I. The Natural Gas Sector and Dutch Disease[1]

A. Introduction

1. **During the past decade, Bolivia has experienced major increases in its gas reserves, production, and exports**. Following the privatization of the Bolivian state oil company (YPFB) and the establishment of new incentives for investment in 1996, there was an increase in investment in the sector, which resulted in a large discovery of natural gas resources and increases in gas production. In recent years, this process has been followed by a rise in world energy prices of natural gas, as well as, more recently, by a sharp increase in the government's tax take from the hydrocarbons sector. This combination of factors has transformed the Bolivian natural gas sector, so that it now constitutes not only the main component of country's exports (43 percent of total exports in 2006) but also is a large source of revenues for the government (about 27 percent of total revenues in 2006).

2. **These developments raise the possibility of a new case of "Dutch disease."** After all, the term Dutch disease originated with another case of natural gas discovery and its subsequent adverse effects on some sectors of the Dutch economy.[2] This chapter examines the transmission channels of Dutch disease in Bolivia, as well as its main symptom, the appreciation of the real exchange rate. Following the literature (e.g., Corden and Neary 1982), Dutch disease usually spreads via two main channels: the resource movement effect and the spending effect. The resource movement effect is associated with the reallocation of factors from different sectors of the economy (e.g., manufactures) to the natural resources/export boom sector. The spending effect is associated with the impact on the economy of the booming sector's extra income. Both effects, directly or indirectly, tend to imply a real exchange rate appreciation.

3. **The evidence suggests that Bolivia has not yet exhibited important Dutch disease signs, but does point out that some real exchange rate appreciation pressures could already be present.** The real exchange rate has remained relatively stable in recent years, and hence, this primary symptom of Dutch disease is not fully present yet. The capital intensive characteristics of the gas industry, together with the important capital outflows in 2004 and 2005, and the recent sizable fiscal surplus, are some of the factors that help explain the lack of appreciation of the real exchange rate. Nevertheless, the recent increases of both headline and core inflation due to nontradable price increases, and the record levels of net international reserves (NIR) are evidence of real exchange rate appreciation pressures.

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[1] Prepared by Eugenio Cerutti.

[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.

Moreover, an analysis of the equilibrium exchange rate suggests that the real exchange rate may now be below its estimated equilibrium real exchange rate level.

4. **This chapter is structured as follow.** Section B presents a brief description of the natural gas boom; section C discusses Dutch disease transmission channels in the Bolivia context; section D assesses the equilibrium real exchange rate level and its determinants; and section E presents some concluding remarks and policy implications. The appendix contains a description of the criteria and the robustness test performed in the estimation of the equilibrium real exchange rate.

B. Bolivia's Booming Natural Gas Sector

5. **While Bolivia's natural gas sector began production and exports three decades ago, there have been remarkable changes in the sector since the mid-1990s.** Not only the level of gas reserves, production, and exports has increased significantly, but there have been extensive regulatory changes, which range from the privatization of the mid-1990s to the recent increase in the government's tax take from the hydrocarbons industry.[3] These changes, together with the recent increase in international gas prices have increased the economic role of the gas industry in Bolivia.

6. **The size of the increases in gas reserves, production and exports are consistent with a booming sector**. The level of gas reserves increased by 350 percent from 2000 to 2005 (see Table 1). These major gas discoveries catapulted Bolivia to the second country in Latin America, in terms of gas reserves, after Venezuela, but with the additional benefit that Bolivia is closer geographically to the two biggest natural gas consumption centers in South America (Brazil and Argentina). From 2000 to 2006, gas production rose dramatically (380 percent) and even more so the volume of sales to the external market (820 percent). As a consequence, and helped by the increase in gas prices, gas exports increased by 4,600 percent in the same period, and they are now the main component of Bolivia's total exports (43 percent in 2006), representing 15 percent of GDP.

