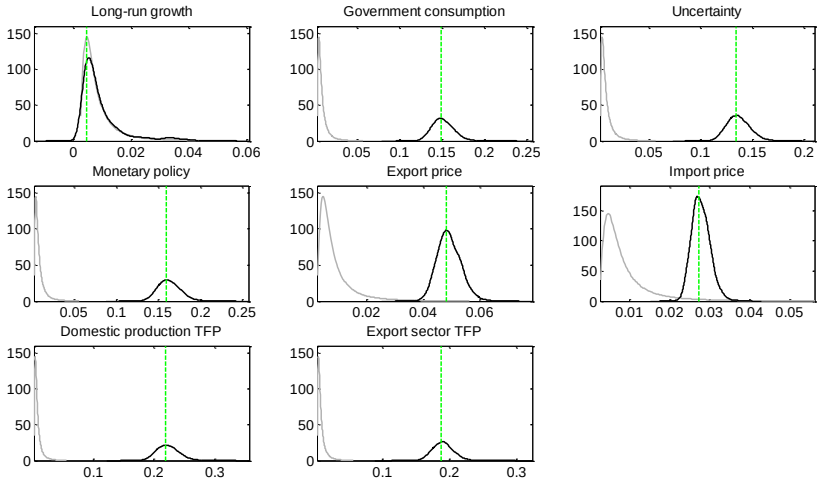
Figure 1. Peru: Time Series for Bayesian Estimation (1996Q1–2014Q4)

The figure shows quarter on quarter percentage changes of real GDP, real investment, real private consumption, real exports and imports, as well as the first log differences of export and import price inflation.

Source: National Authorities.

Figure 2. Peru: Prior and Posterior Distributions of Bayesian Estimation

The figure shows prior and posterior distributions of the standard deviations of the eight shocks of the model. The grey line shows prior distributions, and the black line posterior distributions, with the green line pointing towards the final estimate.



Source: Fund staff estimates.

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DRIVERS OF PERU'S EQUILIBRIUM REAL EXCHANGE RATE: IS THE NUEVO SOL A COMMODITY CURRENCY?[1]

This chapter tests the hypothesis of 'commodity currency' on the nuevo sol and identifies the drivers of Peru's equilibrium real exchange rate using cointegration analysis. The results show that export commodity prices do not have a statistically significant impact on Peru's real effective exchange rate, suggesting that the nuevo sol is not a commodity currency. Large profit repatriation and foreign exchange intervention have effectively insulated Peru's real exchange rate from the impact of commodity price shocks. The results suggest that Peru's real exchange rate is broadly in line with fundamentals.

A. Introduction

1. Understanding whether the real exchange rate is in line with its equilibrium is important for the efficient allocation of resources in an economy.[2] The real exchange rate is the relative price of tradable and nontradable goods. A misaligned real exchange rate, i.e. a real exchange rate that deviates substantially from equilibrium levels, could create macroeconomic imbalances and distort incentives and the allocation of resources.

2. While the equilibrium real exchange rate is an unobservable variable, economic theory suggests that it is driven by observable economic fundamentals. The fundamentals that underlie the equilibrium real exchange include the terms of trade (or the real prices of key export commodities for commodity dependent economies), the relative productivity of tradables to nontradables, government consumption, and the net foreign liability position. For commodity dependent economies like Peru, the equilibrium real exchange rate is conjectured to be primarily determined by the real prices of export commodities so much that their currencies are commonly referred to as 'commodity currencies' (Chen and Rogoff, 2003; Cashin et al, 2004; Bodart et al, 2012).

3. The objective of this chapter is to establish an econometric relationship between the real exchange rate and economic fundamentals. In particular, the study aims to test if Peru's real exchange rate is primarily determined by the real prices of key export commodities as the 'commodity currency' hypothesis would suggest. To achieve this objective, the study employs the Johansen cointegration method. The robustness of the results is tested with various specifications, including with varying definitions of the real exchange rate and real commodity prices, sample sizes, and methodologies.

[1] Prepared by M. Tashu.

[2] The terminologies 'real exchange rate' and 'real effective exchange rate', both of which refer to the exchange rate of the nuevo sol against a basket of currencies of major trading partner countries adjusted for price differentials between Peru and trading partner countries, are used interchangeable in this study.

4. The study also attempts to estimate the path of the notional equilibrium real exchange rate. The equilibrium real exchange rate estimated in this study, however, does not have a normative implication as it does not necessarily imply optimality from a welfare perspective. A normative assessment of the equilibrium real exchange rate requires judgment on the optimality of the values of the fundamentals, which is beyond the scope of this study.

5. The study is organized as follows. The analytical framework is presented in section B, followed by a description of the estimation results in section C. Sections D and E discuss the drivers of the equilibrium real exchange rate. Section F concludes.

B. Theoretical and Empirical Framework

6. Attempts to model the equilibrium real exchange rate goes back to the Purchasing Power Parity (PPP) theory. In its absolute form, the PPP theory states that the exchange rate between the currencies of two countries is simply given by the relative price levels expressed in the same currency (i.e., generalization of the law of one price); in its relative form, the theory asserts that the percentage change in the exchange rate between two currencies is determined by the inflation differential between the corresponding countries. In its relative form, the PPP hypothesis requires deviations from the PPP real exchange rate to die out eventually and the real exchange rate to be stable, exhibiting a stationery or mean reverting property in the long run (Rogoff, 1996; Astorga, 2012). Then, the equilibrium real exchange rate would be constant and could be represented by the long-run or PPP real exchange rate. However, the PPP hypothesis received very little empirical support, especially in the short run, as most studies show that real exchange rate deviations are persistent and that the real exchange rate exhibits a unit root process (Meese and Rogoff, 1983; Rogoff, 1996; Engel, 2000; Astorga, 2012).

7. The empirical failure of the PPP theory led to the hypothesis that the equilibrium real exchange rate could be time varying driven by real factors or fundamentals. In a seminal paper on the PPP puzzle, Rogoff (1996) argues that the high short-term volatility of the real exchange rate and the very slow adjustment of shocks to PPP are so irreconcilable that the deviations from PPP must be accounted for by real factors. Real factors that are hypothesized to drive the equilibrium real exchange rate include the terms of trade (or real prices of commodities for commodity dependent economies), the relative productivity of tradables to nontradables, government consumption, and the net foreign liability position (Froot and Rogoff, 1995; Rogoff, 1996; Montiel, 2007; Ricci et al, 2013).

- *Real price of commodities:* While the terms of trade are generally used in real exchange rate models, for commodity dependent small open economies the real price index of key export commodities is a more relevant variable. As Chen and Rogoff (2003) indicate, aggregate export and import price indices used to construct the terms of trade include goods with sluggish nominal price adjustments and incomplete pass-through, leading to identification problems in econometric estimations. On the contrary, world commodity prices are purely exogenous for small exporting economies as they are determined in world markets. An increase in commodity prices can lead to wage increases in the commodity sector, and across the economy since labor

is assumed to be mobile, leading to an increase in the relative price of nontradables as the price of tradables is determined in the world market and, therefore, to a real exchange rate appreciation (Chen and Rogoff, 2003; Cashin et al, 2004).

- *Relative productivity of tradables to nontradables:* According to the Balassa-Samuelson hypothesis (Balassa, 1964; Samuelson, 1964), an increase in the relative productivity of tradables to nontradables will drive up economy-wide wages, and assuming labor is mobile between the two sectors, will result in a higher relative price of nontradables (i.e., a real appreciation).

- *Net foreign liability position:* An increase in net foreign liabilities will require a more depreciated real exchange rate to generate the trade surplus necessary to service the external debt (Rogoff, 1996; Ricci et al, 2013).

- *Government consumption:* Higher government consumption is likely to lead to an appreciation of the equilibrium real exchange rate as government consumption tends to fall more on nontradables than tradables (Froot and Rogoff, 1995; Rogoff, 1996; Ricci et al, 2013).

8. To test if the nuevo sol is a commodity currency, this chapter follows Chen and Rogoff (2003) and Cashin et al (2004). They specify the real effective exchange rate as a function only of the real price of commodities. Given Peru's reliance on commodity exports, in particular metals such as copper and gold,[3] the hypothesis of commodity currency expects Peru's real effective exchange to be driven primarily by the real price of export commodities. Hence, the regression model takes the following log-linear form:

$$LREER_t = \alpha_0 + \alpha_1 LRP\_COM_t + \mu_t \quad (1)$$

Where,

- *REER* = the real effective exchange rate index, which is a trade-weighted and exchange-rate-adjusted ratio of domestic to foreign prices; an increase in the REER is an appreciation. For the robustness exercise, the bilateral real exchange rate index (RER) vis-à-vis the US dollar is also used. The source of REER data is IMF's Information Notice System (INS) database and the RER is constructed using data on the bilateral exchange rate and prices from the IMF's International Financial Statistics (IFS) database.

- *RP_COM* = the real price of export commodities, constructed as the weighted average world price indices of copper, gold, lead, and zinc (Peru's major export metals) deflated by the manufacturing export unit value index (MUVI) of advanced economies. Metal price indices are obtained from the IFS database and the MUVI is from the IMF's World Economic Outlook (WEO) database.

- μ = stochastic error term; L = Natural logarithm transformation operator; and t = time index.

[3] Metal exports represent about 55 percent of Peru's total export receipts.

The nuevo sol would be regarded as a commodity currency if α_1 is positive and statistically significant.

9. Equation (1) is modified by including the remaining fundamentals as:

$$(2)\ LREER_t = \beta_0 + \beta_1 * LRP\_COM_t + \beta_2 * LPROD_t + \beta_3 * LGCN_t + \beta_4 * LNFL_t + \varepsilon_t$$

Where,

- PROD = relative productivity. The economy-wide labor productivity of Peru relative to a trade-weighted average labor productivity of trading partner countries is used since data on sectoral productivity is not available. The implicit assumption is that productivity growth is likely to be biased in favor of the tradable sector, meaning that a country with high growth of overall productivity will also exhibit higher productivity growth in the tradable sector relative to that of the nontradable sector. Source of data is Haver.

- GCN = the primary current public sector consumption (spending on wages and salaries and goods and services) as a ratio of GDP of Peru relative to that of trading partner countries. Only U.S. data is used in the denominator as consistent time series data is not available for most other trading partner countries. Sources of data are the Central Reserve Bank of Peru (BCRP) and the U.S. Bureau of Economic Analysis (BEA).

- NFL = the stock of net foreign liabilities at the end of the previous period as a ratio of previous period's total external trade in goods and services. As alternatives, NFL as a ratio of GDP and the cumulative current account balance (as a ratio to trade and GDP) are explored. Source of data is the BCRP.

- ε = stochastic error term.

