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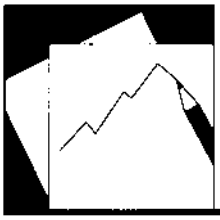

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Bolivia: The Hydrocarbons Boom and the Risk of Dutch Disease

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Bolivia: The Hydrocarbons Boom and the Risk of Dutch Disease

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Abstract

The hydrocarbons sector has become one of the most dynamic economic activities in the Bolivian economy and the main driver of improved export performance and international reserve accumulation. The central role of the hydrocarbons sector in the economy is attributable to the high levels of investment made in the late 1990s, which permitted much higher production levels, particularly of natural gas. However those positive developments in the hydrocarbons sector have given rise to the possibility of a new case of "Dutch disease." While Bolivia's economy has already seen many benefits from its higher gas exports, especially in terms of lower external vulnerability and improved fiscal stance, the new resources could also limit the development of other economic sectors in terms of output and factor income. This paper explores the transmission channels of Dutch disease, as well as its main symptom, the appreciation of the real exchange rate

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Keywords: Bolivia, Dutch Disease, Hydrocarbons, Equilibrium Real Exchange

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I. INTRODUCTION

Over the last ten years, the hydrocarbons sector has become one of the most dynamic economic activities in the Bolivian economy and the main driver of improved export performance and international reserve accumulation.[1] Thanks to this boom, hydrocarbons are now Bolivia's main export (about US$2.3 billion in 2007, or half of total exports compared to less than 8 percent in the late 1990s), with about 85 percent consisting of natural gas exports. Hydrocarbons also provide the basis for almost one-third of government revenue (10 percent of GDP). However, its value added represents just 7 percent of the GDP and, as production is highly capital-intensive, the sector accounts for only a minor share of total employment.

The current central role of the hydrocarbons sector in the Bolivian economy is attributable to the high levels of foreign direct investment made in the late 1990s, which permitted much higher production levels, particularly of natural gas. In the context of the capitalization/privatization process undertaken in the mid-1990s (discussed below), the role of the public sector was refocused from direct ownership into regulation of downstream activities. Currently, that process is being reversed and the state oil company Yacimientos Petrolíferos Fiscales Bolivianos (YPFB) is being called upon to again play a pivotal productive role. While this has entailed, at least temporarily, a contraction in private investment and consequently stagnated production volumes, the sharp increases in international energy prices in recent years have sustained high and growing hydrocarbons export receipts. Meanwhile, a sharp increase in the government's tax take has bolstered hydrocarbons-based public sector revenue.

Developments in the hydrocarbons sector have given rise to the possibility of a new case of "Dutch disease."[2] While Bolivia's economy has already seen many benefits from its higher gas exports, especially in terms of lower external vulnerability and improved fiscal stance, the new resources could also limit the development of other economic sectors in terms of output and factor income. Following a review of the main developments in the hydrocarbons sector and their economic impact as well as the current constraints to further progress, this chapter examines the transmission channels of Dutch disease in Bolivia, as well as its main symptom, the appreciation of the real exchange rate.

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[1] Bolivia began developing its natural gas reserves and producing natural gas in the late 1960s. Export volumes became somewhat significant in the early 1970s after initial export agreements with Argentina were activated.

[2] The first printed reference in the literature to the term is in the article "The Dutch disease" in The Economist, November 26, 1977. This appellation refers to the adverse effect on manufacturing of the real exchange rate appreciation resulting from the 1960s natural gas discoveries in the Netherlands.

II. KEY DEVELOPMENTS IN THE HYDROCARBONS SECTOR

In 1994, the *Capitalization Law* established the framework for the privatization of state-owned companies, which had a major impact on YPFB, until then the main player in the sector. Although YPFB constituted one of the main sources of government income, its production was modest, the company remained undercapitalized, and its capacity to invest very limited. In the context of the privatization/capitalization program, YPFB was divided into several components: two upstream units, two transport units, and two refining units. The upstream and transportation units were privatized in 1996–97, giving rise to Petrolera Chaco and Petrolera Andina in upstream activities, and Transredes and Compañía Logística de Hidrocarburos Boliviana in transportation and distribution. The privatization/capitalization program allowed the effective transfer of management and significant shareholding stakes to private companies in exchange for investment commitments (hence the term "capitalization"). The auctions were won by three groups of companies, from the United States and Argentina. The refining units were later sold to the Brazilian state-controlled company Petrobrás and the logistics company to a consortium of German and Peruvian investors. Thus, as a result of the privatization/capitalization process, most activities related to the hydrocarbons sector were transferred to foreign energy companies.

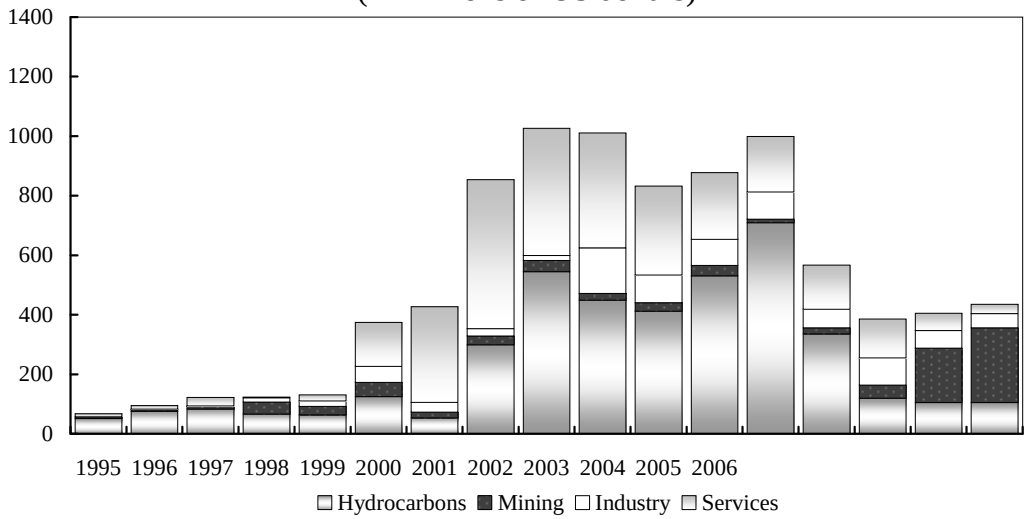
In the hydrocarbons sector, the post-Capitalization Law framework was set forth by a new Hydrocarbons Law, enacted in 1996. That law established the responsibilities of the newly created Superintendency of Hidrocarbons and the regulatory mechanisms governing exports and the domestic market. The role of YPFB was also redefined, enabling it to participate in joint venture projects with other parties, national or foreign, in all the stages of hydrocarbons production. The state retained its role in wholesale marketing activities.

