



PERU

SELECTED ISSUES PAPER

January 2014

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PERU

SELECTED ISSUES

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January 8, 2014

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PERU: FISCAL FRAMEWORK ALTERNATIVES FOR A RESOURCE RICH COUNTRY¹

A. Introduction

1. Many resource-rich developing countries (RRDCs) have to reconcile high development and infrastructure needs with low per capita incomes, scarcity of domestic capital, and limited access to international capital markets. They face the challenges of transforming resource wealth into other assets that support sustained development, while also maintaining mechanisms to avoid the boom-bust cycles that stem from volatility in natural resource revenues. Given these challenges, the common advice, based on traditional consumption-savings/investment theories, has been difficult to assimilate and justify at the individual country level. Taking this experience into the account, the Fund has recently developed a macro-fiscal framework that presents new policy analysis tools for RRDCs that could help them target multiple objectives of development and saving.

2. While growth has been at historical highs over the last decade, Peru still has an important infrastructure gap and a quarter of its population still lives in poverty.² Like other RRDCs, Peru has been confronted with the problem of finding an optimal solution to raise per capita income through sustainable growth and investment while safeguarding macro stability against the price volatility and exhaustibility of its natural wealth. While Peru depends much less on revenue resources than many oil-producing countries, the linkages to the fiscal accounts and the real economy are significant enough to warrant the design of an appropriate fiscal anchor to help the country deal with the challenges posed to fiscal management by the “resource curse.”³ A fiscal framework, like the one recently approved, anchored by suitable fiscal rules and strong institutional setup would help Peru reach these multiple objectives.

3. This paper applies illustratively new modified frameworks recently developed by the Fund to the case of Peru. It takes stock of analytical considerations to resource management in section B, overviews Peru’s natural resource wealth and the investment climate in Section C, recaps the fiscal framework and the recent changes in Section D. Section E presents results from simulating alternative Permanent Income Hypothesis (PIH) based approaches and expenditure smoothing fiscal rules, and offers some options for Peru.

¹ Prepared by S. Vtyurina (WHD).

² Some analysts estimate the infrastructure gap in 2012 to be around 44 percent of GDP, or about US\$88 billion.

³ Resource curse is a term coined by Richard M. Auty to describe the phenomenon that many RRDCs often develop more slowly than counties with fewer natural resources.

B. Analytical Considerations to Resource Management⁴

4. Virtually all natural resource-rich countries are faced with two main issues relating to the proper use and price volatility of resource wealth. More specifically, the issues are (i) how much of resource revenues to consume and invest and how to save the remainder; and (ii) how to cope with the uncertainty and price volatility of resources which affect exports, revenues, and non-resource GDP growth. As mentioned before, for RRDCs the former is complicated by greater pressure to spend as their development needs are considerable. At any rate, it is important to consider the length of the extraction horizon. If the horizon is relatively long, in the short to medium term, identifying policies to cope with the price uncertainty takes precedence to the issue of exhaustibility. Uncertainty, in turn, relates to the size of reserves, extraction potential in a given period, average prices, and their likely volatility in the short term.

5. While estimating reserves and production levels is certainly difficult, a much greater challenge is to deal with commodity price fluctuations. Given the ever-changing global environment, it has proven extremely difficult to forecast prices with a reasonable degree of confidence, even over the medium term. Large swings in prices also complicate the task of policy makers who wish to assess whether a shock is permanent (warranting adjustment) or temporary (warranting smoothing). In addition, production might be disrupted by technical difficulties, accidents, strikes, social and political unrest, and cross-border disputes. Production forecasts may prove too optimistic because of delays in investment or for economic reasons (e.g., drop in international demand, substitution to other commodities).

6. Volatility and uncertainty call for a holistic approach to natural resource management. Many countries deal with the unforeseen swings in resource envelopes through building up a liquidity fund to smooth consumption spending. Saving for precautionary (prudential) reasons is conceptually different from other motives, such as saving for future generations or temporary parking of revenue to minimize absorptive capacity disruptions. Additional savings can be used to pay down debt, ramp up domestic investment spending, or invest in external financial assets (for example, when absorptive capacity constraints make it impossible to invest faster).

⁴ This section draws from IMF (2012).

C. Natural Resources and Fiscal Framework in Peru

Peru's Wealth and Investment Climate

7. Peru is rich in various natural resources. In 2011, Peru occupied a leading position in the global production of the following mineral commodities:

- **Copper.** Second after Chile
- **Silver.** Second after Mexico
- **Tin.** Third after China and Indonesia
- **Zinc.** Third after China and Australia
- **Lead.** Fourth after China, Australia, and the United States
- **Molybdenum.** Fourth after China, the United States, and Chile
- **Gold.** Sixth after China, Australia, the United States, Russia, and South Africa

Commodity	Reserves
Coal, all types	1,100,000
Copper	90,000
Gold	Metric tons 2,762
Iron ore	10,853
Lead	9,106
Molybdenum	450
Natural gas	Billion cubic meters 823
Natural gas liquids	Million barrels 1,550
Petroleum crude	Million barrels 3,055
Phosphate rock	820
Salt	100,000
Silver	Metric tons 120,000
Sulfur	150,000
Tin	160
Uranium	100
Zinc	25,137

Sources: "Anuario de la Minería del Perú", 2012.

In Latin America, Peru was first in the production of gold, lead, tin, and zinc, and second in the production of cadmium, copper, mercury, molybdenum, phosphate rock, selenium, and silver. Peru also has large actual and potential reserves, including of natural gas (Table 1). In 2012, Peruvian mining production amounted to US\$27 billion, equivalent to about 4 percent of global mining production, placing Peru in seventh place among the world's largest mining producers.

8. Peru's economy is relatively dependent on extraction and export of natural resources.

In 2011 (latest data available for this breakdown), Peru's resource GDP constituted about 18 percent of nominal domestic product, comparing to about 13 percent in 2001 (Table 2). In real terms, however, this share has actually decreased from over 15 percent of GDP to about 13 percent over the same period due to changes in terms of trade. After growing at an average of 5.2 percent in the first half of the 2000s in real terms, the sector's growth rate in 2012 slowed to the same rate of a decade ago (3.5 percent). Exports (which broadly follow production) accounted for 15.5 percent of GDP in 2012, growing 8 percentage points, in

	2012
Real sector	
Mineral value added as percent of nominal GDP 1/	17.6
Mineral value added percent of real GDP 1/	12.8
Fiscal accounts	
Resource revenue as percent of nominal GDP	3.7
Resource revenue as percent of total fiscal revenue	14.0
o/w metal minerals	7.6
o/w hydrocarbons	6.4
Resource revenue from taxes as percent of total tax revenue	19.1
Metal minerals revenue as percent of total resource revenue	54.3
Hydrocarbons revenue as percent of total resource revenue	45.7
Metal Minerals revenue of percent of exports value of metals	15.6
Hydrocarbons revenue as percent of exports value of hydrocarbons	68.4
External sector	
Resource exports as percent of GDP	15.5
Resource exports as percent of total exports of goods	67.7
o/w metal minerals	56.8
o/w hydrocarbons	10.9

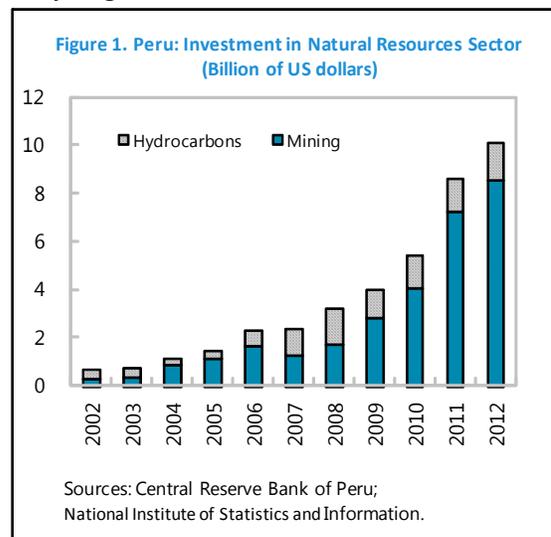
Sources: Peru's Statistical Agency; Ministry of Economy and Finance; Central Reserve Bank of Peru; and Fund staff calculations.

1/ 2011. Minerals and hydrocarbons.

dollar terms, over the past decade.

9. Investment in the minerals and petroleum sector in Peru has been growing at an impressive rate. This was due to increased world demand (not least from China) and low extraction costs, but also due to the country's macroeconomic stability, a good investment climate, and

increasing engagement of the operating companies with the local community. The stability of the Peruvian judicial framework has also helped encourage investment in this sector. Foreign direct investment (of which 70 percent goes to the extractive sector) has tripled over the last decade to some 6 percent of GDP in 2012. Investment in the minerals and hydrocarbon industries was about US\$8.5 and US\$1.5 billion in 2012, respectively, together resulting in a sevenfold increase since 2001 (Figure 1). In 2012, Peru was fifth in the global destinations for exploration of nonferrous metals, behind Canada, Australia, the U.S., and Mexico, at par with Chile.⁵ The leading countries investing in



Peru's mining sector were China, the United States, Canada, Switzerland, Australia, Mexico, and Brazil. The cumulative level of mineral commodity investments are in copper (\$35.4 billion), gold (\$6.9 billion), iron ore (\$6.8 billion), copper-zinc (\$2.1 billion), and polymetallic minerals, including silver (\$0.6 billion each).⁶ According to the Ministry and Energy and Mining, US\$28 billion (with total portfolio at US\$57.4 billion) is expected to be invested through 2016 in the mining sector.⁷ Production of a flagship mineral—copper—is expected to double by 2016 with the coming on stream of the four large mines (Toromocho, which started in December 2013, Las Bambas, Constancia, and Cerro Verde). Some analysts estimate that copper production could quadruple by 2021 if the intended investment materializes (Table 3). According to the Hydrocarbons Committee, the portfolio of projects in the hydrocarbon sector amounts to US\$12 billion.⁸

⁵ Metals Economics Group, 2013.

⁶ Ministerio de Energía y Minas, 2012; ProInversión—Private Investment Promotion Agency in Peru, 2012.

⁷ US\$35 billion relates to copper projects, US\$7.1 billion to iron projects, and US\$6.7 billion to gold projects.

⁸ Among the major projects include the southern gas pipeline, the LPG pipeline between Pisco and Lima, and the petrochemical and oil tender.

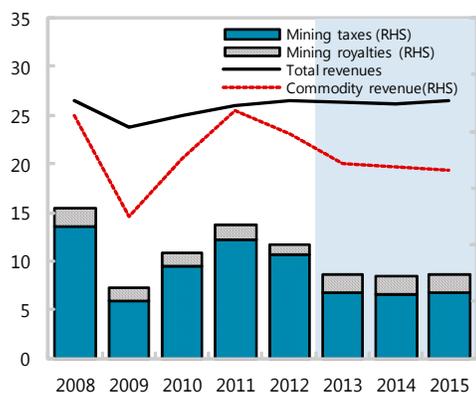
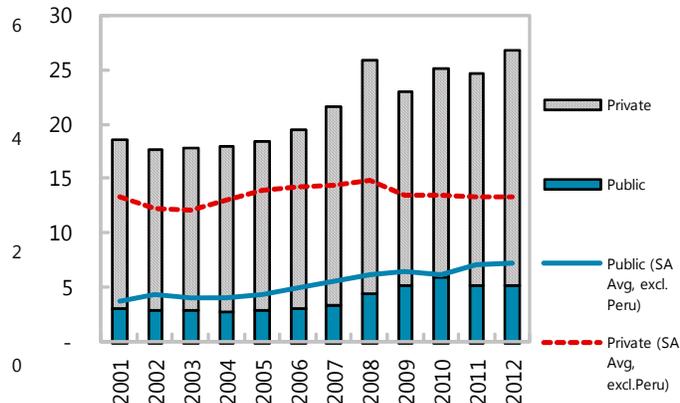
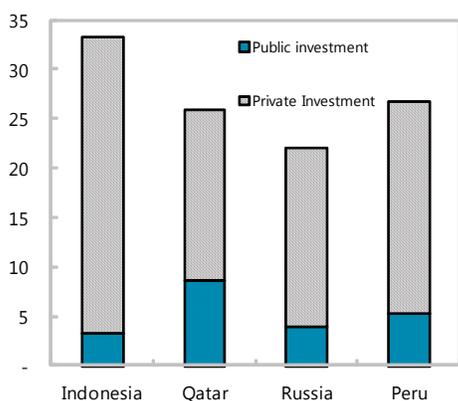
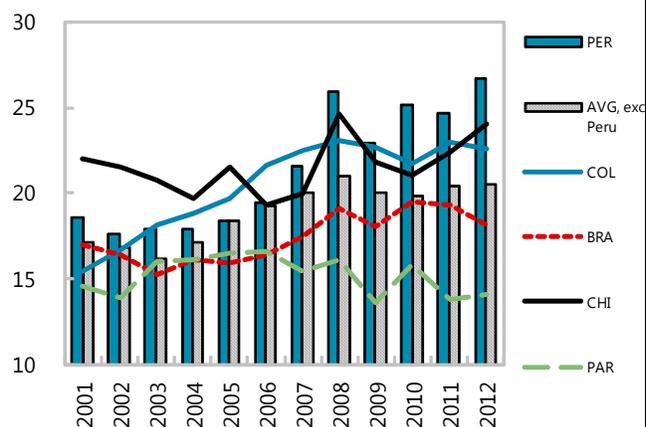
Table 3. Peru: Investment in Metal Minerals Industry

Local company	Country of Origin Investment Company		Name of the Project	Mineral	Completion Date	US\$ million
Expansion Stage						
SPCC	Mexico	Grupo Mexico	Cuajone	Cu	2013	300
SPCC	Mexico	Grupo Mexico	Fundición	Cu		
SPCC	Mexico	Grupo Mexico	Toquepala	Cu	2014	600
SPCC	Mexico	Grupo Mexico	Refinería de Ilo	Cu		
Compania Minera Miski Mayo S.R.L.	Brasil	Vale	Bayovar	Fosfats	2014	520
Minera Barrick Misquichilca S.A.	Canada	Barrick Gold Corp.	Lagunas Norte	Au	2013	400
Shougang Hierro Peru S.A.A.	China	Shougang Corporation	Marcona	Fe	2014	1,480
Sociedad Minera Cerro Verde S.A.A.	Usa	Freeport-MacMoran Copper	Cerro Verde	Cu	2016	4,400
Sociedad Minera El Brocal S.A.A.	Peru	Grupo Buenaventura	Colquijirca	Polimetals	2013	305
Minera Chinalco Perú S.A.	China	Chinalco-Aluminium Corp.of China	Toromocho	Cu	2016	1,320
Construction Stage						
Anglo American Quellaveco S.A.	Uk / Japon	Anglo American 81.9 %, Mitsubishi 18.1%	Quellaveco	Cu	2016	3,300
Invicta Mining Corp S.A.C.	Canada	Andean American Mining Corp	Invicta	Polimetals	2014	93
Minera Chinalco Perú S.A.	China	Chinalco-Aluminium Corp.of China	Toromocho	Cu	2013	3,500
Minera Yanacocha S.R.L.	Usa / Peru	Newmont 51.35%, Buenaventura 43.65%, IFC 5%	Minas Conga	Cu, Au	2017	4,800
Hudbay Minerals Inc.	Canada	HudBay Minerals Inc.	Constancia	Cu	2014	1,546
Xstrata Las Bambas S.A.	Suiza	Xstrata Copper	Las Bambas	Cu	2014	5,200
Compañía Minera Alpacarca S.A.C.	Peru	Grupo Volcan	Alpacarca-Rio Pallanga	Pb-Zn-Ag-Cu	2013	90
Minera Suyamarca S.A.C.	Peru / Usa	Grupo Hochschild 60% / IMZ -International Minerals Corp 40%	Inmaculada	Au - Ag	2014	370
Reliant Ventures S.A.C.	Canada	Silver Standard Peru S.a.	San Luis	Au - Ag		
Total Current						28,224
Submitted and in Exploration (24 projects)						29,299
TOTAL						57,523
Source: Ministry of Energy and Minerals.						

10. Resource revenue is an important source of revenue for the budget. The significance of resource revenue is further underscored by the revenue sharing agreements established by law between the central government and resource producing regions (in particular, under the law known as *Canon Minero*). These regions, in turn, are required to spend funds on infrastructure and education projects (Figure 2, Table 2).⁹

⁹ Managing Peru's mineral wealth is complex because of decentralization arrangements giving regional and local governments a claim on mining revenues. Subnational governments' own revenues are relatively low, with their main source of income being transfers from general government natural resource revenues. Subnational governments receive 50 percent of the canon. All royalties paid by mining companies are transferred to the region where exploration takes place. Hydrocarbon exploration companies also pay royalties, half of which are transferred to subnational governments. Transfers from mining revenue can be used only for capital spending, which is usually under-executed and results in subnational governments' accumulating financial assets despite running overall deficits (IMF, 2013).

Figure 2. Peru: Mining Revenue and Investment

Peru: Mining revenue 1/
(Percent of GDP)Peru: Public and Private Investment 2/
(Percent of GDP)Peru: Investment in Selected EMBI Resource Countries
(In percent of GDP, 2012)Peru: Investment in South America
(Percent of GDP)

1/ Net of restitutions.

2/ National Accounts data.

Source: Ministry of economy and Finance, World Economic Outlook, Fund staff calculations.

11. A mining taxation reform was approved in September 2011, aimed at increasing progressiveness of the tax system, while preserving competitiveness of the sector. The new reforms 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 government¹⁰; (ii) a new special

¹⁰ Tax stability contracts were offered to mining companies to ensure a stable legal, tax and administrative environment to attract multinational companies in the mid-1990s.

mining tax (IEM)— going to the central government—levied on a sliding scale between 2 to 8.4 percent of operating margins (ratio of operating profit divided by net sales) applicable to companies with no tax stability contracts; and (iii) a special (voluntary) levy (GEM) of 4 to 13 percent of profits on the extraction of mineral resources targeting companies holding stability contracts. The reform was well received by the investor community. At the time, revenues were expected to increase by about 0.5 percent of GDP on an annual basis but the recent sharp drop in metal prices has lowered the effective tax rate.

12. Future growth of the extractive industry will depend on further improving the investment climate. In the volatile global environment which affects commodity prices, special attention is being placed on cultivating domestic investment conditions that safeguard previous commitments and generate new investment. Political stability, a reasonable tax regime and adherence to best business practices have been identified as key elements to maintaining investor interest. According to the World Bank’s “Doing Business Indicators,” Peru’s relative strength lies in protecting investors, ease of getting credit, and registering property (Table 4). While Peru compares relatively well with other countries in the region, additional measures to enhance competitiveness in such subcategories as enforcing contracts, resolving insolvency, dealing with construction permits, ease of paying taxes, and getting electricity are warranted. Reforms announced by the government in 2013 aim at reducing excessive paperwork and facilitating faster granting of permits. However, due to limitations in capacity implementation, these reforms are likely to require time to take effect.

Table 4. Peru: Doing Business in Selected Latin American Countries

Ranking (2013)

	Brazil	Chile	Colombia	Mexico	Peru	Uruguay
Ease of Doing Business Rank	130	37	45	48	43	89
Starting a Business	121	32	61	36	60	39
Dealing with Construction Permits	131	84	27	36	86	158
Getting Electricity	60	40	134	130	77	20
Registering Property	109	55	52	141	19	164
Getting Credit	104	53	70	40	23	70
Protecting Investors	82	32	6	49	13	100
Paying Taxes	156	36	99	107	85	140
Trading Across Borders	123	48	91	61	60	104
Enforcing Contracts	116	70	154	76	115	102
Resolving Insolvency	143	98	21	26	106	54

Source: Doing Business, 2013.