7. These important expansions in production and exports were mainly the result of the high level of investment in gas exploration and exploitation in the late 1990s after a series of important regulatory changes in the hydrocarbons sector. Bolivia privatized most units of the state oil company (YPFB) and established new incentives for investment in 1996 (e.g., lower royalties on new gas fields, taxes on profits but with high investment depreciation schemes, repatriation of profit guarantees, acceptance of international arbitration). These changes, together with the need to satisfy the gas demand of Brazil in the late 1990s, propelled such a transformation of the sector.

[3] See chapter II of the Bolivia Selected Issues, IMF, Country Report No. 06/273.

Table 1. Gas Sector Developments

	1999	2000	2001	2002	2003	2004	2005	2006	Increase in the period 2000-2006	
Natural Gas Reserves (Trillions of cubic feet)	14.1	49.8	70.0	77.2	79.1	76.4	63.9	n.a.	355%	1/
Total Gas Production (Billions of cubic feet)	92	127	186	227	261	362	443	n.a.	380%	1/
Gas Export Volumes (Billions of cubic feet)	43	75	137	173	191	297	368	395	821%	
Gas Export Prices (US$ per 1,000 cubic feet	0.8	1.6	1.7	1.5	2.0	2.1	2.7	4.2	408%	
Total Gas Exports (Millions of US$)	36	122	234	266	381	620	1086	1672	4584%	
Gas Exports as % of Total Exports	3.4	9.8	18.2	20.4	23.9	28.9	38.9	43.3	--	
Gas Exports as % of GDP	0.4	1.5	2.9	3.4	4.7	7.0	11.5	14.9	--	

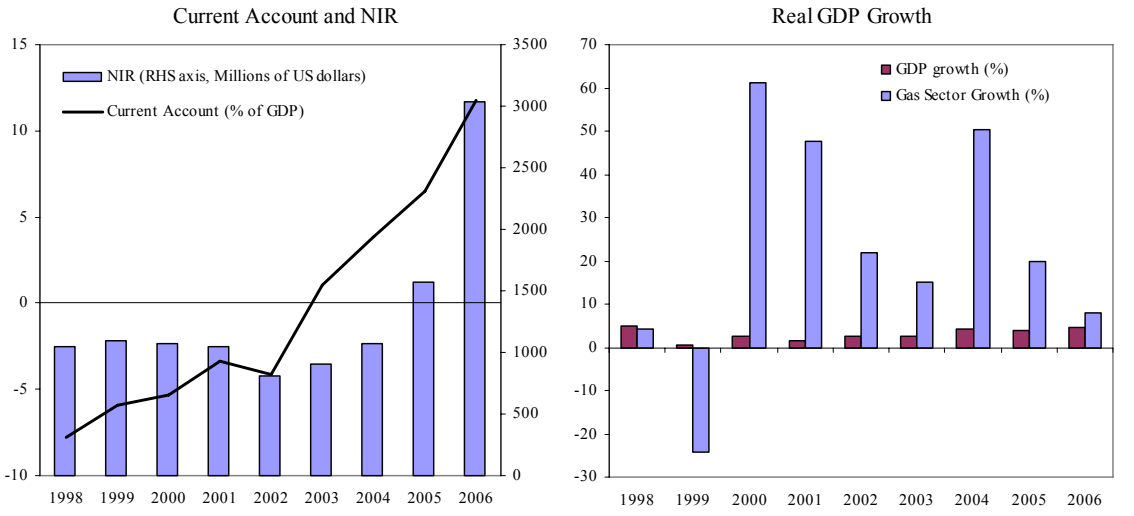
1/ Since there are not available data for 2006 gas reserves and production, the estimations are for the period 2000-05. At end-2005 Bolivia's proven natural gas reserves represented 10 percent of those of Latin America.