Along with the changes in the institutional setup, the 1996 Hydrocarbons Law established new tax incentives for investment in both upstream and downstream activities. Regarding upstream activities, new hydrocarbons projects (that is, in fields that were not in production at the time of the law) would pay royalties of only 18 percent of the value of gross production, compared with the royalties of 50 percent paid by existing fields. At the same time, in the context of a wider tax reform, the net income tax rate was reduced from 40 percent to 25 percent, while new taxes of 12.5 percent on dividend repatriation and extraordinary net income were introduced. Other provisions included profit repatriation guarantees and acceptance of international arbitration.

Investments in exploration in the context of the capitalization program led to a seven-fold increase in the total natural gas reserves of Bolivia. Between 1995 and 2003, foreign direct investment in the hydrocarbons sector was almost US$3.5 billion, reaching almost 10 percent of the GDP on average. This was mainly oriented to export projects to Brazil, the main market in the region. The main drilling discoveries were those by Total Fina Elf in Tarija, Repsol–YPF in the Caipipendi block, and Petrobras in San Antonio and San Alberto. According to the International Energy Agency, Bolivia thus became the country with the

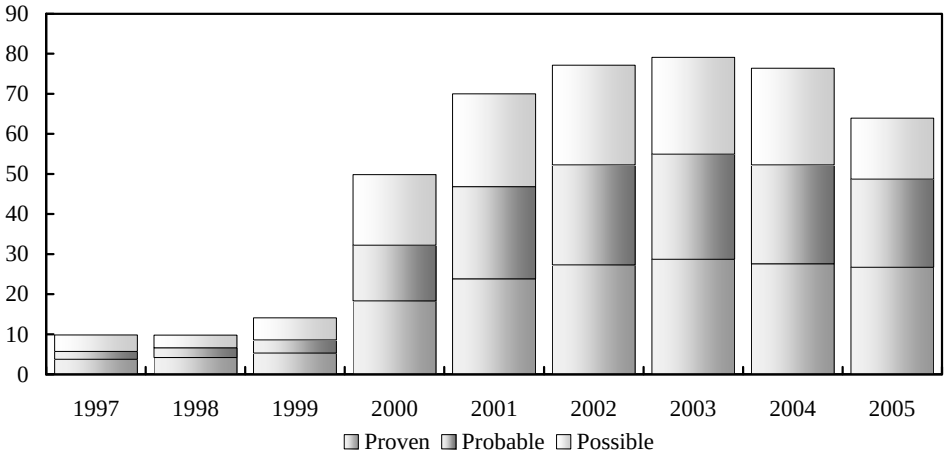
highest nonassociated gas reserves in the region.[3] The reduction of the government take and the new legal framework contributed critically to the major increase in investment in the hydrocarbons sector (Figures 1-3).

Figure 1: Foreign Direct Investment by Sectors
(In millions of US dollars)



Source YPFB

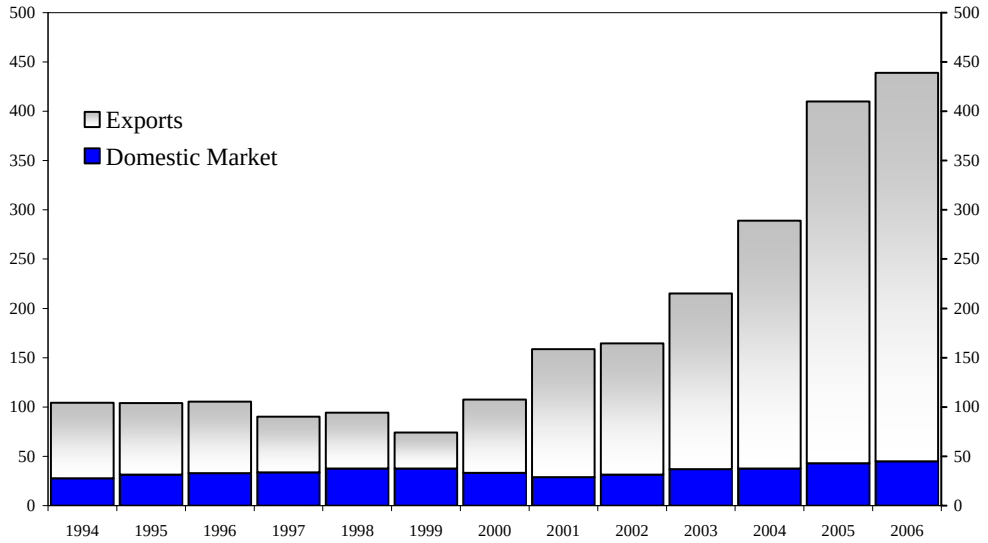
Figure 2: Natural Gas Reserves
(In trillions of cubic feet)



Source YPFB

[3] Although Venezuela has almost 60 percent of the region's gas reserves, only about half of their reservoirs have nonassociated or free gas, while Bolivian reserves are mostly of free gas. Free gas reservoirs are more efficient to exploit than those with associated gas because the complex logistics of producing liquid and gas fuels increases the overall costs.