13. Social stability is seen as equally important for maintaining conducive business environment. In Peru, social conflicts have increased by 300 percent during the last five years with 149 recent disputes involving extractive industries. While mining regions within Peru have benefited from an established transfer mechanism, local and regional governments have a limited capacity to manage such windfall revenue, and governance challenges appear to be limiting the benefits from mining at the regional and local level. Much of the funding remains unspent, contributing to anti-mining protests and depriving poor communities of necessary infrastructure, such as water treatment facilities, roads, education, and health care. The absence of government services may have created unrealistic demands—and dependency—on the mining companies. The authorities are well aware of these challenging issues and are working with the local governments and investors on

finding best suited solutions to accommodate local development and infrastructure needs and to be able to benefit from Peru's vast natural wealth.¹¹

D. Fiscal Framework and Recent Changes

14. The previous fiscal regime served the country relatively well. The Fiscal Responsibility and Transparency Law (FRTL) approved in 1999 and valid until 2013 included a combination of a nominal deficit target and real current expenditure ceiling for the nonfinancial public sector (NFPS) and central government respectively, as well as debt ceilings for subnational governments. By limiting real current spending at a rate lower than the growth of the economy, it was highly successful in reducing the country's debt from 44 to 20 percent of GDP from 2004 to 2012; and the public sector now boasts financial assets of around 15 percent of GDP.

15. However, the 1999 FRTL fell short of providing an adequate fiscal anchor and a framework to deal with commodity-related challenges, did not prevent pro-cyclicality and its coverage was not applied consistently.¹² Fiscal policy was pro-cyclical in 2008 due to increased spending beyond the limits imposed by the FRTL, and in 2010, despite the rapid recovery of output post 2009 global financial crisis. Moreover, the FRTL allowed for discretionary changes in tax rates, as in 2011, when the authorities reduced several tax rates, which was pro-cyclical. Expenditures caps changed several times, including the use of deflators and targets for real growth rates and transactional coverage used to set the cap (i.e., from current to consumption expenditures). Moreover, the institutional coverage of the rule was not applied consistently across subsectors since expenditure caps applied only to central government, while the overall deficit limit covered the nonfinancial public sector. The use of exceptional clauses proved to be challenging and there was no direct mechanism for saving high-cycle commodity revenues, despite the existence of the Fiscal Stabilization Fund (FEF). Finally, subnational governments were constrained by a different set of rules.

16. To address the aforementioned shortcomings, a new fiscal framework was approved in October 2013.¹³ The revised framework, *inter alia*, outlines a stronger regulatory structure though a more comprehensive spending rule, creates an independent body to contribute to the technical

¹¹ The Mining law includes a non-binding consultation clause (*Consulta Previa*) where investors have to meet with the local community to discuss the future project and identify solutions to any issues (environmental, social, etc.) that may arise from its implementation.

¹² IMF (2010, 2012).

¹³ The design of the new fiscal framework followed the recommendations of the commission of experts appointed in 2012, and involved the participation of the central bank, technical assistance from the Fund, and independent experts to provide more transparency and commitment to the process.

analysis of fiscal and macro policy, and introduces corrective actions in cases of breaches in the fiscal rule. Some detailed provisions include the following:

- **Structural fiscal objective.** After general elections, the new administration within 90 days of taking office has to present a declaration of the macro-fiscal policy for the period of the presidential mandate, with a numerical structural fiscal objective for the presidential period which should not exceed a deficit of 1 percent of GDP.^{14,15}
- **Budgetary implications.** The limit of non-financial public spending has to be aligned to the structural fiscal objective as well as the assumptions on revenues consistent with the business cycle and commodity prices. The limit can be altered if spending in the previous year was less than budgeted. In that case, the amount of the subsequent year's spending can be adjusted upwards by no more than 0.2 percent of GDP.
- **Countercyclical policy.** If there is a positive or negative output gap of at least 2 percent of potential GDP, the spending limit should be adjusted through transitory counter-cyclical measures which together cannot exceed 0.5 percent of GDP.
- **Fiscal revenues.** If measures are adopted to generate a permanent increase in fiscal revenues of at least 0.3 percent of GDP, the spending limit can be adjusted by the same amount.
- **Regional and local governments.** The level of debt cannot be more than 100 percent of the average total current revenues of last four years, and the annual growth of non financial expenditure cannot be more than the moving average growth of annual revenues over the past four years. The governments can only borrow under the state guarantee and only for capital projects.
- **Corrective measures.** In case of deviations from the spending limit, corrective measures are to be taken within a two years if over-spending is below 0.5 percent of GDP, and immediately if it is above this threshold, with an exception of those years when there is a negative output gap of more than 2 percent of potential GDP.

¹⁴ The structural fiscal balance corrects for the business cycle (which affects non-mining revenues) and deviations of metal prices from a long-term "shadow" price (which affects mining-related revenues). The key parameters needed for the calculation of the structural fiscal balance are: (i) the output gap; and (ii) the "shadow" price of metals (to be used in calculating structural mining-related revenues).

¹⁵ A commission has been appointed to propose the methodology used in the calculation of the structural fiscal balance under the new fiscal framework. The commission is expected to announce their conclusions by March 2014.

E. Alternative Fiscal Balance Targets and Sustainable Investment Approach

Simulating Alternative Permanent Income Hypothesis (PIH)-Based Fiscal Rules

17. While Peru’s new fiscal framework establishes an important structural anchor, targeting a non-resource primary balance (NRPB) could also be an alternative that would also help generate a certain level of savings. Above the line, the overall fiscal balance can be decomposed into resource revenues, non-resource revenues, primary expenditure, income from financial assets and interest payments on the stock of liabilities. The overall fiscal balance is also equal to the change in the net financial assets. Below the line, the NRPB is defined as the difference between non-resource revenues minus primary expenditure. Resource-rich countries often run overall fiscal surpluses, which can facilitate the accumulation of substantial financial assets over time, but the NRPB is often in deficit. In this exercise, the NRPB is anchored around the expenditure envelope that could be maintained over the long term and is consistent with the stabilization of the net resource wealth. Over long horizons, the net present value (NPV) of future resource revenues should be equal to the NPV of future non-resource primary balances. Over shorter horizon, a stable level of net wealth should be maintained.

18. Simulations can help analyze and visualize the trade-offs associated with alternative Permanent Income Hypothesis (PIH)-based approaches.¹⁶ The simulations compute fiscal sustainability benchmarks and enable a comparison of key fiscal indicators for three alternative PIH-based rules (see Annex I for details): (i) *the traditional PIH rule, with the main stipulation that in order to meet the inter-temporal budget constraint, the annual level of primary balance should be equal to the return on net wealth*; (ii) *the modified PIH (MPIH)*, which allows for an increase in the non-resource primary balance above the PIH sustainability benchmark but needs to be offset with a consolidation effort to return to the PIH benchmark, while there is no impact on growth from investment; and (iii) *the fiscal sustainability framework (FSF)*, which incorporates the impact of higher public investment on growth, and non-resource revenues, generating a fiscally sustainable path consistent with a lower level of financial wealth. The results of simulations for Peru are presented in Box 1.

¹⁶ The simulations were generated with a model developed by the Fiscal Affairs Department of the IMF.

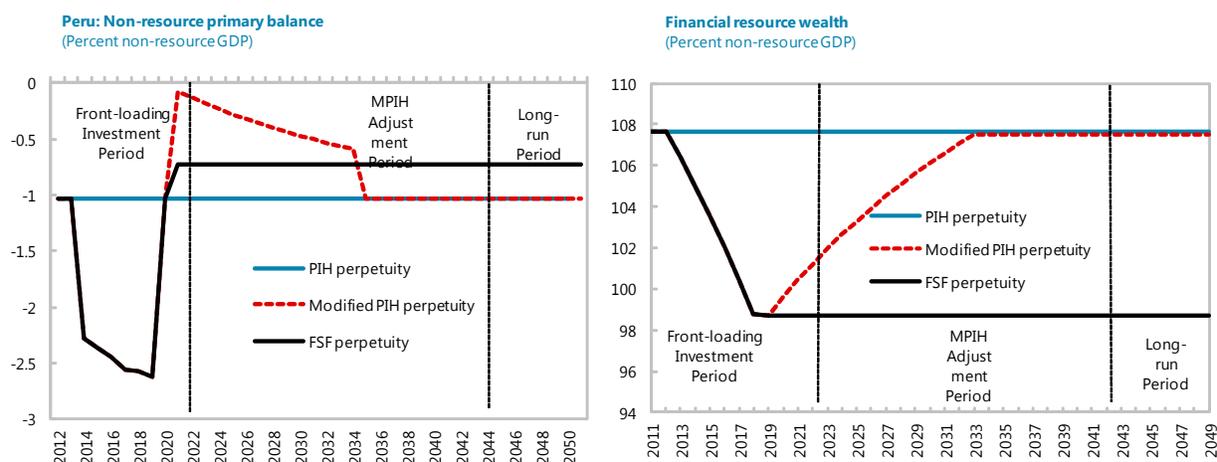
Box. Peru: Simulating Alternative PIH-based Fiscal Rules

Several key assumptions underpin the simulations: (i) the hydrocarbon reserves last until 2050 at 2013 production rates; (ii) other commodities have various production horizons ranging between 5 and 50 years, (iii) non-resource sector grows at a constant growth rate of 4 percent in real terms per year; (iv) the hydrocarbon and mineral revenue share accruing to the government remains constant;¹ and (v) inflation is at 2 percent per year, while the average real rate of return on financial assets is 1 percentage point above the non-resource growth rate. The simulations compute fiscal sustainability benchmarks and enable a comparison of the paths for the non-resource primary deficit, financial wealth, primary expenditure, and non-resource revenue for three alternative PIH-based rules (Figure 3 and 4):

- **Traditional PIH rule**, where the NRPB remains constant over time and is financed with the rate of return on the net present value of projected resource revenues. In this case, the PIH sustainability benchmark is equal to around -1 percent of non-resource GDP (NRGDP).
- **Modified PIH (MPIH)**, which allows for an increase in the NRPB above the PIH sustainability benchmark by about 1.6 percentage points of NRGDP per year on average during 2012–18 (if investment increases 20 percent a year). The simulation provides an estimate of the inter-temporal trade-off between an increase in spending in the short term and future fiscal adjustment needs, given that the additional investment is not expected to generate higher growth. As shown in Figure 3, the front-loaded investment would need to be offset with a consolidation effort of about 0.5 percent of NRGDP per year on average, smoothed over 18 years in order to return to the PIH benchmark of around -1 percent by 2036.
- **Fiscal sustainability framework (FSF)**, which incorporates the positive impact of higher public investment on growth, and non-resource revenues, generates a fiscally sustainable path that is consistent with a lower level of financial wealth. Under this approach, fiscal spending can still be stabilized at a higher level because part of the resource wealth has been transformed into physical assets and higher growth will have “fiscal returns” through larger non-resource revenues and notwithstanding lower financial wealth relative to the PIH and MPIH approaches.

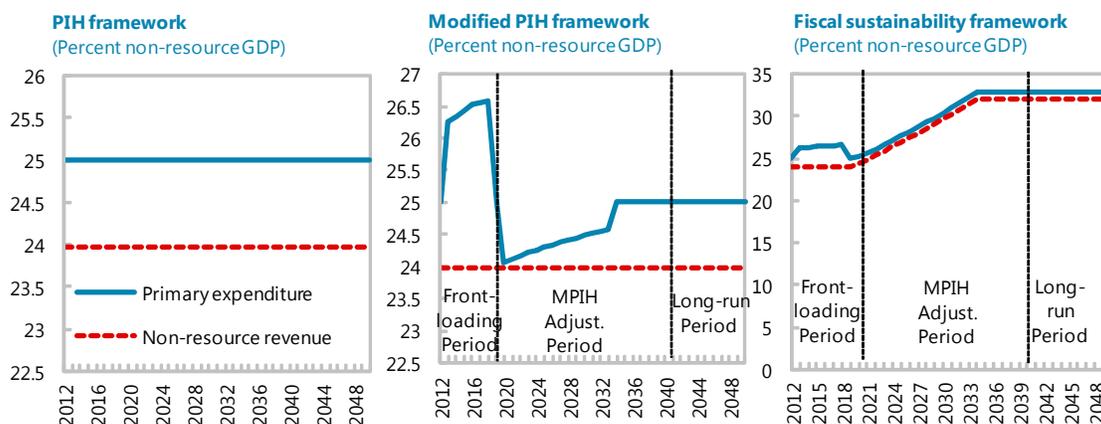
¹ In 2012, the ratios of fiscal revenue to export values were 68 and 15 percent for hydrocarbons and minerals, respectively.

Figure 3. Peru: Fiscal Sustainability Frameworks



Source: Fund Staff calculations

Figure 4. Peru: Fiscal Sustainability Frameworks for Resource-Rich Countries

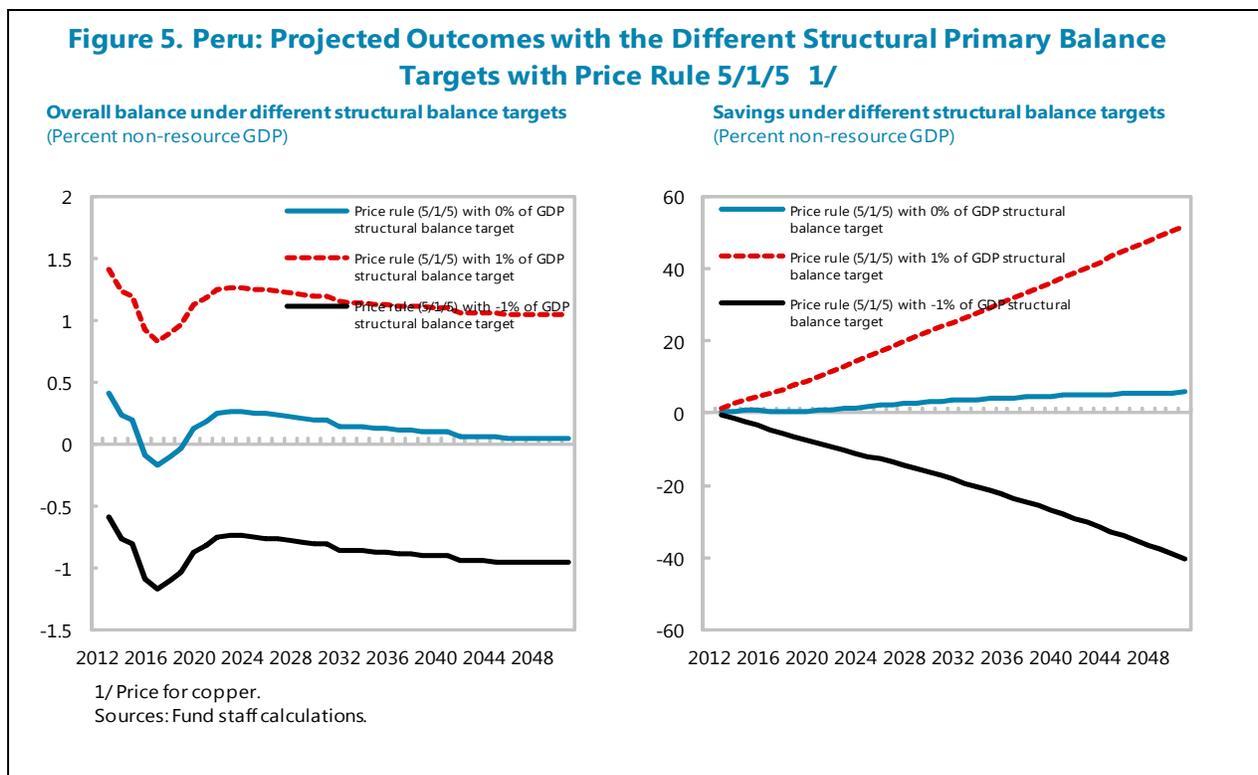


Source: Fund staff calculations.

Structural Primary Balance Based Sustainability Framework

19. As discussed above, the choice of fiscal targets should also depend on the duration of the resource reserve horizons. For RRDCs with short reserve horizons, exhaustibility is the main concern and the key fiscal indicator to assess the fiscal stance should be NRPB—in some variant of the framework described above. Excluding resource revenues from fiscal targets (as the NRPB rule suggests) is, however, less relevant to countries with relatively long horizons (Peru) and to countries that derive an increasingly large part of their revenue from natural resources. In this case, a structural primary balance (SPB) is a more relevant target which complements the NRPB indicator.

20. To address cyclical and sustainability issues targeting an SPB with some sort of price smoothing and/or expenditure growth rules would be appropriate.¹⁷ While a price-based smoothing rule does not offer a direct link to sustainability benchmarks, it can help support solvency through “prudent” forecasting of structural revenues by deliberately under-projecting the sustainable resource price.¹⁸ On the other hand, an expenditure growth rule can help to limit pro-cyclicality and can help guide the scaling up of public investment. Figure 5 presents the results for overall balances and savings when targeting SBP between -1 and 1 percent of GDP under a 5/1/5 rule.¹⁹



¹⁷ See IMF, 2010 and 2012, on considerations for structural rules options.

¹⁸ The FAD model also facilitates the simulations of alternative price-based fiscal rules. This would not be a straight forward exercise to apply in Peru as it depends on several commodity prices, different production capacities and resource horizons. If considered, however, results may point to the trade-offs of alternative price-based rules in terms of smoothing out volatility and generating different levels of financial assets. For a given price formula, higher/lower structural targets would be associated with an increase/decrease the level of financial savings over time. The FAD model is not yet set up to accommodate multiple commodities (which is the case in Peru). For scenarios, which take into account different production horizons and reserves to calculate the government’s intake from the resource revenue, outcomes were normalized by a constant relative price of copper to project an overall metals production level.

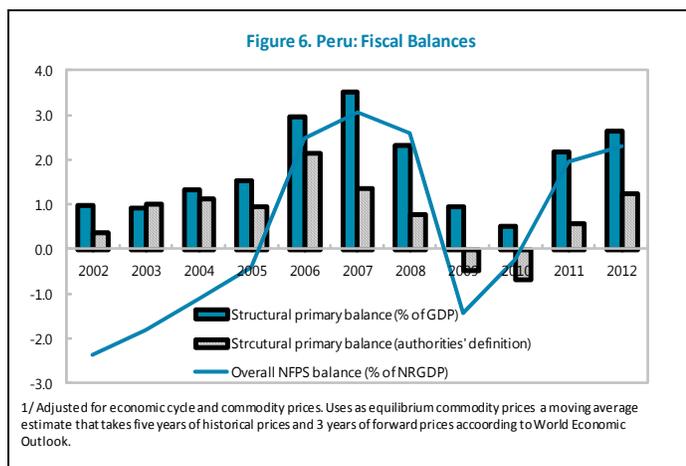
¹⁹ The “5/1/5” rule uses 5 years of past prices, the current year price, and a 5 year projection for the calculation.

Alternatives for Peru

21. In Peru, considerations for savings need to be balanced against expenditure needs that could boost potential economic growth. As mentioned, Peru has pressing social needs (with elevated poverty in rural areas) and ranks relatively low in education and human capital. There are also large public infrastructure investment needs that could enhance economic growth in the future. While Peru compares favorably with its South American neighbors in terms of overall ratio of investment to GDP, with private investment averaging 17 percent of GDP against 13 percent for the rest of South America, it does not come out as well when it comes to public sector investment, which averages less than 4 percent against more than 5 percent for the region although efforts have been made in the past few years to raise the average (Figure 2). Besides other fiscal pressures and priorities, this relatively low spending on public investment could also be explained by short- and medium-term capacity constraints that have hampered its effectiveness and execution.²⁰ Therefore, Peru is, perhaps, best placed to take a gradual approach to increasing investment spending (PIH) and save more of its resource revenues in financial assets, even if only temporarily, while investment capacity is built domestically. Sustainable—or gradual—investing will also continue to mitigate Dutch disease, and reduce the costs of absorptive capacity constraints.

