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Mauritius: Selected Issues

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MAURITIUS

Selected Issues

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Approved by African Department

June 18, 2008

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I. Assessing the External Competitiveness of Mauritius[1]

A. Introduction

1. **Mauritius, a relatively undiversified but very open small island economy dependent on the external sector, has been facing a triple negative terms of trade shock** due to (1) the phasing out of the Multi-Fiber Agreement starting in 2004, (2) the reduction in sugar price guarantees from the European Union starting in 2006, and (3) higher world commodity prices, especially for food and petroleum. As export growth dwindled and the economy began adjusting to the new external environment, the current account (CA) deficit has worsened (to an average of 4 percent of GDP for 2004–07). Growth has been low by historic standards (averaging 3.6 percent of GDP between 2001 and 2007 compared to 4 percent in the 1990s and 5 percent in the 1980s).

2. **Recent performance raises questions about the competitiveness of the Mauritian economy and what needs to be done to ensure external stability and reduce vulnerabilities**. One key measure of competitiveness is the extent to which the real exchange rate (RER) is aligned with its equilibrium value. Assessment of the equilibrium real exchange rate (ERER) is important because there is evidence that misalignment can undermine growth (Cottani, Cavallo, and Khan, 1990; Razin and Collins, 1997; Fosu, 2000). RER misalignment can affect growth by altering domestic and foreign investment decisions, thereby affecting capital formation and the tradable sector. Furthermore, an RER misalignment, if allowed to worsen, could lead to a disruptive adjustment. Competitiveness assessments also look at external sector outcomes, business climate indicators, and production costs.

3. **This paper assesses the external competitiveness of Mauritius over the period 1980–2007, with particular attention to the most recent years**.[2] We estimate the ERER using the macroeconomic balance approach, the single-equation equilibrium exchange rate approach, and the capital-enhanced equilibrium exchange rate approach. A wealth of structural competitiveness indicators are also analyzed.

4. **Our findings indicate that the real exchange rate at the end of 2007 was broadly in line with its equilibrium value (as determined by economic fundamentals).** We also find that Mauritius fares better than comparator countries in terms of structural competitiveness, especially in terms of the business climate.

5. In what follows, Section B describes the evolution of Mauritius' exchange rate regimes going back to its colonial past. In Section C three econometric methods are applied

[1] Prepared by Patrick Imam and Camelia Minoiu.

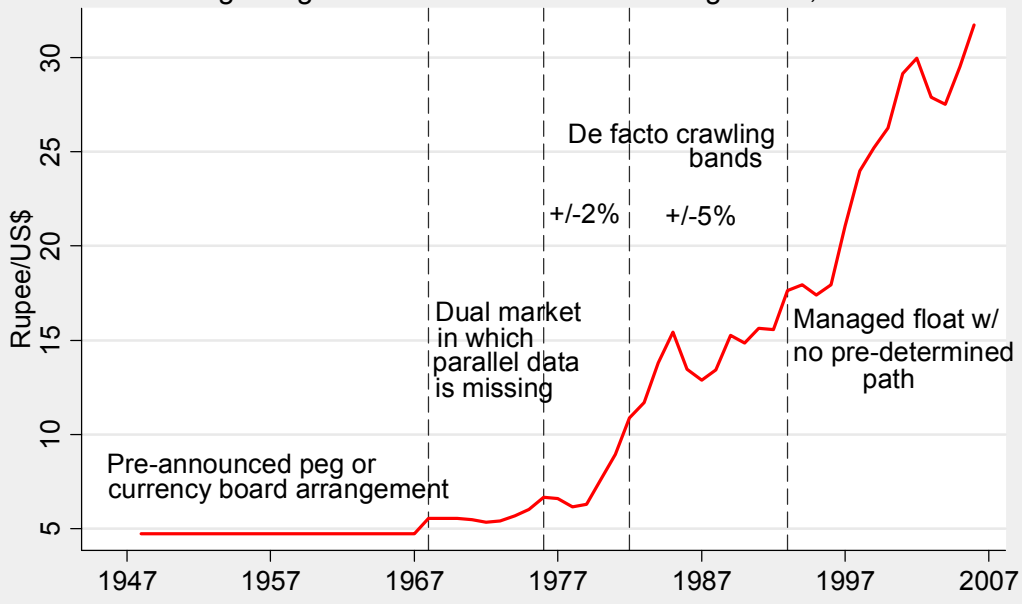
[2] The analysis uses annual data until 2007 and monthly data up to December 2007.

to estimate the equilibrium value of the RER. Section D surveys the country's competitiveness using various structural indicators, and Section E concludes.

B. The Evolution of the Mauritius Exchange Rate

6. **Mauritius has adopted a variety of exchange rate regimes over time.**[3] As part of the British Empire it did not initially have its own currency, but the government established a currency-board-like system in 1848. Until 1870 Mauritius switched between the pound sterling (gold) and the Indian rupee (silver). Between 1878 and 1934, Mauritius was part of a common monetary union with India, so the legal tender was the Indian rupee. This reflected the inflow of Indian rupees with Indian immigrants to Mauritius. During that period the currencies of British colonies were almost all linked to the pound sterling through currency boards. When the United Kingdom abandoned the gold standard in September 1931, most British colonies did likewise. In 1934, Mauritius followed the lead of several other British colonies by introducing its own currency, but still under a currency board pegged to the pound sterling. This regime lasted until November 1967 (Figure 1).

Figure 1
Exchange Regimes and the Nominal Exchange Rate, 1948-2007



Source: Reinhard and Rogoff (2004) and AREAER.

7. **In preparation for independence, the Mauritian rupee moved from a currency board to a peg to the pound sterling in November 1967.** A dual market co-existed,

[3] This section draws on Reinhard and Rogoff (2004); the *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER*), and Mauritius Staff Reports going back to the late 1960s.

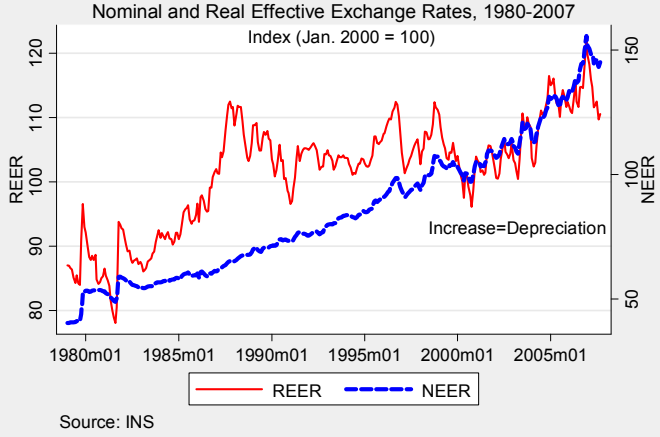
however, separating foreign exchange markets for capital transactions from CA transactions. Capital transfers were subject to a stamp duty initially set at 15 percent. With gold convertibility ending when the dollar standard was abandoned in 1971, trade diversifying away from Britain, and the weakness of the pound sterling, Mauritius left the sterling area in June 1972 and established a central exchange rate with Special Drawing Rights (SDRs). It maintained a second exchange rate for the stamp duty rate for capital transfers. In January 1976 Mauritius officially pegged the rupee to the SDR, with a 2 percent band. In practice, the exchange rate for official purposes was a crawling band around the U.S. dollar. Following a period of overvaluation, the rupee was devalued in 1979 and 1981. The stamp duty on transfer of capital was raised in July 1981 from 36 percent to 45 percent.