Figure 3: Natural Gas Sales Volume
(Billions of cubic feet per year)



Source YPFB

A. Looming Capacity Constraints and Prospects for Additional Investments

Despite the major expansion over the past decade, the production capacity of natural gas in Bolivia is now close to full utilization. This constraint will therefore limit increases in exports and domestic consumption over the medium term, unless significant additional investments are carried out. The current capacity of production is approximately 37 million of cubic meters per day. Of this total, about 24 million are exported to Brazil and 6 million to Argentina, while the domestic market consumes about 5 million of cubic meters per day.

Brazil has become the main export market for Bolivia's natural gas, importing 75 percent of the country's total production, or the equivalent to one third of its merchandise exports in 2007. Culminating protracted negotiations started in the 1970s, Bolivia signed in 1992 an agreement of energy complementarity with Brazil, which provided the bilateral framework for investments in the sector. This agreement, combined with the privatization process described above, led to the construction of a gas pipeline in the mid-1990s, at an approximate cost of about US$2 billion, to transport gas from Santa Cruz to São Paulo. The Bolivia-Brazil pipeline is the longest in the region, spanning over more than 3,000 kilometers. Natural gas exports to Brazil started in 1999 under a 20-year contract that established a maximum of 30 million of cubic meters/day. Thus far, the maximum volume has been reached only recently but not yet on a sustained basis, mainly due to slower-than-expected development of the gas market in Brazil. Under the long-term contract, the pricing of Bolivian gas exported to Brazil is based on the cost of a basket of alternative fuels, which is adjusted periodically. On this basis, the gas export price has increased gradually since 2001, from US$1.7 to US$4.2 per thousand cubic feet.

Domestic consumption of natural gas is still very low due to the country's relatively undeveloped productive base and small population, but has increased to about 15 percent of total production, mainly for power generation. Bolivia's per capita energy and electricity consumption are roughly one-half and less than one-fourth of the averages for South America. This is due to the limited coverage of the electricity network, since about three-fourths of rural households and one-fifth of urban households do not have access to electricity. Compared to the rest of South America, the power generation mix in Bolivia is now relatively tilted towards the use of natural gas as gas-based electricity production now represents about 45 percent of total electricity production. Under existing energy legislation, use of natural gas for domestic consumption is a priority over exports; however pipeline capacity constraints limit a rapid expansion in some regions. Meanwhile, use of natural gas for residential use corresponds to only about 3 percent of total gas production.[4]

The need for additional investments to expand capacity is heightened by a new agreement signed in 2006 to increase exports to Argentina to a much higher level starting in 2010. Under this twenty-year agreement, exports to Argentina—which represented 13 percent of total gas production in 2006—are envisaged to gradually increase almost four times to 27 million cubic meters per day. Implementation of this project would require major investments (about US$2.5 billion on both sides of the border, with most of it in the Argentina side) on the building of a new pipeline. The pricing scheme for existing and new exports was also renegotiated to follow prices of a basket of fuels through periodic adjustments. The latter allowed export prices to almost double since 2005 to US$5.1 per million BTU.

B. Recent Institutional Changes and Possible Impact on Investment

Therefore, a critical question ahead for Bolivia's economic prospects is the extent to which additional capacity expansion will materialize in a context of significant shifts in the regime governing the hydrocarbons sector. Despite the successful outcomes in terms of investment and output growth, political support for privatization/capitalization program launched in 1990s eroded sharply early in this decade. The growing opposition led to the calling of a national referendum in mid-2004, which indicated widespread public support for a greater state role in the hydrocarbons sector. A new hydrocarbons law was enacted in May 2005, whose provisions were broadly in line with the results of the referendum. One year later, in May 2006, the government issued a decree, the "Nationalization Decree," aimed at further guiding the implementation of key elements of the 2005 hydrocarbons law.

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[4] There is a potential for use of natural gas in new industrial activities, but given the large scale of production needed in most cases, viability will hinge on the scope for servicing the regional market. It is expected that an iron/ore project (El Mutun) will be one of the main users of natural gas in the medium term. In addition, petrochemical products (e.g., methane, ammonia, and hydrogen), could be future new sources of exports and inputs for domestic industries. Another possible use of gas is in transportation, in the form of compressed natural gas, an application that is still incipient in Bolivia.

In broad terms, the effect of the new legislation is to reverse certain aspects of the 1990s privatization/capitalization program in the hydrocarbons sector, and to markedly raise the government's tax take from it. Specifically, the new legislation has mandated: (a) a "migration" of the contracts with the foreign companies operating in Bolivia, from risk-sharing contracts to an arrangement whereby all production is surrendered to the state energy company YPFB, which has been made the country's sole exporter of natural gas; (b) a permanent increase in natural gas royalties,[5] from 18 percent to 50 percent of turnover;[6] and (c) a requirement that YPFB regain control over the five hydrocarbons companies that were privatized in the 1990s. The last point would be achieved, partly, through a reallocation to YPFB of the shares previously given in trust to private managers;[7] this would be supplemented by acquisition of the necessary shares to reach majority control. Thus, the 2005–06 legislative package established that YPFB would become again the main player in the sector, including in terms of setting prices and production volumes, as well as the terms of exports and distribution.[8]

III. HYDROCARBONS BOOM AND RISK OF DUTCH DISEASE

The recent increase in natural gas production and exports has had a major impact on the long–term outlook of the economy, in particular on the level and sources of public sector revenues. The strength in hydrocarbons-based revenue is expected to continue for an extended period given the expected investments in production in the medium term on the basis of sustained demand from Bolivia's energy-importing neighbors. Moreover, the information on reserves indicates that Bolivia can count on this resource for the next 50–60 years, depending on the expansion of domestic consumption and the continuation of exploration activities. However, while the rise in export volumes and the energy price environment have played a role, most of the increase in hydrocarbons-based revenue has stemmed from changes in the legal framework for the sector.