22. However, the need to close the infrastructure gap may require alternative fiscal framework. The PIH, or even the Modified PIH, could be seen as too constraining for Peru's

circumstances since public investment is not very high by emerging market country standards. Peru could thus consider applying the fiscal sustainability framework (FSF) with a fast scale up of investment spending. This would be consistent with recent IMF guidance for RRDC with relatively longer reserve horizons, which puts less emphasis on the issue of the exhaustibility of resources for medium-term planning. Introducing FSF, however, would require expedient improvements in capacity constraints and a good public understanding of the rule that could generate better support and credibility on its enforcement. Furthermore, to ensure quality and continuity of investment, there is merit to first develop a long-term national infrastructure plan.



23. Taking the above considerations into account, it would seem most appropriate to target a SBP supported by price rules. Simulations show that with a SPB rule of -1 percent of GDP,

²⁰ Capital spending execution has averaged about 85 percent of the budgeted amounts over the past several years.

the cumulative financial saving would be negative, whereas with a zero SPB target the cumulative saving would reach only around 4 percent of NRGDP by 2040, around the time when copper reserves are projected to be exhausted (Figure 5). A target of a SPB of 1 percent of GDP seems more reasonable and would generate a cumulative financial saving of around 40 percent of NRGDP over the same period at the overall NFPS of about 1 percent of NRGDP. Over the last decade, Peru has averaged an overall NFPS surplus of 0.5 percent of NRGDP; and 1–1.8 percent in SPB to GDP (Figure 6).²¹ Peru's new fiscal framework gives an opportunity to implicitly target a structural balance, and the authorities would be well advised to aim for structural primary surpluses between 0.5 and 1 percent of GDP to successfully pursue multipronged objectives of sustainability, continue to accumulate buffers and savings, while persevering with the investment and development agenda.

²¹ Staff and the authorities' estimates, respectfully. The authorities use a moving average of last 15 years filter of prices of resource exports to estimate the structural primary balance to GDP.

Annex. Peru: The New Framework for Fiscal Policy in RRDCs

Non-Resource Primary Balance (NRPB) Based Sustainability

Framework

The framework proposes three alternative approaches to guide long-term sustainability considerations. A comparison of the primary balance path under the three approaches (which are more or less accommodative to public investment) gives policymakers a better understanding of the trade-offs implied when deciding to invest or save. The framework provides estimates for long-term paths of NRPB and financial savings under different scenarios.

A. The PIH-based Rule

- **Inter-temporal budget constraint.** To be sustained for an infinitely long period, the annual level of primary balance should be equal to the return on net wealth, adjusting for inflation.
- **Inadequacy.** However, the PIH-based rule might be inadequate for RRDCs as some tilting of consumption paths toward relatively poorer current generations may be welfare-improving.

B. The Modified PIH-based Rule

- **Scaling up.** This approach accommodates scaling up of public investment.
- **Front-loading.** Assumes that government front-loads investment spending above the baseline forecasts until the last year of investment front-loading, year F. The additional front-loaded capital spending could be financed by “saving” less natural resource revenue during the scaling up period.
- **Possible policy failure.** The approach is based on two additional assumptions: (i) The front-loading investment may not have growth impact; and (ii) over the long run (year T), the level of financial wealth from this front-loaded investment scenario has to be equal to the level from the usual PIH fiscal framework, requiring some future adjustment.
- **Future adjustment.** These two assumptions together imply that the front-loaded investment has to be fully compensated by a fiscal adjustment in the medium term (spread over T-F years). Hence, the level of financial wealth after year T would be the same for the two alternative fiscal paths.
- **Outlines worst case scenario.** The MPIH approach provides an ex-ante measure of possible future fiscal adjustment needs if the scaling up of investment does not have an impact on growth. It therefore provides a future fiscal adjustment path in a worst case scenario where higher public investment has no impact on growth and hence provides a measure of the potential implications for future fiscal adjustment.

C. The FSF-based Rule

- **Tolerates lower savings.** This approach stabilizes net wealth at lower levels than the PIH or the MPIH. Higher investment is assumed to have a positive impact on growth, which generates higher non-resource revenue, but also increases operation and maintenance outlays.
- **Asset substitution strategy.** The intuition behind this framework is that instead of accumulating higher financial savings, the country has accumulated higher physical assets that also provide a fiscal and social return.

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RESISTING THE PRESSURES FROM CAPITAL FLOWS: ARE FOREIGN EXCHANGE INTERVENTIONS EFFECTIVE? ¹

A. Overview

1. The growing size and volatility of capital flows to Peru call for measures to prevent the buildup of financial and macroeconomic risks. Capital flows have grown significantly in recent years, reflecting both push (easy money in advanced economies) and pull (strong fundamentals of the Peruvian economy) factors. While a large share of these flows is foreign direct investment (FDI), the growing size and volatility of portfolio and short-term flows is a source of concern as these often lead to the buildup of risks and vulnerabilities in the financial system.

2. The central bank employs foreign exchange (FX) intervention to ease the pressure of high and volatile capital flows on the FX market in the context of relatively high financial dollarization. While utilizing prudential measures to contain the buildup of financial and macroeconomic risks, on a daily basis, the Central Reserve Bank of Peru (BCRP) relies on FX intervention to safeguard the FX market against the pressures from persistent and volatile capital flows. In 2013 alone, the BCRP intervened with FX purchases of US\$5.2 billion through April and with FX sales of a similar amount between July and mid-December in the spot market, reflecting the volatility of capital flows.

3. The objective of this paper is to assess empirically the motives and effectiveness of FX interventions in Peru. Given the BCRP's use of FX intervention as a policy instrument to safeguard the FX market from high and volatile capital flows, it is important to empirically assess the effectiveness of such intervention. The effectiveness is assessed not only against officially stated objectives but also against other motives empirically "revealed" by the data. In this regard, the paper estimates a reaction function of the BCRP to identify the "revealed" motives of the BCRP's interventions and to address the simultaneity problem between FX interventions and exchange rates. In doing so, the paper also tests if there is asymmetry in the BCRP's responses to appreciation and depreciation pressures and if there is an asymmetry in the effectiveness of interventions between FX purchases and FX sales.

4. The results of this study indicate asymmetries both in the BCRP's reaction function and in the effectiveness of FX interventions. Probit estimates of the likelihood of FX purchases and FX sales, in the first stage of the regression, show that both forms of intervention are

¹ Prepared by Melesse Tashu (WHD).

targeted at “leaning against the wind;” that is, resisting appreciation in the former case and resisting depreciation in the latter. But only FX sales, not FX purchases, react to volatility. Similarly, Instrumental Variable (IV) regression results, in the second stage, provide evidence for asymmetry in the effectiveness of FX interventions. While FX sales are more effective in preventing depreciation and reducing volatility of the exchange rate, FX purchases are effective mostly in reducing volatility. This implies that attempts to resist appreciations through FX intervention may not be that effective. In fact, if reducing volatility is not the objective (as the results of this study seem to suggest), FX purchases could perpetuate the appreciation by reducing volatility and encouraging a one-sided bet on the domestic currency.²

5. The remainder of this chapter is structured in five sections. Following this introduction, section B highlights capital flows and policy reactions in Peru, followed by a discussion of methodological issues in section C. Section D presents data and estimation results, and section E presents some concluding remarks.

B. Capital Flows and Policy Reactions

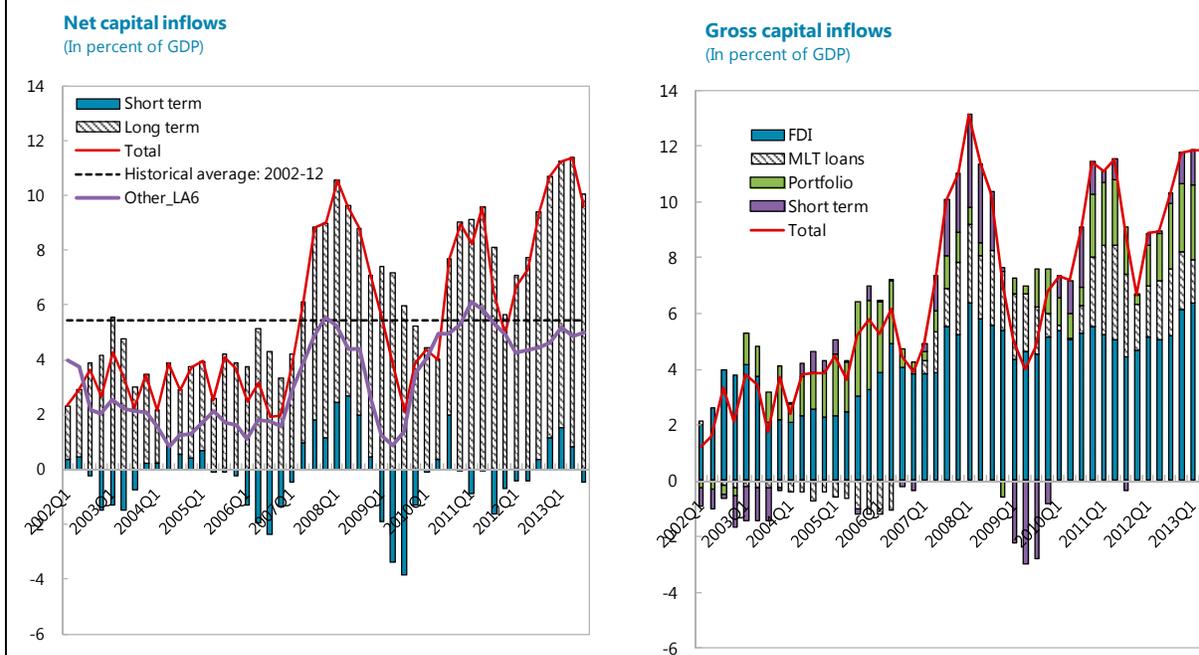
6. Peru has received large amounts of capital inflows in recent years. Net capital flows amounted to about 8 percent of GDP a year, on average, during 2010–12 and the first three quarters of 2013, well above the average of the last decade for Peru (5 percent of GDP) and the recent regional average³ (also about 5 percent of GDP). Gross inflows amounted to about 9½ percent of GDP a year during 2010–12 and reached about 11¼ percent through the third quarter of 2013. This surge in capital flows reflects both push factors (easy money and low interest rates in advanced economies) and pull factors (strong domestic fundamentals). In advanced economies, interest rates hit bottom and monetary aggregates hiked significantly following the recent global financial crisis, pushing a glut of financial flows to emerging economies. Meanwhile, Peru has become an increasingly attractive destination for capital flows with a record of high economic growth (about 6½ percent a year during the last decade), strong terms of trade (TOT), and sound monetary and fiscal policies. The inflows have, however, slowed significantly in recent months, reflecting the tapering of both push and pull factors.⁴

² Another motivation for FX purchases could be to accumulate international reserve. In such case, the central bank could purchase FX regardless of the impact on the exchange rate.

³ The average net capital flows to Brazil, Chile, Colombia, Mexico, and Uruguay.

⁴ On push factors, the U.S. Federal Reserve has announced its plan for slowing down the monthly purchases of Treasury bonds and mortgage securities, which will start in January 2014; and on the pull factors, Peru’s growth has slowed and the TOT has deteriorated in 2013.

Figure 1. Peru: Capital Flows, 4-quarter MA

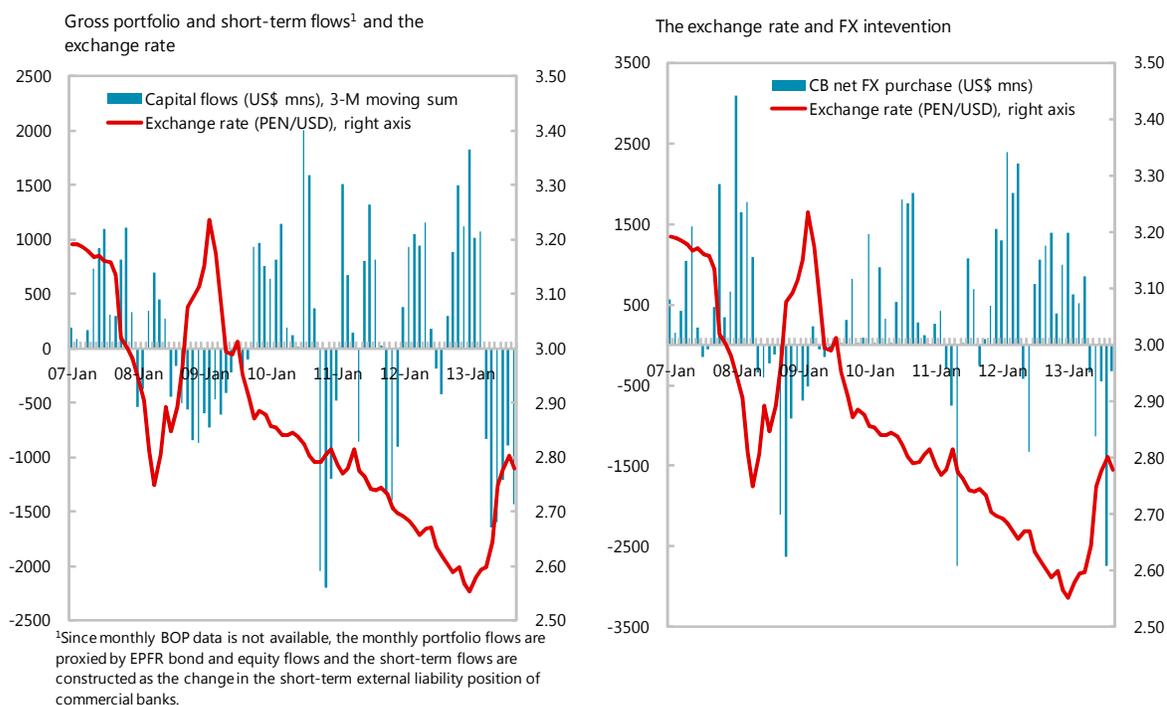


7. Although a large share of capital flows to Peru has been FDI, the volatility and recent growth of portfolio and short-term flows have raised concerns. Despite the authorities' efforts to encourage capital outflows to ease appreciation pressures (including by increasing the limits on external investment by pension fund managers), net portfolio inflows continued to increase as Peruvian firms' demand for external financing increased to take advantage of the low global interest rates. For instance, external bond issuance by Peruvian firms reached US\$6.4 billion (3 percent of GDP) in the first half of this year, eclipsing the US\$3 billion issuance for the whole year of 2012. In addition, the absence of a secondary market for corporate bonds and other securities increases the attractiveness of public bonds to non-residents. The share of non-residents' holding of public bonds more than doubled since 2010 to about 56 percent as of September 2013. The volatility of short-term flows tends to create disorderly conditions in the FX market, creating challenges for the central bank as it aims to contain exchange rate volatility.

8. Surges in non-FDI capital flows are often associated with boom-bust cycles. Empirical evidence shows that surges in capital flows are associated with excessive expansion of credits, asset price bubbles, real exchange rate appreciations, and current account deteriorations, which are likely to lead ultimately to financial and economic crisis (Reinhart and Reinhart, 2008; Cardarelli et al, 2010; Furceri et al 2012).

9. In response to anticipation of a possible overheating, the Peruvian authorities reacted with timely preventive measures. While avoiding capital control measures, the authorities relied on preventive measures, including accumulating international reserves, strengthening macro-prudential policies, and encouraging capital outflows to avoid the buildup of vulnerabilities associated with capital flows (see Box 1). Consequently, early signs of overheating (with credit growth of over 20 percent and significant appreciation of stock and housing prices in 2011) moderated towards the end of 2012 despite the continuation of capital flows.

Figure 2. Peru: Capital Flows, Exchange Rate, and Foreign Exchange Intervention

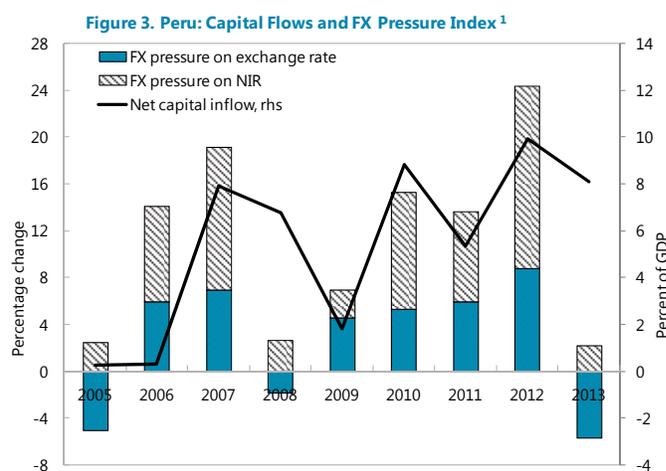


Source: BCRP, Haver Analytics, and Fund staff estimates.

10. More importantly, the authorities relied on FX intervention to safeguard the FX market and the financial system from the impact of high and volatile capital flows. Peru's FX market is an interbank market based primarily on spot transactions. The derivatives market is not well-developed and is limited to very small forwards and options transactions, compared to the size of the spot market. Trading in the spot market can be thin; consequently, modest changes in capital flows can generate volatilities in the FX market (see Figure 2), with potential impacts on balance sheets and the buildup of vulnerabilities in the financial system due to

relatively high financial dollarization.⁵ As a result, the BCRP tries to reduce exchange rate volatility by intervening in the FX market. Interventions are conducted mainly in the spot market and occasionally through making swaps and sales of dollar-indexed securities (equivalent to selling FX forward) (Rossini et al 2011 and 2013). By and large, FX interventions by the BCRP are not pre-announced.⁶ FX interventions during the recent episodes of capital inflows have led to reserve accumulation. Net international reserves (NIR) stood at about US\$66 billion (about 32 percent of GDP) as of November 2013. These interventions were mostly sterilized through issuance of BCRP securities, Treasury deposits and reserve requirements. BCRP securities denominated in local currency are sold to financial institutions and have a return of about 4 percent and a 4 percent fee is charged on transfers of the securities to non-financial entities to ensure that they do not attract further capital inflows from non-residents. The BCRP has also sold FX during times of depreciation pressures such as following the Lehman crisis, the euro zone crisis, and recently following the United States Federal Reserve Board's (USFR) announcement of unconventional monetary policy tapering. FX sales are also sterilized (local currency liquidity injected) mainly through swaps and repos.

11. FX intervention absorbs a significant amount of FX pressures. The estimated foreign exchange market pressure (EMP) index,⁷ broken down by the pressures on the exchange rate and that on the NIR, shows that FX intervention absorbs a significant share of the pressures from capital flows although the authorities continue to allow increasing exchange rate flexibility. While the increases in FX reserves during periods of high capital inflows can in principle be the result of a reserve buildup motive, recent FX interventions in Peru seem to have been motivated mainly to ease the pressure on the exchange rate. For instance, the NIR was already high at end-2011, and the 2012 FX interventions were most likely done to ease FX pressures.



⁵ Despite significant progress in reducing financial dollarization over the last decade, credit and deposit dollarization remain high at around 40 percent.