8. **In June 1982 the Mauritian rupee was officially de-linked from the SDR and pegged to a trade-weighted basket of the currencies of its major trading partners,** but the composition of the basket was not disclosed. The change was part of the broad liberalization launched under an IMF program. The exchange rate remained pegged de facto to the U.S. dollar, with a 5 percent band. The limit on the sale of foreign exchange for travel was administered as a capital control. Until the early 1990s Mauritius maintained a multiple currency practice in the form of a 15 percent tax on some capital remittances.

9. **Exchange rate restrictions were lifted in 1992 and transactions involving foreign currencies were fully liberalized in July 1994.** Beginning in 1992, the crawling band was de facto maintained around the U.S. dollar but narrowed to 2 percent. The capital transfer tax was abolished. Since the mid-1990s Mauritius has maintained a managed float, and the Bank of Mauritius intervenes solely to smooth exchange rate fluctuations rather than alter the trend.

10. **Post-Bretton Woods the nominal exchange rate (NER) continuously depreciated against the U.S. dollar (Figure 2).** This reflected higher inflation in Mauritius than in its trading partners. Monetary policy accommodated the higher inflation differentials by letting the NER depreciate to achieve a stationary REER.

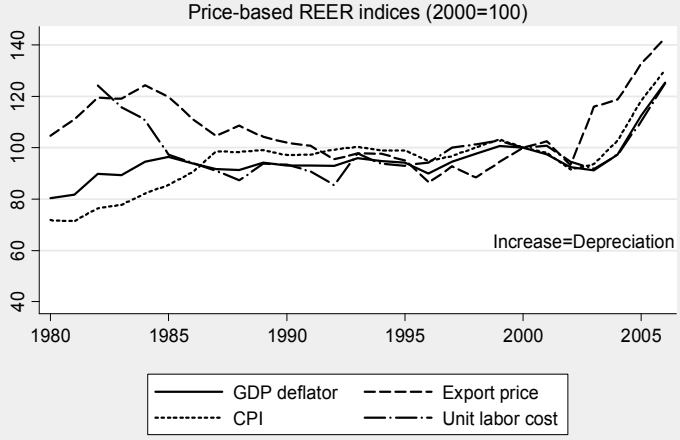
Figure 2
Nominal and Real Effective Exchange Rates, 1980-2007



Source: INS

11. **An examination of various price-based REER indices relative to its main trading partners indicates that Mauritius's competitiveness has improved markedly since 2002** (Figure 3). [4] The real exchange rates are computed relative to an aggregate of trading partners[5] and are adjusted for inflation of consumer prices, GDP deflator, unit labor costs, and export prices. Figure 3 shows that the various price-based REER indices move closely together over time. After staying relatively flat throughout the 1990s they suggest sharp depreciation since 2002. This path is a consequence of negative terms of trade shocks, which required it so as to restore the economy to sustained growth (Funke, Granziera, and Imam, 2008).

Figure 3
Price-based REER indices (2000=100)



Source: Mauritius Central Statistics Office, INS, and Staff estimates.

C. Empirical Analysis of the Equilibrium Exchange Rate

12. **Assessing the departure of the actual level of the REER from its equilibrium value is key to identifying external imbalances.** The desired level of competitiveness is attained when the REER is consistent with both internal balance—low unemployment and low inflation—and external balance—a sustainable long-term CA position. If a country faces persistently high unemployment or a persistently high CA deficit, the REER must be adjusted—through NER depreciation or subdued wage growth—to restore equilibrium.[6] In this section we present the results of three econometric approaches to identifying equilibrium value and assessing external competitiveness: the macroeconomic balance approach (FEER-MB), which assesses a country's deviation from equilibrium by observing by how much the

[4] The terms "real depreciation" and "competitiveness" are often used interchangeably. However, as shown by the experience of Germany and Japan in the 1970s, it is possible for the REER to appreciate even when competitiveness is rising. This happens, for instance, when productivity growth outpaces the appreciation.

[5] See list of trading partners in Data Sources and Definitions.

[6] Success in explaining exchange rate behavior largely depends on the time horizon chosen. Ever since the seminal work of Meese and Rogoff (1983), economists generally agree that models incorporating economic fundamentals do not outperform random walks in predicting exchange rate behavior. This in turn implies that exchange rates are not expected to adjust in the short run to equilibrium levels determined by fundamentals.

CA is projected to deviate from its sustainable norm implied by the fundamental determinants of saving and investment; the single-equation equilibrium exchange rate approach (FEER-SE), which assesses the equilibrium exchange rate based on a country's macroeconomic fundamentals; and the capital-enhanced equilibrium exchange rate approach (CHEER), which adds the uncovered interest parity (UIP) condition to analyzing deviations from equilibrium. These methodologies assess the exchange rate misalignment from different angles, but in the case of Mauritius (see below), they lead to the same conclusions.

Macroeconomic Balance Approach (FEER-MB)

13. **The FEER permits the calculation of the ERER as implied by medium-term macroeconomic fundamentals** (Edwards, 1989; Williamson, 1994; Isard and Faruqee, 1998; Faruqee, Isard, and Mason, 1999; Driver and Westaway, 2005). The FEER abstracts from the influence of transitory factors. We focus on the REER that secures external balance for Mauritius in the sense of CA sustainability.

14. **The analysis consists of three steps.** First, we estimate a model of the determinants of the CA balance using panel data for 140 countries between 1980 and 2005. Second, we project the CA norm for Mauritius over the medium term (2008-13) using coefficient estimates from the model and staff's forecast for economic fundamentals. In the last step, we determine the exchange rate adjustment that would be needed to close the gap between the CA norm and the underlying CA (measured using WEO projections for the medium-term) based on estimated trade elasticities.

15. **To project the CA norm, coefficient estimates based on three panel estimators are considered: pooled OLS, random effects, and fixed effects** (Appendix Table 1).[7] The results are reassuring: the coefficients do not vary much across methods. Note, nevertheless, that the purpose of the model is not to identify the causal effect of macroeconomic variables on the CA balance. Rather, it is to obtain strong statistical covariates of the CA balance so as to interpret the predicted values as reflecting the country's economic fundamentals.

16. Coefficient estimates from the panel analysis accord with economic theory and intuition in terms of signs and magnitude.[8] An increase in the overall fiscal balance-to-GDP ratio predicts a CA balance higher by one third of a percentage point of GDP; and a

[7] We restrict the analysis to 1980–2005 to obtain as large a sample of countries as possible. The panel analysis helps improve the precision of coefficient estimates by using both within- and between-country variation. Earlier data are also omitted because for most countries they are sparse.

[8] The coefficients are robust to estimation in different subsamples relevant for Mauritius, such as middle-income countries and small open island economies. Furthermore, a Hausman test yields no evidence of systematic differences between the random and fixed effects coefficient estimates.