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[5] The nationalization decree also established a temporary additional royalty for YPFB of 32 percent of the value of hydrocarbon production in the two largest gas fields until October 2006. This royalty was then extended by decree until end-April 2007.

[6] The distribution of the post-royalty revenue between the service operators and YPFB is governed by an agreed contractual formula for each gas field, which takes into account, inter alia, investment-related costs and the production level.

[7] Such trust had been created in the context of the privatization of the 1990s, it included equity shares of the privatized companies with the purpose to generate a retirement pension supplement for all Bolivians at least 21 years old at end-1995.

[8] Following extensive negotiations, the government signed 44 operating contracts with 12 energy companies in early 2007. Those contracts were subsequently approved by Congress. While the transition to new service contracts has been completed, only one of the five companies targeted for nationalization (i.e., the company in charge of the country's two oil refineries, formerly owned by Brazil's Petrobras) has thus far returned to YPFB control.

Beyond their implications for the fiscal system, these developments in the hydrocarbons sector raise the possibility of a new case of Dutch disease. Generally, this phenomenon spreads via two main channels: the resource movement effect and the spending effect (Box 1). Both effects, directly or indirectly, entail a real exchange rate appreciation with possible serious ramifications to the entire economy.

Box 1: Dutch Disease's Transmission Channels

The literature usually identifies two main channels on the propagation of Dutch disease: **the resource movement effect and the spending effect**.

The 'resource movement effect' refers to the reallocation of factors from different sectors of the economy (e.g., manufactures or other lagging sectors) to the natural resources export boom sector. Corden and Neary (1982) and Corden (1984) show that the resource movement effect is due to the increase of the marginal factor remunerations in the export boom sector. For example, if labor is mobile across production sectors, higher wages would cause a movement of labor to the export booming sector, lowering the output of the lagging sector.[1] This resource reallocation is usually denominated 'direct de-industrialization' since it does not involve appreciation of the exchange rate. However, resource allocation can also lead to an increase in the real exchange rate as a second round effect. The relative loss of production factors in the nontradable sector would result, ex ante, in excess demand for nontradables, resulting in an increase in the prices of nontradables and in the real exchange rate, since the price of tradables is exogenously determined in the international markets.[2]

The spending effect relates to the appreciation of the real exchange rate as a result of the spending of some part of the booming sector's extra income in nontradables. The spending can be performed directly by the owners of the factors or indirectly by the government through tax collection. The identification of the sector which carries out most of the spending is essential to determining the strength of the spending effect. The propensity to consume nontradable goods and services is usually higher in the case of the government. In general, the spending effect entails an unambiguous exchange rate appreciation, and the size of this appreciation is a function of the amount of extra resources spent in the nontradable sector.

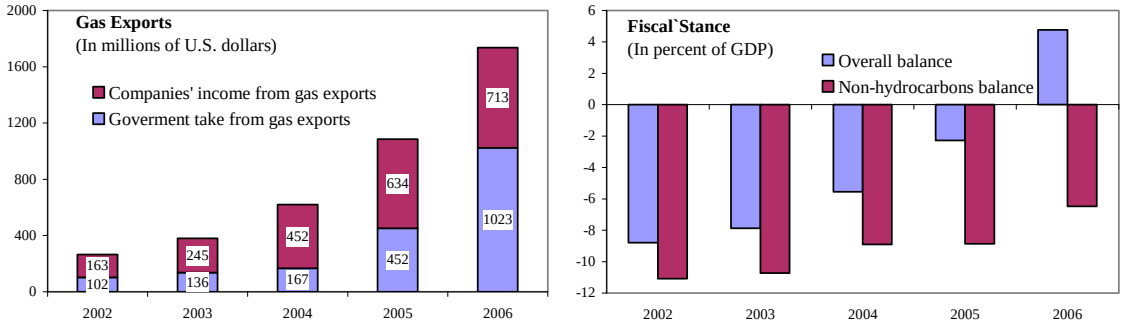
[1] In the case of Bolivia, the lagging sector can be producing both importables (e.g., agricultural sector) and/or non-boom exportables, not necessarily a manufacturing industry.

[2] If more than one factor is mobile across sectors, the sign of the resource allocation effect is not so clear, and it could even theoretically cause a real exchange rate depreciation (e.g., the Paradox model described by Corden and Neary 1982)

As is the case amongst most energy producers, the reallocation effect is not significant in Bolivia since the gas sector does not compete for factors with the rest of the economy. Not only does Bolivia's hydrocarbon sector employ only around 0.04 percent of total employment, but also capital movement between sectors seem to be insignificant, as the capital used in the gas industry is sector-specific and financed by FDI. In other words, there is no mobility of factors between the gas sector and the rest of the economy. In the Dutch disease literature, a sector with these characteristics is usually denominated as an "enclave" sector.

Even though gas export receipts have increased and their distribution has shifted towards the government, the impact of the spending effect so far in Bolivia has been compensated by the emergence of a large fiscal surplus (Figure 4). Following the May 2005 Hydrocarbons law and the nationalization decree of May 2006, the participation of the government in external gas receipts increased to about 60 percent of the companies' turnover (from 27 percent in 2004). This change in the context of higher international energy prices led to a shift in the fiscal position over the same period from an overall deficit of 5½ percent of GDP to a surplus of 4½ percent of GDP—or from a non-hydrocarbons deficit of 9 percent of GDP to a deficit of 6½ percent of GDP. That is to say, a significant portion of the new revenues was saved. Moreover, even though total public spending increased over the years (about 7 percent in real terms during 2002–06), it was driven by capital expenditure, as current expenditure—which tends to include mostly nontradable items—decreased by 6 percent in real terms in the same period.