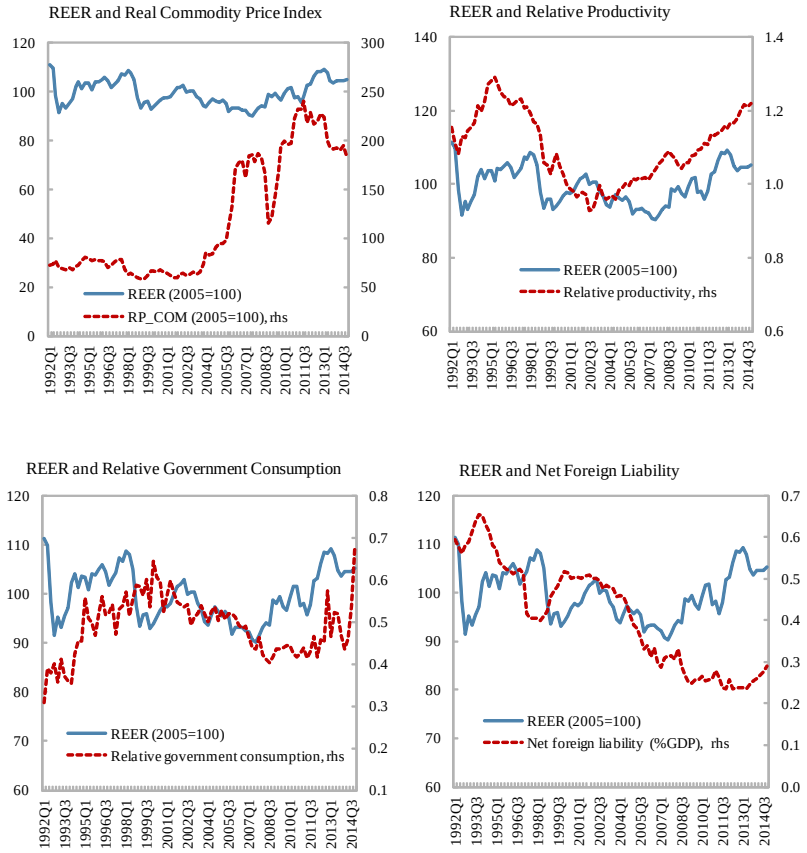
- All other terms are as defined above.

10. The regression sample covers quarterly data for the period 1992–2013. The year 1992 was chosen as the beginning of the sample period to avoid potential structural shifts in the real exchange rate data due to changes in currency prior to 1992 and major stabilization efforts realized since then. Peru's current currency, the nuevo sol, was introduced and has been in use since July 1991. For robustness exercise, however, annual data for the sample period 1970–2013 and monthly data for the sample period 1992–2013 were also used.

11. Descriptive analysis of the data shows that Peru's real effective exchange rate is strongly correlated with relative productivity and relative government consumption. On the other hand, the real effective exchange rate does not seem to have a discernible correlation with the real commodity price index and its correlation with the net foreign liability appears to shift from positive prior to 2007 to negative since 2007 (Figure 1).

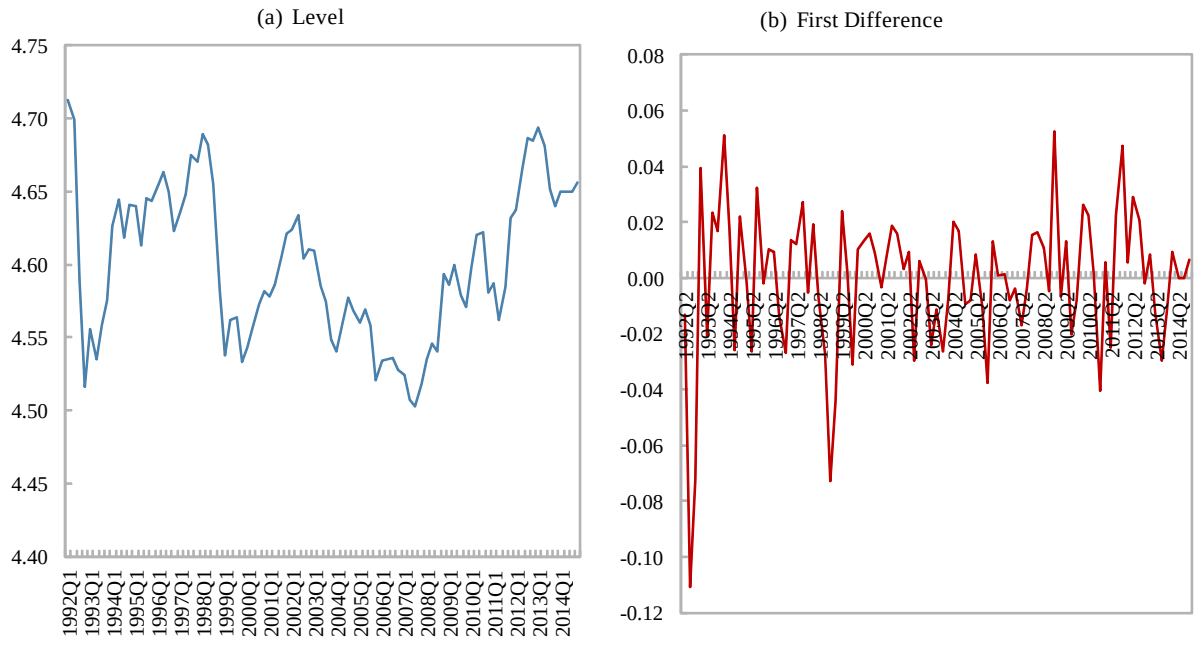
12. The real effective exchange rate does not seem to exhibit a stationary process (Figure 2a). The first difference of the real exchange rate, however, clearly portrays a stationary process (Figure 2b). This observation is supported by the results of formal unit root tests, which show that Peru's real effective exchange rate follows an I (1) process (Appendix Table 1). Unit root tests for the fundamentals also shows that they are all integrated of order one (Appendix Table 1), implying that the right approach for estimating the real effective exchange rate equation is a cointegration analysis. Hence, the Johansen cointegration method is used to test and estimate cointegration relationships between the REER and the fundamentals. Alternative estimation methods, including Dynamic OLS (DOLS), Fully Modified OLS (FMOLS), and Two-Stage Least Squares (2SLS) are also explored to test the robustness of the results.

Figure 1. Peru: Real Effective Exchange Rate and the Fundamentals



Source: Central Reserve Bank of Peru; US Bureau of Economic Analysis; Haver; IMF (IFS, INS, and WEO); and author's calculations.

Figure 2. Peru: Real Effective Exchange Rate
(In logarithm)



Source: IMF and Author's calculations.

C. Is the Nuevo Sol a Commodity Currency?

13. The results suggest that the nuevo sol is *not* a commodity currency. The estimates below show that the real price index of commodities does not explain the behavior of the REER (the number in parenthesis is the t-value).

(3) $LREER_t = 4.55 + 0.02 * LRP\_COM_{\mathrm{t}}$
(0.793)

- Although Johansen's Trace and Maximum Eigenvalue tests indicate the presence of cointegration at 10 the percent level (Appendix Table 2a), the estimated coefficient on LRP_COM is very small and not statistically significant, ruling out the hypothesis of a commodity currency. The result is robust to changes in the definition of the real exchange rate (using the RER instead of the REER) and the RP_COM (using the real price of copper and the terms of trade in place of

Peru: The Real Exchange Rate and Commodity Prices: Alternative Specifications

Alternative specification	Coefficient	T-value
Dynamic OLS	0.03	1.21
Fully Modified OLS	0.02	0.43
RER as dependent variable	0.05	0.87
Real price of copper	0.02	0.73
Terms of trade	0.04	0.41
Monthly data: 1992-2013	0.03	1.17
Annual data: 1970-2013	0.01	0.11

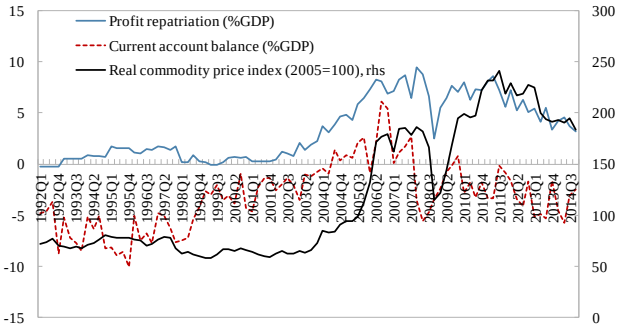
Source: Author's estimates.

RP_COM), data frequency (using monthly and annual data),[4] estimation method, and sample coverage. In all cases, the coefficients are positive as expected, but not statistically significant.

14. The absence of a statistically significant long run relationship between export commodity prices and the real exchange rate in Peru is somewhat puzzling. While similar studies on other commodity dependent economies generally find evidence of commodity currency, Peru was one of the few countries with no such evidence in Cashin et al (2004) as well (Appendix Table 5). Potential factors that could have weakened the statistical relationship between commodity prices and the real effective exchange rate may include large profit repatriation and active foreign exchange intervention.

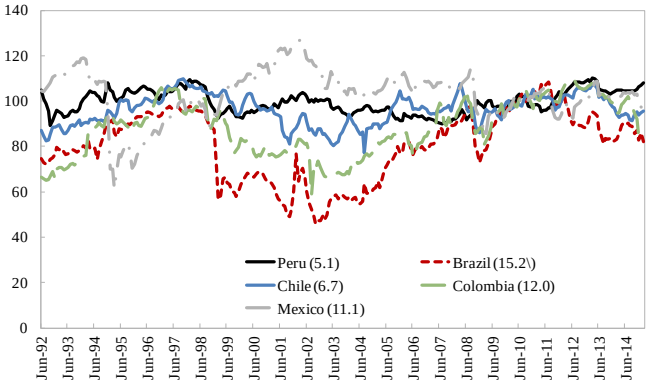
15. Despite the commodity price boom, Peru has run current account deficits during most of the past decade as large profit repatriations more than offset trade surpluses. The mining sector in Peru is operated by the private sector, mostly owned by non-residents. As a result, most of the profit from the sector is repatriated. During 2003–13, the time identified by Adler and Magud (2013) as the commodity income windfall period, profit repatriation from Peru amounted to about 6 percent of GDP a year on average. This might have weakened the statistical relationship between commodity prices and the real effective exchange rate since a large part of the commodity price shock may have been reflected in profit repatriation without having a significant impact on domestic demand. It is true that a large part of the repatriated profit has been reinvested in Peru in the mining sector, but the investments rely mostly on imported machineries with limited impact on domestic demand.

Peru: Real Price of Commodities, Profit Repatriation, and Current Account Balance



Sources: Central Reserve Bank of Peru and author's estimations.

Real Effective Exchange Rate Indices in Selected Latin American Economies 1/ (2010=100)



Sources: IMF and author's caculations.
1/ Numbers in parenthesis infron of country names refer to standard deviations of the REER.

16. Peru's central bank intervenes actively in the FX market with a stated objective of limiting exchange rate

[4] The test for linear cointegration in the annual sample yielded no cointegration with coefficients sensitive to changes in specification. The Gregory-Hansen cointegration test with a regime shift shows evidence of non-linear cointegration with a regime shift in 1987 at the 10 percent level (Appendix Table 3a). Following this result, a dummy was created for this structural shift and the non-linear cointegration relationship was estimated using FMOLS with LRP_COM and LRP_COM interacted with a dummy for a structural shift on the right hand side. The Wald restriction test for the sum of the coefficients equals zero could not be rejected at any level of significance (Appendix Table 4c).

volatility to contain the risks of financial dollarization. Empirical evidence shows that the BCRP's FX interventions are successful in containing exchange rate volatility (Tashu, 2014). On the other hand, Peru has one of the lowest and most stable rates of inflation in the region, thanks to an inflation targeting framework that has successfully anchored inflation expectations (Armas and Grippa, 2005; Armas et al 2014).5 As a result, Peru's real exchange rate is the most stable among financially open large Latin American economies.