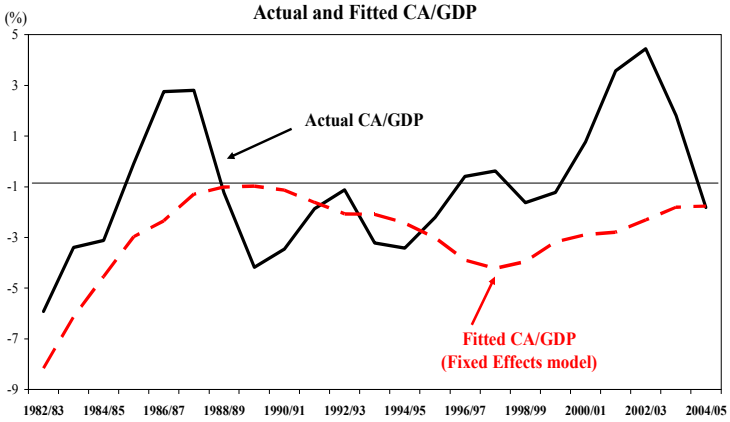
higher NFA/GDP position is also associated with a higher CA balance but the coefficient size is much lower. While higher income (relative to the U.S.) improves the CA balance, higher per capita growth causes it to deteriorate. The demographic control variable shows that an increase in the population growth rate by 1 percentage point is associated with a CA balance that is lower by ½ percentage point of GDP. Finally, countries that export fuel, have been affected by the East Asian crisis, or are global financial centers have substantially higher CA surpluses over the period; the reverse is true of offshore financial centers (such as Mauritius), whose CA balances are 5–6 percentage points lower than in onshore centers.

17. **It appears that the REER has been close to its equilibrium value for much of the period (1980–2005) and that the exchange rate policy of Mauritius has been appropriate given the economic fundamentals.** Figure 4 plots the actual CA balance against that fitted from the fixed effects model. Over the period analyzed, the average fitted CA balance is slightly below the average realized CA balance. This implies that for the two to have been aligned historically, a slight real exchange rate appreciation would have been required.

18. **Looking ahead, the macroeconomic balance approach suggests that the level of the REER is broadly appropriate as the projected CA deficit is close to the underlying CA norm** (Figure 5). Over the medium term (2008–13), the CA norm (determined by medium-term fundamentals and coefficient estimates from panel regressions) is close to the underlying CA (based on medium-term WEO projections). Therefore, the method predicts that little or no RER adjustment will be necessary.[9]

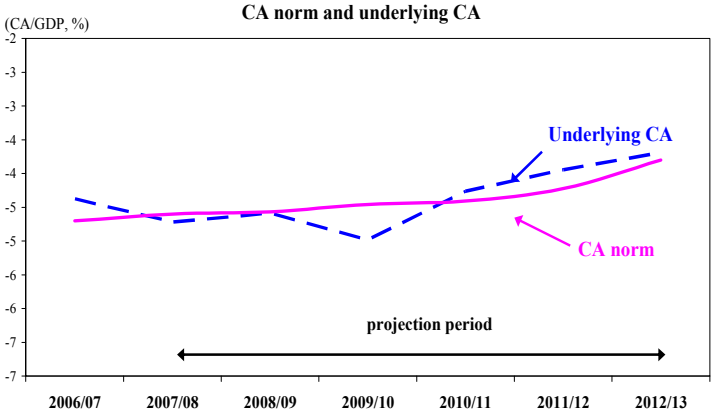
[9] For completeness, trade elasticities were estimated using single-equation error correction models for exports and imports. We obtained an export elasticity of 1.6 and an import elasticity of –1.1 over the longest period for which we have complete data (1977–2006). Using the formula *(export elasticity)* × *(EXP/GDP)-(import elasticity)* × *(IMP/GDP)* and average trade ratios over the same period (of 57 and 60 percent), we found that the CA elasticity with respect to the exchange rate is 1.6. An alternative set of estimates (3.5 and -0.8, respectively) was presented by Barkbu (2006).

Figure 4. Macroeconomic Balance Approach:
Actual and Fitted CA/GDP



Note: the actual CA/GDP is expressed as a three-year moving average.
Source: Staff estimates.

Figure 5. Macroeconomic Balance Approach:
CA norm and underlying CA



Note: the underlying CA is expressed as a three-year moving average and is stripped of temporary factors such as purchases of aircraft and ships.
Source: Staff estimates.

Single-Equation Equilibrium Exchange Rate Approach (FEER-SE)

19. **Here we analyze the ERER by estimating a reduced-form structural relationship between the REER and a vector of economic fundamentals.**[10] The concept of equilibrium used is again medium-term. We assess whether the level of the exchange rate reflects the value of the fundamentals. The data consist of time series for the period 1960–2007. For purposes of estimation, we use the autoregressive distributed lag (ARDL) approach to cointegration developed by Pesaran and Shin (1999) and Pesaran, Shin, and Smith (2001).[11]

20. **The starting point is a general model comprising the following variables: terms of trade, government consumption, openness, relative productivity, interest rate differential, NFA position, and a capital controls dummy for post-1994 liberalization.** Using a general-to-specific methodology, we eliminate those variables that do not appear to have a cointegrating relationship with the REER. Notably, data paucity over the period analyzed precludes a reliable analysis of the interest rate differential, notwithstanding its importance. We also find that the NFA/GDP ratio, the capital account liberalization dummy, and relative productivity do not yield statistically significant or meaningful results in the long-run model.

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[10] The approach is similar to estimating a behavioral equation in which expected future movements in the real exchange rate are determined by fundamentals and short-run behavior by the risk premium and the interest rate differential (also known as the BEER). The focus of this section is on medium-term determination of the ERER rate rather than short-term.

[11] This framework allows testing for cointegration when it is not known with certainty whether regressors are stationary, integrated of order 1, or mutually cointegrated.

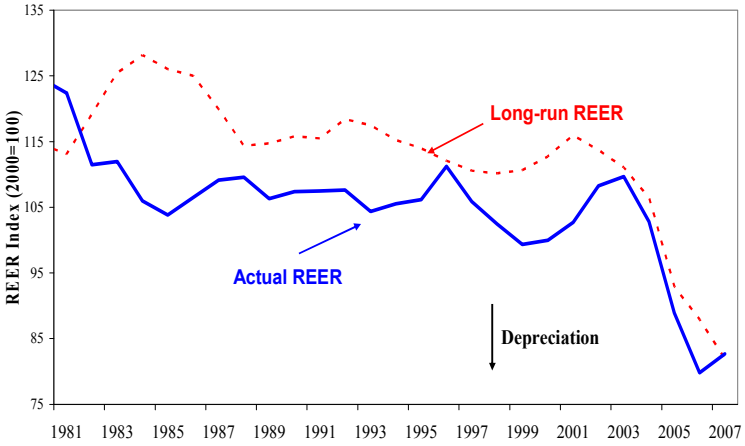
21. **We identify long-run cointegrating relationships between the REER and three variables: terms of trade, openness, and government consumption**.[12] We report only one parsimonious specification (which preserves degrees of freedom), as follows:

$$\ln(REER)_t = 0.53 \times \ln(TOT)_t - 0.97 \times \ln(OPEN)_t - 0.92 \times \ln(GCONS)_t \quad (1)$$
$$\text{[t-stat]} \qquad [2.22]^{***} \qquad [-3.51]^{***} \qquad [-2.19]^{***}$$

First, as expected, the terms of trade of goods have a positive coefficient, since a positive shock improves the trade balance and the resulting higher domestic demand pushes up the prices of nontradables, leading the real exchange rate to appreciate. Second, an increase in openness (which can be seen as a proxy for the easing of trade restrictions) is associated with lower domestic prices, hence a real depreciation. Third, a rise in government consumption (about 15 percent of GDP) is associated with real depreciation (suggesting that the government spends primarily in the tradable sector).