Figure 4: Distribution of Gas Exports Receipts and Fiscal Results



Source: Bolivian authorities

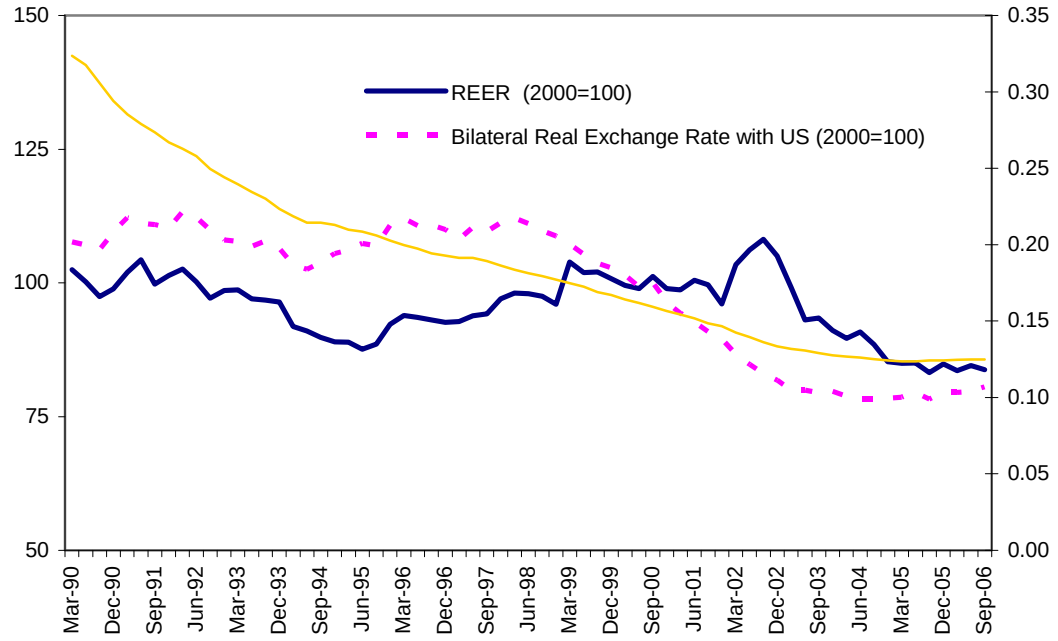
A. Evolution of the real exchange rate

The evolution of the CPI-based real effective exchange rate (REER) has been relatively stable in recent years, but appreciating pressures are already visible after mid-2007 (Figure 5). Driven by changes in the nominal effective exchange rate, the REER displayed a downward trend from 2000 to mid-2005, and a flat trend up to mid-2007.[9] However, the recent appreciations of the REER since mid-2007 are explained both by the nominal appreciation of the Boliviano (around 3 percent) and by higher inflation levels in Bolivia with respect to the weighted average inflation of its trading partners. Although relatively small, these appreciation pressures could be an early signal of the anticipated reversal in the REER's trend, given that both headline and core inflation have shifted upwards mainly due to increasing inflation in nontradables (Figure 6).

Figure 5. Real and Nominal Exchange Rate

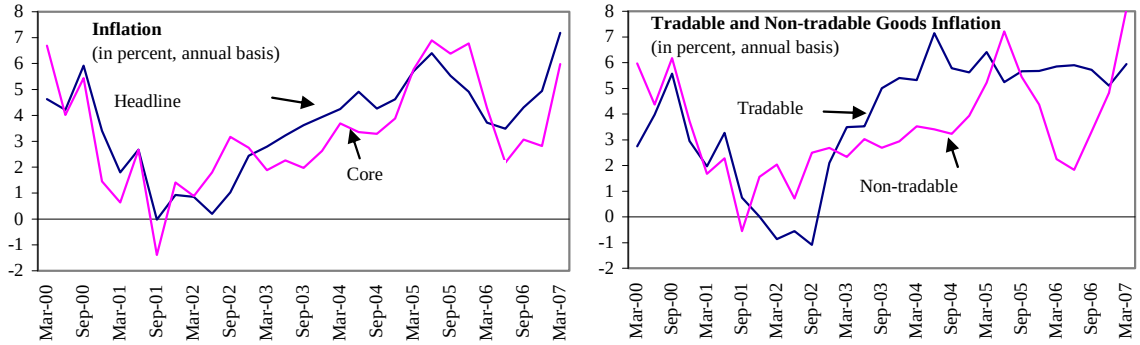
[9] The sudden increase in 2002 and posterior decrease of the REER is explained by the Argentinean crisis.

(Increase = appreciation)



Source: Fund staff estimates.

Figure 6. Inflation Indicators



Sources: Bolivian authorities and Fund staff estimates.

While the relatively stable behavior of the real exchange rate might seem puzzling given the remarkable gas export boom starting in the early 2000s, it is consistent with the above-described Dutch disease transmission channels. The depreciating trend through 2005 stemmed from the still low prices of gas and the low share of government in gas export receipts, the very capital intensive nature of the gas sector, as well as from large net capital outflows (due to capital outflows related to the political crises in that period and depressed FDI). These factors seem to have been strong enough to more than offset the real exchange rate appreciation pressures from the increase in gas export volumes and the resulting trade surplus. Since 2006, there was a reduction in capital outflows but at the same

time the large increase in public savings helped sterilize the spending impact of the increasing export receipts—in fact, in 2006 more than half of the increase in international reserves was sterilized by an increase in government deposits. The fact that the government has been saving most of the extra resources from the gas sector meant that the spending effect was not set in full motion.