8. **Looking ahead implementation of the new gas export agreement with Argentina could increase exports further**. The current government has reached new agreements with foreign oil companies that will allow foreign companies to continue recovering part of their old investments, and they also provide the scope for incentives to new investments in the sector. The latter is essential to fulfill the recent long-term agreement on increased gas exports to Argentina in the coming years. This context suggests that Bolivia not only has experienced a gas export boom but also that the full magnitude of such a boom may not yet have fully materialized. The new contract with Argentina alone would, if its targets were fully achieved, correspond to a 65 percent increase in the volume of gas exports over the next five years.

C. Dutch Disease Risks

9. **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.** On the positive side, for example, Bolivia has reached record high NIR levels (Figure 1) 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. Additionally, the gas sector has become one of the important sources of GDP growth. However, as discussed below, the new resources could also limit the development of other economic sectors in terms of output and factor income.

Figure 1. Bolivia: Macroeconomic Impact of the Gas Sector Boom



Resource movement effect

10. **The economic literature identifies the 'resource movement effect' as the reallocation of factors from different sectors of the economy (e.g., manufactures or other lagging sectors) to the natural resources export boom sector.**[4] 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.[5] This resource reallocation is usually called 'direct de-industrialization' since it does not involve appreciation of the exchange rate. However, resource reallocation 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, causing 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. If more than one factor is mobile across sectors, the sign of the resource allocation effect is not clear, and it could even theoretically cause a real exchange rate depreciation (e.g., the Paradox model described by Corden and Neary 1982).

11. **As is the case in 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

[4] Seminal papers on this topic are Corden and Neary (1982), Corden (1984), and Sachs, J.,and A. Warner (1995). Iimi (2006) and Sala-i-Martin and Subramanian (2003) provide recent country studies.

[5] 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.

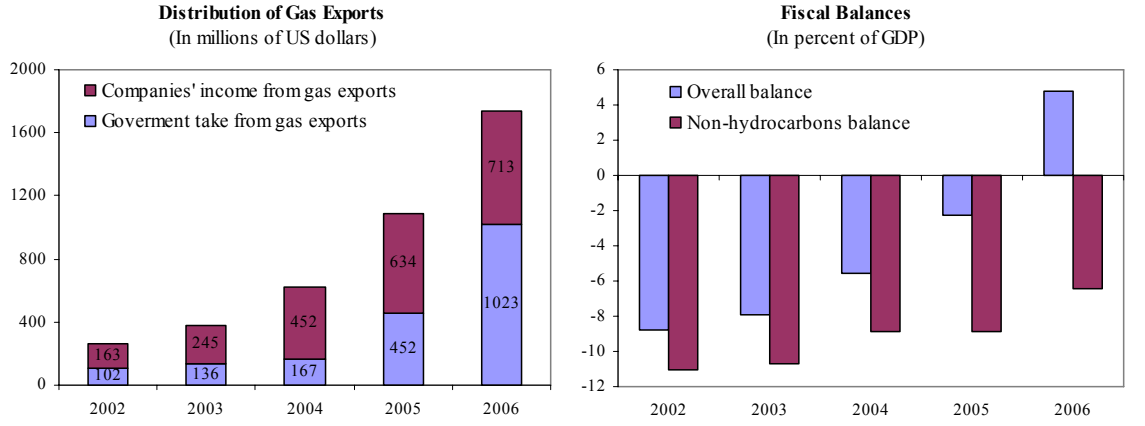
employment (this has not varied much since the late 1990s), but also capital movement between sectors seem to be insignificant, as the capital used in the gas industry is sector-specific and financed by FDI. In other words, there is no mobility of factors between the gas sector and the rest of the economy. In the Dutch disease literature, a sector with these characteristics is usually denominated as an "enclave" sector, as in the case of oil sectors (Corden 1984).

Spending effect

12. **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 of production 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.

13. **Even though gas export receipts have increased and their distribution has changed towards the government, the size of the spending effect so far in Bolivia is not clear, because of the emergence of a large fiscal surplus.** Following the May 2005 Hydrocarbons law and a related decree in May 2006, the participation of the government in external gas receipts increased to about 60 percent of total receipts in 2006. However, the fiscal position shifted, over this period, from an overall deficit of 9 percent of GDP in 2002 to a surplus of 4½ percent of GDP in 2006—or from a non-hydrocarbons deficit of 11 percent of GDP to a deficit of 6½ percent of GDP over the same period (Figure 2). Moreover, even though total public spending increased about 7 percent in real terms, driven by capital expenditure increases, current expenditure decreased by 6 percent in real adjusted terms.