22. **The single-equation equilibrium exchange rate analysis suggests that the Mauritian rupee has been close to its equilibrium value since 2003 (Figure 6).** This implies that exchange rate policy has been appropriate for the past several years. To qualify our findings, let us mention that ensuring alignment between the actual and equilibrium value of the real exchange rate should not be viewed as a policy goal in itself. Temporary deviations of the exchange rate from the level implied by fundamentals can be beneficial, as illustrated by the finding that an appreciating currency can put a brake on GDP growth or make it difficult to sustain periods of growth acceleration (Hausman,

Figure 6. Single Equation Approach: Actual vs. Equilibrium REER



Note: The price measure is the GDP deflator.
Source: Staff estimates.

[12] Openness is defined as the ratio of total trade (exports + imports) to GDP. Government consumption is also defined as a ratio to GDP. The estimation was undertaken using the ARDL program developed by Chudik and Mongardini (2007) with a lag structure given by ARDL(1,0,0,0). The SBC (Swartz Bayesian Criterion) is the information criterion that helped select the model. Linear interpolation was used to fill in gaps in the data series. According to the bounds test for the existence of a level relationship, the null hypothesis of no such relationship is comfortably rejected at the 1 percent level for all models. Augmented Dickey-Fuller (ADF) tests for unit roots are shown in Appendix Table 2.

Pritchett, and Rodrik, 2005), and a depreciating currency can relaunch growth (Rodrik, 2007).

Capital-Enhanced Equilibrium Exchange Rate Approach (CHEER)

23. **To better assess the recent evolution of the Mauritian rupee, we apply the CHEER approach to monthly data between July 1995 and December 2007**. The CHEER approach is based on the idea that CA imbalances generated by real shocks must be financed through the capital account (Johansen and Juselius, 1992; Juselius, 1995; Juselius and MacDonald, 2004; MacDonald, 2000). It has the advantage of accounting for the interplay between the two components of the balance of payments by combining two parity conditions: purchasing power parity (PPP) and uncovered interest parity (UIP). Therefore, the extent of over- or undervaluation is defined as the variation in the exchange rate which is unexplained by interest rate differentials. Mauritius having opened up its capital account, the CHEER approach, unlike the others, captures capital flows as a factor affecting the ERER.

24. **In the CHEER approach, departures from PPP are explained with real interest rate differentials**. First, note that the UIP condition equalizes nominal rates of return on domestic and foreign currency assets. Therefore, the expected change in the nominal exchange rate is determined by the interest rate differential and any risk premium (e.g., for country risk) as follows:

$$s_t = E_t s_{t+1} + (i_t - i_t^*) + \sigma_t \tag{2}$$

where s_t is the (log) nominal exchange rate (MUR/US$); $(i_t - i_t^*)$ is the interest rate differential for T-bills; σ_t is the risk premium; and E_t is the expectations operator. Assuming $\sigma_t = 0$, it follows that if domestic interest rates are above foreign rates, the domestic currency must be expected to depreciate to equalize rates of return. Imposing $\sigma_t = 0$ and subtracting the expected inflation differential from both sides of the equation, we have

$$e_t = E_t e_{t+1} + (r_t - r_t^*) \tag{3}$$

where e_t is the real exchange rate and $(r_t - r_t^*)$ is the real interest rate differential. (For a visual interpretation of the two parities relative to the U.S., see Appendix Figure 1.)

25. **We estimate a vector autoregressive model (VAR) of the nominal exchange rate, the inflation differential, and the interest rate differential.** The vector of monthly variables is given by

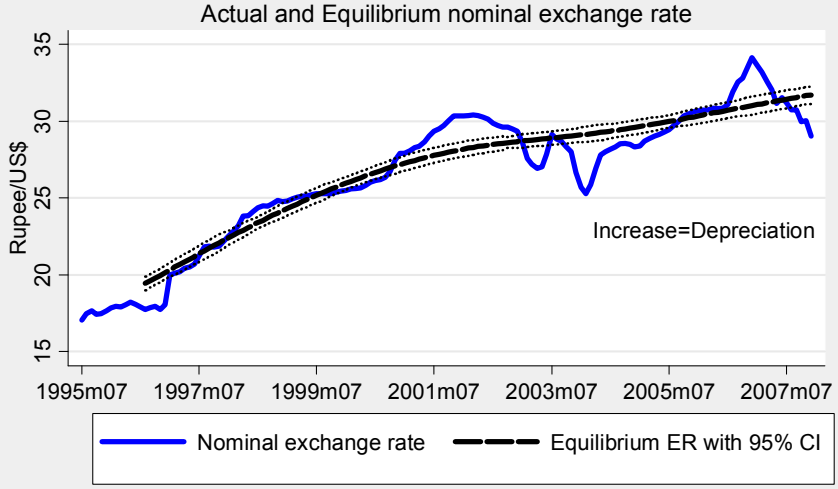
$$\left[s_t, \Delta p_t, \Delta p_t^*, i_t, i_t^*\right] \sim I(1) \tag{4}$$

where Δp_t and Δp_t^* represent inflation in Mauritius and the U.S. (measured by the consumer price index). The interest rates are yields on the 90-day T-bill. All variables

considered (nominal exchange rate, prices, and interest rates) have unit roots in the level series (Appendix Table 3). We use the Hodrik-Prescott filter to obtain the equilibrium nominal exchange rate.[13]

26. **The CHEER approach suggests that the MUR/US$ spot exchange rate has been in line with economic fundamentals since July 1995 (Figure 7).**[14] Our findings based on the CHEER approach therefore confirm those from the previous methods, underlining the result that exchange rate policy in Mauritius has been appropriate in recent years. The nominal exchange rate has, however, been volatile around the estimated equilibrium, depreciating above the trend in mid-2006 because of a large real interest rate differential with the U.S. dollar. The rupee started to appreciate again at the end of 2006 as monetary policy became more credible once an independent Monetary Policy Committee was established. The cuts in U.S. interest rates since August 2007—the beginning of the rupee's deviation from long-run equilibrium—was not followed by commensurate reductions in Mauritian interest rates, leading to a rising positive interest rate differential. This explains the continued appreciation of the rupee against the U.S. dollar and its slight deviation from trend toward the end of 2007.

Figure 7. CHEER Approach
Actual and Equilibrium nominal exchange rate



Note: Last data point is December 2007.
Source: Staff estimates.

D. Structural Indicators of Competitiveness

27. **In addition to equilibrium exchange rate methods, a comparative analysis of nonprice indicators may be essential in portraying a country's relative competitiveness.** Indicators such as institutional quality (reflecting labor market flexibility, access to finance, or rule of law) can offer valuable insights on where bottlenecks lie and may help policy-

[13] Our approach closely follows Juselius and MacDonald (2004) and Heerah-Pampusa and Hurree-Gobin (2006).

[14] Granger causality Wald tests (Appendix Table 4) indicate that the nominal exchange rate is Granger-causally affected by the T-bill differential.

makers to identify potential policy reforms. Caution is required in interpreting this section's results: Structural indicators of competitiveness can be useful in identifying binding constraints on growth but often conceal problems because economic agents often adapt to the environment by addressing binding constraints themselves. For example, power outages are known to be a problem in Mauritius, but surveys fail to show this as a problem because most firms have bought expensive power generators, thus bypassing the constraint (Clarke et al, 2006). While typical surveys (and indicators based on them) would thus suggest that power outages are not an issue for normal business functioning, in reality an upgrade of the power system is desirable to bring down input costs.