A quantitative analysis of the equilibrium exchange rate seems to confirm these findings. The study of the equilibrium REER is especially relevant for the more recent period since limited exchange rate flexibility under the crawling peg regime could be masking appreciation pressures. Using the Behavioral Equilibrium Exchange Rate (BEER) model, in which co-integration techniques are used to identify persistent patterns of co-movements among the equilibrium exchange rate and its determinants, the estimation of a time-varying equilibrium real exchange rate indicates that:

- **For the period 2000–05, that the negative trend in the REER was an equilibrium phenomenon**. The evolution of the determinants, especially the negative trend in net FDI during the period 2000–05, seems to explain the negative trend in the equilibrium real exchange rate.

- **For the more recent period, there is evidence of a change in the trend of the equilibrium real exchange rate, with the result that the real exchange rate may now be below its estimated equilibrium level**. Specifically while the gap between the REER and its smoothed estimated equilibrium level indicates a 6 percent undervaluation as of December 2006, the gap between the REER and its non-smoothed estimated equilibrium level is about 26 percent. However, the estimated deviation from the non-smoothed series may well be overestimated given its volatility.[10]

The above analysis suggests that while there is a surprising lack thus far of significant Dutch disease symptoms, there are signs in the recent period that this could become an important policy issue for Bolivia. The relative benign outcomes to date are related, first, to the characteristics of the gas industry, which is very capital intensive, and hence neutralize the resource allocation effect and, second, to the fact that the spending effect did not play an important role through 2005 due to the government's then low share in gas sector profits, as well as to important capital outflows (e.g. negative trend in net FDI). Moreover, beginning in 2006, appreciation pressures emerged but were largely contained by the absence of significant increases in government current expenditure and the shift into a large fiscal surplus. However, the outlook poses challenges, and the analysis also points to policy elements that would be key for keeping Dutch disease symptoms manageable.

[10] Appendix A includes a detailed description of the estimation results and methodology.

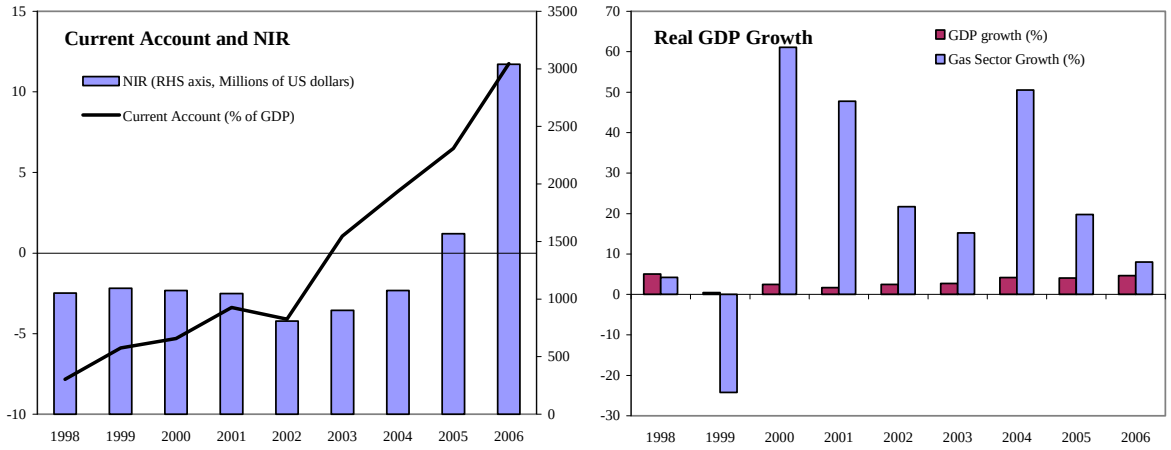
IV. POLICY IMPLICATIONS

While Bolivia has already seen many benefits from its higher gas exports, experience elsewhere shows that effective management of natural resource wealth is key to spread the benefits more widely, contributing to improve living standards and increase potential growth. For example, Bolivia has reached record high NIR levels in the context of a sharp turnaround in the external current account balance, from a 5 percent deficit in 2000 to an almost 12 percent surplus in 2006 (Figure 7). This has reduced the vulnerability of the country to external shocks but at the same time has brought effects in the foreign exchange market that present challenges to the monetary authorities.

To preserve macroeconomic stability, the authorities will need to exercise prudent fiscal and monetary policies, and ensure continued openness of the exchange rate system. To prevent excessive monetary expansion in the context of rapid NIR accumulation, the government will need to keep under restraint its overall fiscal balance excluding revenues from hydrocarbons. The central bank will also need to maintain a cautious monetary stance and increase the exchange rate flexibility. Containment of nominal appreciation pressures could lead to an adjustment of the real exchange rate through prices, with unintended effects on the overall economy. Exchange controls should be avoided as they could result in implicit taxes on exporters.

Finally, the gas sector has become one of the important sources of GDP growth. However, the new resources could also limit the development of other economic sectors in terms of output and factor income. Medium term policies could address these effects through productivity-enhancing investments, including in education and infrastructure.

Figure 7: External Sector Performance and Growth



Source: Bolivian authorities.

Appendix. Equilibrium Real Exchange Rate

This appendix describes the variables and BEER methodology used to estimate a time-varying equilibrium real exchange rate.[11,12]

Determinants of the equilibrium real exchange rate

Based on the main REER determinants identified in the literature for developing countries, specific variables have been selected as factors that are likely to be significant for Bolivia's real exchange rate. These are terms of trade movements, productivity differentials vis-à-vis trading-partner countries, the size of the fiscal balance, and net capital inflows.[13]

- ***Terms of trade*.** An improvement in the terms of trade tends to require an appreciation of the REER in order to compensate for the positive impact on the external accounts. For example, the recent increase in commodity prices tends to raise the disposable income in Bolivia's natural resource sectors and to increase the government's resource envelope, both of which would put pressure on the relative prices of nontradable goods, thus offsetting the initial positive terms of trade shock.