17. A sustained sterilized FX intervention in an inflation targeting regime appears to have weakened the impact of commodity prices on the real exchange rate.[6] To illustrate this, consider a positive commodity price shock. In an inflation targeting regime, the central bank could prevent the inflationary pressure from the commodity windfall income by increasing its policy rate, which in turn can lead to an increase in capital inflows. In a freely floating exchange rate regime, the capital inflows would have appreciated the nominal, and hence the real, exchange rate. The BCRP's sterilized FX intervention has, however, limited the impacts of capital inflows on the exchange rate, effectively insulating the real exchange rate from the impact of commodity price shocks.

18. The results support the hypothesis that the commodity price shock has been absorbed mostly by large profit repatriations and a sustained FX intervention. To test the hypothesis that large profit repatriations and the central bank's FX interventions could have insulated the REER from the impact of commodity prices, alternative specifications were estimated where the REER depends on the commodity prices, profit repatriation in percent of GDP (PREP), and net international reserves in percent of GDP (NIR) as a proxy for FX intervention.[7]

(4) $LREER_t = \theta_0 + \theta_1 * LRP\_COM_t + \theta_2 * LPREP_t + \theta_3 * LNIR_t + \epsilon_t$

(5) $LPREP_t = \gamma_0 + \gamma_1 * LRP\_COM_t + \varphi_t$

(6) $LNIR_t = \delta_0 + \delta_1 * LRP\_COM_t + \tau_t$

- Profit repatriation should lead to a depreciation of the nominal, and hence the real, exchange rate because it increases demand for foreign exchange. As a result, $\theta_2 < 0$. The NIR is also expected to have a negative relationship with the real exchange rate, as an increase in the NIR (FX purchases by the central bank) and a decrease in NIR (FX sales by the central bank) should

[5] While the inflation targeting framework was introduced in 2002, the monetary targeting framework, which was in place prior to 2002, is also credited to have reduced and stabilized inflation from the 1980s hyperinflation.

[6] Complementary fiscal policy and the use of reserve requirements have helped the BCRP sustain its sterilized FX interventions without compromising the health of its balance sheet. For instances, about 37½ percent and 34½ percent of the FX intervention in 2013 was sterilized by public sector deposits and reserve requirements, respectively, and only about 11½ percent of the intervention was sterilized through central bank instruments (Rossini et al, 2014). In this regard, the positive commodity price shock, which increased tax revenues from the mineral sector, has helped the Treasury to provide support to the central bank's sterilization effort.

[7] The NIR used here excludes valuation effects so that changes in NIR reflect mostly of FX interventions and other measures aimed at containing exchange rate volatility such as changes in reserve requirements on foreign currency liabilities.

lead to a depreciation and appreciation of the national currency, respectively, if successful. Hence, $\theta_3 < 0$.

- Equations (5) and (6) aim to evaluate if changes in commodity prices can also affect profit repatriation and net international reserves. From (4), the impact of commodity prices on the REER if we were to hold PREP and NIR constant is θ_1. In reality, however, both PREP and NIR change when commodity prices change. Firms' profit increases as commodity prices increase, implying $\gamma_1 > 0$, and a positive commodity price shock prompts central bank intervention in the FX market and hence an increae in the NIR, implying $\delta_1 > 0$. As a result, the net impact of commodity prices on the REER is given by $(\theta_1 + \theta_2 * \gamma_1 + \theta_3 * \delta_1)$, and could be zero, negative or positive depending on the relative size of the individual coefficients.

19. The results show that all of the coefficients have the expected sign and are statistically significant at standard levels of significance. Equations (4)–(6) were estimated using the Johansen cointegration method and the results are shown below:[8]

(7) $$LREER_t = 4.22 + 0.49 * LRP\_COM_t - 0.16 * LPREP_t - 0.56 * LNIR_t$$
(3.63) (-1.79) (-4.89)

(8) $$PREP_t = -3.87 + 1.01 * LRP\_COM_t$$
(5.53)

(9) $$LNIR_t = 0.38 + 0.55 * LRP\_COM_t$$
(5.52)

- The estimate for the net impact of the commodity prices $(\theta_1 + \theta_2 * \gamma_1 + \theta_3 * \delta_1)$ equals 0.01, which is very low and virtually the same as the estimated coefficient obtained when the real effective exchange rate is regressed only on the commodity prices (equation (3)).

- The impact of commodity prices on the real effective exchange rate, if we were to hold profit repatriation constant and assume no FX intervention, would have been statistically significant with an estimated elasticity of about 0.5. In reality, however, changes in commodity prices have statistically significant positive impact on profit repatriation and central bank intervention, which in turn affect the real effective exchange rate negatively, neutralizing the initial impact of the commodity prices on the real effective exchange rate.

[8] All of the variables have unit root (Appendix Table 1). The Augmented-Dickey-Fuller (ADF) test seems to suggest that LNIR is I(0) when constant or constant and trend are added. But the ADF test is known to have low power; i.e., has the tendency to reject the null hypothesis of I(1) too often when it is true. The more efficient unit root test, the Dickey-Fuller GLS (DF-GLS) test, however, accepts the null hypothesis at all levels of significance, suggesting that the NIR is I(1). Johansen's Trace and Maximum Eigenvalue cointegration tests show the presence of a statistically significant cointegration vector among the variables in each of the three equations.

D. Identifying the Drivers of the Equilibrium Real Exchange Rate

20. Relative productivity and government consumption are the main drivers of the equilibrium real effective exchange rate in Peru. The search for a cointegrating vector between the REER and fundamentals involved an algorithm, which: (i) discards models that do not have a statistically significant vector; (ii) eliminates variables which do not have coefficients with the theoretically expected sign or whose inclusion changes the signs of other variables; (iii) discards models which do not have a statistically significant error correction term with negative sign; and (iv) maximizes the R-square of the ECM. The net foreign liability was dropped from the chosen model, following this algorithm, similar to the results of other studies, including Montiel (2007) and Coudart et al (2011). The test for cointegration among the remaining variables shows a single cointegrating vector at 10 percent significant level (Appendix Table 2b), which after normalizing for the coefficient of LREER, takes the following form:

(10) $$LREER_t = 4.74 + 0.03 * LRP\_COM_t + 0.36 * LPROD_t + 0.37 * LGCN_t$$

(1.48) (2.97) (4.35)

Where numbers in parenthesis refer to t-values.

- While all of the fundamentals in equation (10) have the expected signs on their coefficients, the real price of commodities is not statistically significant as is the case in equation (3). Tests for cointegration restrictions show that LRP_COM is not important for the cointegrating vector (Appendix Table 2c).
- As a result, equation (10) is re-estimated without LRP_COM and the resulting cointegration vector, which becomes statistically significant at 1 percent level (Appendix Table 2d), and the short-run dynamic equation are shown in equations (11) and (12), respectively:

(11) $$LREER_t = 4.90 + 0.48 * LPROD_t + 0.39 * LGCN_t$$
(3.57) (4.32)

(12) $$DLREER_t = 0.0001 - 0.13 * ECM_{t-1} + 0.22 * DLREER_{t-1}$$
(0.05) (-3.02) (2.33)
$$+0.45 * DLPROD_{t-1} - 0.09 * DLGCN_{t-1}$$
(3.60) (-2.92)

Where, D-stands for the first difference, the subscript (-1) refers to the first lag, and ECM stands for the error correction term, which is the error term of equation (11). Numbers in parenthesis are t-values.[9]

21. The results are robust to changes in specifications. The exception is when annual data used, which show a statistically significant RP_COM, but the elasticity remains very small (0.03).[10]

Peru: The Real Exchange Rate and Fundamentals: Alternative Specifications 1/

Alternative specification	RP_COM	LPROD	LGCN
Two-stage Least Squares *(using first lags as instruments)*	0.01 *(0.52)*	0.43 *(8.59)*	0.14 *(2.09)*
Dynamic OLS	0.02 *(0.95)*	0.36 *(3.63)*	0.15 *(1.95)*
Fully Modified OLS	0.01 *(0.83)*	0.36 *(4.20)*	0.11 *(1.71)*
RER as dependent variable 2/	...	0.92 *(3.32)*	0.41 *(2.87)*
Real price of copper	0.02 *(1.05)*	0.40 *(3.08)*	0.41 *(4.38)*
Terms of trade	0.05 *(0.65)*	0.43 *(3.12)*	0.41 *(4.22)*
Annual data: 1970-2013 3/	0.03 *(2.95)*	0.19 *(9.26)*	0.19 *(8.62)*

Source: Author's estimates.
1/ Numbers in parenthesis are t-values
2/ RP_COM is dropped from the RER model as it carries a theoretically-wrong sign.
3/ Net foreign liabilities becomes significant with a theoretically-expected negative sign and elasticity of 0.06. The trade openness index, which was included in the quarterly data since Peru liberalized its external trade regime in 1991, is also included in the annual sample (Appendix Tables 4b and dc).

[9] The half-life of a shock to the REER is estimated at about 5 quarters. The coefficient on the error correction term in the dynamic equation is -0.13 and is statistically significant at 1 percent, implying that about 13 percent of deviations of the real exchange rate from the long run equilibrium would be corrected after one quarter. Both productivity and government consumption are also significant in the short run dynamic model (equation (12)), the latter with an unexpected negative sign. The half-life of a shock to the REER is calculated as log(0.5)/log(1-0.13).

[10] The results for the annual data are obtained following the procedure described above; i.e. testing for cointegration with regime shift using Gregory-Hansen's test and estimating the long-run relationship using non-linear FMOLS (Appendix Tables 3b, 4b and 4c). In this case, the break was identified as 1988/89.

E. Is the Real Effective Exchange Rate Misaligned?

22. The equilibrium real exchange rate is estimated using the cointegration relationship between the REER and fundamentals. While a proper estimation of the equilibrium real exchange rate requires a multi-country panel regression analysis similar to the IMF's external balance assessment (Phillips et al, 2013), the estimated long-run relationship between the REER and statistically significant fundamentals is used to estimate the notional path of the equilibrium REER. In theory, the equilibrium real effective exchange rate is the value of the real effective exchange rate predicted by the 'sustainable' or 'steady state' values of the fundamentals (Montiel, 2007). Hence, the fundamentals are filtered by the Hodrick-Prescott (HP) filter to remove cyclical components and estimate their sustainable components.

23. Based on this study, the real exchange rate appears to be broadly in line with the fundamentals. The estimated results show that, over the past decade, Peru's real effective exchange rate appears to have been broadly in line with the fundamentals with the exception of mild misalignments in some years. In particular, the REER was:

- *Mildly undervalued during 2004–07 by 2¼ percent on average:* the REER depreciated by about 4 percent during this period, while the equilibrium REER depreciated by about 2 percent as the impact of large retrenchments in government consumption (relative to the U.S.) more than offset the impact of improvements in relative productivity.