28. **In analyzing several composite competitiveness indicators we find that Mauritius is one of the best performers in sub-Saharan Africa and often outranks comparator economies.** We look at four indicators: (i) the Global Competitiveness Index developed by the World Economic Forum; (ii) the World Governance Indicators of the World Bank; (iii) the Doing Business Report indicators of the World Bank; and (iv) the Corruption Perception Index of Transparency International.

29. **Mauritius fares well on structural competitiveness.** Figure 8 plots standardized scores for Mauritius and three comparator groups. Mauritius ranks in the top third of most competitive countries in the world according to the Global Competitiveness Index. It is ahead of comparator small-island economies for which data are available but lags behind high-growth Asian economies (South Korea, Hong Kong, Singapore, Taiwan, Malaysia, Thailand, and Indonesia). The World Governance Indicators summarize survey opinions on several dimensions of institutional quality: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. Again, Mauritius ranks high by international standards, outperforming high-growth economies as well as small island states. The Doing Business Report 2008 named Mauritius the best-performing country in sub-Saharan Africa and ranked it 27th in the world. Compared to other nations, the country fares particularly well on institutional variables related to commerce and entrepreneurship, such as starting a business and dealing with licenses.

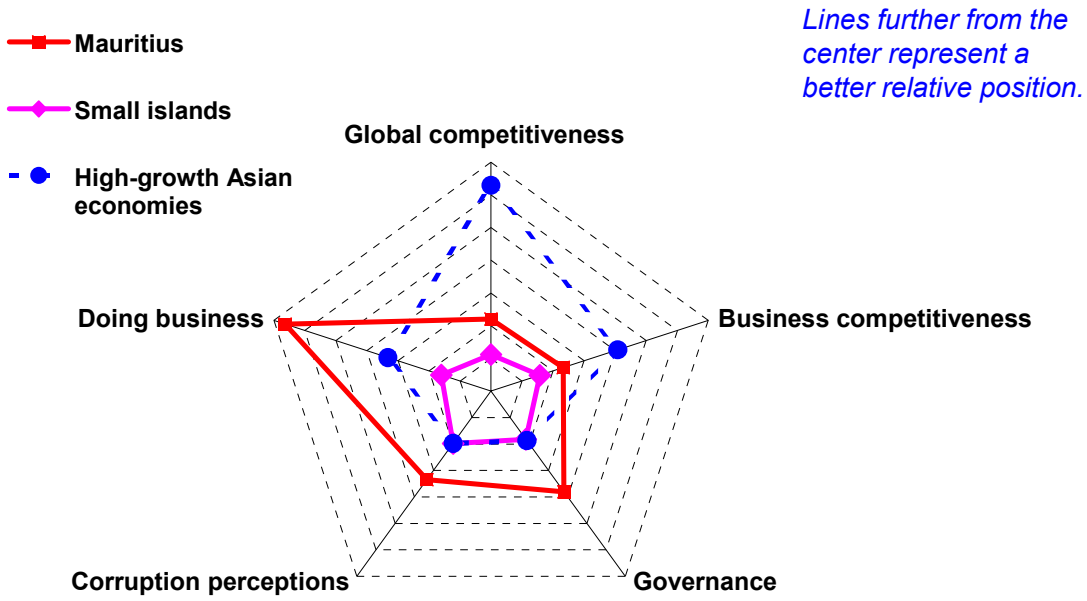
30. **The analysis of structural competitiveness indicators helps identify areas for improvement in Mauritius.** According to the 2007/08 Global Competitiveness Report, the main challenges are relatively inefficient government bureaucracy, limited labor flexibility, and an inadequately skilled workforce. The 2008 Doing Business Report flags a need for progress in registering property and the cost of closing businesses. The same report highlights relatively limited access to credit.

31. **Looking at relative performance in trade and the information, communications, and technology (ICT) sector we conclude that Mauritius again fares well compared to both high-income countries and regional averages.** We consider a sub-index of the Global

Competitiveness Index—the trading across borders measure—to determine how Mauritius stands in terms of exporter and importer costs of doing business. Djankov, Freund, and Pham

(2006) have documented the trade cost of delays in shipments and highlighted the importance of reducing them (not just reducing tariff barriers) to stimulate exports. In the number of documents required for a transaction, the cost (in US$ per container), and the time to export, Mauritius is outperformed only by the OECD countries (Figure 9 and Appendix Table 4).

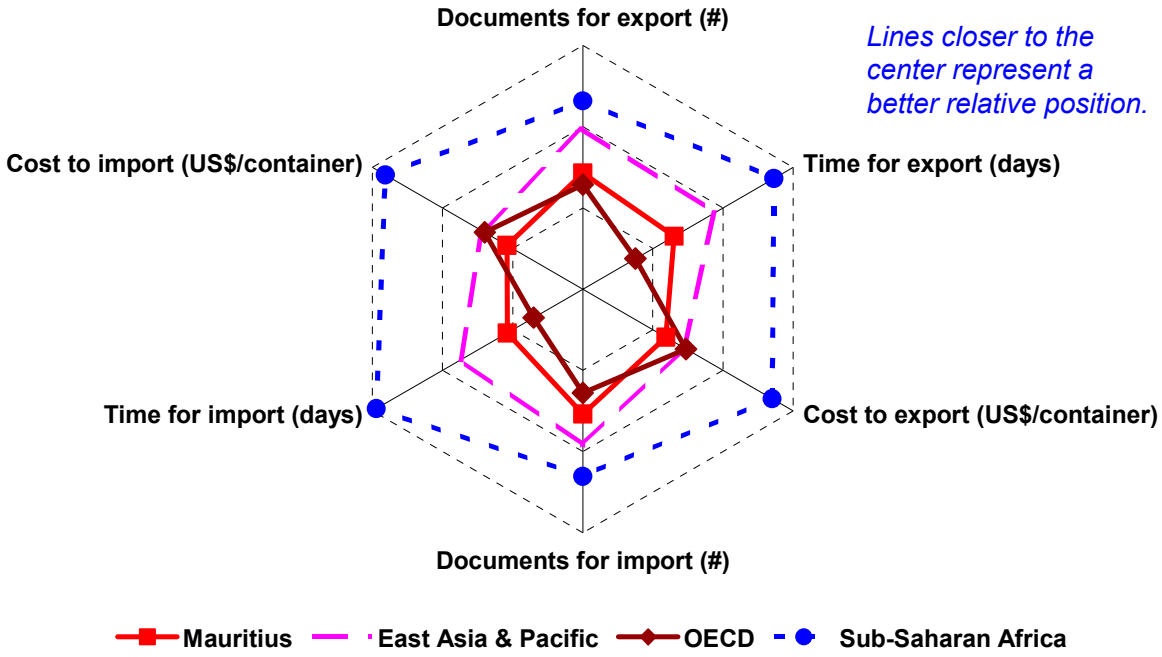
Figure 8. Composite Indicators of Structural Competitiveness



Source: World Economic Forum, World Bank World Governance Indicators, World Bank Doing Business Indicators, and Transparency International.