Figure 2: Gas Export Receipts and the Fiscal Accounts



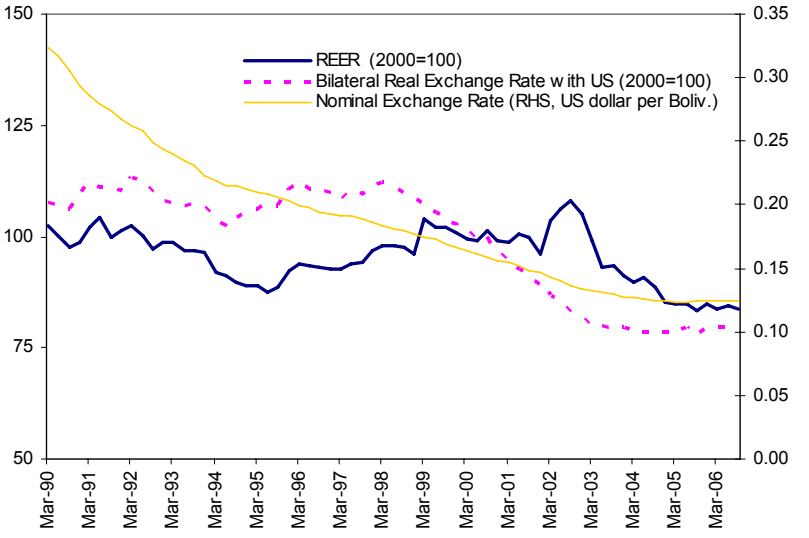
Evolution of the real exchange rate

14. **The CPI-based real effective exchange rate (REER) has not appreciated in recent years.** [6] It displayed a downward trend from 2000 to mid-2005, and a flat trend over the last two years (Figure 3). Changes in the REER have been mostly associated with changes in the nominal effective exchange rate as the inflation rate in Bolivia has been in the single digits since 1997, and very similar to the weighted average inflation of its trading partners. The bilateral real exchange rate with the U.S. dollar exhibited similar behavior during the sample period.

15. **While the behavior of the real exchange rate might seem puzzling given the gas export boom, it seems consistent with the above-described Dutch disease transmission channels.** The depreciating trend through 2005 stemmed from still low prices of gas and 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. In 2006, there was a reduction in capital outflows but this was partially offset by the large increase in public savings—more than half of the increase in international reserves was sterilized by an increase in government deposits. The fact that the government saved most of the extra resources from the gas sector meant that the spending effect was not set in motion.

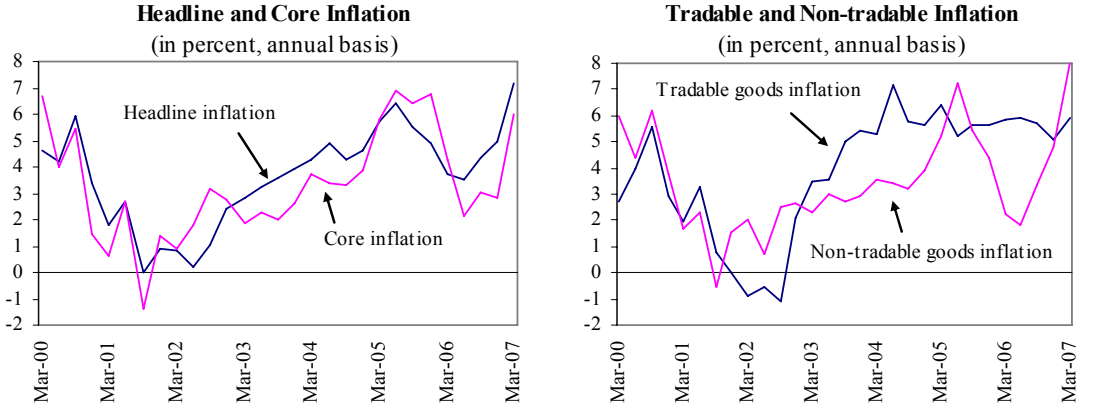
[6] See appendix A for a more detail description of the real effective exchange rate used in this note.