- *Consistent with the equilibrium REER in 2008.*

- *Mildly overvalued during 2009–13 by about 4¾ percent on average*: possibly because the massive capital inflow, which caused a significant REER appreciation (14 percent), was driven not only by Peru's fundamentals, which justified only 9 percent equilibrium REER appreciation, but also by global push factors. However, a large part of the misalignment, which peaked in the 1st quarter of 2013 at 8¾ percent, was corrected in the second half of 2013, as the nuevo sol depreciated following the U.S. Fed Reserve's announcement of monetary policy tapering.

- *Broadly in line with fundamentals in 2014.* The correction in the second half of 2013 continued through 2014, when the real exchange rate was overvalued only by about ½ a percentage point.

24. The REER assessment of this study does not necessarily have a normative value. A REER close to its equilibrium level may still reflect distortions in the fundamentals (Phillips et al, 2013). A normative assessment of the equilibrium REER requires making judgments on the 'appropriateness' of the fundamentals from a welfare perspective, which is beyond the scope of this study.

Peru: Actual and Estimated Equilibrium Real Effective Exchange Rate

Year	Actual	Equilibrium	Misalignment
2004	100.8	102.3	-1.4
2005	100.0	101.4	-1.4
2006	98.2	100.7	-2.4
2007	96.5	99.9	-3.5
2008	100.8	99.6	1.2
2009	104.1	99.8	4.3
2010	106.6	100.9	5.6
2011	105.5	102.9	2.5
2012	114.5	105.8	8.2
2013	115.0	109.3	5.2
2014	114.0	113.3	0.6

Peru: Contributions of Fundamentals to Changes in EREER
(Percentage change)

F. Concluding Remarks

25. The results of this study suggest that the nuevo sol is not a commodity currency. This appears puzzling for a country that relies heavily on metal commodities for its exports. This study provides empirical evidence that large profit repatriation and the BCRP's active FX intervention could have mitigated the impact of commodity prices on the real effective exchange rate.

26. Relative productivity and government consumption are the main drivers of the equilibrium real exchange rate in Peru. The empirical analysis identifies the main drivers of the equilibrium real exchange rate from a pool of economic fundamentals that include the real price of commodities, Peru's productivity relative to that of trading partners, Peru's government consumption relative that of trading partners, and net foreign liabilities. The results show that only productivity and government consumption, both relative to that of trading partners, have

statistically significant relationships with the real effective exchange rate, suggesting that the equilibrium REER is driven by these two fundamentals.

27. Peru's real effective exchange rate appears to be broadly in line with the notional equilibrium level predicted by the 'sustainable' values of the fundamentals. The equilibrium real effective exchange rate is estimated based on the cointegrating relationship between the real effective exchange rate and the statistically significant fundamentals. The REER was mildly overvalued in the years following the 2008 global financial crisis, which is not surprising given the surge in capital inflows triggered mostly by easy monetary policy in advanced economies. But the depreciation of the REER following the U.S. Fed Reserve announcement of unconventional monetary policy tapering in May 2013 appears to have broadly corrected the overvaluation.

28. The results of the study on the equilibrium real exchange rate need to be interpreted only as indicative. A proper exchange rate assessment requires a panel data based analysis, in line with the IMF's EBA assessment, to deal with technical problems associated with small sample size and potential structural breaks. Also, a normative assessment of the real exchange rate requires determining the optimal levels of the fundamentals and desirable policy settings, as conducted in the Article IV staff report.

Appendix. Tables

Table 1. Unit Root Test Results 1/ 2/

Variable		ADF t-statistic			DF-GLS t-statistic		Remarks
		None	*Constant*	*Contant and trend*	*Constant*	*Contant and trend*	
Real effective exchange rate	Level	-0.24	-2.59	-2.44	-1.36	-1.71	*I(1)*
	Difference (1st)	-7.51	-7.46	-7.53	-7.01	-7.58	
Real bilateral exchange rate	Level	-0.20	-2.37	-1.70	-1.24	-1.37	*I(1)*
	Difference (1st)	-6.93	-6.89	-6.96	-6.73	-7.01	
Real price index of export commodities	Level	0.84	-0.73	-2.13	-0.41	-1.76	*I(1)*
	Difference (1st)	-6.75	-6.80	-6.79	-6.84	-6.84	
Real price of copper	Level	0.57	-0.89	-2.54	-0.65	-1.87	*I(1)*
	Difference (1st)	-7.01	-7.02	-7.01	-7.06	-7.07	
Terms of trade	Level	0.06	-1.78	-2.41	-1.78	-2.19	*I(1)*
	Difference (1st)	-6.38	-6.34	-6.29	-6.21	-6.24	
Relative productivity	Level	-0.57	-0.93	-0.54	-0.91	-0.73	*I(1)*
	Difference (1st)	-8.01	-7.98	-7.99	-2.50	-6.19	
Relative government consumption	Level	-1.05	-2.44	-2.51	-0.48	-1.11	*I(1)*
	Difference (1st)	-15.08	-15.03	-17.08	-1.67	-3.46	
Net foreign liability 3/	Level	-0.95	-0.65	-1.44	0.53	-1.43	*I(1)*
	Difference (1st)	-6.97	-7.36	-7.32	-7.38	-7.33	
Net international reserves 4/	Level	2.50	-4.46	-4.35	0.94	-1.03	*I(1)*
	Difference (1st)	-6.34	-6.81	-7.14	-4.53	-5.60	
Profit repatriation 4/	Level	-0.58	-1.50	-2.38	-0.90	-2.51	*I(1)*
	Difference (1st)	-12.16	-12.12	-12.10	-11.93	-11.63	
Critical Values							
1%		*-2.59*	*-3.51*	*-4.07*	*-2.59*	*-3.63*	
5%		*-1.95*	*-2.90*	*-3.46*	*-1.95*	*-3.07*	
10%		*-1.61*	*-2.59*	*-3.16*	*-1.61*	*-2.78*	

1/ Null Hypothesis is unit root in all cases. The Null Hypothesis is accepted for t-statistics greater than corresponding critical values.
2/ All variables are expressed in natural logarithmic form.
3/ As a ratio of previous period's total external trade in goods and services.
4/ In percent of GDP.

Table 2. Johansen Cointegration Tests between the Real Effective Exchange Rate and the Fundamentals

(a) Cointegration between LREER and LRP_COM

Unrestricted Cointegration Rank Test (Trace)

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob. 1/
None*	0.147	14.960	15.495	0.060
At most 1	0.015	1.304	3.841	0.254

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Maximum-Eigen Statistic	Critical Value	Prob. 1/
None*	0.146826	13.6561	14.2646	0.0622
At most 1	0.015048	1.30398	3.841466	0.2535

1/ MacKinnon-Haug-Michelis (1999) p-values

*Rejection of the hypothesis at 10% level.

(b) Cointegration among LREER, LRP_COM, LGCN, and LPROD_M

Unrestricted Cointegration Rank Test (Trace)

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob. 1/
None*	0.266075	46.37389	47.85613	0.0684
At most 1	0.120272	19.76994	29.79707	0.4385
At most 2	0.071095	8.749647	15.49471	0.3891
At most 3	0.027603	2.407229	3.841466	0.1208

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Maximum-Eigen Statistic	Critical Value	Prob. 1/
None*	0.266075	26.60395	27.58434	0.0663
At most 1	0.120272	11.02029	21.13162	0.6453
At most 2	0.071095	6.342418	14.2646	0.5697
At most 3	0.027603	2.407229	3.841466	0.1208

1/ MacKinnon-Haug-Michelis (1999) p-values

*Rejection of the hypothesis at 10% level.

(c) Cointegration restriction tests

Null hypothesis	Restricted log-likehood	LR Statistic	Degrees of Freedom	Probability
Coefficient on LRP_COM is zero	650.3344	1.920112	1	0.1658
Coefficient on LPROD is zero **	649.2462	4.096616	1	0.0430
Coefficient on LGCN is zero***	645.7832	11.02264	1	0.0009

** Rejection of the hypothesis at 5% level.

*** Rejection of the hypothesis at 1% level.

(d) Cointegration among LREER, LGCN, and LPROD_M

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob. 1/
None ***	0.236197	37.57606	29.79707	0.0052
At most 1	0.103207	14.40381	15.49471	0.0725
At most 2 **	0.056874	5.035806	3.841466	0.0248

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Maximum-Eigen Statistic	Critical Value	Prob. 1/
None **	0.236197	23.17225	21.13162	0.0255
At most 1	0.103207	9.368004	14.2646	0.2568
At most 2 **	0.056874	5.035806	3.841466	0.0248

1/ MacKinnon-Haug-Michelis (1999) p-values

** Rejection of the hypothesis at 5% level.

*** Rejection of the hypothesis at 1% level.

Table 2. Johansen Cointegration Tests between the Real Effective Exchange Rate and the Fundamentals (concluded)

(e) LREER, LRP_COM, LPROFIT, and LNIR

Unrestricted Cointegration Rank Test (Trace)

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob. 1/
None **	0.3317	54.1336	47.8561	0.0115
At most 1	0.1118	20.2804	29.7971	0.4040
At most 2	0.0752	10.3257	15.4947	0.2565
At most 3*	0.0438	3.7582	3.8415	0.0525

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Maximum-Eigen Statistic	Critical Value	Prob. 1/
None ***	0.331698	33.85326	27.58434	0.0069
At most 1	0.111755	9.954619	21.13162	0.7489
At most 2	0.075207	6.567558	14.2646	0.5415
At most 3*	0.043754	3.758178	3.841466	0.0525

1/ MacKinnon-Haug-Michelis (1999) p-values

* Denotes rejection of the hypothesis at 10% level.

** Denotes rejection of the hypothesis at 5% level.

*** Denotes rejection of the hypothesis at 1% level.

(f) LNIR and LRP_COM

Unrestricted Cointegration Rank Test (Trace)

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob. 1/
None ***	0.247573	24.18814	15.49471	0.0019
At most 1	0.003496	0.294206	3.841466	0.5875

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Maximum-Eigen Statistic	Critical Value	Prob. 1/
None ***	0.247573	23.89393	14.2646	0.0011
At most 1	0.003496	0.294206	3.841466	0.5875

1/ MacKinnon-Haug-Michelis (1999) p-values

*** Denotes rejection of the hypothesis at 1% level.

(g) LPROFIT and LRP_COM

Unrestricted Cointegration Rank Test (Trace)

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob. 1/
None **	0.155422	16.85422	15.49471	0.031
At most 1	0.031229	2.665094	3.841466	0.1026

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized no. of CE(s)	Eigenvalue	Maximum-Eigen Statistic	Critical Value	Prob. 1/
None*	0.155422	14.18913	14.2646	0.0514
At most 1	0.031229	2.665094	3.841466	0.1026

1/ MacKinnon-Haug-Michelis (1999) p-values

* Denotes rejection of the hypothesis at 10 level.

** Denotes rejection of the hypothesis at 5 level.

Table 3. Gregory-Hansen Test for Cointegration with Regime Shift: Annual sample (1970—2013)[1/]

(a) LREER and LRP_COM

	Test statistic	Shift year	Asymptotic critical values 1%	5%	10%
ADF	-4.70*	1987	-5.47	-4.95	-4.68
Z_t	-4.75*	1987	-5.47	-4.95	-4.68
Z_a	-30.34	1987	-57.17	-47.04	-41.85

(b) LREER and All Fundamentals 2/

	Test statistic	Shift year	Asymptotic critical values 1%	5%	10%
ADF	-7.08***	1988	-6.92	-6.41	-6.17
Z_t	-6.24*	1989	-6.92	-6.41	-6.17
Z_a	-30.34	1989	-90.35	-78.52	-75.56

1/ The null hypothesis is 'no cointegration'.