⁶ The exception is between September 2012 and April 2013, when BCRP purchased FX almost on a daily basis after announcing in August 2012 that it will purchase more stable amounts of FX purchases even during days of downward pressures, while keeping the amounts of intervention unannounced. The decision was taken due to concerns of predictable appreciating pressure on the *nuevo sole* and the strategy sought to generate higher exchange rate volatility. (BCRP, 2012; Rossini et al, 2013)

⁷ The index tries to measure exchange rate and reserve accumulation pressures (see Box 2 for the methodology used to construct the EMP index).

Box 1. Peru: Coping with Capital Flows

In addition to FX intervention, the Peruvian authorities have employed a number of prudential measures to prevent the buildup of financial and macroeconomic risks arising from capital flows. These include; (i) fine-tuning reserve requirements; (ii) requiring additional capital and liquidity against FX risks; (iii) limiting net open and derivative positions by pension fund managers and banks; and (iv) encouraging capital outflows.

Reserve requirements: The BCRP uses reserve requirements to control credit and indirectly as a countercyclical response to capital flows. During periods of high capital inflows, credit expands and the BCRP increases reserve requirements both on local currency and foreign currency liabilities to avoid excessive credit growth, discourage capital flows, and build buffers against potential capital flow reversals. These are reversed during periods of slowdown or reversal in capital inflows.

For instance, following the Lehman crisis which was associated with capital outflows, the legal minimum reserve requirement was reduced to 6 percent (from 9 percent), the marginal reserve requirement on foreign currency liabilities were reduced by 19 percentage points to 30 percent, reserve requirements applicable to non-resident deposits in local currency was reduced by 85 percentage points to 35 percent, and marginal reserve requirements on short-term external debt was abolished and a ceiling of 35 percent was established on the average reserve requirement.

These measures were reversed gradually following the recovery in global financial markets and the return of capital flows to emerging markets. For instance:

- The minimum reserve requirement was gradually raised to 9 percent by May 2012.
- The marginal reserve requirement on foreign currency liabilities was increased by 25 percentage points to 55 percent by October 2010.
- The average reserve requirement on foreign currency liabilities was hiked by 6.2 percentage points between September 2010 and April 2013.
- The marginal reserve requirement on short-term external debt was reintroduced in February 2010 and was further raised to 75 percent by October 2010.¹
- The reserve requirement on non-resident deposits in local currency was hiked back to 120 percent, essentially eliminating the incentives for holding these deposits.
- A special reserve requirement of 20 percent was established on previously exempt long-term debts and bonds exceeding 2.5 times the regulatory capital of financial institutions in May 2012. This was further raised to 25 percent in February 2013 if such liabilities exceed the prudential limit of 2.2 times effective equity.
- The marginal reserve requirement on local currency liabilities was hiked by 30 percentage points between July 2010 and May 2012 and had been maintained at 30 percent till June 2013. Similarly, the average reserve requirement was increased eight times, with a cumulative increase of 3.5 percentage points, between February 2011 and January 2013.

The BCRP is now unwinding some of these measures to alleviate liquidity constraints following the USFR announcement of tapering. The marginal reserve requirements on local and foreign currency liabilities have been reduced by 16 and 5 percentage points to 14 percent and 50 percent, respectively, between August 2013 and January 2014. Ceilings have also been established on average reserve requirements, at 14 percent on local currency liabilities and at 45 percent in foreign currency liabilities. Furthermore, the marginal reserve requirement on short-term external debt was reduced by 10 percentage points to 50 percent starting from August 2013.

Box 1. Peru: Coping with Capital Flows (Concluded)

Additional provisioning and liquidity requirements for FX risk: In July 2010, additional capital requirements (2.5 percent) for FX credit risk exposure were implemented. Banks are also required to hold liquid assets equivalent to at least 8 percent in domestic currency and 20 percent in foreign currency of all short-term liabilities, although this requirement has already been in place since the late 1990s.

Limits on net open and derivative positions: The Superintendency of Banks and insurance companies (SBS) limited the amounts of daily and weekly FX operations by pension funds and long-position in derivatives for banks.

- *Limits on pension funds' FX trading.* Effective in June 2010, the SBS imposed limits on private pension funds' FX trading at 0.85 percent of assets under management for daily transactions and 1.95 percent of assets under management for weekly transactions.
- *Limits on banks' net FX positions.* In February 2010, the limit on banks' long net FX position was reduced to 75 percent of net equity from 100 percent and that on their short net FX positions was raised to 15 percent of net equity from 10 percent. The long net FX position was further reduced to 60 percent in January 2011 and to 50 percent in December 2012. Similarly, the limit on short net FX position was reduced to 10 percent in December 2012.
- *Limits on FX derivatives.* In January 2011, the SBS imposed a limit on the absolute value of the net position in financial products derived from foreign currency of either 30 percent of assets or S/. 400 million (US\$ 144 million), whichever is higher. This was reduced to 20 percent of effective equity or S/. 300 million, whichever is higher, in December 2012.

Encouraging capital outflows: The foreign investment limits of pension management funds (AFPs) were gradually lifted to 36 percent in May 2013, from 20 percent in October 2009 to encourage capital outflows. Consequently, the AFP's external investment almost tripled to US\$13 billion (36 percent of total portfolio) in May 2013, from US\$4.5 billion (20 percent of total portfolio) in October 2009.

¹This was reduced to 60 percent in February 2011, but the definition for short-term external debt was revised to 3 years or less (from 2 years or less) since May 2012.

12. While the BCRP intervenes in the FX market with a stated objective of containing volatility, statistical evidence suggests that volatility may not be the only objective. The BCRP's intervention before May 2013 had been concentrated on FX purchases and that since July 2013 has been on FX sales, indicating that FX interventions might be aimed at more than just containing volatility. In other words, the pattern of the BCRP's intervention may indicate attempts to lean against the wind or to limit the rate of appreciations/depreciations. Empirical studies have also found evidence that the deviation of the exchange rate from its trend induces FX intervention in Peru (see Gonzalez, 2009; Humala and Rodriguez, 2009). Furthermore, despite the generally stated objective of containing FX volatility, the BCRP's intervention during September 2012–April 2013 appears to have targeted at increasing volatility.

13. The purpose of this paper is to empirically investigate the motives and effectiveness of FX interventions in Peru. To achieve these goals, the paper proceeds in two steps. First, the BCRP's reaction functions are estimated separately for FX purchases and sales to shed light on the motives of interventions, which may vary between episodes of appreciations and episodes of depreciations. Second, the determinants of the likelihoods of interventions, identified in the first step, are used as instrumental variables for FX interventions (to overcome

potential simultaneity biases) in the exchange rate equations to assess the effectiveness of interventions. The subsequent section discusses the methodology for conducting these exercises.

Box 2. Constructing an FX Pressure Index

The foreign exchange market pressure (EMP) index is calculated as the sum of the percentage change in the exchange rate and the percentage change in reserves, following the empirical literature (Aizenman and Hutchison, 2012; Cardarelli et al, 2010).¹ The exchange rate is defined, for this purpose, in terms of U.S. dollars per *nuevos soles* so that the pressure on the exchange rate has the same sign as the pressure on FX reserves. For instance, depreciation (a negative change in the exchange rate) will have the same sign as a reserve loss. Following Cardarelli et al (2010), the components of the FX pressure index are scaled by their respective standard deviations to equalize the volatilities of each component and ensure that neither of them dominates the index. The index is calculated as follows:

First, month-to-month percentage changes are calculated for each of the series.

Second, annual end-period percentage changes of the series are obtained by adding monthly percentage changes.

Third, annual end-period percentage changes are scaled by the standard deviations of the respective series' monthly percentage changes.

The resulting FX pressure index, split between the pressure on the exchange rate and that on FX reserves is shown in Figure 3.

¹Studies, which focus on the monetary effect of reserve loss, express the change in FX reserves in percent of the monetary base (Bertoli et al 2010; Cardarelli et al, 2010).

C. Methodology

Literature Review

14. The theoretical literature identifies portfolio balance and signaling as the main channels through which a sterilized intervention can affect the level of the exchange rate.⁸

According to the portfolio balance approach, sterilized intervention alters the composition of agents' portfolios, as central banks buy/sell domestic assets in their sterilization effort, and thereby the relative prices of domestic and foreign currency denominated assets, assuming that these assets are imperfect substitutes in investors' portfolios (Dominguez and Frankel, 1993; Sarno and Taylor, 2001). Alternatively, foreign exchange intervention could work through the signaling channel if central bank interventions are perceived by private agents as a signal for future policy stance or as a means of disseminating private information about exchange rate fundamentals, assuming that the central bank has superior information (Dominguez and Frankel, 1993; Sarno and Taylor, 2001; Kearns and Rigobon, 2005).

⁸ Dominguez (2003 & 2006) also shows how intervention can affect the intra-daily exchange rate returns through a third channel, the microstructure channel. This approach shows how heterogeneity among traders, based on their differences in understanding and interpreting information revealed through central bank information, can affect the short-run value and volatility of the exchange rate.

15. Efforts to empirically test the impact of foreign exchange interventions on the exchange rate are often hampered by potential simultaneity biases. While intervention could affect the exchange rate, the decision to intervene is not independent of movements in the exchange rate (Dominguez and Frankel, 1993; Galati et al, 2005; Kearns and Rigobon, 2005; Disyatat and Galati, 2007). Even after the central bank has decided to intervene, the timing and amount of the intervention depends on the reaction of the exchange rate to the initial intervention (Kearns and Rigobon, 2005; Disyatat and Galati, 2007).

16. A common solution to the simultaneity problem is the use of lagged intervention variable (see, for instance, Dominguez and Frankel, 1993; Baillie and Osterberg, 1997; Guimaraes and Karacadag, 2004; Broto, 2012). But this method may underestimate the true impact of interventions, as part of the impact may be reflected through lagged values of the dependent variables, which are often included among the explanatory variables (Galati et al, 2005). Furthermore, central banks often intervene with the aim of influencing not only future movements but also contemporaneous movements of the exchange rate.

17. Another approach employed in recent empirical studies is event study style regressions. This method attempts to address the simultaneity problem by precisely identifying the time of intervention and relating it to the exchange rate returns using a very high frequency intra-daily data (see, for instance, Dominguez, 2003 and 2006).⁹ But as Dominguez (2003) points out, this method may not resolve the simultaneity problem if central banks base their intervention decisions on intra-daily exchange rate movements or volatility. That said, there is evidence that central banks are more likely to base their intervention decisions on longer-term objectives, although the size of the interventions may be determined by market reactions to the initial interventions (Neely, 2001).¹⁰ But this method demands very high frequency (minute-by-minute) data on exchange rates and interventions, which is not publicly available for Peru.

18. A third approach to addressing the simultaneity bias is using an Instrumental Variable (IV) method. The method involves estimating a central bank's reaction function and using predicted values of intervention from the estimated reaction function as an instrument for intervention in the exchange rate equation (see, for instance, Galati et al, 2005; Kearns and Rigobon, 2005; Disyatat and Galati, 2007; Adler and Tovar, 2011). The common practice is to use lagged values of the exchange rate in an ordinary least squares (OLS) estimation of the central bank's reaction function. The exclusion of the contemporaneous values of the exchange rate

⁹ Dominguez (2003 and 2006) runs regressions of 5-minute exchange rate returns (mean and volatility) on (time-stamped to the nearest 5-minute) signed intervention and other announcement dummy variables.

¹⁰ Two-thirds of 22 central banks surveyed by Neely (2001) indicate that they intervene in the FX market to align the exchange rate to "fundamental values," and about 90 percent of them indicate that the purpose of their intervention is to resist short-run trends. But 95 percent of the respondents report that market reactions to their initial intervention sometimes or always affects the size of the intervention.

could, however, create an omitted variable bias, although the bias could be trivial since there is no empirical evidence of persistence in exchange rate moments¹¹ (Galati et al, 2005).

Method of the Study

General

19. This paper employs an IV estimation method to assess the effectiveness of FX intervention in Peru. However, unlike the common practice of using lagged exchange rates in the reaction functions, the paper uses the same-day exchange rates, taking advantage of intra-daily exchange rate data availability and the approximate timing of FX interventions. The FX market in Peru operates between 9:00AM and 1:30PM local time and decisions on FX interventions are made every day by a committee that meets between 11:30AM and 1:00PM (Laura and Vega, 2013), indicating that interventions are conducted after 11:30AM. On the other hand, intra-daily exchange rate data is publicly available for 3 specific points in time: market opening (around 9:00AM), 11:00AM, and market closing (1:30PM). The paper uses exchange rate movements during the AM session to estimate the BCRP's reaction function. Predicted values of the likelihoods of FX interventions from the BCRP's reaction function are then used as instruments for FX interventions in the regressions for changes in the exchange rate (both the level and volatility) between the PM and AM sessions. The assumption is that the BCRP makes intervention decisions after observing the behavior of the exchange rate during the morning trading session. This method minimizes the possibility of omitted variable bias in the second stage of the regressions. Furthermore, interventions are used in the form of dummy variables since the daily dollar amounts of interventions may depend on market reactions to the initial intervention and hence may create a simultaneity bias. The model also assumes that intervention decisions by the central bank are completely unanticipated by the market, otherwise expectations for intervention could affect the behavior of the exchange in the morning trading session and create simultaneity bias. This assumption is consistent with the BCRP's discretionary intervention strategy except during September 2012–April 2013.

Estimating the Central Bank's Reaction Function

20. The BCRP is assumed to intervene when the behavior of the exchange rate during the morning trading session deviates from its target range.¹² In particular, the BCRP is assumed to intervene to the FX market when the level and volatility of the exchange rate deviate from respective implicit target ranges following the standard literature (for example, Sarno and

¹¹ Consequently the correlation between the included lagged moments and the omitted contemporaneous moments is likely to be negligible.

¹² International reserve accumulation could be another potential motive for FX purchases, but this is not included in our model since the central bank is less likely to have a daily target for international reserves. Furthermore, since international reserves were already high in Peru, it is less likely to be a principal motive for FX intervention during the sample period of this study, in particular in 2012 and 2013.

Taylor, 2001; Galati et al, 2005; and Disyatat and Galati, 2007). The likelihood of the central bank's intervention depends on the extent of the deviations. This can be represented mathematically as:

$$(1) \quad INT_t = \alpha_0 + \alpha_1(s_t - s_t^*) + \alpha_2(\sigma_{s_t} - \sigma_{s_t}^*) + \varepsilon_t$$

where INT is the dummy for intervention (1 when the BCRP intervenes, 0 otherwise), s_t and s_t^* are logs of the actual and target levels of the PEN/USD exchange rate, σ_{s_t} and $\sigma_{s_t}^*$ are the actual and target volatility of the exchange rate, ε_t is the random error term, and t is the time index. Each period, the BCRP is assumed to set its target ranges for the level and volatility of the exchange rate based on historical averages. The main results of the paper are obtained based on exchange rate level and volatility targets estimated by one-year simple moving average, but the exercise is replicated with 6-months simple moving average and one-year rolling Hodrick-Prescott filtered average targets (for the level of exchange rate only) to test if the results are robust to changes in the time length and method of averages.

21. Equation (1) is estimated using a probit model for FX purchases and FX sales separately to capture the potential asymmetry in the BCRP's reactions to episodes of appreciations and depreciations.¹³ For FX sales, INT is a dummy variable with 1 on days when there were FX sales and 0 otherwise. Similarly, for the equation with FX purchases, INT equals 1 on days when there were FX purchases and 0 otherwise. There is empirical evidence on asymmetry of central bank intervention in the FX market (Ramachandran and Srinivasan, 2007; Pontines and Raja, 2011; Lahura and Vegas, 2013). For instance, volatility is likely to be a main concern and a reason for intervention during episodes of depreciations than episodes of appreciations, as the former are often associated with anxiety and stresses in the financial market. On the other hand, motives for intervention during episodes of appreciation are likely to be reserve accumulation and leaning against the wind to prevent real exchange rate appreciations and current account deficit deteriorations.

22. The intervention rules are defined as follows:

- **The BCRP intervenes to prevent excessive appreciations and depreciations.** The BCRP's tolerable range is assumed to be the target exchange rate, estimated by historical average, plus or minus one standard deviation. The BCRP intervenes to prevent excessive appreciations if the exchange rate during the morning (AM) trading session¹⁴ falls below the

¹³ A single equation for intervention, defined as a multinomial dummy of '1' for FX purchases, '0' for no - intervention and '-1' for FX sales, is also estimated using a multinomial logistic regression as a robustness exercise for the test of asymmetry in the central bank's reaction to episodes of appreciation and depreciation (results are discussed in section D).

¹⁴ Due to lack of higher frequency data, the morning (AM) session exchange rate is calculated as the average of the opening (9:00AM) and the 11:00AM exchange rates.

lower bound of its tolerable range (historical average minus one standard deviation) and intervenes to avoid excessive depreciations if the exchange rate during the morning trading session exceeds the upper bound of its tolerable range (historical average plus one standard deviation).¹⁵

Consequently, the exchange rate gap (deviation) is derived as follows:

$$(s_t - s_t^*) = \begin{cases} (s_t - s_t^{*u}) & \text{if the exchange rate rises above the upper bound} \\ (s_t^{*l} - s_t) & \text{if the exchange rate falls below the lower bound} \end{cases}$$

α_1 is expected to be positive in both cases since the likelihood of intervention increases with increasing exchange rate gap.

- **The BCRP intervenes to contain excessive volatility.** Intervention takes place if the volatility of the AM trading session (as measured by the square root of the squared deviation of the AM session exchange rate from the weekly average exchange rate) exceeds the historical average weekly standard deviation. A higher volatility gap is expected to increase the likelihood of intervention.

Estimating the Impacts of FX Interventions

23. Predicted values of interventions, the estimated likelihoods of intervention, from the above regressions are used as instrumental variables in the exchange rate equations. In the second stage, regression equations for the level and volatility of the exchange rate are specified. Both estimated likelihoods of FX purchase and FX sale enter the equations for the level and volatility of the exchange rate in addition to control variables (other potential factors which could affect the daily variability of the exchange rate). The dependent variables are defined as the differences between the PM session levels¹⁶ and the corresponding AM session levels.

$$(2) \quad \Delta er_{pm}_t = \beta_0 + \beta_1 \widehat{INT_pur}_t + \beta_2 \widehat{INT_sale}_t + \beta_3 Control_t + \epsilon_t$$

$$(3) \quad \Delta vol_{pm}_t = \gamma_0 + \gamma_1 \widehat{INT_pur}_t + \gamma_2 \widehat{INT_sale}_t + \gamma_3 Control_t + \mu_t$$

where Δer_{pm}_t is the difference between the closing exchange rate and the exchange rate at 11:00AM, and Δvol_{pm}_t is the difference between the PM session volatility and the AM session volatility. $\widehat{INT_pur}_t$ is the predicted likelihood of FX purchase, $\widehat{INT_sale}_t$ is the predicted likelihood of FX sale, and $Control$ is the other control variables as defined below.

¹⁵ In a similar setup, Galati et al (2005) uses the historical average ± 1.5 standard deviation as target bounds for the yen/dollar exchange rate. Given the low variability of the PEN/USD rate, this study tightens the target bound to ± 1 standard deviation, although the model is re-estimated using ' ± 1.5 *standard deviation' target bound to see if the results are sensitive to the width of the target bound.

¹⁶ Due to data limitations, the 1:30PM (closing) exchange rate is used as the PM session exchange rate.

24. The likelihoods of FX purchases and FX sales enter the regression equations separately to test for potential asymmetric responses to FX sales and purchases.