Figure 3: Real and Nominal Exchange Rate
(Increase = appreciation)



16. **Nonetheless, there have been some signals of appreciation pressures in Bolivia in the more recent period.** Although the nominal appreciation of the exchange rate has been relatively small, the change of the direction of the crawling peg reflects appreciation pressures. Moreover, the trend in both headline and core inflation has shifted upwards since mid-2006, with inflation of nontradables driving the change (Figure 4).

Figure 4: Quarterly Inflation in Bolivia during the Period 2000q1-2007q1



D. Equilibrium Real Exchange Rate

17. **An analysis of the equilibrium exchange rate and its determinants facilitates a better understanding of the absence thus far of significant real appreciation.** This is especially relevant for the more recent period since limited exchange rate flexibility under the crawling peg regime could be masking appreciation pressures. Drawing on the recent

literature, in which co-integration techniques are used to identify persistent patterns of co-movements among the equilibrium exchange rate and its determinants, this section estimates a time-varying equilibrium real exchange rate by estimating a vector error correction (VEC) model, through Johansen's (1995) maximum likelihood estimator. The advantage of this procedure is not only that it enables study of the determinants but also that it offers the possibility of measuring the equilibrium real exchange rate level and of quantifying the gap between equilibrium real exchange rate and the prevailing REER.[7]

Determinants of the equilibrium real exchange rate

18. **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.[8]

- ***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.

[7] 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).

[8] 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.

- ***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 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.[9]

- ***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

19. **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.

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

20. **Figure 5 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. The definition of the variables can be found in Appendix A, together with the Augmented Dickey-Fuller unit tests that suggest that the series are I(1), a necessary condition for applying a VEC model.