2/ Includes LRP_COM, LPROD, LGCN and LNFL.

*Null hypothesis regected at 10% significance level.

***Null hypothesis regected at 1% significance level.

Table 4. Estimating Non-linear Cointegration using the FMOLS Method: Annual Sample (1970–2013)

(a) LREER and LRP_COM

LREER= a(1)*LRP_COM+a(2)*LRP_COM×RS1987+a(3)

Coefficient 1/	Coefficient	Standard error	Probability
a(1)	-0.26	0.12	0.0349
a(2)	0.27	0.02	0.0000
a(3)	4.59	0.54	0.0000

(b) LREER and All Fundamentals

LREER= b(1)*LRP_COM+b(2)*LRP_COM×RS1988+b(3)*LGCN+b(4)*LGCN ×RS1988 + b(5)*LPROD + b(6)*LPROD×RS1988 + b(7)*LNFL + b(8)*TRADE_OPEN + b(9)

Variable 2/	Coefficient	Standard error	Probability
b(1)	-0.16	0.01	0.0000
b(2)	0.19	0.00	0.0000
b(3)	-0.44	0.03	0.0000
b(4)	0.63	0.04	0.0000
b(5)	-0.76	0.04	0.0000
b(6)	0.95	0.04	0.0000
b(7) 3/	-0.06	0.01	0.0000
b(8) 3/ 4/	0.52	0.01	0.0000
b(9)	4.01	0.04	0.0000

(c) Wald coefficient restriction tests

Null hypothesis	value	t-statistic	Probability
a(1)+a(2)=0	0.01	0.11	0.9100
b(1)+b(2)=0	0.03	2.95	0.0057
b(3)+b(4)=0	0.19	9.26	0.0000
b(5)+b(6)=0	0.19	8.62	0.0000

1/ RS1987 refers to dummy for regime shift in 1987, identified by the Gregory-Hansen test (Appendix Table 3a).

2/ RS1988 refers to dummy for regime shift in 1988, identified by the Gregory-Hansen test (Appendix Table 3b).

3/ LNFL and TRADE_OPEN (dummy for trade openness) show no change in the sign of their coefficients when interacted with RS1988. As a result, they are included without interactions.

4/ TRADE_OPEN was not included in the cointegration test in Appendix Table 3b since the Gregory-Hansen test does not allow for more than four right hand side variables and dummy variables.

Table 5. Empirical Evidence on Commodity Currency

Author/s (year)	Country/ies	Sample	Method	Elasticity on commodity prices	Definition of commodity prices
Chen and Rogoff (2003)	Australia, Canada, New Zealand	Quarterly: year varies	Time Series cointegration	Australia (0.4), Canada (0.4), and New Zealand (0.6)	Real commodity prices
Cashin et al (2004)	58 commodity exporting countries, including Peru	Monthly: 1980-2002	Time Series cointegration	Median=0.4. TOT not important for Peru.	Real commodity prices
Ferreyra and Salas (2006)	Peru	Quarterly: 1980-2005	Time series cointegration	0.3	TOT
Montiel (2007)	Argentina, Bolivia, Brazil, Chile, Paraguay, Uruguay	Annual: 1969-2005	Time series cointegration	TOT important only for Argentina (1.7), Bolivia (0.6), and Uruguay(0.6)	TOT
Iossifov and Loukoianova (2007)	Ghana	Quarterly: 1984-2006	Time series cointegration	0.4	Real commodity prices
Astorga (2012)	Argentina, Brazil, Chile, Colombia, Mexico, Venezuela	Annual: 1900-2000	Time series cointegration	Argentina (0.4), Brazil (0.2), Chile (0.1), Colombia (0.4), Mexico (not significant), Venezuela (0.1)	TOT
Coudert et al (2011)	52 commodity exporters	Annual: 1980-2007	Panel cointegration	0.4	Real commodity prices
Boudart (2012)	42 commodity dependent countries	Monthly: 1980-2009	Panel cointegration	0.2	Real commodity prices
Ricci et al (2013)	48 industrial and emerging countries	Annual: 1980-2004	Panel cointergration	Advanced countries (0.8) Emerging markets (0.5)	Real commodity prices
Phillips et al (2013)	40 advanced and emerging countries	Annual: 1990-2010	Panel OLS(fixed effect)	0.1	Real commodity prices

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TAXATION IN PERU: TAXING TIMES AHEAD[1]

Resolute efforts in the 1990s and 2000s helped to transform the tax system after years of serious difficulties. The instability of taxes and tax regulations, the prevalence of informality and tax non-compliance, and proliferation of exemptions were serious problems. Some of these issues continue to linger in the present and broadly explain the relative low tax pressure in Peru. In light of falling commodity revenues, recent tax rate reductions and large social and infrastructure needs, continuing to increase the tax-to-GDP ratio in the medium term will require compensatory measures, which should aim to improve the equity of the tax system and eliminate remaining distortions.

A. Introduction

1. The evolution of the Peruvian tax system has been beset by serious tribulations over the last thirty years. The tax-to-GDP ratios have been as low 11 percent in 1980s and close to 17 percent in 2014. Resolute administrative efforts in the 1990s and 2000s have paid off as the system was transformed to one of good quality and efficient administration, even if tax collection only improved by 2–3 percentage points of GDP since then. In some evaluations, Peru has been recognized as one of leaders in the region in efficiency in paying taxes. Nonetheless, the tax burden is still low when compared with peers and important challenges remain.

2. This paper assesses Peru's advances in the tax area and offers insight on further enhancements. In particular, the paper: (i) overviews the tax structure; (ii) evaluates performance in comparison with peers; (iii) takes stock of the 2014 reforms, and (iv) identifies areas for improvement.

B. Peru's Tax System: Stylized Facts and Performance

Stylized Facts

3. Today Peru has a modern tax system and a relatively efficient tax administration.[2] The transition from a regime plagued with various exemptions, small taxes and fees (most of them with cascading effects), and very high customs duties to the current system was led by the tax agency (SUNAT). SUNAT currently boasts highly qualified staff, operates under strategic management principles, and widely applies information technology (IT) in its services (Box 1).

[1] Prepared by Ricardo Fenochietto and Svetlana Vtyurina.

[2] The term tax administration refers to both customs and domestic tax administration.

Box 1. Peru: Progress and Challenges in Tax Administration

SUNAT is now one of the most advanced revenue agencies in the region. After receiving the status of autonomous agency along with defined budgetary resources in 1991, SUNAT embarked on a process of modernization and streamlining of its operational procedures.[1] SUNAT's core functions in audit and control became headquartered in Lima, together with the establishment of the Regional Office. The organizational structure was concentrated around the strengthening of the Large Taxpayers Unit, and state-of-the-art IT systems in support of the key functions of taxpayer registration were introduced in revenue collection, audit and enforcement, and arrears collection.

In 2003, the tax and customs (SUNAD) administrations were merged into a single agency.[2] However, the merger diverged from regional examples as it was conceived as the "absorption" of customs by the tax administration, rather than a merger of equal agencies. This created a number of organizational problems, including an uneven distribution of resources and IT systems. It was not until 2011 that the structural problems began to be addressed. With technical assistance from the IMF, SUNAT's modernization strategy aimed at improving taxpayer services and trade facilitation, enhancing control of taxpayer's compliance, enforcing strategies to better address compliance risks, and strengthening audit and collection, most of which formed a comprehensive Compliance Improvement Program (CIP). Moreover, in line with the government's commitment in mid-2012 to increase the tax-to-GDP ratio to 18 percent by 2016, the Ministry of Economy and Finance passed a number of administrative measures to give SUNAT increased powers to enforce taxpayer compliance.

SUNAT has made good progress in its modernization but challenges remain. In 2013–14, SUNAT strengthened its core processes through improved debt recovery, increased audit coverage, and improved quality of taxpayer services. Also, the agency recently produced a strategic plan for 2015–18 that establishes a new model based on facilitating voluntary taxpayer compliance and reducing compliance costs. Going forward, SUNAT's modernization goals should include: (i) deepening tax and customs compliance actions based on risk; (ii) expediting the implementation of its human resources policies; (iii) reducing the level of informality, and (iv) urgently addressing IT capacity constraints.[3]

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[1] The law creating SUNAT earmarked up to 3 percent of revenue collected for the agency's budget. This was almost twice the average for the region at the time; in 1991, the regional average for the operational cost of the tax administration was about 1.62 percent of total (net) revenue collected, according to the Inter-American Center of Tax Administrations.

[2] In Latin America, similar agencies were created in Mexico (1995), Argentina (1997), Guatemala (1997), and Colombia (1998).

[3] Till now, however, existing operational systems at domestic taxes and at customs are not integrated and, in fact, were built over the years under non-compatible platforms; as a result, both the quality of critical data in SUNAT's databases and its timeliness remain compromised.

4. The authority to levy taxes is mainly concentrated at the central government level. The central government levies direct taxes such as income taxes (IR, Impuestos a la Renta), and indirect taxes such a VAT-type sales tax (GST, or Impuesto General a las Ventas). It also collects excises, customs duties, a tax on banking transactions (BTT), and a special tax on small businesses (RUS). Regional and local governments mostly collect property taxes (on immovable property, transfer of immovable property, and vehicles).

5. Although compared to the 1970s tax revenues increased only marginally, reforms brought important changes to the system. Specifically, central government tax revenue increased from 12.6 percent of GDP in 2003 to 16.6 percent in 2014.[3] While high economic growth during this period was an important factor, sound tax policy and administration measures such as the reduction of non-compliance, broadening of tax bases, and the development of a fiscal regime for the mining sector were also important reasons behind the increase in collection. During this period, more than 70 small taxes and fees with very low level of revenue were eliminated. The composition of central government tax revenue also changed. The combined share of the GST and IR increased from 35 to 66 percent of total revenue, while trade taxes declined from almost 22 percent to less than 5 percent between 1970 and 2014. The elimination of the tax on company's assets and the assignment of the property tax to local governments explain the reduction of wealth tax revenues; and the elimination of export taxes and trade liberalization explains the reduction of trade taxes.