32. **In what concerns access, quality, affordability, and institutional efficiency and sustainability, ICT sector services fare relatively well (Table 1).** Mauritius seems to be outperformed (though by a large margin) only by high-income countries; it has clearly outpaced other income-based country groupings (including the upper-middle-income group). Still, progress is needed in the area of quality, notably in broadband Internet access and fewer telephone faults.

Figure 9. Trade Costs



Source: World Economic Forum.

Table 1. The Relative Performance of the Mauritius ICT Sector

	Mauritius	Upper middle income group	High income group	Lower middle income group	Low income group
ACCESS					
Telephone main lines (per 1,000 people)	289	230	503	205	37
International voice traffic (minutes per person)	92	46	171	14	5
Mobile subscribers (per 1,000 people)	574	671	835	306	77
Internet users (per 1,000 people)	146	196	527	95	44
Personal computers (per 1,000 people)	162	113	579	45	11
Households w/ television (%)	93	91	97	84	15
QUALITY					
Telephone faults (per 100 main lines per year)	41.5	21.2	5.8	25	…
Broadband subscribers	2.2	21	163.2	23.1	0.9
Interantional internet bandwidth (bits per person)	50	218	4537	116	15
AFFORDABILITY					
Price basket for fixed line (US$ per month, residential)	7.9	12.1	…	8.5	8.7
Mobile	4.2	9.5	27.6	10.2	9.6
Internet	17.5	17	17.8	16.8	30.1
Price of call to the US (US$ per 3 minutes)	1.59	1.06	19.9	2.08	1.99
INSTITUTIONAL EFFICIENCY AND SUSTAINABILITY					
Total TC revenue (% of GDP)	3.2	3.6	4.5	1.9	0.7
Total telephone subscribers per employee	451	583	586	444	141
ICT expenditure (% of GDP)	…	5.2	7.2	5.5	5.9

Source: World Bank ICT at a Glance Tables.

E. Conclusions

33. **With the phasing out of the European Union sugar protocol, the elimination of the Multi-Fiber Agreement, and rising world commodity prices, Mauritius faces a triple terms of trade shock.** To identify vulnerabilities to the country's external position, this study analyzed its equilibrium exchange rate using three econometric approaches—the macroeconomic balance, the single-equation, and the capital-enhanced approach—and also analyzed the business climate, trade, and ICT costs in comparative terms.

34. **The Mauritian rupee appears to be close to its equilibrium value.** The macroeconomic balance approach employed parameters from a model estimated on panel data for 140 countries and staff projections of economic fundamentals to project the Mauritius CA norm over the medium term (2008–13). It found that the CA norm is close to the underlying CA stripped of temporary factors, suggesting that little or no REER adjustment is needed. The single-equation approach used time series methods to explain the variation in the REER using fundamentals such as openness to trade, terms of trade shocks, and government consumption as a share of GDP. It concluded that the real exchange rate has been in line with the equilibrium level since 2003. The capital-enhanced approach brought the uncovered interest parity condition into the analysis; it investigated the relationship between monthly exchange rate variations and the interest rate differential with the U.S. Despite some volatility around the trend, the nominal exchange rate was close to equilibrium over the period, but appreciation pressures were noticeable at the end of 2007.

35. **Given that the exchange rate regime is a managed float, the government should continue its policy of intervening in the foreign exchange market only to reduce volatility, not affect the trend**. This policy should keep the RER at its equilibrium level consistent with economic fundamentals. Desired levels of the CA balance (and the net foreign asset position) over the medium term may require small exchange rate corrections, but these can be limited if accompanied by measures to address structural bottlenecks and bolster competitiveness.

36. **Structural competitiveness indicators offer a glimpse into areas that require attention, such as labor market reforms, ICT, and certain dimensions of institutional quality.** While the government's reform program have had far-reaching effects in restoring competitiveness, actions may also be required to stimulate competition in goods markets, make labor markets more flexible, raise the average skill level, increase broadband access, and further reduce the cost of doing business. As Mauritius embarks on its ambitious plan to become a business and financial services hub, such measures are essential for improving its competitiveness profile.

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Data Sources and Definitions

Econometric analysis: The data have been extracted from *International Financial Statistics* (IFS), *Information Notice System* (INS), *World Economic Outlook* (WEO), *World Development Indicators* (WDI), and Penn World Tables Mark 6.2. Data on the Mauritius 90-day average T-bill yield have been drawn from the *Bank of Mauritius Monthly Statistical Bulletin* (1994 to 2007).

Trading partners: Mauritius's trading partners for purposes of calculating the REER are, in descending order of importance, France, Germany, the U.S., the UK, Japan, South Africa, Italy, Belgium, Singapore, the Netherlands, Taiwan Province of China, Hong Kong SAR, Spain, Switzerland, India, Korea, Canada, China, and Thailand. Trade weights have been obtained from the INS.

Comparator countries: Regional and income country groupings have been obtained from the WDI.

- **Small island economies**: Comoros, Madagascar, Maldives, and Seychelles.
- **High-growth Asian economies**: Hong Kong, SAR, Singapore, South Korea, Taiwan Province of China, Malaysia, Thailand, and Indonesia.

Structural competitiveness indicators:

- Global Competitiveness Index and Business Competitiveness Index 2007/80, World Economic Forum. (http://www.weforum.org)
- World Governance Indicators 2007, World Bank. (http://info.worldbank.org/governance/wgi2007/)
- World Bank Doing Business Indicators 2008. (http://www.doingbusiness.org/)
- Corruption Perception Index 2007. Transparency International. (http://www.transparency.org/)

Appendix

Table 1. Correlates of the Current Account Balance.
Panel Estimates (1980–2005)

Dependent variable: Current account to GDP ratio	Pooled OLS	Random Effects	Fixed Effects
Overall budget balance/GDP	0.372***	0.388***	0.377***
	(0.030)	(0.035)	(0.037)
Net foreign assets/GDP	0.039***	0.027***	0.024***
	(0.006)	(0.008)	(0.008)
Relative income	0.048***	0.035***	-0.054*
	(0.004)	(0.010)	(0.030)
Per capita GDP growth	-0.073**	-0.101***	-0.093***
	(0.035)	(0.034)	(0.035)
Population growth	-0.028	-0.350**	-0.403**
	(0.099)	(0.144)	(0.180)
1=Fuel exporting	2.528***	3.337***	
	(0.315)	(0.982)	
1=Financial center	4.248***	4.316**	
	(0.660)	(1.943)	
1=Offshore center	-5.954***	-6.240***	
	(0.680)	(1.707)	
1=East Asian crisis	5.611***	5.651***	6.231***
	(0.811)	(0.781)	(0.773)
1=Euro zone	-0.858	-1.825***	-1.764***
	(0.550)	(0.537)	(0.522)
Constant	-5.465***	-4.704***	-0.929
	(0.652)	(0.742)	(1.181)
Observations	2474	2474	2474
No. of countries	140	140	140
Time fixed effects?	Yes	Yes	Yes
Country fixed effects?	No	No	Yes

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Note: Old dependency ratio (defined as the ratio of population over 65 years of age to population between 15 and 64 years of age) as well as a measure of financial deepening (M2/GDP) are insignificant in most specifications and are excluded from the model. Financial centers are Belgium, Luxembourg, the Netherlands, Singapore, Switzerland, and Hong Kong. Offshore financial centers are St. Vincent & Grenadines, Dominica, St. Lucia, Grenada, St. Kitts & Nevis, Antigua and Barbuda, Barbados, the Bahamas, and Mauritius. To account for the large current account deficits up to the East Asian crisis and the surpluses thereafter, the East Asian crisis dummy takes value 1 for the following countries starting in 1998: Thailand, Indonesia, Korea, Malaysia, Laos, the Philippines, and Hong Kong. The euro zone dummy takes value 1 for the countries that have adopted the euro (in 1999 except for Greece, which adopted it in 2001). Fuel-exporting economies are Algeria, Angola, Bolivia, Cameroon, Ecuador, Egypt, Gabon, Indonesia, Iran, Iraq, Libya, Mexico, Oman, Syria, Trinidad & Tobago, and Venezuela, RB. To minimize the impact of outliers and measurement errors, outliers for the CA and overall government balance to GDP ratios are trimmed asymmetrically (around the 95th percentile). NFA/GDP is trimmed symmetrically at the 99th percentile. All variables are expressed as three-year moving averages to eliminate short-term fluctuations.
Source: Staff estimates.