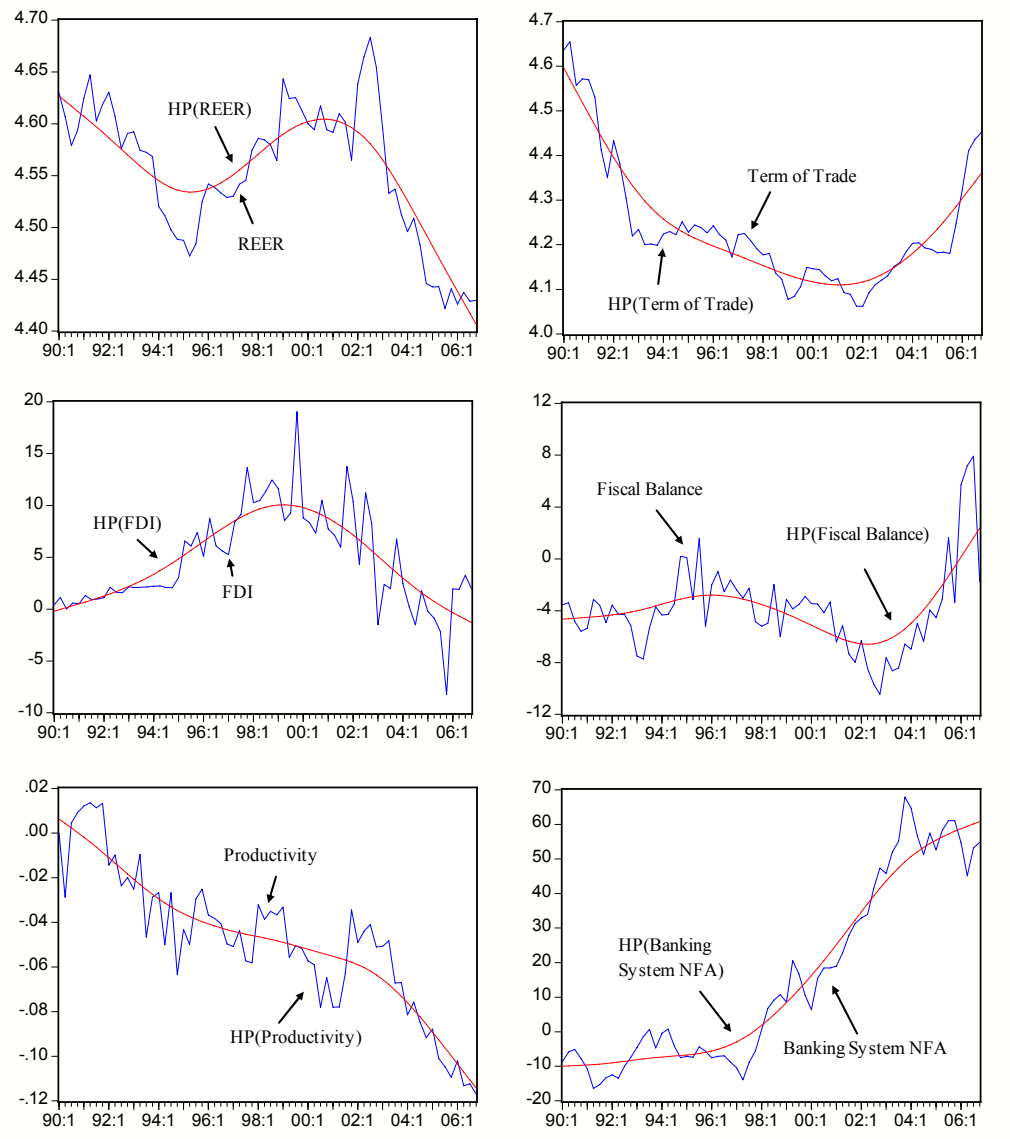
Estimation results

21. **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.[10] 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, especially model 4, showed satisfactory properties regarding the normality and no-autocorrelation of the residuals, and the lag structure specification of the model (set at 4 lags—see Appendix B). The results suggest that:

- A 1 percent increase in the terms of trade has an effect of about 1 percentage point appreciation on the REER.
- A 1 percent increase in FDI as a percentage of GDP has an effect of a 2 percent appreciation on the REER
- A 1 percent increase in the Fiscal Balance as a proportion of GDP has a 1 percent depreciation on the REER.

[10] 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 MacDonal and Ricci (2003).

Figure 5: REER and Its Determinants 1/



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

22. **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.

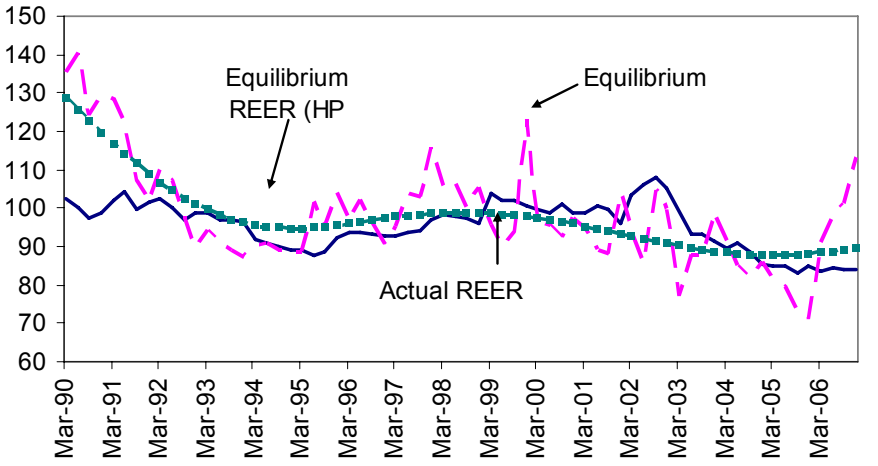
Table 2 - Bolivia: Estimation Results

	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.