Asymmetric responses may result if FX purchases and FX sales signal different information to the market (Lahura and Vega, 2013). For instance, FX purchases during episodes of appreciation may be perceived as an effort by the central bank to build international reserves. Such accumulation of international reserves may in turn attract more capital inflows, due to improved self-insurance against external shocks, and weaken the effectiveness of the FX intervention. On the other hand, FX sales by the central bank during episodes of depreciation can be effective as the intervention may be perceived by the market as a signal that the central bank is attempting to correct misalignments in the exchange rate. In this regard, evidence for asymmetric effects of FX interventions has been found by Lahura and Vega (2013) for Peru and Broto (2013) for Brazil, Chile, Colombia, and Peru.

25. In addition to the likelihood of central bank intervention, other control variables are included in equations (2) and (3). The aim is to include other factors that could explain the variability of the exchange rate between the afternoon and morning sessions. Similar empirical studies on intra-daily exchange rate variations include the unexpected components of major economic data announcements (surprises), measured by the differences between the officially announced data and the corresponding average analyst estimates just before the announcement (see for instance Dominguez, 2003 and 2006; Galati et al, 2005; Disyatat and Galati, 2007). However, the announcements of major economic news in Peru and the US (economic growth, CPI, unemployment, and the policy rate), with the exception of GDP growth in Peru, are made either early in the morning or after the FX market closes and are not expected to have differential impacts on the morning and afternoon exchange rate variability. The Peruvian authorities announce monthly economic growth data sometime around noon and, as a result, the difference between the announced GDP growth rate and the average estimates before the announcement (in absolute value terms for the volatility equation) are included to equations (2) and (3). In addition, indicators for regional and global factors are included. The change in the Chicago Board of Exchange Market Volatility Index (VIX) between the opening and closing quotes is included in the volatility regression to capture the impact of global market volatility, which is expected to be positive¹⁷. On the other hand, the daily change (between market opening and closing) in the common factor (principal component) of LA6¹⁸ exchange rates is included in the exchange rate equation to capture the impact of regional factors, such as the impact of commodity prices, which is also expected to be positive.

¹⁷ Ideally, the changes in VIX should have been between the 1:30PM and 11:00AM quotes to match the changes in the dependent variables. But minute-by-minute historical quotes are not available for the period of coverage of this study.

¹⁸ Brazil, Chile, Colombia, Mexico, Peru and Uruguay.

D. Data and Estimation Results

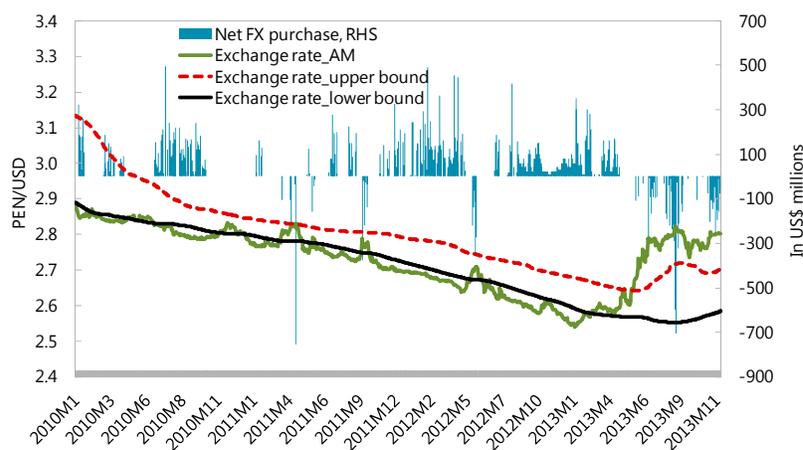
Descriptive Analysis

26. Data sources. Data on average daily 11:00AM and 1:30PM exchange rates and daily FX interventions are obtained from the online statistical database of the BCRP. Data for the opening session exchange rate for Peru, exchange rates for other LA6 economies, and analysts' consensus estimates of GDP are from Bloomberg. Finally, VIX data is obtained from Chicago of Board Options Exchange (CBOE) online database. The sample covers daily data for January 2010–November 2013, a total sample of 962 observations.¹⁹

27. Descriptive analysis of the exchange rate and intervention data suggests that intervention decisions are prompted mainly by the deviations of the level of the exchange rate from the target range. In particular, FX purchases are strongly associated with the

deviation of the level of the exchange rate from the lower bound of the BCRP's tolerable range. But FX sales are conducted during exchange rate depreciations even when the level of exchange rate falls within the target range, possibly due to volatility concerns. In general volatility is high during periods of depreciations as shown by the widening of the target range in recent months.

Figure 4. Peru: Exchange rates and FX intervention



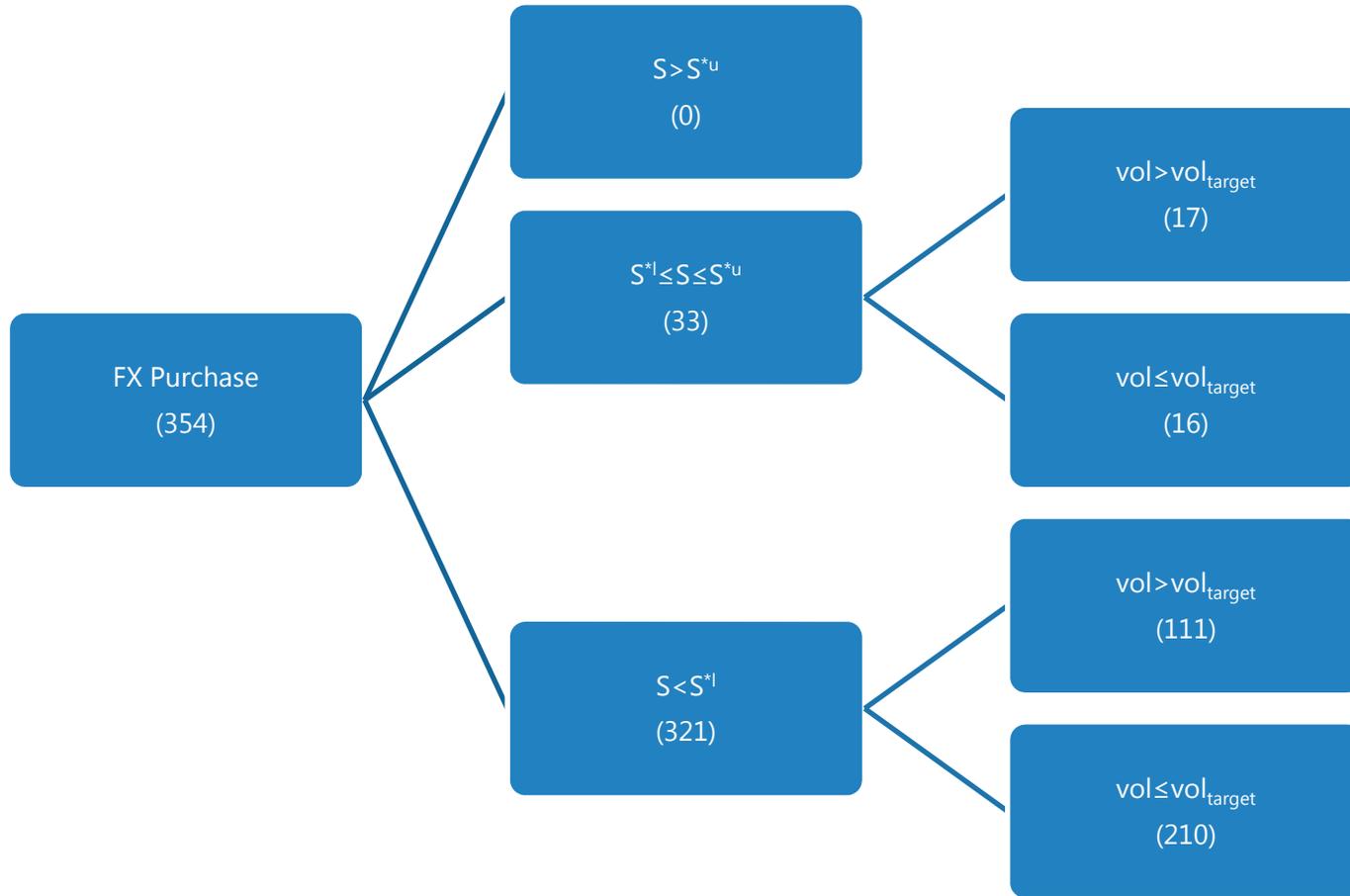
Sources: BCRP and Fund staff estimates.

28. FX purchases seem to be driven primarily by the deviation of the exchange rate from the BCRP's tolerable range (leaning against the wind). About 91 percent of the FX purchases were conducted during days when the level of the morning session exchange rate fell below the lower bound of the tolerable range.²⁰ Less than 5 percent of the FX purchases were conducted during days when only exchange rate volatility deviated from the target, while the level of the exchange rate remained within target (Figure 5).

¹⁹ Of the 962 observations, BCRP purchased FX in 354 days (37¾ percent of total observations), sold FX in 74 days (7¾ percent of total observations), and did not intervene in 534 days (55½ percent of total observations).

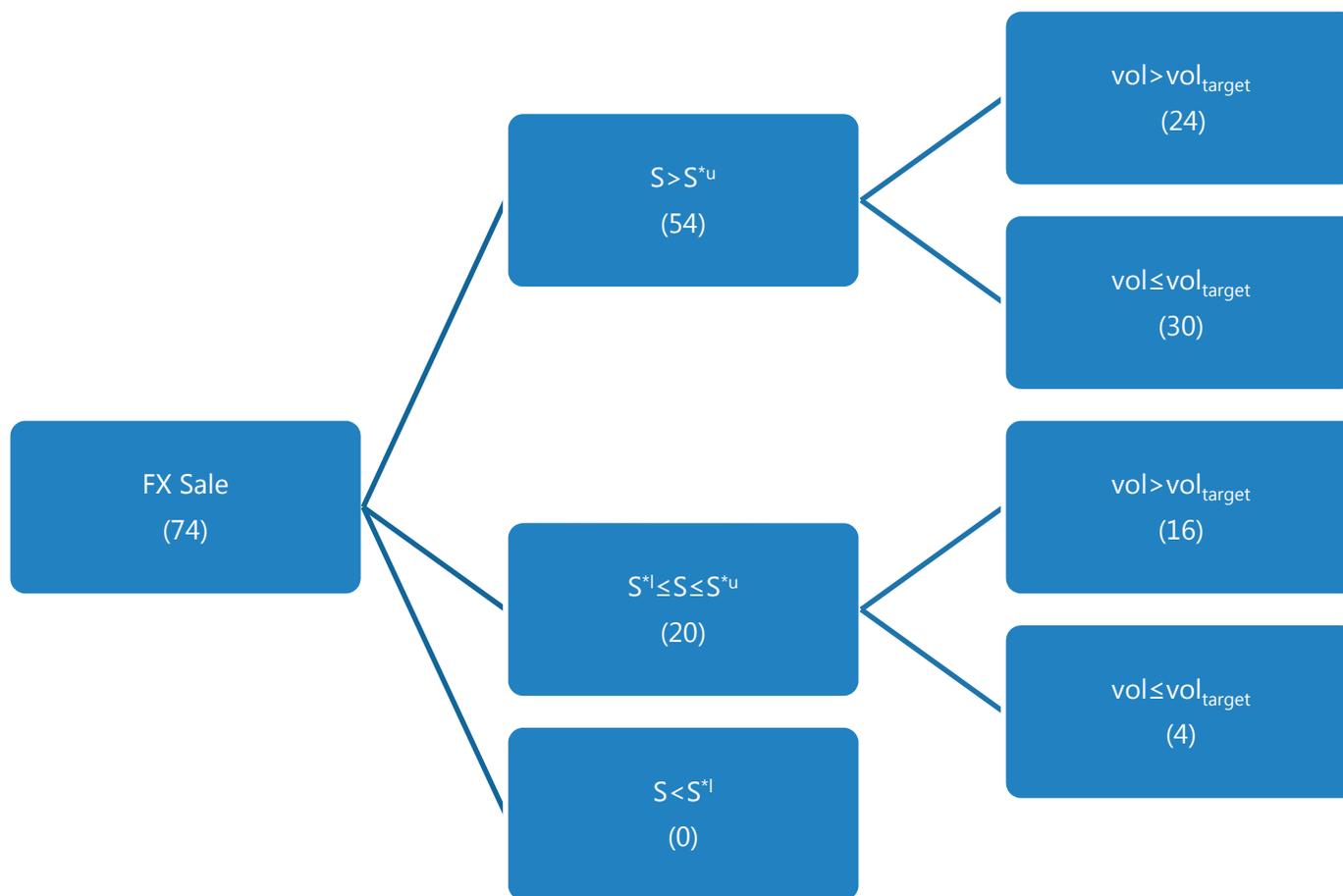
²⁰ It refers to purchase days, not the number of purchase events. The BCRP could intervene several times during the day, but intervention data is available only on a daily basis.

Figure 5. Characterization FX Purchases by BCRP: January 2010–November 2013.



Note: Numbers in parenthesis indicate the number of intervention days during the sample. S^l and S^u represent the lower and upper bounds, respectively, of the BCRP's tolerable range for the level of the exchange rate.

Figure 6. Characterization FX Sales by BCRP: January 2010–November 2013.



Note: Numbers in parenthesis indicate the number of intervention days during the sample. S^l and S^u represent the lower and upper bounds, respectively, of the BCRP's tolerable range for the level of the exchange rate.

29. However, leaning against the wind does not seem to be the only target of FX sales.

Compared to FX purchase days, a lower proportion (72 percent) of the FX sales was conducted during days when the morning session exchange rate deviated from the upper bound of the BCRP's tolerable range. On the other hand, relatively large share of the FX sales (about 22 percent) were conducted during days when the exchange rate volatility deviated from the target while the level remained within the BCRP's tolerable range (Figure 6).

Estimation results

The BCRP's reaction functions

30. The BCRP's reaction functions are estimated by probit regressions. The estimated regressions seem to explain intervention decisions very well. The likelihood ratio (LR) statistics and the Pseudo R² values are large, indicating strong goodness of fit. Two-day lags of the dependent variables are found to be statistically significant indicating the tendency of intervention clustering (Table 1).

31. The results provide strong evidence that the BCRP intervenes to prevent excessive appreciations and depreciations (deviations from the tolerable range). Deviations of the level of exchange rate from the lower and upper bounds of the BCRP's tolerable range are positively and significantly associated with FX purchases and FX sales, respectively indicating that such deviations prompt FX interventions (Table 1). But the BCRP's reaction to volatility appears to be asymmetric. While the deviation of the exchange rate volatility from the BCRP's target is positively and significantly associated with FX sales, its correlation with FX purchases is negative but not statistically significant. This indicates that excessive exchange rate volatility seems to be more of a concern for the BCRP during episodes of depreciations. In addition to the baseline regression (1), a second regression (2) was fit to the FX purchase with the addition of intervention policy change dummy interacted with excessive appreciations and volatility to test if the BCRP changed its reactions following its preannouncement of interventions in August 2012.¹ The results do not change in a significant way. The BCRP's reaction to excessive appreciations remains significant and its reaction to excessive volatility remains negative and becomes weakly significant after controlling for the impact of the policy change, suggesting that the BCRP might have reacted to low volatility during episodes of appreciations.

32. The results of the BCRP's estimated reaction function are robust to changes in estimation methodology. The above results were obtained based on separate regressions for FX purchase and FX sales. But the main results remain unchanged when a single equation reaction

¹ The dummy takes '1' during September 2012- April 2013, the appreciation episode when the central bank's new intervention strategy was applied, and 0 otherwise.

function is estimated using a multinomial logistic regression (Annex I)². In particular, the odds of FX purchases are affected only by excessive appreciations, but the odds of FX sales are affected both by excessive depreciations and volatility.

Table 1. Peru: Probit Regression Results for the Probability of FX Intervention 1/

Independent variable	(1)	(2)
<i>Dependent variable= FX purchase</i>		
FX purchase_1 st lag	1.613 (11.60) ^{***}	1.511 (10.73) ^{***}
FX purchase_2 nd lag	0.525 (3.76) ^{***}	0.398 (2.79) ^{***}
Excessive appreciation	31.437 (6.64) ^{***}	29.139 (5.79) ^{***}
Excessive volatility	-0.110 (-1.11)	-0.215 (-1.90) [*]
Excessive appreciation*dummy for intervention policy change	...	306.325 (2.44) ^{**}
Excessive volatility*dummy for intervention policy change	...	-0.695 (-1.17)
Constant	-1.766 (-16.93) ^{***}	-1.710 (-16.10) ^{***}
<i>Model statistics</i>		
No. of observations	960	960
LR- χ^2 (4)	632.4 ^{***}	663.0 ^{***}
Pseudo R ²	0.50	0.52
<i>Dependent variable= FX sale</i>		
FX sale(-1)	1.143 (5.42) ^{***}	...
FX sale(-2)	0.711 (3.24) ^{**}	...
Excessive depreciation	12.823 (6.36) ^{***}	...
Volatility	0.304 (3.72) ^{***}	...
Constant	-2.280 (-18.81) ^{***}	...
<i>Model statistics</i>		
No. of observations	960	...
F-stat.	249.5 ^{***}	...
Adj. R ²	0.49	...

1/ Purchase and sale of FX are represented by dummy variables with values of 1 when there was purchase (sale) and 0 otherwise.

Equations (1) and (2) are without and with intervention policy change dummy interaction, respectively.

Numbers in parentheses are z-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

² The dependent variable is a dummy that takes '1' for FX purchase, '-1' for FX sales, and '0' for no-intervention. Multinomial logistic regression was used because no convergence was achieved using multinomial probit regression.

Impacts of FX interventions

33. IV estimates for the level and volatility of the exchange rate give support to asymmetric effects of FX intervention on exchange rate variability. (Table 2) Three regressions are estimated each for the change in the level and volatility of the exchange rate. Regression (1) includes only FX intervention variables (likelihoods of FX purchases and FX sales)³, whereas regression (2) includes other control variables. Regression (3) includes interaction of dummy for intervention policy change with the likelihood of FX purchase. According to the results, there is no strong statistical evidence to suggest that FX purchase by the BCRP is successful in raising the level of the exchange rate as the likelihood of FX purchases is either statistically insignificant (regression (1)) or only weakly significant (regressions (2) and (3)). But the likelihood of FX purchase has a statistically significant and negative impact on volatility, indicating that FX purchase by the BCRP reduces volatility. In other words, although the BCRP's objective for intervention during episodes of appreciation is to lean against the wind, it ends up reducing volatility without achieving its primary goal. On the other hand, FX sales appear to be successful not only in reducing volatility, but also in reducing the level of the exchange rate although some of the impacts appear to be reversing the following day. These results are consistent with findings of Lahura and Vega (2013)⁴ that FX sales are more successful in preventing depreciation than FX purchases in preventing appreciation. With the exception of the first lag of FX sales, lags of FX intervention are found to be statistically insignificant indicating that the impacts of interventions are short lived.

34. Unfortunately, the overall fit of the estimated models is not good, as is the case with similar empirical studies on exchange rates. The variables included in this study explain very little about the exchange rate variability. This is in part due to the fact that not all potential determinants are included due to limitations on daily data, but it also reflects the difficulty of explaining exchange rate variability. Among the control variables, only the common factor (principal component) of the exchange rates of LA6 economies became statistically significant, reflecting the importance of regional common factors such as the impact of commodity prices.