Peru: Tax Revenue Composition, 1970-2014

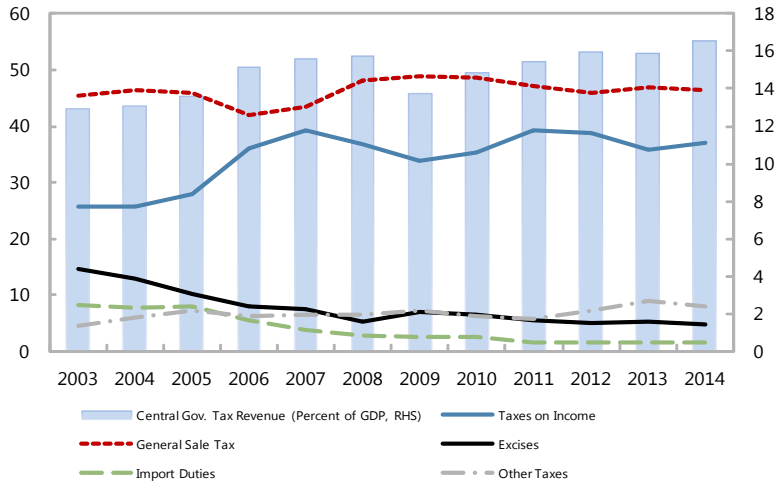
(In percent of GDP)

	1970-79	1980-85	1985-89	1990-99	2000-09	2010-2014
Income tax	3.8	3.2	2.3	2.5	4.7	7.0
Capital tax	0.7	0.6	0.5	0.3	-	-
Export tax	0.9	0.9	0.2	0.0	-	-
Import tax	2.7	3.2	2.3	1.6	1.1	0.3
General sales tax (IGV)	4.1	4.4	2.4	5.4	7.4	8.7
Domestic	3.0	2.6	1.5	3.1	4.2	5.0
Imports	1.1	1.8	0.9	2.3	3.2	3.8
Selective consumption tax (ISC)	1.6	3.2	4.2	2.8	1.7	0.9
Fuels	0.7	2.2	2.5	1.7	1.1	0.4
Other	0.9	1.0	1.7	1.1	0.6	0.5
Other revenue	0.8	0.8	0.8	1.2	1.1	1.0
Total	**14.2**	**15.1**	**11.7**	**13.2**	**14.3**	**16.6**

Source: Central bank.

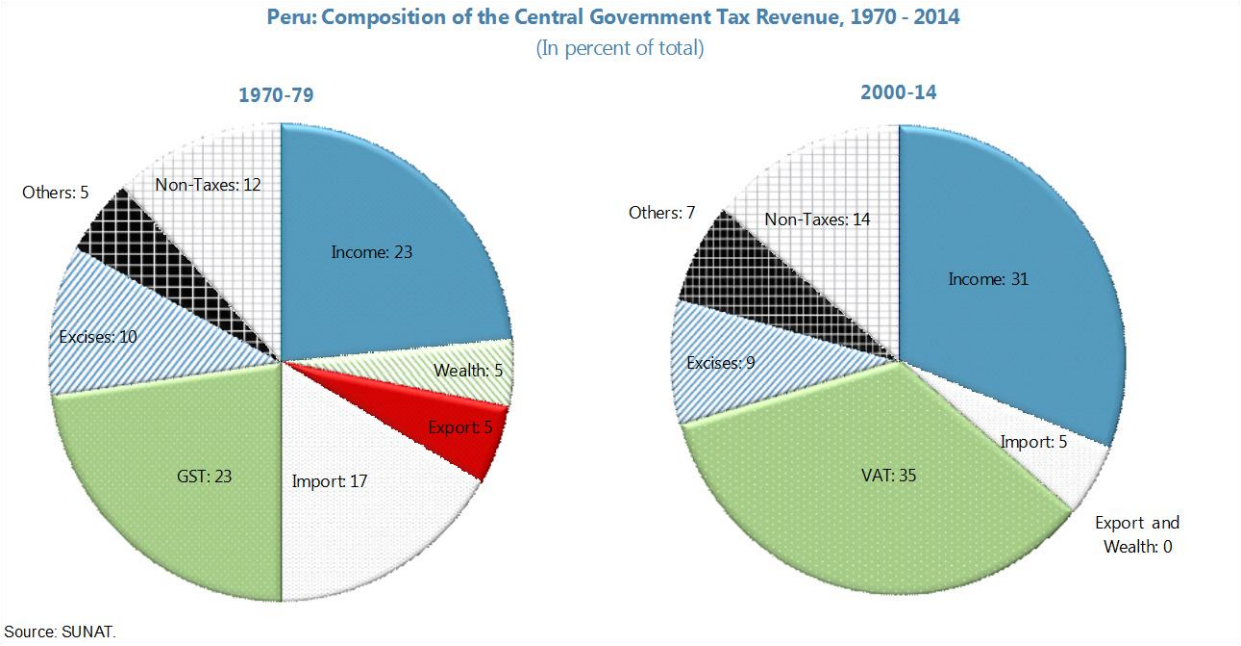
Peru: Selected Tax Revenue 1/

(In percent of total revenue)



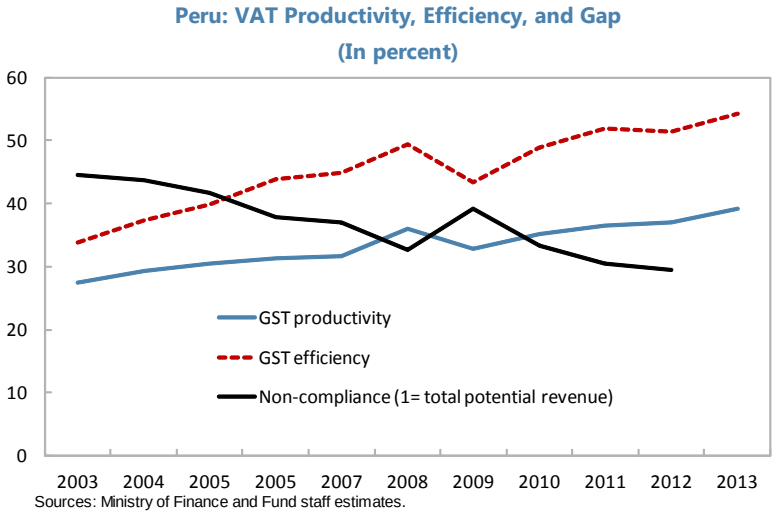
Source: SUNAT.

[3] Tax revenue includes royalties and other revenue from the mining sector but does not include sub-national government revenue due to the lack of data for most of the period. Sub-national revenues amounted only to 0.47 percent of GDP in 2013.



Structure and Performance by Tax Category

- **General Sales tax**. The GST has a relatively wide base and a single rate of 18 percent (of which 2 percentage points are allocated to the Regional Promotion Fund). In 2014, this tax (net of tax returns) accounted for 6.8 percent of GDP, or 37 percent of total revenues. The GST productivity and efficiency have notably increased, while GST non-compliance has been significantly reduced from 46 percent of potential revenue to 29 percent during 2001–13. Non-compliance rates are in line with the regional average but double the average for OECD countries (Appendix).[4]



[4] A common measure of VAT performance is the ratio of VAT revenue to GDP or to consumption divided by the VAT rate. This ratio is commonly referred to as the VAT productivity (in terms of GDP) or efficiency ratio (in terms of consumption). This ratio represents the percentage of GDP (consumption) that each percentage point of the VAT rate collects (e.g., the efficiency ratio for the Peruvian GST was 0.47). The ratio is a useful tool in analyzing the performance of the VAT within a country over a period. A low ratio indicates erosion of the base (either through zero-rating or exemptions) and/or evasion.

- **Income taxes.** The income tax is the second revenue generating tax. The design of both the Corporate Income Tax (CIT) and Personal Income Tax (PIT), in general, is in line with good principles of taxation. The CIT rate is close to the average for the region and the minimum PIT rate is below it.[5,6] In 2014, the CIT yielded 27 percent and the PIT 22 percent of tax revenue due to improvements in control, the elimination of some exemptions, and the introduction of the minimum CIT on net wealth. Coupled with high economic growth, revenue from taxes on income increased significantly over the last decade (from 3.7 of GDP in 2003 to 7 percent of GDP in 2014).

Selected Latin American Countries: CIT, PIT and VAT

Country	Bracket of Top PIT (multiple of GDP/capita PPP)	Top PIT Rate (in percent)	Bracket of Top PIT (US$)	Minimum PIT Rate (In percent)	Standard CIT Rate (In percent)	GDP per capita, PPP (const. 2011 US$)	PIT Exemption to PPP	PIT Exemption (US$)	Rate for Dividents (In percent)		VAT Standard Rate (In percent)
									Residents	Non residents	
Argentina		35.0	14,101	9.0	35.0			10,600	10.0	10.0	21.0
Brazil	1.9	27.5	27,138	7.5	34.0	14,555	1.0	14,589	0.0	0.0	
Chile	5.7	40.0	123,549	4.0	20.0	21,714	0.5	11,119	Progresive rates 1/	CIT - 35.0	19.0
Colombia	4.9	33.0	58,940	19.0	34.0	11,977	1.5	18,062	0.0	0.0	19.0
Costa Rica	2.3	25.0	30,899	10.0	30.0	13,431	0.5	6,190	15.0	15.0	13.0
Dominican Republic	1.7	25.0	18,839	15.0	28.0	11,323	0.8	9,064	10.0	10.0	16.0
Ecuador	10.5	35.0	106,200	5.0	22.0	10,135	1.0	10,410	Progresive rates 1/	0.0	12.0
El Salvador 2/	3.0	30.0	22,875	10.0	30.0	7,515	0.8	5,664	5.0	5.0	13.0
Guatemala	1.7	7.0	11,819	5.0	25.0	7,063	0.9	6,303	5.0	5.0	12.0
Honduras 3/	5.3	25.0	23,552	15.0	29.0	4,445	1.2	5,181	10.0	10.0	15.0
Mexico	13.5	35.0	220,588	1.9	30.0	16,291	0.4	6,618	10.0	10.0	16.0
Nicaragua	4.3	30.0	18,918	15.0	30.0	4,425	0.9	3,784	5.0	5.0	15.0
Panama	2.7	25.0	50,000	15.0	25.0	18,793	0.6	11,000	10.0	10.0	7.0
Paraguay	6.3	10.0	48,979	8.0	10.0	7,787	0.4	3,265	General rates 4/	15.0	10.0
Peru	**6.4**	**30.0**	**72,951**	**8.0**	**28.0**	**11,400**	**0.8**	**9,057**	**4.1**	**4.1**	**18.0**
Uruguay	9.0	30.0	171,245	10.0	25.0	18,966	0.5	9,826	7; 12	7.0	22.0
Simple Average without Peru	5.2	27.5	63,176	10.0	27.1	12,030	0.8	8778			15.0

Sources: International Bureau of Fiscal Documentation; Country Authorities, and Fund staff calculations.

1/ The CIT is granted as tax credit.

2/ The CIT rate is 25 percent for companies whose taxable income does not exceed USD 150,000.

3/ The CIT rate is 25 percent; during 2014 there is a surtax of 4 percent (temporally solidarity contribution).

4/ Only 50 percent of the dividends received.

- **Other taxes.** Excise revenue decreased from 2.3 percent of GDP in 2003 to less than 1 percent in 2014 mainly because of the reduction of taxation on oil and derivatives in order to mitigate the increase in prices of these goods. The level of revenue reached by the RUS is also not significant;

[5] Colombia CIT's rate is now 25 percent. There is an additional tax of 9 percent (CREE), and no tax on dividends (if the company paid the CIT). CIT in Chile will increase from 20 to 25 percent over the next four years. The CIT in Peru was reduced from 30 to 20 in late 2000; then increased to 27 percent (plus 4.1 percent tax on dividends) in 2002, then scaled back to 30 in 2004.