23. **The estimated long-run relationship between the REER and its determinants allows an estimation of the equilibrium real exchange rate**. Ideally, this estimation should be defined as the level of REER that is consistent, in the long-run, with the equilibrium values of its determinants. Since it is not possible to know the equilibrium values of each determinant, the literature usually reports the estimated equilibrium exchange rate using series of each unmodified variable and their smoothed series (e.g. using the standard Hodrick and Prescott filter with lambda=1600—see Figure 5). The HP smoothed series variables are a proxy for the long–run equilibrium values of these variables since the filter eliminates short-term fluctuations. Using Model 4 estimations, Figures 6 and 7 show the estimated equilibrium real exchange rate and the gap with the REER, respectively. The REER and the equilibrium real exchange rate seems to be close to each other most of the time, except in the beginning of the 1990s, when the higher terms of trade seem to have played a significant role.

Figure 6: REER and Equilibrium REER

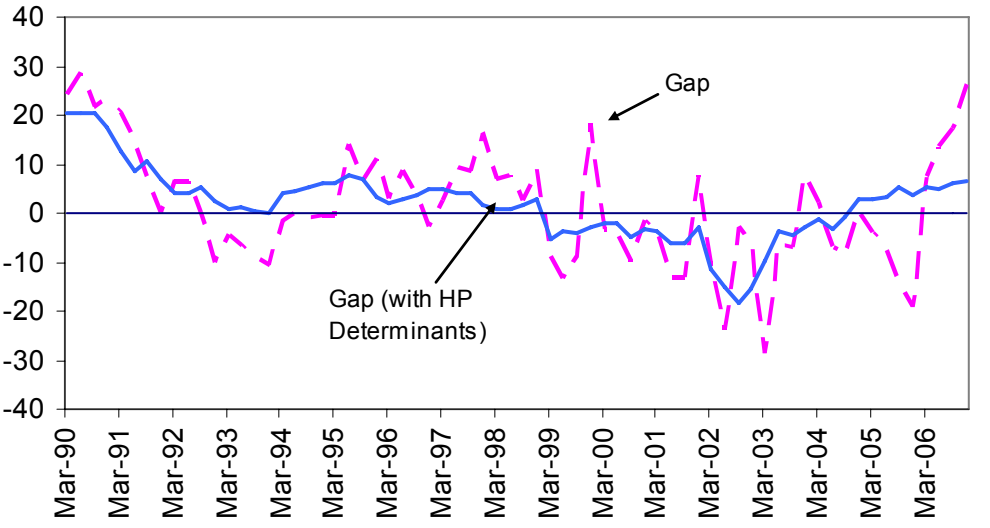


24. **For period 2000–05, the analysis suggests that the negative trend in the REER was an equilibrium phenomenon.** The evolution of the determinants, especially the negative trend in net FDI during the period 2000–05, seems to explain the negative trend in the equilibrium real exchange rate.

25. **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 overvaluation 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. At the same time, comparison with the smoothed equilibrium level might be underestimating the gap as recent trends are not fully captured by the HP series (e.g. the recent changes in the trend of net FDI are not captured by the HP filter yet; see Figure 5).[11]

[11] Although not statistically significant, the coefficient of the speed of adjustment in Model 4 suggests that the adjustment is slow, about 50 percent of the deviation would be corrected in about 4 years.

Figure 7: Gap between REER and Equilibrium REER 1/



1/ Gap in percent of equilibrium level

E. Concluding Remarks

26. **The above analysis suggests 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. Second, 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). Finally, beginning in 2006, appreciation pressures emerged bur 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. In particular, maintaining a prudent fiscal policy, especially by containing the growth of current spending, will be instrumental for avoiding intensified appreciating pressures.