Robustness of the results

35. The results are robust to changes in the definition of the target and tolerable range of the exchange rate. The above regressions were re-estimated for the target exchange rate defined as a 6-month moving average and a 1-year Hodrick-Prescott (HP) rolling filtered average and for the tolerable range defined as a 1-year historical average ± 1.5 times the standard deviation. The results both for the BCRP's reaction function and the exchange rate regressions, presented in Annexes II-IV, show that the conclusions drawn above are robust to changes in the definition of the target and tolerable range of the exchange rate. The only exception is that volatility became statistically

³ Statistically significant variables in regressions (1) and (2) of Table 1 are used as instruments for likelihood of FX sales and purchases, respectively..

⁴ The authors employ event study regressions and structural VARs.

significant in the FX purchase equation when the BCRP's tolerable range is broadened to a 1-year historical average ± 1.5 standard deviation, in particular in the second regression when dummy for intervention policy change is added. But the coefficient remains negative, still supporting the hypothesis of asymmetric BCRP reaction.

Table 2. Peru: Estimated Impacts of FX Intervention on the Level and Volatility of the Exchange Rate 1/

Explanatory variables	Change in the level of the exchange rate			Change in volatility of the exchange rate		
	(1)	(2)	(3)	(1)	(2)	(3)
Likelihood of FX purchase	0.020 (1.62)	0.021 (1.68)*	0.029 (1.91)*	-0.069 (-2.12)**	-0.074 (-2.25)**	-0.124 (-3.03)***
Likelihood of FX sale	-0.143 (-2.80)***	-0.140 (-2.78)***	-0.139 (-2.75)***	-0.132 (-1.96)**	-0.143 (-2.10)**	-0.151 (-2.22)**
Likelihood of FX sale_1 st lag	0.126 (2.46)**	0.124 (2.45)**	0.124 (2.46)**	...	...	...
Change in ER_LA 2/	...	0.013 (4.39)***	0.013 (4.38)***	...	...	...
GDP surprise 3/	...	-0.007 (-0.30)	-0.007 (-0.32)	...	-0.004 (-0.07)	-0.003 (-0.06)
Absolute value of change in VIX	...	...	...	...	-0.012 (-1.06)	-0.011 (-1.00)
Likelihood of FX purchase interacted with dummy for intervention policy change	...	...	-0.016 (-0.95)	...	...	0.092 (2.04)**
Constant	-0.004 (-0.61)	-0.004 (-0.64)	-0.006 (-0.80)	0.110 (6.02)***	0.123 (5.60)***	0.130 (5.83)***
<i>Model statistics</i>						
No. of obs.	959	959	959	960	960	960
F-stat.	3.93***	6.31***	5.41***	3.16**	1.86*	2.32**
Adj. R ²	0.009	0.027	0.027	0.005	0.004	0.007

1/ Estimated using IV (2SLS) method. Statistically significant variables in regressions (1) and (2) of Table 1 are used as instruments for likelihood of FX sales and purchases, respectively.

2/ Change in the principal component of exchange rates in LA6 (Brazil, Chile, Colombia, Mexico, Peru and Uruguay) economies.

3/ The difference between actual real GDP growth and consensus estimates prior to data release. Entered in absolute value in the volatility equations.

Equation (1) is baseline regression, equation (2) includes control variables, and equation (3) includes interaction of FX purchases with dummy for intervention policy change on top of control variables.

Numbers in parentheses are t-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

E. Concluding Remarks

36. This study finds empirical evidence for asymmetric BCRP reactions to appreciation and depreciation pressures. While FX purchases are driven mainly by the deviation of the exchange from the lower bound of the tolerable range, FX sales respond to exchange rate volatility, in addition to the deviation of the exchange rate from the upper bound of the tolerable range. This implies that exchange rate volatility may be more of a concern for the BCRP during depreciation pressures than during appreciation pressures. In all regressions, excessive volatility is negative associated with the likelihood of FX purchases by the BCRP and in some of the regressions it becomes statistically significant, albeit weakly, indicating that the BCRP might have intervened against very low volatility

during appreciation episodes. This latter result is consistent with the BCRP's public statements in 2012 that it was concerned by the low volatility and persistent appreciation of the nuevo sol and its decision to preannounce FX purchases of stable amounts even during days of depreciations.

37. While FX sales seem to be effective in preventing depreciation, there is no sufficient statistical evidence to support the success of FX purchases. The results show that FX sales by the BCRP are effective in reducing the level and volatility of the exchange rate. However, FX purchases do not have statistically significant impacts on the level of the exchange rate, while having unintended statistically significant negative impact on exchange rate volatility. The results also show that the BCRP's preannouncement of its interventions in August 2012 did not change the effectiveness of the intervention.

38. Since interventions can be costly, the BCRP needs to target its interventions where they are most effective⁵. In this regard, the results of this study imply that:

- **FX sales by the central bank** can be warranted during periods of depreciation pressures if there are concerns of excessive volatility and depreciation. The statistical evidence in this study shows that FX sales are effective in reducing the excessive volatility and depreciation of the nuevo sol. But since these effects are found to be short-lived, interventions should not aim at preventing the depreciating trend of the exchange rate, which ought to be driven by fundamentals in any case.
- **FX purchases by the central bank** during periods of appreciation pressures are warranted mostly if volatility is a concern.⁶ If reducing volatility is not the objective, as the results of this study indicate, FX purchases could perpetuate the appreciation by reducing volatility and encouraging a one-sided bet on the domestic currency.

⁵The cost of sterilization in 2012 estimated at about ½ percent of GDP.

⁶ Building international reserves can also be a reason for intervention during episodes of appreciations although this is less likely to be the case in Peru recently.

Annex I. Single Equation Regression of the Central Bank's Reaction Function

Peru: Multinomial Logistic Regression of FX Intervention 1/

Independent variable	(1)		(2)	
	FX sale	FX purchase	FX sale	FX purchase
FX purchase_1 st lag	-1.632 (-4.52) ^{***}	2.636 (11.04) ^{***}	-1.630 (-4.52) ^{***}	2.439 (10.15) ^{***}
FX purchase_2 nd lag	-0.856 (-2.32) ^{**}	0.853 (3.57) ^{***}	-0.854 (-2.32) ^{**}	0.634 (2.63) ^{***}
Deviation from target (appreciation)	-74155 (-0.01)	45.131 (5.12) ^{***}	-78743 (-0.01)	38.431 (4.10) ^{***}
Deviation from target (depreciation)	14.077 (3.78) ^{***}	-10014 (-0.00)	14.000 (3.75) ^{***}	-10443 (-0.00)
Volatility	0.324 (2.01) ^{**}	-0.130 (-0.68)	0.323 (2.01) ^{**}	-0.300 (-1.39)
Deviation from target (appreciation)*dummy for intervention policy change	...	...	60712 (0.00)	519.681 (2.39) ^{**}
Volatility*dummy for intervention policy change	...	...	-1.828 (-0.42)	-1.453 (-1.39)
Constant	-2.747 (-9.08) ^{***}	-2.668 (-12.63) ^{***}	-2.736 (-9.04) ^{***}	-2.517 (-11.78) ^{***}
<i>Model statistics</i>				
No. of observations	960		960	
LR- χ^2 (10)	851.7 ^{***}		883.8 ^{***}	
Pseudo R ²	0.50		0.52	

1/ The dependent variable is a dummy taking values of 1 for FX purchase, -1 for FX sale, and 0 otherwise. The base outcome is no-intervention.

Equations (1) and (2) are without and with, respectively, intervention policy change dummy interaction.

Numbers in parentheses are z-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

Annex II. The Exchange Rate Target Estimated By Six Months Moving Average Exchange Rate

Table IIa. Peru: Probit Regression Results for the Probability of FX Intervention 1/

Independent variable	(1)	(2)
<i>Dependent variable= FX purchase</i>		
FX purchase_1 st lag	1.629 (11.70) ^{***}	1.541 (11.00) ^{***}
FX purchase_2 nd lag	0.562 (4.02) ^{***}	0.457 (3.23) ^{***}
Excessive appreciation	46.549 (6.21) ^{***}	44.767 (5.70) ^{***}
Excessive volatility	-0.110 (-1.13)	-0.217 (-1.94) [*]
Excessive appreciation*dummy for intervention policy change	...	...
Excessive volatility*dummy for intervention policy change	...	0.624 (1.58)
Constant	-1.650 (-17.43) ^{***}	-1.619 (-16.95) ^{***}
<i>Model statistics</i>		
No. of observations	960	876
LR-chi ²	626.4 ^{***}	472.4 ^{***}
Pseudo R ²	0.50	0.43
<i>Dependent variable= FX sale</i>		
FX sale(-1)	1.465 (7.30) ^{***}	...
FX sale(-2)	1.016 (4.90) ^{**}	...
Excessive depreciation	7.881 (2.84) ^{***}	...
Volatility	0.241 (2.90) ^{***}	...
Constant	-2.096 (-20.38) ^{***}	...
<i>Model statistics</i>		
No. of observations	960	...
F-stat.	216.70 ^{***}	...
Adj. R ²	0.42	...

1/ Purchase and sale of FX are represented by dummy variables with values of 1 when there was purchase (sale) and 0 otherwise.

2/ Dropped from equation 2 as it predicts success perfectly.

Equations (1) and (2) are without and with intervention policy change dummy interaction, respectively.

Numbers in parentheses are z-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

Table IIb. Peru: Estimated Impacts of FX Intervention on the Level and Volatility of the Exchange Rate 1/

Explanatory variables	Change in the level of the exchange			Change in volatility of the exchange rate		
	(1)	(2)	(3)	(1)	(2)	(3)
Likelihood of FX purchase	0.018 (1.48)	0.019 (1.54)	0.026 (1.83)*	-0.085 (-2.59)***	-0.090 (-2.72)***	-0.122 (-3.20)***
Likelihood of FX sale	-0.133 (-3.06)***	-0.126 (-2.93)***	-0.126 (-2.93)***	-0.169 (-2.38)**	-0.178 (-2.51)**	-0.180 (-2.53)**
Likelihood of FX sale_1 st lag	0.118 (2.71)***	0.112 (2.58)**	0.112 (2.59)**	...	...	...
Change in ER_LA 2/	...	0.013 (4.32)***	0.013 (4.31)***	...	...	...
GDP surprise 3/	...	-0.007 (-0.33)	-0.008 (-0.35)	...	-0.004 (-0.07)	-0.003 (-0.05)
Absolute value of change in VIX	...	...	...	...	-0.012 (-1.08)	-0.011 (-1.01)
Likelihood of FX purchase interacted with dummy for intervention policy change	...	...	-0.017 (-1.00)	...	...	0.078 (1.69)*
Constant	-0.004 (-0.55)	-0.004 (-0.57)	-0.005 (-0.65)	0.119 (6.46)***	0.132 (6.03)***	0.134 (6.11)***
<i>Model statistics</i>						
No. of obs.	959	959	959	960	960	960
F-stat.	4.22***	6.37***	5.47***	4.81***	2.69**	2.72**
Adj. R ²	0.010	0.027	0.027	0.008	0.007	0.009

1/ Estimated using IV (2SLS) method. Statistically significant variables in regressions (1) and (2) of Table IIa are used as instruments for likelihood of FX sales and purchases, respectively.

2/ Change in the principal component of exchange rates in LA6 (Brazil, Chile, Colombia, Mexico, Peru and Uruguay) economies.

3/ The difference between actual real GDP growth and conSensus estimates prior to data release. Entered in absolute value in the volatility equations.

Equation (1) is baseline regression, equation (2) includes control variables, and equation (3) includes interaction of FX purchases with dummy for intervention policy change on top of control variables.

Numbers in parentheses are t-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

Annex III. The Exchange Rate Target Estimated By One Year Average Rolling HP Filtered Exchange Rate

Table IIIa. Peru: Probit Regression Results for the Probability of FX Intervention 1/

Independent variable	(1)	(2)
<i>Dependent variable= FX purchase</i>		
FX purchase_1 st lag	1.615 (11.62) ^{***}	1.514 (10.76) ^{***}
FX purchase_2 nd lag	0.526 (3.76) ^{***}	0.400 (2.81) ^{***}
Excessive appreciation	31.427 (6.60) ^{***}	29.038 (5.73) ^{***}
Excessive volatility	-0.117 (-1.17)	-0.221 (-1.95) [*]
Excessive appreciation*dummy for intervention policy change	...	322.133 (2.38) ^{**}
Excessive volatility*dummy for intervention policy change	...	-0.677 (-1.14)
Constant	-1.755 (-16.98) ^{***}	-1.699 (-16.16) ^{***}
<i>Model statistics</i>		
No. of observations	960	960
LR-chi ² (4)	631.8 ^{***}	662.2 ^{***}
Pseudo R ²	0.50	0.52
<i>Dependent variable= FX sale</i>		
FX sale(-1)	1.143 (5.42) ^{***}	...
FX sale(-2)	0.712 (3.25) ^{**}	...
Excessive depreciation	12.890 (6.35) ^{***}	...
Volatility	0.303 (3.70) ^{***}	...
Constant	-2.279 (-18.82) ^{***}	...
<i>Model statistics</i>		
No. of observations	960	...
F-stat	249.4 ^{***}	...
Adj. R ²	0.48	...

1/ Purchase and sale of FX are represented by dummy variables with values of 1 when there was purchase (sale) and 0 otherwise.

Equations (1) and (2) are without and with intervention policy change dummy interaction, respectively.

Numbers in parentheses are z-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

Table IIIb. Peru: Estimated Impacts of FX Intervention on the Level and Volatility of the Exchange Rate 1/

Explanatory variables	Change in the level of the exchange rate			Change in volatility of the exchange rate		
	(1)	(2)	(3)	(1)	(2)	(3)
Likelihood of FX purchase	0.020 (1.64)	0.021 (1.69)*	0.029 (1.92)*	-0.069 (-2.11)**	-0.074 (-2.24)**	-0.124 (-3.10)***
Likelihood of FX sale	-0.142 (-2.81)***	-0.139 (-2.77)***	-0.138 (-2.75)***	-0.132 (-1.96)**	-0.143 (-2.10)**	-0.151 (-2.22)**
Likelihood of FX sale_1 st lag	0.126 (2.47)**	0.124 (2.45)**	0.124 (2.46)**	...	...	...
Change in ER_LA 2/	...	0.013 (4.39)***	0.013 (4.38)***	...	...	...
GDP surprise 3/	...	-0.007 (-0.30)	-0.007 (-0.32)	...	-0.004 (-0.07)	-0.003 (-0.06)
Absolute value of change in VIX	...	...	...	...	-0.012 (-1.05)	-0.011 (-1.00)
Likelihood of FX purchase interacted with dummy for intervention policy change	...	...	-0.016 (-0.94)	...	...	0.092 (2.04)**
Constant	-0.004 (-0.62)	-0.004 (-0.65)	-0.006 (-0.81)	0.110 (6.04)***	0.123 (5.57)***	0.129 (5.83)***
<i>Model statistics</i>						
No. of obs.	959	959	959	960	960	960
F-stat.	3.94***	6.31***	5.41***	3.15**	1.85*	2.31**
Adj. R ²	0.009	0.027	0.027	0.005	0.004	0.007

1/ Estimated using IV (2SLS) method. Statistically significant variables in regressions (1) and (2) of Table IIIa are used as instruments for likelihood of FX sales and purchases, respectively.

2/ Change in the principal component of exchange rates in LA6 (Brazil, Chile, Colombia, Mexico, Peru and Uruguay) economies.

3/ The difference between actual real GDP growth and consensus estimates prior to data release. Entered in absolute value in the volatility equations.

Equation (1) is baseline regression, equation (2) includes control variables, and equation (3) includes interaction of FX purchases with dummy for intervention policy change on top of control variables.

Numbers in parentheses are t-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

Annex IV. Tolerable Range Defined As 1-Year Historical Average Exchange Rate ± 1.5 Times Standard Deviation

Table IVa. Peru: Probit Regression Results for the Probability of FX Intervention 1/

Independent variable	(1)	(2)
<i>Dependent variable= FX purchase</i>		
FX purchase_1 st lag	1.683 (12.21)***	1.617 (11.68)***
FX purchase_2 nd lag	0.598 (4.32)***	0.514 (3.68)***
Excessive appreciation	40.711 4.94)***	33.300 (3.71)***
Excessive volatility	-0.171 (-1.76)*	-0.247 (-2.27)**
Excessive appreciation*dummy for intervention policy change	...	...
Excessive volatility*dummy for intervention policy change	...	0.371 (0.86)
Constant	-1.526 (-17.90)***	-1.481 (-17.24)***
<i>Model statistics</i>		
No. of observations	960	876
LR-chi ² (4)	612.1***	449.4***
Pseudo R ²	0.48	0.42
<i>Dependent variable= FX sale</i>		
FX sale(-1)	1.420 (7.00)***	...
FX sale(-2)	0.978 (4.68)**	...
Excessive depreciation	10.188 (3.6)***	...
Volatility	0.269 (3.35)***	...
Constant	-2.111 (-20.26)***	...
<i>Model statistics</i>		
No. of observations	960	...
F-stat.	221.61***	...
Adj. R ²	0.43	...

1/ Purchase and sale of FX are represented by dummy variables with values of 1 when there was purchase (sale) and 0 otherwise.

2/ Dropped from equation (2) because it predicts success perfectly.

Equations (1) and (2) are without and with intervention policy change dummy interaction, respectively.

Numbers in parentheses are z-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

Table IVb. Peru: Estimated Impacts of FX Intervention on the Level and Volatility of the Exchange Rate 1/

Explanatory variables	Change in the level of the exchange rate			Change in volatility of the exchange rate		
	(1)	(2)	(3)	(1)	(2)	(3)
Likelihood of FX purchase	0.017 (1.38)	0.018 (1.42)	0.026 (1.73)*	-0.078 (-2.38)**	-0.083 (-2.50)**	-0.119 (-3.02)***
Likelihood of FX sale	-0.135 (-3.07)***	-0.130 (-2.97)***	-0.130 (-2.96)***	-0.182 (-2.60)***	-0.191 (-2.71)***	-0.194 (-2.75)***
Likelihood of FX sale_1 st lag	0.114 (2.56)**	0.109 (2.48)**	0.109 (2.49)**	...	...	...
Change in ER_LA 2/	...	0.013 (4.34)***	0.013 (4.33)***	...	...	...
GDP surprise 3/	...	-0.007 (-0.32)	-0.007 (-0.34)	...	-0.006 (-0.09)	-0.004 (-0.07)
Absolute value of change in VIX	...	...	...	...	-0.011 (-1.06)	-0.011 (-1.00)
Likelihood of FX purchase interacted with dummy for intervention policy change	...	...	-0.017 (-0.99)	...	...	0.078 (1.71)*
Constant	-0.003 (-0.42)	-0.003 (-0.43)	-0.004 (-0.54)	0.118 (6.41)***	0.130 (5.96)***	0.133 (6.08)***
<i>Model statistics</i>						
No. of obs.	959	959	959	960	960	960
F-stat.	4.14***	6.35***	5.46***	4.80***	2.68**	2.72**
Adj. R ²	0.010	0.027	0.027	0.008	0.007	0.009

1/ Estimated using IV (2SLS) method. Statistically significant variables in regressions (1) and (2) of Table IVa are used as instruments for likelihood of FX sales and purchases, respectively.

2/ Change in the principal component of exchange rates in LA6 (Brazil, Chile, Colombia, Mexico, Peru and Uruguay) economies.

3/ The difference between actual real GDP growth and consensus estimates prior to data release. Entered in absolute value in the volatility equations.

Equation (1) is baseline regression, equation (2) includes control variables, and equation (3) includes interaction of FX purchases with dummy for intervention policy change on top of control variables.

Numbers in parentheses are t-values. * significant at 10%; ** Significant at 5%; and *** Significant at 1%.