[6] Revenues from PIT amount to about 2 percent of GDP. This level is similar to the average revenue collected in Latin America, but below the level of the collection in middle income countries outside the region and below what would have been expected given Peru's natural resources, levels of informality, and demographics. The minimum exemption is close to the simple average of the region. At 25,900 nuevos soles, it is equivalent to the level of per-capita income (adjusted by power purchasing parity), although high compared to the OECD average (about 30 percent of GDP per capita). While it eliminates a significant share of the population from the PIT, it is line with the region and appropriate for a developing country. In the same way, the threshold at which the top marginal rate is applied (7.6 times) is somewhat over the average of the region (6 times). The PIT now has six rates (0, 8, 14, 17, 20, and 30). The highest rate is close to the simple average in the region of about 27 percent.

however, the tax fulfills its purpose of simplifying the tax system (both for the private sector and SUNAT). Revenue from customs duties and BTT is low at 0.03–0.05 percent of GDP, respectively.[7]

- **Property taxes.** Taxes on property (at the local level) represented 0.33 percent of GDP in 2012 (latest data available). Two taxes are applied on property: one on wealth from holding the immovable property (rates varies between 0.2 and 1 percent) and another (Alcabala) on sales of immovable property (at a rate of 3 percent).[8]

- **Mining revenues.**[9] Fiscal revenue from mining remains important but has been declining in recent years. Between 1999 and 2013, while tax and non-tax revenues in nominal terms quadruped, revenues from the mining sector increased more than seven times. In 2012, the government introduced a more efficient and equitable reform to the mining sector, which was well received by the investment community (Box 2). However, while in 2007 this revenue represented 16 percent of general government revenues, its weight has dropped to 5 percent by 2013 (about 1.5 percent of GDP) reflecting improved collection of other taxes and a reduction in metal prices.

6. Despite good progress, the tax effort is still below potential and somewhat below the simple average of the region. The current Peruvian tax system yields 53 percent of the maximum level of its potential revenue.[10] The still low tax effort is not the result of low tax rates, which are near the average of the region, but rather stems from inefficiency in collection (non-compliance) and large tax exemptions (tax expenditure).

Selected Latin American Countries: Tax Effort and Capacity

Country	Year	Total Revenue /1	Percapita GDP, PPP 2005	Tax Effort	Tax Capacity
Guatemala	2013	11.4	7,063	0.39	28.9
DominicanRepublic	2013	14.8	11,323	0.42	35.4
Panama	2012	16.9	17,627	0.44	38.6
ElSalvador	2013	17.3	7,515	0.47	37.0
Peru	**2013**	**17.2**	**11,400**	**0.53**	**32.4**
Paraguay	2013	16.4	7,787	0.53	30.6
Chile	2012	21.3	21,049	0.55	38.9
CostaRica	2012	21.2	13,158	0.59	35.7
Nicaragua	2013	20.6	4,425	0.60	34.6
Colombia	2013	20.2	11,977	0.61	33.4
Honduras	2011	18.5	4,345	0.63	29.3
Jamaica	2011	23.3	8,485	0.63	37.0
Argentina	2011	34.7	15,501	0.67	52.0
Guyana	2012	22.4	6,054	0.68	32.7
Uruguay	2013	26.6	18,966	0.74	35.9
Brazil	2013	29.6	14,555	0.87	34.2
Un-weighted average without Peru		21.0	11,322	0.59	35.6

Sources: Fenochietto y Pessino (2013) and IMF's World Economic Outlook.
1/ Tax and social contributions as percent of GDP.

[7] BTT's main objective is to inform SUNAT of bank transactions.

[8] Revenue from tax on the immovable property and Alcabala reached only 0.18 and 0.15 percent of GDP in 2012, respectively.

[9] Peru's mining sector (mining and hydrocarbon) represents about 12 percent of GDP; and about 60 percent of total export (of which mineral accounted for 55 percent).

[10] By employing a stochastic frontier analysis (see Fenochietto and Pessino, 2013), a maximum level of revenue that is possible (i.e., the frontier), for given economic and social characteristics of a country, is estimated. By comparing the actual revenue with this tax capacty, the so-called tax effort is obtained.

Box 2. Peru: Mineral Taxation

In September 2011, the mining taxation reform was approved aiming at increasing progressiveness and raising public revenues, while preserving competitiveness of the sector. The law included: (i) new royalties based on operating profits of 1 to 12 percent to replace the sales–based royalties for companies with no stability contracts with the government; (ii) a new special mining tax —revenue for the central government—levied on a sliding scale between 2 to 8.4 percent of operating margins applicable to companies with no tax stability contracts; and (iii) a special (voluntary) levy of 4 to 13 percent of profits on the extraction of mineral resources targeting companies holding stability contracts.[1]

Peru: Mineral Taxation

CIT	Royalties	Import duties	Withholding taxes		Other charges
			Interest	Dividend	
32 percent for companies with stability contract	Most minerals: 1-12 percent based on profit margin	Exempt	30 percent non-treaty rate	4.1 percent	8 percent workers profit share based on net income before tax. Special Mining Tax of 2-8.4 percent and Special Mining Duty of 4-13.12 percent both based on operating margin and only if the company has a stability contract.

Sources: IMF's Fiscal Analysis of Resource Industries (FARI) database.

Changes to the taxation regime were constrained by stability contracts and the regional distribution of mineral revenue. The new special voluntary levy aimed to increase the contribution from companies with stability contract agreements and replaced the voluntary contribution paid in the past. Under the voluntary contribution scheme, introduced for regional development in 2006, the amount transferred could be up to 3.75 percent of profits after tax (2.75 percent for the local fund and 1 percent to the regional government fund). In 2014, the government introduced changes to the stability contract regime by raising the amount of the initial investment and output capacity, and changed some of the conditions for investment to be eligible for these types of contracts.

Peru: Revenues from Mining

(In millions of Nuevo soles)

	2007	2008	2009	2010	2011	2012	2013
Corporate income tax (advanced payments)	6,439	6,056	2,609	4,831	6,290	5,393	2,922
Corporate income tax (clearing)	2,264	688	409	787	1,474	1,064	399
Mining Royalties	519	445	338	646	841	584	517
Special Mining Tax	-	-	-	-	59	442	337
Tax Lien	-	-	-	-	136	942	809
VAT	817	797	632	1,038	1,442	1,318	1,176
Personal Income Tax	642	743	968	1,153	1,607	1,595	1,411
Temporary Tax on Net Assets	105	110	103	128	162	226	254
Other tax revenues	494	592	137	196	224	599	682
Tax Refunds	-425	-352	-905	-994	-1,045	-1,959	-2,707
Other Non Tax Revenues	861	807	122	179	99	216	210
Total		**9,885**	**4,828**	**8,124**	**11,612**	**10,667**	**6,114**
Percentage of GDP	*3.7*	*2.8*	*1.3*	*1.9*	*2.5*	*2.1*	*1.1*
Percentage of General Government Revenues	*16.7*	*12.5*	*6.7*	*9.3*	*11.4*	*9.4*	*5.1*

Source: Ministry of Finance.

The 2011 measures were expected to raise additional revenue. Gains estimated at US$1 billion per year (0.5 percent of GDP at 2011 commodity prices) would have helped fund infrastructure and social gaps. However, as metal prices started to decline in 2012, the actual intake was not a high as expected.

1/ Tax stability contracts were offered to mining companies to ensure a stable legal, tax, and administrative framework to attract multinational mining companies in the mid 1990s.

C. 2014 Tax Measures

7. In mid-2014, the authorities introduced several tax measures. The objective was to spur domestic demand, further streamline regulations, and ease the tax burden in several tax categories. According to the authorities' estimates, approximately 1.2 million taxpayers are expected to benefit from these measures.

- *Income tax rate cuts.* The bottom marginal PIT rate was reduced from 15 to 8 percent for the lowest income segment. The CIT rate will be reduced gradually from 30 to 26 percent by 2019. While the simultaneous increase in the dividend tax was meant to keep the combined rate stable, the increase in dividends for domestic corporations was not approved by congress resulting in a decline in the combined rate. Staff estimates an impact from the cuts of about 0.14 percent of GDP per each percentage point of reduction, with the total cost of the reform at about 2 percent of GDP.

- *Gradual elimination of GST withholding schemes* (Box 3). This system is deemed to negatively affect liquidity of small firms. The measure is expected to inject 2 billion nuevos soles into the economy (0.4 percent of 2014 GDP).

- *Gradual reduction in the drawback mechanism.* The drawback mechanism was seen as an export subsidy, which allows exporters to claim back 5 percent of their exports' value as long as import tariffs have been paid on intermediate goods used.[11]

Peru: Estimates of Impact of Tax Reforms

(In percent of GDP; loss -)

	2015	2016
VAT system		
Detracciones		
Simplification (Rationalization)	-0.10	-0.10
Reduction of rates on services (from 12 to 10 percent in 2014)	-0.05	-0.05
Retenciones, 2014	-0.01	-0.01
Perceptiones	-0.03	-0.03
Drawback	0.02	0.04
Returns	-0.02	-0.02
Income tax	0.00	0.00
Corporate	-0.26	-0.28
individuals (5th category)	-0.20	-0.22
individuals (4th category)	-0.03	-0.03
Dividends	0.00	0.07
Accelerated depreciation /1	0.00	-0.15
ITAN	-0.01	0.00
Customs duties (on certain categories of products)	-0.02	-0.02
Selected Consumption Tax	-0.04	-0.04
Total	**-0.75**	**-0.83**

Sources: Ministry of Finance; SUNAT; and Fund staff calculations.

1/ Only for projects initiated in 2015-17.

Peru: CIT and Dividend Tax

(In percent)

	2014	2015/16	2017/18	2019
CIT rate	30	28	27	26
Divident rate (shareholders)	2.87	4.9	5.84	6.89
Combined rate	32.87	32.9	32.84	32.89
Divident rate (modified) 1/	2.87	2.87	2.87	2.87
Combined rate	**32.87**	**30.87**	**29.87**	**28.87**

Source: Ministry of Finance.

1/ Dividend rate paid to non-residents and residents (natural persons) will increase from 4.1 to 9.3 percent from 2014 through 2019, respectively.

[11] Currently, the drawback rate is 5 percent, but will be lowered to 4 and 3 percent in 2015 and 2016, respectively. The government estimated that exporters claim US$280 million per year through this mechanism. A recent measure to eliminate all import tariffs on intermediate goods had rendered the drawback ineffective, but the Finance Ministry's decree also reinstated tariffs on 732 of the 1817 goods whose tariff was eliminated to ensure the drawback mechanism remains operational.