- ***Productivity***. An increase in productivity in the tradable sector vis-à-vis its trading partners would appreciate the REER through the well-known Balassa-Samuelson effect. The higher wages in the tradable sector due to the higher productivity would put upward pressure on wages in the nontradable sector, resulting—in the absence of nominal exchange rate adjustments—in an increase in the CPI relative to its partners. Given the lack of data on productivity for Bolivia and some of its main trading partners, the relative GDP per capita is used as a proxy for the Balassa-Samuelson effect.

- ***Fiscal balance*.** The effect of this variable on the REER is ambiguous. On the one hand, an improvement in the fiscal balance would normally be accompanied by a smaller decline in private savings, reducing total domestic demand and hence increasing overall national savings. Hence, the REER would tend to depreciate since

[11] Further details about the REER estimations for Bolivia can be found in chapter I of the 2007 Bolivia Selected Issues, IMF Country Report No. 07/249.

[12] See Hinkle and Montiel (1999) for a description of the possible determinants of the equilibrium real exchange rate. A similar VEC procedure has been applied to a number of countries, including South Africa (MacDonald and Ricci 2003), Malawi (Mathisen 2003), Algeria (Koranchelian 2005), Venezuela (Zalzuendo 2006), Jordan (Saadi-Sedik and Petri 2006), and Brazil (Paiva 2006).

[13] A measure of trade openness (defined as ratio of imports plus exports over GDP) was initially included but then dropped because the increase in export and imports in recent years in Bolivia was not necessarily associated with more competition in the tradable sector. The exclusion of this variable does not affect the results presented in this chapter.

part of the decrease in domestic demand would be for nontradable goods. On the other hand, an improvement in the fiscal balance could imply an appreciation of the REER if the tightening of fiscal policy had a medium-term expansionary impact—for example, higher private investment in response to the policy credibility gain.[14]

- ***Capital inflows.*** Capital inflows could lead to a REER appreciation through their effect on the nontradable sector, and are approximated in this analysis by net FDI flows. Net FDI is a very important variable in Bolivia, and has ranged from 12 percent of GDP in 1999 to negative 3 percent of GDP in 2005, when a large proportion of the gas export profits was repatriated by foreign companies. The expected relationship is positive—an increase in net FDI would lead to appreciation pressures.

- ***Net foreign assets***. The literature usually also calls for including net foreign assets in order to capture another dimension of capital flows. Economies with high levels of net foreign assets could temporally sustain a more appreciated REER because they can finance the associated trade deficits. Conversely, debtor countries might need more depreciated exchange rates in order to generate trade surpluses needed to service external liabilities. Here, the net foreign asset position of the economy is proxied by the net foreign assets of the banking system (i.e., including the central bank).

Econometric approach

Johansen (1995)'s maximum likelihood estimation procedure is used to identify the characteristics of the potential long run relationship between the REER and the variables discussed above. The Johansen methodology, which corrects for autocorrelation and endogeneity parametrically, can be represented in the following VEC form:

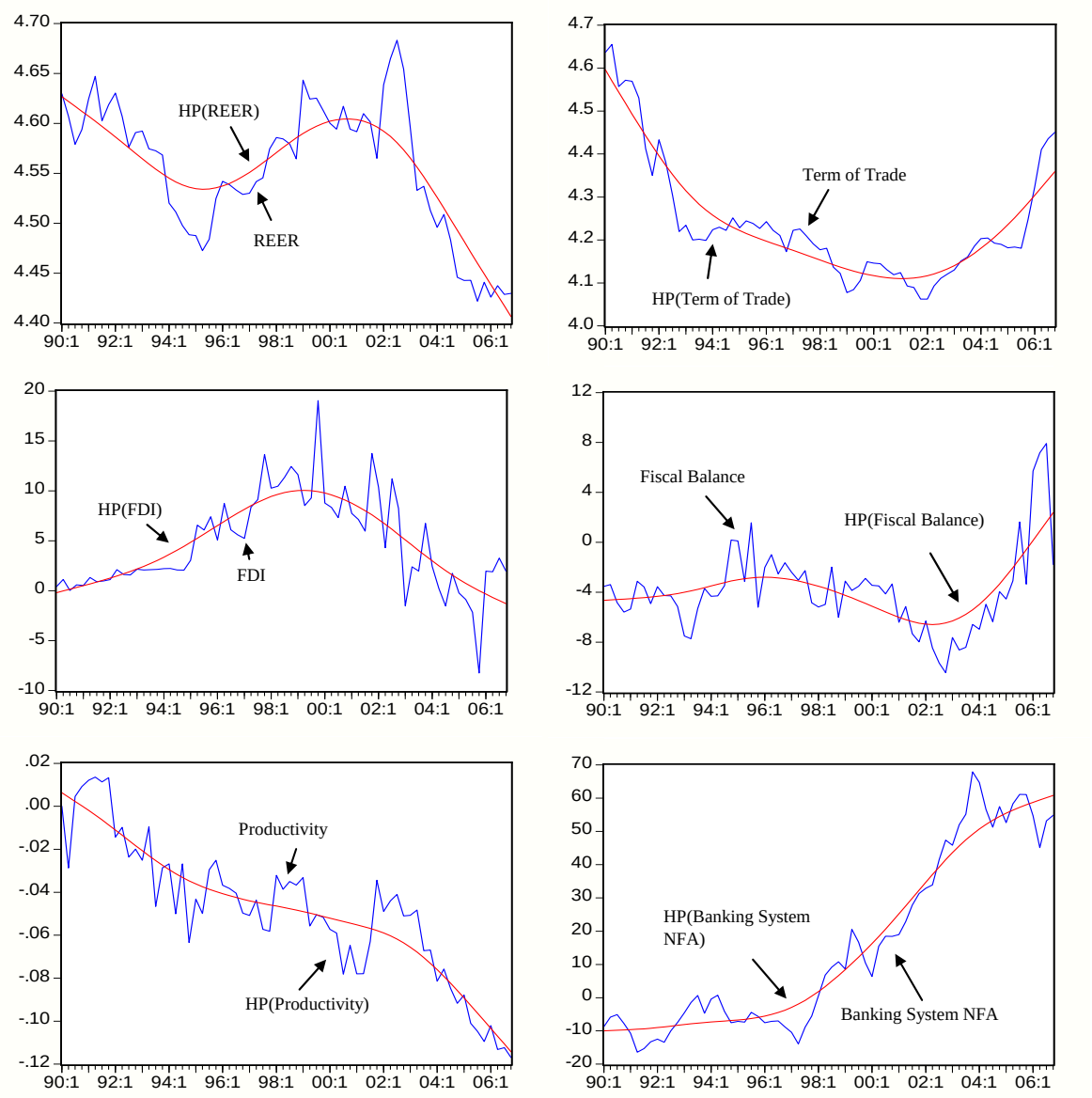
$$\Delta x_t = \eta + \sum_{i=1}^{p-1} \Phi_i \Delta x_{t-i} + \alpha \beta^{'} x_{t-1} + \varepsilon_t$$