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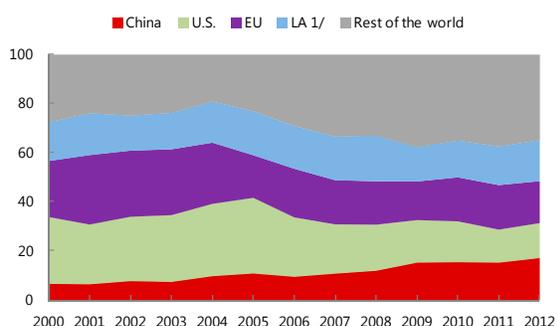
CHINA'S SPILLOVERS TO PERU: INSIGHTS FROM A MACROECONOMIC MODEL FOR A SMALL OPEN AND PARTIALLY DOLLARIZED ECONOMY ¹

This chapter quantifies the spillover effects of China on Peru's economic activity, with particular attention to the impact of China's investment slowdown. The estimates suggest that the shock to investment growth in China has a significant impact on Peru's economic growth. Furthermore, a macroeconomic model for a small open and partially dollarized economy is built and estimated to measure the transmission channels, and simulate Peru's macroeconomic and policy responses to the shock of China's investment slowdown. The counterfactual analyses suggest that Peru's output is exposed to the shock despite a well-targeted inflation, and underscore the importance of a flexible exchange rate in light of external demand shocks.

A. Introduction

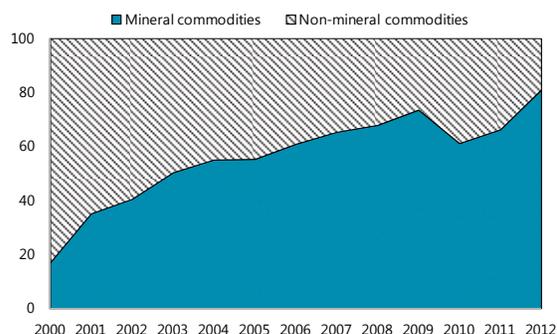
1. As a small open economy, Peru is exposed to external shocks, particularly the shocks from China. One of Peru's largest trading partners is China. Peru sold 17 percent of its total exports to China in 2012 (about 4 percent of GDP), of which 81 percent are metals. Cross-country comparison shows that over a third of Peru's copper exports, 64 percent of gold exports, and 22 percent of other mineral commodities went to China during 2008–12. However, China's mineral imports from Peru including copper and gold are still at a relatively small share in its total mineral imports.

Peru: Exports by Destination
(Percent of total exports)



Sources: UN Commodity Trade Statistics; and Fund staff calculations.
1/ Comprising LA6 economies, Argentina, Bolivia, Ecuador, Paraguay, and Venezuela.

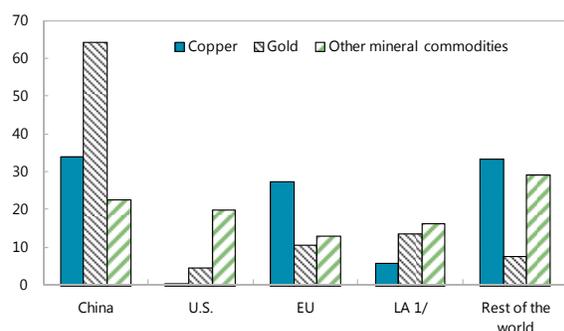
Peru's Real Exports To China: Mineral v.s. Non-Mineral
(Percent of real total exports to China)



Sources: UN Commodity Trade Statistics; IFS; and Fund staff calculations.

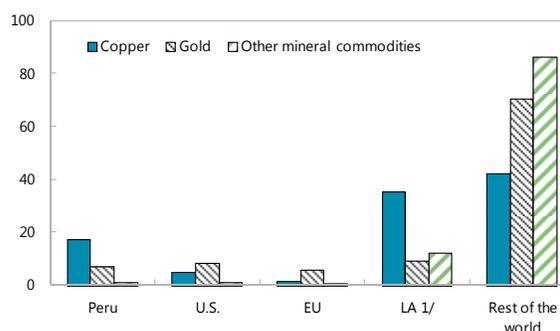
¹ Prepared by Fei Han (WHD) and Juan Alonso Peschiera Perez-Salmon (WHD-Lima Office). The authors would like to thank the Central Reserve Bank of Peru (BCRP) for kind data provision and helpful discussions.

Peru's Real Mineral Exports by Destination
(Percent of corresponding exports to the world during 2008-12)



Sources: UN Commodity Trade Statistics; IFS; and Fund staff calculations.
1/ Comprising LA6 economies, Argentina, Bolivia, Ecuador, Paraguay, and Venezuela.

China's Real Mineral Imports by Origin
(Percent of corresponding imports from the world during 2008-12)



Sources: UN Commodity Trade Statistics; IFS; and Fund staff calculations.
1/ Comprising LA6 economies (excluding Peru), Argentina, Bolivia, Ecuador, Paraguay, and Venezuela.

2. The IMF's 2012 Spillover Report found that China has significant spillover effects on its main trading partners and world prices, mainly through its high growth of investment.

Investment has been a key driver of economic growth and lower external surpluses in China. As found in the IMF's 2012 Spillover Report, "a slowdown in China's investment growth, while desirable to rebalance demand towards consumption in the medium term, could in the interim hit partners and world prices, especially if the adjustment were to be sharp and disorderly."

3. This chapter quantifies the inward spillovers from China's investment slowdown to Peru's economic activity using Vector Autoregressive (VAR) models. The results suggest that shocks to China's investment growth have significant overall effects on Peru's output growth, and these effects mainly operate through their impact on world metal prices, and hence Peru's terms of trade and real GDP growth.

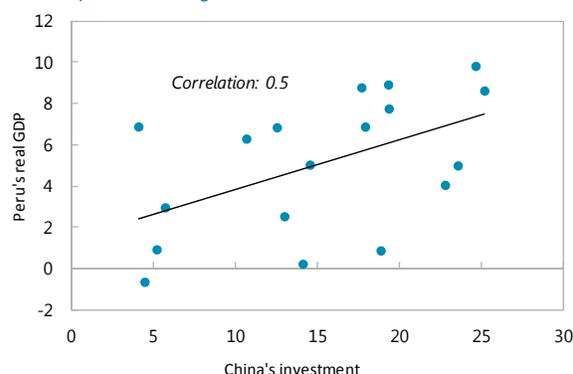
4. In addition, this chapter estimates and simulates Peru's macroeconomic and policy responses to China's investment slowdown using a new-Keynesian macroeconomic model. In particular, we measure the main spillover channels, and conduct counterfactual analyses to simulate Peru's macroeconomic and policy responses, following Salas (2010).

5. This chapter is organized as follows. Section B quantifies the overall spillover effects of China's investment slowdown on Peru's real GDP growth, and identifies the main spillover channels. Section C develops the macroeconomic model for a small open and partially dollarized economy. Section D describes the data and estimation strategy of the model, and discusses briefly the estimation results. Section E presents and discusses the counterfactuals generated from the model under two scenarios, a baseline scenario and an alternative scenario where China's investment growth slows down. The final section concludes with a brief discussion of policy implications.

B. Stylized Facts

6. Peru's economic activity is closely linked to China's investment growth. The correlation between Peru's real GDP growth and China's investment growth during 1995–2012 is 0.5. However, the IMF's 2012 Spillover Report did not find significant impact of China's investment slowdown on Peru's output growth. This is because the Spillover Report only measured the direct trade exposures, and the indirect transmission channels (for instance, through the impact on Peru's terms of trade) were not captured.

Peru: Real GDP and China's Investment
(Annual percent change; 1995-2012)

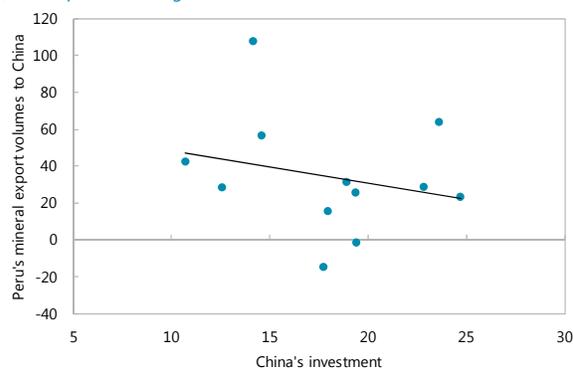


Sources: Haver Analytics; Fund staff calculations.

Direct transmission channels

7. The direct trade spillover effects of China's investment growth on Peru's economic growth are relatively limited.² Peru's mineral export volumes to China do not seem to be positively affected by China's investment growth. This suggests that the quantity effect of a lower investment growth in China on China's demand for Peru's mineral exports is likely to be small, or in other words, a small income elasticity of China's demand for Peru's mineral exports.

Peru: Mineral Export Volumes to China and China's Investment
(Annual percent change; 2001-12)



Sources: UN Commodity Trade Statistics; Haver Analytics; and Fund staff calculations.

8. China is a relatively small source of foreign direct investment (FDI) for Peru. According to Peru's investment promotion agency (*Proinversion*), the stock of Chinese FDI (as measured by contributed capital) in Peru was US\$208 million as of 2012, which is still far below Peru's top three sources of FDI: Spain (US\$4.7 billion), the U.K. (US\$4.5 billion), and the U.S. (US\$3.2 billion). China's FDI is mainly focused in the mining (US\$158 million) and financial (US\$50 million) sectors.

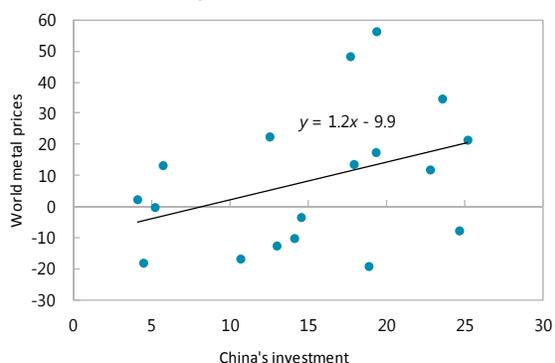
² See Annex IV of Peru's Staff Report for the 2013 Article IV Consultation.

Indirect transmission channels

10. The main indirect spillovers of China’s investment growth are transmitted through its impact on Peru’s terms of trade (price effect).³ According to the IMF’s 2012 Spillover Report, China’s investment slowdown has significant impact on world metal prices. In particular, the report estimates that a one standard deviation decline in China’s investment growth is likely to reduce world copper prices and world metal prices by about 5½ percent and 4½ percent in one year, respectively. Thus, due to a high correlation of 0.9 between Peru’s terms of trade and world metal prices, as well as a large impact of terms of trade on real GDP growth, China’s investment growth is likely to influence Peru’s economic growth, as reflected by the charts below.

World Metal Prices and China's Investment

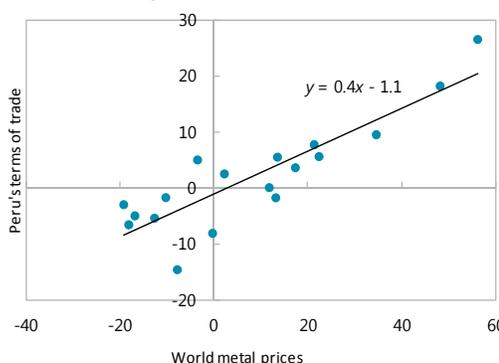
(Annual percent change; 1995-2012)



Sources: Haver Analytics; International Financial Statistics; Fund staff calculations.

Peru: Terms of Trade and World Metal Prices

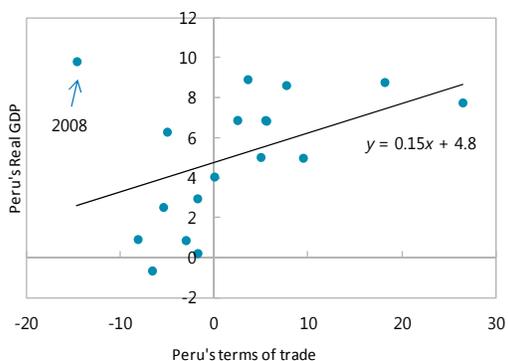
(Annual percent change; 1995-2012)



Sources: Haver Analytics; International Financial Statistics; Fund staff calculations.

Peru: Real GDP and Terms of Trade

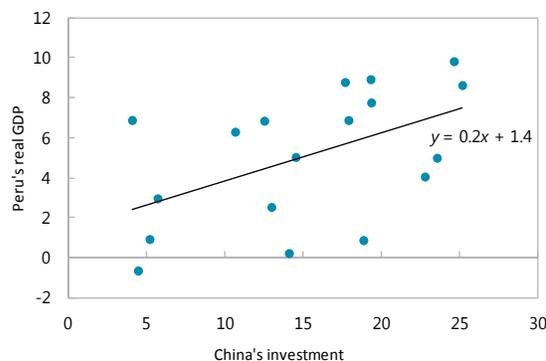
(Annual percent change; 1995-2012)



Sources: Haver Analytics; Fund staff calculations.

Peru: Real GDP and China's Investment

(Annual percent change; 1995-2012)



Sources: Haver Analytics; Fund staff calculations.

³ The impact of Peru’s terms of trade on real GDP growth and the transmission channels have been analyzed in Annex IV of Peru’s Staff Report for the 2013 Article IV consultation.

11. VAR models suggest that a one standard deviation decline in China’s investment growth is likely to reduce Peru’s real GDP growth by 0.4 percentage points cumulatively over one year after the shock.⁴

A quarterly VAR model is estimated over the sample period 2000Q1–2013Q3 to assess the overall impact of China’s investment slowdown on Peru’s real GDP growth. The VAR model includes China’s investment growth⁵, Peru’s terms of trade, real exchange rate (*vis-à-vis* the U.S. dollar), the index of Lima Stock Exchange (IGBVL), and Peru’s real GDP growth as endogenous variables, and the U.S. and euro area real GDP growth as exogenous variables. Cholesky decomposition is used as shock identification strategy, and the Cholesky ordering is the same as listed above. The impulse response functions to the negative shock suggest a deterioration in Peru’s terms of trade, a decline in the stock index IGBVL, and a drop in Peru’s real GDP growth. The cumulative impact of the shock on Peru’s real GDP growth is approximately 0.4 percentage points in one year after the shock.⁶ In addition, we estimate the spillovers of China’s consumption using the same VAR model except that the investment growth is replaced by consumption growth.⁷ The impulse response functions for a one standard deviation negative shock to China’s consumption growth suggests insignificant spillover effects. Thus, a rebalancing of the Chinese economy towards consumption could negatively affect Peru’s economy.

C. A Macroeconomic Model for a Small Open and Partially Dollarized Economy

12. A new-Keynesian macroeconomic model for Peru is developed to better study the policy responses and conduct counterfactual analyses in the context of a small open and partially dollarized economy. The model is based on a general equilibrium and rational expectations model developed by Salas (2010), which consists of a core set of behavioral equations. Since the model is relatively small compared to the traditional dynamic stochastic general equilibrium (DSGE) models and yet has a well-grounded economic interpretation (Berg *et al.*, 2008), it has been used by the Central Reserve Bank of Peru (BCRP) for policy making. The model has four building blocks, namely: (i) an IS curve or aggregate demand equation; (ii) an expectations-augmented Phillips Curve or aggregate supply equation; (iii) a Taylor-type monetary policy rule for the short-term interest rate; and (iv) an uncovered interest rate parity (UIP) condition. Three features of the model are worth noting. First, in the context of a small open economy, terms of

⁴ One standard deviation is equivalent to 3½ percentage points in quarter-on-quarter, seasonally adjusted, growth rates. The shock is approximately equivalent to a 2.5 percent decline in the investment levels.

⁵ China’s investment growth is proxied by China’s fixed asset investment due to the data limitation of China’s total investment.

⁶ This result is consistent with the finding in Annex IV of Peru’s Staff Report for the 2013 Article IV Consultation that a one percentage point decline in China’s real GDP growth is likely to reduce Peru’s real GDP growth by 0.2–0.4 percentage points, because investment accounts for about a half of real GDP in China, and China’s consumption seems to have insignificant spillover effects on Peru as mentioned below.

⁷ China’s consumption growth is proxied by the growth of retail sales due to the data limitation of China’s private consumption.

trade and foreign output are included as exogenous variables in the aggregate demand equation. Second, in a partially dollarized economy, agents can take loans in U.S. dollars, thus the interest rate in U.S. dollars also enters the aggregate demand equation as an exogenous variable. Third, to capture the frequent foreign exchange interventions conducted by the central bank, a backward-looking behavior in the determination of the exchange rate expectations is considered in the model.⁸

13. Aggregate demand. Equation (1) characterizes the aggregate demand or IS curve, which describes the dynamics of the output gap (y_t).

$$y_t = a_y y_{t-1} + a_r (\beta_r r_t + \beta_{r,\$} r_t^\$) + a_{tot} [\beta_{tot} ToT_t + (1 - \beta_{tot}) ToT_{t-1}] + a_q q_t + a_{y^*} y_t^* + \varepsilon_t^y \quad (1)$$

In this equation, r_t is the real interest rate in domestic currency, and $r_t^\$$ is the real interest rate in U.S. dollars. Their effects on output gap are affected by a common coefficient a_r and idiosyncratic coefficients, or weighting parameters, β_r and $\beta_{r,\$}$. ToT_t is the terms-of-trade gap, i.e. the gap of international relative prices⁹, and this captures the indirect spillover channel from China to Peru. It is assumed that both contemporaneous and lagged terms of trade could directly affect current output gap, and β_{tot} is the weighting parameter for current terms-of-trade gap. q_t is the gap of real effective exchange rate (REER).¹⁰ The external demand measured by foreign output gap, y_t^* , is also considered. We assume that Peru, as a small open economy, does not affect its terms or trade or external demand. In other words, terms of trade and external demand in equation (1) are exogenous variables. Finally, the disturbance term ε_t^y denotes a demand shock. Appendix 1 provides a detailed description of the data.

14. Aggregate supply or Phillips curve. Equation (2) is a standard new-Keynesian aggregate supply equation or expectations-augmented Phillips curve, which characterizes inflation (π_t).

$$\pi_t = b_\pi \pi_{t-1} + b_{\pi^e} E_t(\pi_{t+1}) + b_y y_t + b_m (\pi_t^m + s_t - s_{t-1}) + \varepsilon_t^\pi \quad (2)$$

In this equation, inflation has both backward- and forward-looking behaviors, indicated by the two components, π_{t-1} and $E_t(\pi_{t+1})$, respectively, where $E_t(\pi_{t+1})$ is the inflation expectation. $(\pi_t^m + s_t - s_{t-1})$ is the imported inflation measured in domestic currency, computed as the sum of imported inflation π_t^m (measured in U.S. dollars), and the nominal exchange rate variation, $(s_t - s_{t-1})$. The disturbance term ε_t^π represents a supply shock.

⁸ Central banks in several partially dollarized economies actively intervene in the foreign exchange market in order to prevent the balance sheet effects stemmed from large exchange rate movements; see Calvo and Reinhart (2002) and Reinhart and Reinhart (2008).

⁹ All the gap variables in this paper are computed with the Hodrick-Prescott (HP) filter.

¹⁰ REER is also included here because Peru's terms of trade and REER are not highly correlated, and thus seem to contain differentiated information. An increase in REER indicates a real appreciation vis-à-vis its trading partners.