Table 2. Unit Root Tests for Data used in the FEER-SE Approach

Series:	REER	Terms of trade	Openness	Gov-Cons.
Augmented Dickey-Fuller				
level				
p-value	41.5%	38.0%	27.1%	94.0%
1st difference				
p-value	0.3%	0.0%	0.0%	0.0%
2nd difference				
p-value	0.0%	0.0%	0.0%	0.0%

Note: All variables in logs. Constant and trend included. Openness is defined as total trade to GDP. Government consumption is expressed in ratio to GDP. The null hypothesis for the Augmented Dickey-Fuller is of a unit root.
Source: Staff estimates.

Table 3. Unit Root Tests for Data used in the CHEER Approach

Series:	US inflation	MUS inflation	MUS T-bill	US T-bill	NER
Philipps-Perron					
level					
MacKinnon approximate p-value	7.4%	11.1%	38.1%	62.6%	22.8%
1st difference					
MacKinnon approximate p-value	0.0%	0.0%	0.0%	0.0%	0.0%
Augmented Dickey-Fuller					
level					
MacKinnon approximate p-value	20.1%	86.4%	5.7%	23.8%	9.2%
1st difference					
MacKinnon approximate p-value	0.0%	0.0%	33.4%	10.3%	33.1%

Note: The null hypothesis for both tests is that of a unit root. The Augmented Dickey-Fuller uses 12 autoregressive lags. For the VAR, the likelihood-ratio test (not reported) indicates that the optimal lag length is 12. To secure valid statistical inference, we include in the VAR three dummy variables for large outlier observations identified as being higher in absolute value by a factor of 3.5 the sample standard deviation.
Source: Staff estimates.

Table 4. Granger Causality Wald Tests for the Nominal Exchange Rate Equation in the CHEER Approach

Null hypothesis is that the nominal exchange rate is *not* causally affected by ↓	p-value	Decision:
U.S. inflation rate	0.534	Do not reject Ho
Mauritius inflation rate	0.962	Do not reject Ho
U.S. T-bill rate	0.000	Reject Ho
Mauritius T-bill rate	0.001	Reject Ho
All of the above	0.000	Reject Ho

Note: We could not reject that Mauritius inflation and U.S. T-bill rate causally affect the Mauritius T-bill rate.
Source: Staff estimates.

Table 5. Mauritius: Relative Performance on Trade Costs

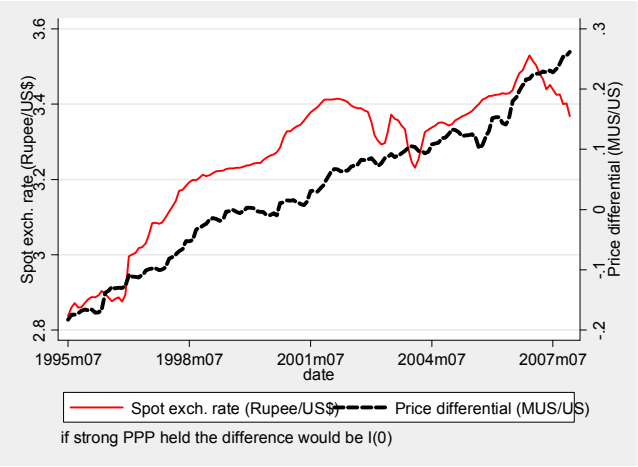
	Mauritius	East Asia & Pacific	Eastern Europe & Central Asia	Latin America & Caribbean	Middle East & North Africa	OECD	South Asia	Sub-Saharan Africa
Documents for export (#)	5	7	7	7	7	5	9	8
Time for export (days)	17	25	29	22	25	10	33	36
Cost to export (US$/container)	728	885	1393	1108	992	905	1180	1660
Documents for import (#)	6	8	8	8	8	5	9	9
Time for import (days)	16	26	31	26	29	10	32	44
Cost to import (US$/container)	763	1015	1551	1228	1129	986	1418	1986

Note: Documents for export and import refer to filing documents, customs declaration, and clearance documents. Cost to export and import measures the fees levied on a 20-foot container in US$ (including costs for documents, administrative fees for customs clearance and technical control, terminal handling charges, and inland transport; it does not include tariffs or trade taxes).

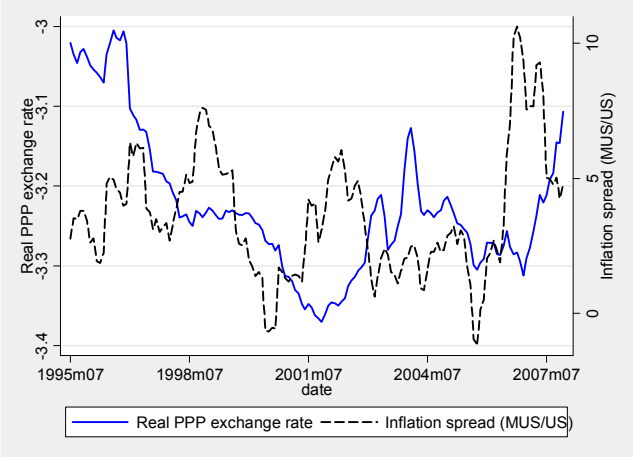
Source: World Bank Doing Business Indicators and Staff estimates.

Figure 1. Visual Interpretation of PPP and UIP (CHEER Approach)

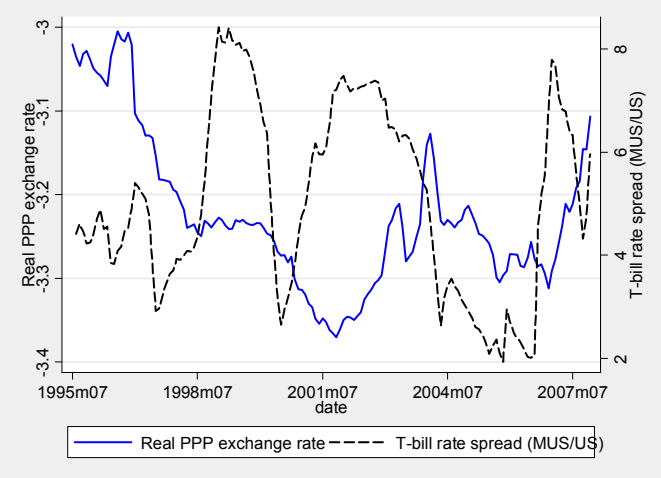
If the strong version of PPP held, then the difference between the spot exchange rate and the price differential (i.e., the real PPP exchange rate) would have to be stationary.