where η is a vector of deterministic variables, ε is a vector of white noise disturbances, $\beta^{'} x_{t-1}$ summarizes the long-run relationships, and α and Φ include the short-tem movements.

Appendix Figure 1 shows the evolution of the variables under consideration, which are nonstationary in levels but stationary in first differences. The REER, terms of trade and productivity are introduced in logs, the remaining variables as percentage of GDP. These series are I(1), a necessary condition for applying a VEC model.

[14] Mathisen (2003) finds this later effect significant for the case of Malawi.

Figure 1: REER and Its Determinants 1/



Source: Fund staff estimates.

Note: HP() refers to the HP filter of the variable with lambda=1600

Table 1: Unit Root Test (Augmented Dickey-Fuller)

	Levels		First Difference	
	t-statistic 1/	Lag length 2/	t-statistic 1/	Lag length 2/
Log REER	-1.48	0	-7.47	0
Log terms of trade	-0.86	3	-7.55	0
Log Productivity	-0.16	1	-13.84	0
Fiscal Balances	-1.90	1	-11.49	0
Net FDI	-1.63	2	-7.74	2
Banking Sector NFA	-2.10	0	-7.41	0

1/ A constant and a linear time trend are included in the estimations. Test critical values are: -4.1 at 1 percent level; -3.47 at 5 percent level; and -3.17 at 10 percent level.

2/ Automatic based on Schwarz information criterion (SIC) with at maximum of 10 lags.

Estimation results

The estimated variables have the expected sign and there is evidence of cointegration between the REER and its determinants (Table 2). Given the standard normalization of the real exchange rate coefficient to one, a negative coefficient implies that an increase in the explanatory variable results in an appreciation of the equilibrium real exchange rate. The coefficients of the cointegrating vector (long-run relationship) have the expected sign, and in most cases, they are significant across models with the exception of two variables—productivity and banking system net foreign assets. Although these two variables are significant in model 1, their significance and stability is not uniform across models.[15] With the exception of models 1 and 2, both the trace test and the maximum eigenvalue test show evidence of at least one co-integration relationship at 1 percent level. The models reported, showed satisfactory properties regarding the normality and no-autocorrelation of the residuals, and the lag structure specification of the model.

The sign of the fiscal balance variable captures well the impact of higher gas exports receipts on the fiscal position in Bolivia, and it is consistent with the Dutch disease spending effect. An improved fiscal balance contributes to the sterilization of the foreign currency receipts, thereby reducing real exchange appreciating pressures. Additionally, the sign of fiscal balances shows that a reduction of the current fiscal surplus arising from an increase in government expenditure would likely tend to appreciate the real exchange rate. This is consistent with the Dutch disease spending effect.[16]

[15] Moreover, although the productivity variable has the correct sign, the value of this coefficient is too high in model 1. Theoretically, Balassa Samuelson effect should be around the share of nontradables in the GDP. See MacDonald and Ricci (2003).

[16] Including government expenditure instead of fiscal balances does not change the results.

Table 2 - Bolivia: Estimation Results

	Model (1)		Model (2)		Model (3)		Model (4)	
Number of Cointegrating vectors								
Trace Statistic								
5% significance level	1		1		2		4	
1% significance level	1		1		1		2	
Maximum eigenvalue statistic								
5% significance level	1		1		1		1	
1% significance level	0		0		1		1	
Estimates of the cointegrating relationship 1/ 2/								
Log REER	1		1		1		1	
Log terms of trade	-0.662		-0.864		-1.033		-1.101	
	[-3.43]	***	[-5.94]	***	[-4.80]	***	[-6.75]	***
Net FDI	-0.017		-0.018		-0.021		-0.024	
	[-4.31]	***	[-4.36]	***	[-4.29]	***	[-5.13]	***
Fiscal Balances	0.010		0.014		0.017		0.010	
	[1.06]		[2.26]	**	[2.70]	***	[1.67]	**
Banking sector NFA	-0.002		0.000					
	[-1.42]	*	[0.33]					
Log Productivity	-2.245				-0.676			
	[-1.87]	**			[-0.88]			
Constant	-1.725		-0.776		-0.062		0.244	
Estimates of the speed of adjustment of the real exchange rate								
CointEq1	0.069		-0.056		0.040		-0.034	
	[0.91]		[-0.72]		[0.75]		[-0.63]	

1/ T-stats between brackets. ***, **, and * denote significance at the 1 percent level, 5 percent level, and 10 percent level respectively.
2/ A negative coefficient implies that an increase in the explanatory variable results in an appreciation of the equilibrium real exchange rate.

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