15. Monetary (interest rate) policy rule. Equation (3) describes a Taylor-type monetary policy rule characterizing the determination of the short-term nominal interest rate (i_t).

$$i_t = c_i i_{t-1} + (1 - c_i) \{ \bar{i} + c_y y_t + c_\pi (\pi_t - \bar{\pi}) + c_{\pi^e} [E_t(\pi_{t+1}) - \bar{\pi}] \} + \varepsilon_t^i \quad (3)$$

In this equation, \bar{i} is the steady-state nominal interest rate or the neutral rate, and $\bar{\pi}$ is the inflation target. Following Barro (1989), an interest rate smoothing is considered when the central bank determines the interest rate, as indicated by its first lag, i_{t-1} . In addition, interest rate also responds to output gap y_t and the deviations of inflation π_t and expected inflation $E_t(\pi_{t+1})$ from the inflation target $\bar{\pi}$. Thus, the interest rate has a forward-looking behavior as both inflation and inflation expectations are anchored by this policy rule. The disturbance term ε_t^i denotes a monetary policy shock.

16. Uncovered interest rate parity (UIP). The nominal exchange rate s_t is determined by the uncovered interest rate parity as expressed in equation (4).

$$4[E_t(s_{t+1}) - s_t] = i_t - i_t^* + \varepsilon_t^s \quad (4)$$

In equation (4), the expected quarterly exchange rate variation $[E_t(s_{t+1}) - s_t]$ is multiplied by 4 to be transformed into an annual term, which is equal to the differential between the interest rate in domestic currency and the interest rate in foreign currency (or U.S. dollars in this paper) plus an error term ε_t^s . Following Salas (2010), we assume that the exchange rate expectation $E_t(s_{t+1})$ is determined by a weighted average of a backward-looking component (s_{t-1}) and a forward-looking component (s_{t+1}), as specified in equation (5), which is in line with the authorities' objective of interventions to reduce the excess volatility of the exchange rate.

$$E_t(s_{t+1}) = \gamma s_{t-1} + (1 - \gamma) s_{t+1} + \varepsilon_t^e \quad (5)$$

The parameter γ (bounded between 0 and 1) implicitly measures the extent to which the exchange rate is smoothed by the central bank's foreign exchange interventions. More specifically, the higher γ is, the higher the degree of exchange rate smoothing is.

In addition, following Salas (2010), REER (in gap terms) in equation (1) is determined by its first lag, nominal exchange rate variation, and the differential between domestic and foreign inflation, as specified in equation (6).

$$q_t = d_q q_{t-1} + d_s (s_t - s_{t-1}) + d_\pi (\pi_t^* - \pi_t) + \varepsilon_t^q \quad (6)$$

π_t^* is the foreign inflation, and the disturbance term ε_t^q denotes a shock to the REER.

Finally, the real interest rates r_t and $r_t^{\$}$ in the aggregate-demand equation (1) are linked to the nominal interest rates i_t and i_t^* in domestic currency and U.S. dollars, respectively, by the following two equations.

$$r_t = i_t - E_t(\pi_{t+1})$$

$$r_t^* = i_t^* + E_t(s_{t+1}) - E_t(\pi_{t+1})$$

17. External shocks. Terms of trade, external demand, and interest rate in U.S. dollars are the main exogenous variables in this model and the main channels that external shocks spillover to Peru. We assume that the terms-of-trade gap evolves according to the following dynamics.

$$ToT_t = \rho_{tot} ToT_{t-1} + \rho_m M_t + \varepsilon_t^{tot} \quad (7)$$

In equation (7), M_t is the world metal price (in gap terms), and ε_t^{tot} is the disturbance term or the terms-of-trade shock stripping out the shocks to world metal prices.

External demand y_t^* is approximated by a trade-weighted average of Peru's top three trading partners' output gaps, including the U.S., China, and the euro area, as specified in equation (7).

$$y_t^* = w_t^{US} y_t^{US} + w_t^{EA} y_t^{EA} + w_t^{CHN} y_t^{CHN} \quad (8)$$

In equation (8), y_t is the output gap of each of these three economies, and w_t is the trade weight between each of the three economies and Peru (summing up to 1).

18. China's investment slowdown is transmitted through its impact on China's output and world metal prices. There are mainly two channels for the transmission of the shock in this model. First, as discussed above, China's investment slowdown directly reduces China's growth and output gap y_t^{CHN} , and thus the external demand y_t^* according to (7) (the direct channel). Second, China's investment slowdown imposes downward pressures on world metal prices M_t and hence on Peru's terms of trade according to (6) (the indirect channel).

D. Data and Estimation

19. The model is estimated with quarterly data of Peru over the sample period 2000Q1–2013Q3. It has six endogenous variables, namely, output gap, inflation, interbank interest rate, nominal exchange rate (quarterly rate of change), REER gap, and terms-of-trade gap. All the gap variables are computed with the Hodrick-Prescott (HP) filter. The inflation expectations $E_t(\pi_{t+1})$ are proxied by the one-year-ahead inflation expectations, obtained from the central bank's inflation expectation survey. The inflation is computed as the seasonally-adjusted annualized rate, and the inflation target $\bar{\pi} = 2$ according to the central bank. The Appendix provides a detailed description of the data and their sources. Finally, the model is estimated as a system using the Generalized Method of Moments (GMM), and the endogenous variables are instrumented by their first lags in the estimation to avoid the endogeneity problem. The weighting parameters β_r , $\beta_{r,s}$, and β_{ToT} are not estimated but calibrated according to Salas (2010) as follows: $\beta_r = 0.3$, $\beta_{r,s} = 0.15$, and $\beta_{tot} = 0.48$.

20. Estimation results are presented in Tables 1–4. The estimates are in line with Salas (2010) and other literature such as Berg *et al.* (2008). Three points are worth mentioning. First, world metal prices are statistically significant in terms of driving Peru's terms-of-trade dynamics, which confirms our previous empirical finding that China's investment slowdown is likely to have significant

spillover effects on Peru's GDP growth through terms of trade. Second, both domestic currency-denominated and U.S. dollar-denominated interest rates have significantly negative impact on Peru's output gap. This suggests a downward sloping IS curve for Peru, and thus also implies that the monetary policy in the U.S. might have a significant impact on Peru's real economy. Third, similar to Salas (2010), we also find a significantly high degree of exchange rate smoothing partly due to the central bank's foreign exchange interventions.

E. China's Spillovers to Peru: Counterfactuals and Macroeconomic Responses

21. This section examines the macroeconomic responses generated by the estimated model under two different external scenarios. The first is a baseline scenario under the IMF's projections, and the second is an alternative scenario where China's investment growth declines by one standard deviation from the baseline in 2014Q1.¹¹ The simulation horizon is 2013Q4-2018Q4.

22. The baseline assumptions for external variables over the simulation horizon come from IMF projections. World metal prices, foreign inflation (proxied by world inflation), and the U.S., euro area, and China's output gaps are taken from the IMF's Global Assumptions (GAS) and World Economic Outlook (WEO) projections. U.S. dollar-denominated interest rates are assumed to remain unchanged throughout the simulation horizon. Projections for imported inflation measured in U.S. dollars and inflation expectations are taken from the projections of the IMF's Peru team.

23. The alternative scenario assumes a one standard deviation decline in China's investment growth compared to the baseline scenario. This negative shock influences the Peruvian economy through two external variables in the model, namely, world metal prices and China's output gap. First, the impact on world metal prices has been analyzed and quantified by the IMF's 2012 Spillover Report and Ahuja and Nabar (2012). A one standard deviation decline in China's investment growth is likely to reduce world metal prices by 3¼ percent over a year.¹² Second, to obtain the impact of this shock on China's output gap, we estimate the impact of this shock on China's output growth using a simple VARX model with China's investment growth and real GDP growth as endogenous variables, and the real GDP growth of the U.S. and euro area as exogenous variables.¹³ Finally, the assumptions for the other external variables remain the same as those in the baseline scenario.

¹¹ This is a one standard deviation negative temporary shock to China's investment growth in one quarter, equivalent to a 2.5 percent decline in China's investment levels from the baseline. This shock is the same as the shock to China's investment growth considered in the IMF's 2012 Spillover Report for a better comparison.

¹² See Table 2 in Ahuja and Nabar (2012). The estimated impact on world metal prices is then transformed into the impact on the gap of the world metal prices by assuming that the trend of metal prices remains the same as in the baseline scenario.

¹³ The estimates suggest that a one-standard-deviation decline in China's investment growth is likely to reduce China's real GDP growth by 0.3 percentage points cumulatively after one year. The estimated impact is then

(continued)

24. Counterfactual analyses suggest that a one standard deviation negative shock to China's investment growth is likely to reduce Peru's output gap by about 0.2 percentage points cumulatively one year after the shock. The simulated dynamics for all endogenous variables are shown in the Figure. The shock is estimated to deteriorate Peru's terms-of-trade gap by about 1¼ percentage points within one year after the shock. This decline in the terms of trade widens Peru's negative output gap by about 0.2 percentage points cumulatively over the year 2014. In the medium term, the output gap in the alternative scenario also converges to zero, but the convergence happens 4 quarters later than in the baseline scenario.

25. The shock has relatively limited impact on inflation, implying a well-anchored inflation targeting system. Inflation declines by only about 1 percentage point (year-on-year) cumulatively throughout the simulation horizon, despite the relatively large decline in the interest rate. This is also partly due to our assumption of well-anchored inflation expectations.

26. The shock has a relatively large impact on the domestic interest rate, suggesting a large response of monetary policy to output gap variations. The nominal short-term interest rate is about 30 basis points lower than in the baseline scenario in the medium term as a response to a widened negative output gap.

27. The shock has little impact on the exchange rate, reflecting a high degree of exchange rate smoothing. Nominal exchange rate depreciates by only 0.1 percent in the medium term cumulatively compared to the baseline scenario, partly due to the foreign exchange interventions by the central bank.

F. Concluding Remarks

28. This chapter finds that Peru's economic activity is vulnerable to China's investment slowdown. The estimates from VAR models suggest that a one standard deviation decline in China's investment growth is likely to reduce Peru's real GDP growth by about 0.4 percentage points cumulatively over one year after the shock. The counterfactual analyses from the macroeconomic model for a small open and partially dollarized economy suggest that a one standard deviation decline in China's investment growth in 2014Q1 is likely to widen Peru's output gap by about 0.2 percentage points cumulatively one year after the shock. Furthermore, the main impact of the shock is transmitted through the indirect terms-of-trade channel instead of the direct trade exposures.

transformed into the impact on China's output gap by assuming the same potential output as in the baseline scenario.

29. The macroeconomic and policy responses to China's investment slowdown suggest that inflation remains well-targeted, but higher exchange rate flexibility might be desirable to mitigate the impact on output. Nominal exchange rate depreciates by only 0.1 percent more in the medium term cumulatively in the alternative scenario compared to the baseline scenario. With a more depreciated nominal exchange rate, the output gap might not be widened as much in face of China's investment slowdown.

Appendix. Data

Variable	Data and Source
Output gap	Gross domestic product (millions of 1994 nuevos soles, seasonally adjusted). Gap computed with the HP filter. Source: Central Reserve Bank of Peru.
Terms-of-trade gap	Export price index relative to import price index (1994=100, quarterly average, seasonally adjusted). Gap computed with the HP filter. Source: Central Reserve Bank of Peru.
Real effective exchange rate (REER) gap	Gap computed with the HP filter. Source: Informational Notice System.
Foreign output gap	A weighted average of the output gaps of the U.S., euro area, and China using the trade shares between each of the three economies with Peru as the weights. Sources: IMF's World Economic Outlook databases; and International Financial Statistics.
Inflation	CPI inflation (Dec. 2001=100, quarterly average, seasonally adjusted). Source: Central Reserve Bank of Peru.
Imported inflation	Computed with the import price index (1994=100, quarterly average, seasonally adjusted). Source: Central Reserve Bank of Peru.
Foreign inflation	World inflation (quarterly average, seasonally adjusted). Source: International Financial Statistics.
World metal price gap	World metal price index (2005=100, quarterly average, seasonally adjusted). Source: International Financial Statistics.
Nominal interest rate in domestic currency	Interbank interest rate (quarterly average). Source: Central Reserve Bank of Peru.
Nominal interest rate in U.S. dollars	3-month U.S. dollar Libor rate (quarterly average). Source: Haver Analytics.
Nominal exchange rate	Quarterly average. Increase denotes depreciation. Source: Central Reserve Bank of Peru.

Table 1. Estimation Results: Aggregate Demand Equation

$$y_t = a_y y_{t-1} + a_r (\beta_r r_t + \beta_{r,s} r_t^s) + a_{tot} [\beta_{tot} ToT_t + (1 - \beta_{tot}) ToT_{t-1}] + a_q q_t + a_{y^*} y_t^* + \varepsilon_t^y$$

Estimated Parameters		
Coefficient	GMM estimate	Std. Error
a_y	0.71**	0.06
a_r	-0.14*	0.08
a_{tot}	0.05*	0.01
a_q	0.06	0.07
a_{y^*}	0.09*	0.05
Calibrated Parameters		
β_r	0.3	—
$\beta_{r,s}$	0.15	—
β_{tot}	0.48	—

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Table 2. Estimation Results: Aggregate Supply Equation

$$\pi_t = b_\pi \pi_{t-1} + b_{\pi^e} E_t(\pi_{t+1}) + b_y y_t + b_m \pi_t^m + \varepsilon_t^\pi$$

Estimated Parameters		
Coefficient	GMM estimate	Std. Error
b_π	0.11*	0.06
b_{π^e}	0.21*	0.02
b_y	0.07*	0.04
b_m	0.06**	0.01

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Table 3. Estimation Results: Monetary Policy Rule

$$i_t = c_i i_{t-1} + (1 - c_i) \{ \bar{i} + c_y y_t + c_\pi (\pi_t - \bar{\pi}) + c_{\pi^e} [E_t(\pi_{t+1}) - \bar{\pi}] \} + \varepsilon_t^i$$

Estimated Parameters		
Coefficient	GMM estimate	Std. Error
c_i	0.70**	0.05
c_y	0.90**	0.29
c_π	0.61*	0.37
c_{π^e}	0.05	0.49
\bar{i}	3.38**	0.47

Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Table 4. Estimation Results: Exchange Rate Expectation Equation

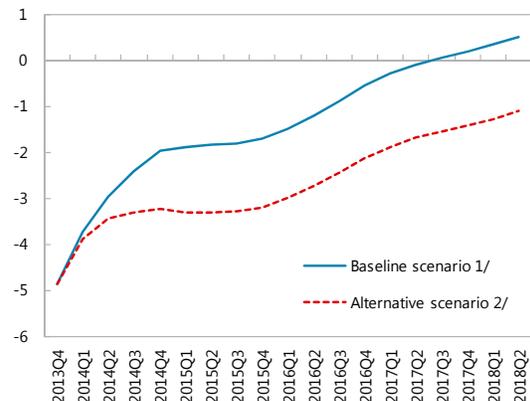
$$E_t(s_{t+1}) = \gamma s_{t-1} + (1 - \gamma) s_{t+1} + \varepsilon_t^e$$

Estimated Parameters		
Coefficient	GMM estimate	Std. Error
γ	0.26**	0.04

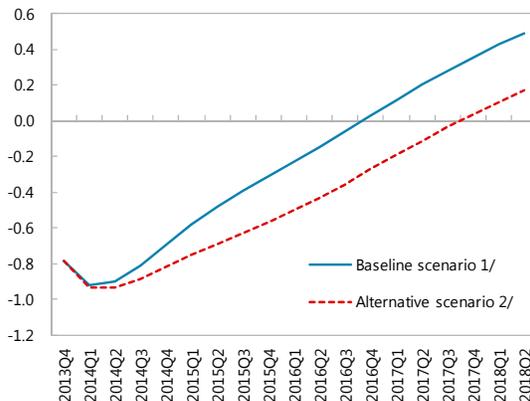
Note: * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Figure. Counterfactual Analysis: Peru's Macroeconomic Responses in Baseline and Alternative Scenarios

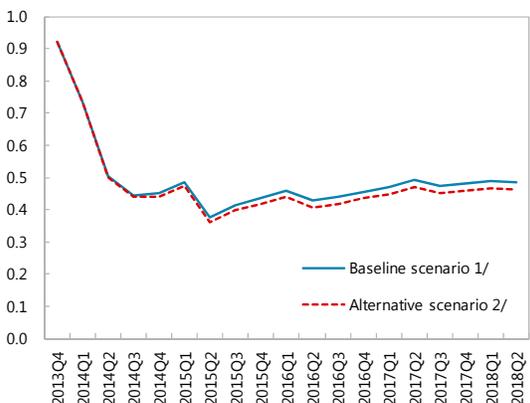
Counterfactuals: Peru's Terms of Trade
(In gap terms)



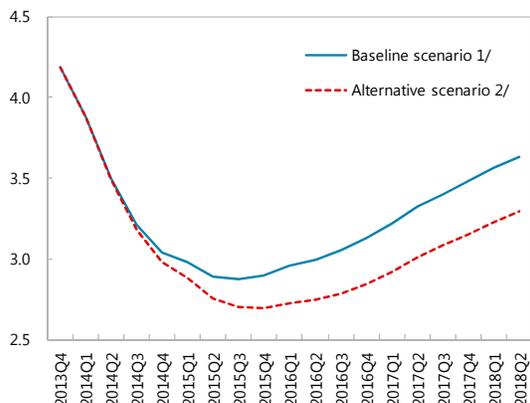
Counterfactuals: Peru's Output Gap
(Percent of potential output)



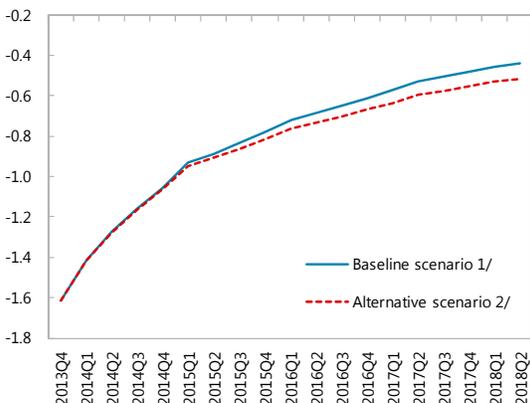
Counterfactuals: Peru's Inflation
(Quarter-on-quarter percent change)



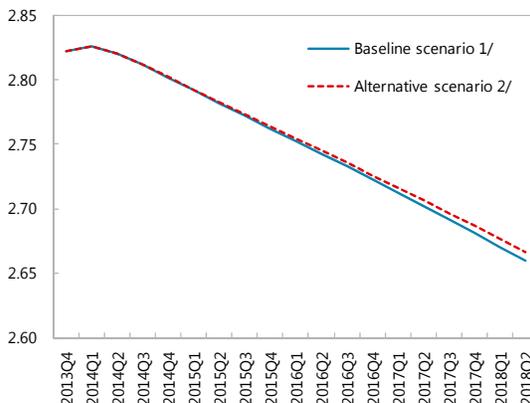
Counterfactuals: Peru's Interbank Interest Rate
(Percent p.a.)



Counterfactuals: Peru's Real Effective Exchange Rate
(In gap terms; increase=real appreciation)



Counterfactuals: Peru's Nominal Exchange Rate
(Percent; increase=depreciation)



1/ Baseline Scenario: IMF's GAS and WEO assumptions. Simulation horizon: 2013Q4–2018Q4.

2/ Alternative Scenario: A one standard deviation decline in China's investment growth in 2014Q1 compared to the baseline. (A one standard deviation decline in growth is equivalent to a 2.5 percent decline in China's investment levels from the baseline.) Simulation horizon: 2013Q4–2018Q4.

Sources: Central Reserve Bank of Peru; National Institute of Statistics; Haver Analytics; International Financial Statistics; Information Notice System; World Economic Outlook databases; and Fund staff estimates.

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