Appendix I—Data Set

The dataset consists of quarterly data from the first quarter of 1990 to the fourth quarter of 2006 for Bolivia and its main trading partners. The Bolivian main trading partners for the period 1990–2005 and their average weight are the following:

Country	Weight	Country	Weight
United State	21.6	Mexico	1.4
Brazil	17.2	Italy	1.4
Argentina	12.8	Sweden	1.3
Peru	6.6	Spain	1.2
Japan	6.2	Korea	1.0
Chile	5.5	France	0.9
Colombia	5.0	Canada	0.9
United Kingd	4.1	Ecuador	0.7
Germany	2.7	Uruguay	0.7
Venezuela	2.7	Netherland	0.6
Switzerland	2.6	Belgium	0.6
China	1.7	Paraguay	0.5

Source: WITS trade dataset.

Variables

- **Log REER:** Logarithm of the Real Effective Exchange Rate. It is calculated using the above weights and CPI and exchange rate data from INS.
- **Log Terms of Trade:** Logarithm of terms of trade. Source: INE.
- **Log of Productivity:** Logarithm of the Bolivian real GDP per capita relative to its 10 main trading partners. Source: INE and WEO. Each country GDP per capita is normalized to 1 in 1990.
- **Net FDI:** Net FDI inflows and outflows as a proportion of GDP. Source IFS (lines 78BD and 78BE) and INE.
- **Banking Sector Net Foreign Assets:** Net Banking Sector foreign assets as a proportion of GDP. Source IFS (line 31n) and INE.
- **Fiscal Balances:** Overall general government fiscal balances as a percentage of GDP. Source UPF and INE.

Appendix II—Robustness Procedures of the VEC Estimation

Table 1 shows the variables included in the analysis are I(1), a necessary condition for applying a VEC model.

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.

Table 2 shows the normality test of the residuals of model 3 and 4. Model 4 accepts the normality of the results. Instead, model 3 does not accept the normality of the residuals because it does not pass the kurtosis test. However, based on Paruolo (1997), the Johansen results are not affected when the normality test is rejected for rejecting kurtosis rather than skewness. It is worthwhile to highlight that the hypothesis of autocorrelation in the residuals is rejected at all plausible lags.

Table 2: VEC test for Skewness, Kurtosis, and Normality of the Residuals 1/2/

	Model (3)		Model (4)	
	Degr. Freedom	Probability	Degr. Freedom	Probability
Skewness	5	0.95	4	0.51
Kurtosis	5	0.00	4	0.02
Normality	10	0.00	8	0.07

1/ Ho: residuals have no skewness, no-kurtosis, and no normal.

2/ Skewness and Kurtosis are based on joint -Chi-square test, Normality is based on joint Jarque-Bera (Lutkepot orthogonalization).

Table 3 also indicates that all four lags are necessary in model 4 VECM specifications. The lag structure appears to be correct if a fifth lag is introduced, the test accepts the hypothesis that the additional lag is jointly insignificant across equations. Even though model 3 does not show statistical evidence that four lags are enough, it has been estimated with four lags due to the use of quarterly data and the short sample period available.

Table 3. VEC Lag Exclusion Wald Test 1/ 2/

	Model (3)		Model (4)	
	Joint	Joint	Joint	Joint
DLag 1	80.71	97.68	56.26	64.38
	[0.00]	[0.00]	[0.00]	[0.00]
DLag 2	54.13	83.46	34.92	48.36
	[0.00]	[0.00]	[0.00]	[0.00]
DLag 3	41.30	52.76	27.94	31.84
	[0.00]	[0.00]	[0.03]	[0.01]
DLag 4	36.54	67.54	33.97	40.36
	[0.00]	[0.00]	[0.00]	[0.00]
DLag 5		44.54		20.14
		[0.00]		[0.21]
df	25	25	16	16

1/ Ho: Lag's coefficients are jointly non-significantly different from 0 (i.e. can be excluded) if probability value is larger than chosen significance level.

2/ Numbers in brackets are probability values.

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