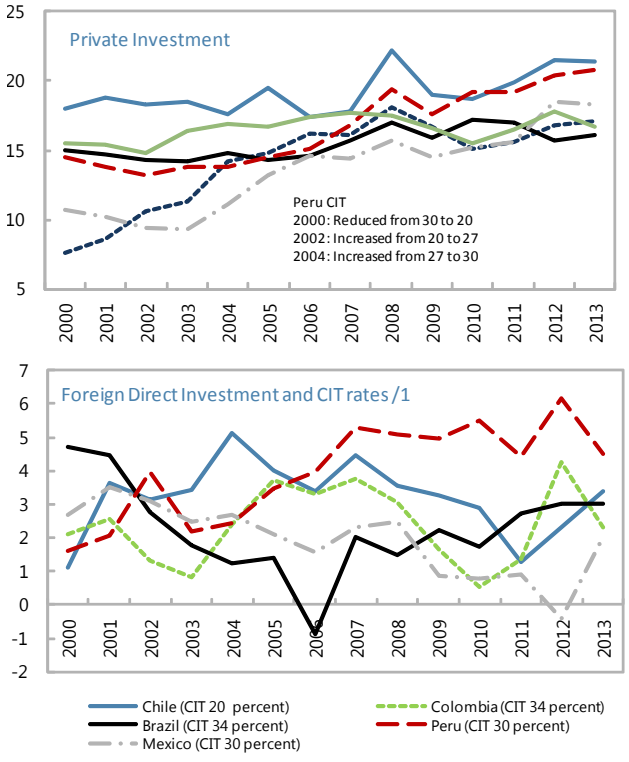
- *Fuel excise tax cut.* The cut is expected to help lower gas prices by around 5 percent. In addition, the fuel stabilization fund will be adjusted to accommodate additional drops in the prices of certain fuels. The authorities are also considering a review of other consumption/excise taxes to reduce negative externalities.

- *Tax benefits for businesses investing in research and development.* The new law will allow companies to reduce their taxable income by 175 percent of the amount spent in research and development, with a limit of 40 percent of income. To be eligible for the tax benefit, research projects will need to be approved by the National Council of Technological Innovation (Concytec), a group which includes private and public research institutions and business groups. Research and development expenditures in Peru are estimated at 0.12 percent of GDP, significantly below the regional average (1.75 percent of GDP).

- *Other changes*. Modifications were introduced to a special scheme for the depreciation of buildings and construction, the temporary tax on net assets (Impuesto Temporal a los Activos Netos, ITAN), provisions on the GST relating to the use of services associated with the import of tangible goods and improvements to its refund procedures, along with several other amendments to the Tax Code. A tax benefit and the accelerated depreciation benefit for the generation of hydroelectricity will be extended until December 31, 2025, targeting investment totaling almost US$3 billion. Changes to the tax stability contracts applicable to mining companies were also introduced (Box 2).

8. While some measures are important for streamlining the tax system, several of them will carry a substantial fiscal cost. While studies suggest that lower CIT rates are good for growth and investment,[12] Peru's exceptionally high growth and investment boom of 2004–12 occurred under the previous tax regime. Given the stated goals to raise tax collection in Peru, and against the progressive decline in mining revenues, it will be essential to introduce compensatory measures to counter the tax cuts over the medium term.

Selected Latin American Countries
(In percent of GDP)



Source: IMF's World Economic Outlook.
1/ CIT rates (percent) as of 2013.

[12] Nicodeme (2009) and Joumard (2002) on OECD countries, and IMF (2015).

Box 3. Peru: The GST Withholding Schemes

A complex system of withholdings, specific to Peru, exists since 2002. The GST systems have helped to improve GST tax collection: in 2002, the withholding system as a whole represented only 5.3 percent of net VAT proceeds, but in 2014, that figure exceeded 28 percent. These withholding schemes collect about 4 percent of GDP. However, this set-up has also increased compliance costs and generated certain administrative inequities.

There are three different withholding schemes in place. They aim to improve compliance and concentrate revenue collection with large taxpayers: (i) *detracciones*; (ii) *percepciones*; and (iii) *retenciones*. Together, the system is even more complex (includes more than 10 tax rates):

- **Retenciones**. This regime forces certain designated companies (large and some public institutions) to act as withholding agents for the SUNAT, retaining part of the GST that their suppliers were supposed to pay.

- **Detracciones**. They are withholdings of GST by large taxpayers on behalf of other taxpayers in the GST chain to ensure compliance. The system of detracciones was widened in 2012 to incorporate other services subject to the GST, exempted goods, public entertainment and non-metallic mining. In 2013, the system was simplified by reducing the number of rates from 13 to 5. The system generates a large number of GST refunds. The main drawback of the scheme is complexity (e.g., payments are fractioned; the rates and timing of payment vary by product; returns are delayed). Furthermore, in cases of wood, sugar, alcohol and rice, the payment has to be made even when these products are not later sold.

- **Percepciones**. It is a mechanism by which the perception agent charges in advance a fraction of the GST that his/her customers will generate at a later stage in operations related to the GST. It is usually charged on purchases by large taxpayers, mainly, of petroleum based liquid fuels and imports.

Measures approved in 2014 will help simplify these withholding schemes and reduce the cost of compliance but further progress is needed. The number of goods subject to tax will be reduced to 12 in system of *percepciones* and *detraccione*s, and to 26 in *detracciones;* the rates in the latter will be kept at 10 and 4 percent. Also the repayment of amounts will be made freely available 4 (rather than 3) times a year. These welcome efforts to simplify the schemes, however, will need to be extended and include further reduction in the number of rates and goods and services; and avoidance of a large number of GST refunds and the increase on the final GST rate that consumers end up paying.

D. The Road Ahead

9. Peru has come a long way in improving the efficiency of the tax system and its administration. However, while buoyancy increased, tax-to GDP ratios are still below the average of countries at the same level of economic development. As mentioned above, Peru still lags its income peer group with respect to tax pressure and effort mostly due to lingering inefficiencies. Moreover, the end of the super commodity cycle, lower potential growth, and the need to cover still large social and infrastructure gaps will require important adjustments on the revenue side in coming years. While the goalpost of raising taxes to 18 percent of GDP by 2016 announced at the start of President Humala's administration in 2011 has now been moved, Peru could still make good gains through improvements in the following areas:

- *Further rationalizing the tax system*. The complex GST withholding schemes should be significantly simplified. The expansion of the number of PIT rates from 3 to 6 is not in line with best practice and consideration should be given to reversing it. Consideration should also be

given to eliminating the practice of fiscal stability agreements: in 2014 there were 877 agreements that imply 877 different tax systems, which are very difficult to administer. Elimination of the advanced payments of CIT (introduced in 2012) would also simplify the system without a loss in revenue.

- *Reforming the GST system:* An implementation of an integrated control strategy for GST would help overcome the lingering weaknesses and align the efforts of regulatory and operational units. This strategy should be based on: strengthening taxpayer registration and tax documents authorization through risk analysis, focusing GST audits on the validity of input tax, establishing an IT system for checking GST suppliers, using all the information from withholding mechanisms, and addressing the abuse of fake invoices. This would also support the rationalization measures already initiated, lead to maturity of the tax system, and lessen reliance on supplementary schemes such as the GST withholding schemes.

- *Reducing high levels of tax arrears:* The level of accumulated tax debt in Peru is higher than a year of revenue.[13] Such excessive level of arrears affects the credibility of the entire tax administration since taxpayers anticipate that in the end they will not pay the total amount owed or pay it gradually after many years. While the debt stock should be reduced by separating the very old debt that is not possible to recover (for instance, because the company goes bankrupt or the taxpayer is deceased), it is also necessary to improve collection enforcement by reducing the time and number of procedures. Consideration should be given to creating a new courtroom in the Tax Court specialized in large taxpayers issues (such as, international taxation, rules to deal with transfer pricing, etc.).

- *Streamlining exemptions:* In order to compensate for the reduction in CIT rates and the elimination of withholding schemes, it is highly advisable to rationalize tax incentives, which have complicated tax administration, eroded the CIT base, and weakened collection efforts.[14] It would also be useful to undertake a comprehensive tax expenditure review, which is an important instrument to identify possible options for revenue mobilization. For instance, some exemptions from the GST have a regressive impact on income distribution, such as those on food and other goods and services consumed by high-income individuals. There is also scope to eliminate regional GST exemptions and channel the increased revenue towards poverty relief programs in these same regions.

- *Increasing collection at the local level:* There is also space to increase property tax collections, which have relatively low efficiency costs and a benign effect on growth, improve the fairness of

[13] Arrears collected in 2014 represented only 2.6 percent of total collection.

[14] Tax expenditures are defined as the revenue forgone from preferential tax treatments, relative to a reference tax system (or benchmark). Due to different benchmarks and different methodologies, a comparison between studies is not always meaningful. Estimates of expenditures in Peru are included transparently in the budget documentation (since 2003), allowing parliamentarians to discuss the fiscal cost of tax incentives and exemptions. The level of tax expenditures in Peru was estimated at about 2 percent of GDP in 2014 (SUNAT).

the system, and could bring more revenue to compensate for lower transfers from the *canon* (a revenue sharing mechanism).

- *Addressing administrative shortcomings*: Key priorities for addressing shortcomings in administration include a better integration of core revenue administration functions—collections, audit, arrears management, risk-management, taxpayer services—for both domestic taxes and customs, moving away from the current organizational model that keeps these areas separate, and the implementation of a new corporate IT strategy.

10. All this suggests taxing times ahead. The challenge of tax policy and administration design is to define a fine line between raising the necessary revenue and accomplishing this in the least distorting way for the economy, while making the system fair and legitimate in the view of tax payers. Reducing exemptions and loopholes that forego revenue with little social benefit can simplify taxation and increase its equity and efficiency. Raising revenue through improving compliance and widening the base will provide resources for further economic and social development.

Appendix. VAT Non-Compliance

	Non-compliance % of Potential	Agriculture % of GDP	PPP 2011	Imports % of GDP
Purchasing power parity (US$ 2011, constant) below US$22,000				
Bolivia	26.1	12.4	5,650	37.2
Costa Rica	30.5	6.3	13,157	38.7
Guatemala	36.8	11.3	7,082	35.0
Colombia	30.1	6.1	11,977	20.2
El Salvador	33.1	12.7	7,515	45.8
Dominican Rep.	33.0	6.1	11,323	31.2
Nicaragua	31.2	20.0	4,425	52.1
Peru	32.6	7.5	11,400	24.6
Uruguay	28.8	10.0	18,965	27.3
Argentina	19.8	11.0	n.a.	14.8
Chile	25.2	3.4	21,049	32.9
Simple average	**29.7**	**9.7**	**11,254**	**32.3**
Purchasing power parity (US$ 2011, constant) above US$22,000				
Latvia	24.0	4.1	22,573	62.7
Lithuania	35.0	3.5	24,758	78.6
Poland	13.0	3.5	22,513	44.2
Hungary	26.0	3.6	22,700	81.2
Estonia	15.0	3.9	24,482	85.2
Czech Republic	23.0	1.9	26,457	71.4
Slovak Republic	7.0	2.5	27,394	68.7
Greece	30.0	3.7	24,389	33.5
Italy	26.0	2.2	32,929	26.3
France	16.0	2.0	35,969	29.8
Finland	13.0	2.8	37,347	39.1
Belgium	13.0	0.2	39,336	81.4
Germany	13.0	0.8	42,045	39.8
Sweden	4.0	1.5	42,155	39.9
Denmark	10.0	1.4	41,524	48.5
U.K.	12.0	1.2	35,013	31.7
Austria	11.0	1.5	43,085	49.9
Holland	5.0	1.6	43,148	72.6
Ireland	8.0	1.5	42,695	84.5
Simple average	**16.0**	**2.3**	**33,185**	**56.3**

Sources: National Authorities; Centro Iteramericano de Administrationes Tributarias; European Commission; IMF.

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