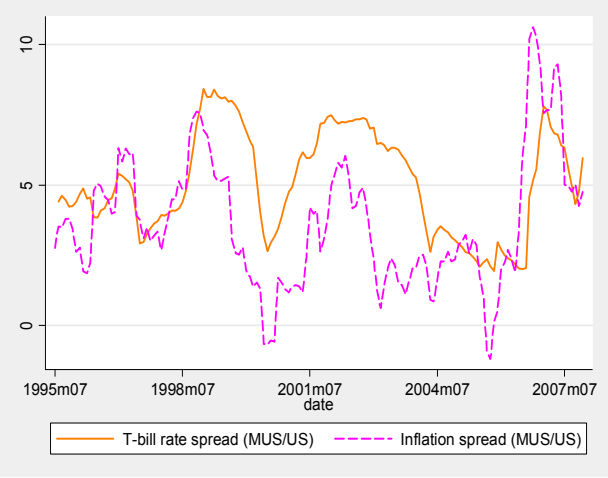
However, the PPP term behaves like a unit root process, suggesting slow adjustment back to parity.



There appears to be limited long-run comovement between PPP term and the interest rate spread. This is not surprising because T-bill rates are mainly determined by short-run policy considerations.



The T-bill spread and inflation differential show strong co-movement; further, the real interest rate spread appears to have narrowed in recent years. Overall the persistence in spreads and parities suggests that the stationarity assumptions to simple parities may not hold.



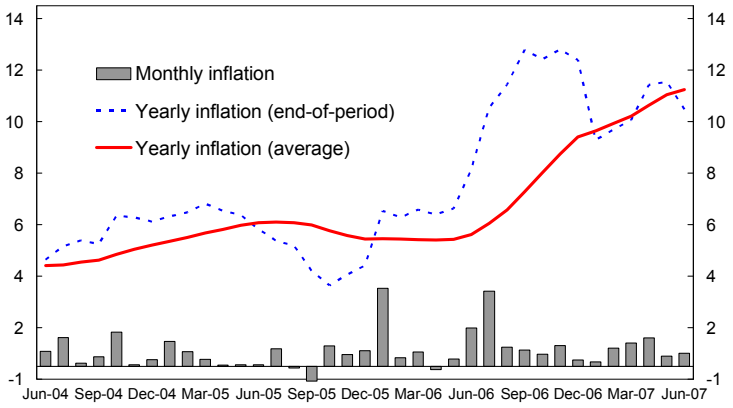
Source: Staff estimates.

II. Inflation and the Role of Administered Prices in Mauritius[15]

A. Introduction

37. **After fifteen years of single-digit inflation rates, price increases in Mauritius began to accelerate in 2006 and remained high in 2007** (Figure 1). In November 2006, end-period consumer price inflation reached 12.3 percent, up from 6.1 percent just six months earlier. Half a year later, end-period inflation was still hovering high at 11.1 percent. This development coincided with the implementation of measures associated with the 2006/07 budget, including the relaxation of certain price controls in mid-2006.

Figure 1. CPI inflation, 2004-07



Source: Mauritius Central Statistics Office.

38. **This paper analyzes the relationship between measured inflation and relative price variability, particularly affected through changes in administered prices, and investigates the determinants of inflation over the period 2002–07**. The analysis suggests that the mid-2006 sharp price liberalization of several administered prices contributed around one half of overall inflation three months later. In general, administered price adjustments account for a large share of the monthly cross-sectional variability of prices, especially during episodes of marked adjustment as in fiscal year 2006/07. The administered price regime in Mauritius and the discrete price changes associated with it leads to increased inflation through higher relative price variability (i.e., higher variance and skewness of the inflation distribution), although money growth and the nominal effective exchange rate (NEER) also play an important role.

39. **The study combines a micro-level analysis of price variations with a macro-level analysis of the determinants of inflation**. We use highly disaggregated consumer price index (CPI) data to investigate the relationship between inflation, and the variance and skewness of price changes. The analysis is undertaken for 163 goods and services in the Mauritian representative consumer basket, an approach that relies on individual product-level inflation.[16] The weights used to compute the CPI were derived by the Central Statistics Office of Mauritius (CSO) from the 2001/02 Household Budget Survey and remained unchanged during the sample

[15] Prepared by Fabian Bornhorst and Camelia Minoiu.

[16] For early contributions that use disaggregated goods data in this type of analysis, see Parks (1978), Lach and Tsiddon (1992), Parsely (1996), and Debelle and Lamont (1997).

period.[17] The determinants of inflation—including monetary policy and the nominal exchange rate—are analyzed through Ordinary Least Squares (OLS) in a simple cointegrating framework.

40. **In recent months, demand pressures and supply conditions have led to a worldwide surge in food prices while many commodity prices are at an all-time high**. In response to rising imported food prices and to contain cost of living increases, Mauritius more than doubled its consumption subsidies on rice, wheat flour, and cooking gas in April 2008. Other countries took measures such as reducing or eliminating customs fees on some food imports, introducing VAT and import duty exemptions, introducing price controls (e.g., ceilings on retail prices), banning food exports, increasing state involvement in procurement, or increasing direct transfers to vulnerable households.[18] These developments have put inflation back on the agenda of policy-makers, rendering it important to better understand the dynamics of inflation and the monetary transmission mechanism to identify appropriate policy responses.

41. In what follows, Section B describes administered prices and post-liberalization inflation developments in Mauritius, and Section C assesses the relationship between relative price variability and inflation. Section D presents a simple empirical model of the determinants of inflation, focusing on the interplay between features of the price change distribution (inflation, variance, and skewness), while controlling for monetary policy variables and the nominal exchange rate. Concluding remarks are offered in Section E.

B. Drivers of Inflation in Mauritius

The Scope of Administered Prices

42. **The prices of several imported basic foodstuffs, including rice, wheat flour, and vegetable oils, have traditionally been administered in Mauritius**. Administered prices have long represented a form of social protection in Mauritius due to the country's dependence on imported staples such as rice and wheat flour. Price controls were introduced in the late 1960s to benefit consumers by providing essential commodities at prices lower than market levels (Ministry of Industry, 2006).

43. **Historically, administered prices have played an important role in the inflation-exchange rate interplay in Mauritius**. Price controls for goods other than the main imported staples were introduced in November 1967 following a devaluation of the Mauritian rupee, and

[17] In July 2007, the CSO revised its CPI methodology using weights for goods and services derived from the 2006/07 Household Budget Survey. For this reason our analysis ends in June 2007.

[18] The relative merits of different policy responses to the current global conditions are not the object of this study. Rather, we seek to understand the role of administered prices and that of monetary policy and the nominal exchange rate in driving the inflation process in Mauritius.

several waves of price adjustments have subsequently ensued. Prior to the November 1967 devaluation (by 14.3 percent) against the pound sterling, average inflation had been very low at 1.3 percent per annum (1962–67). Two more devaluations (in 1979 and 1981) coupled with gradual rises in prices of imported staples and high wage settlements, led to a rise in inflation to 26.5 percent in 1980–81. Following the pegging of the rupee to a basket of currencies reflecting the country's trade patterns, inflation remained relatively low over the following two decades, at an average annual rate of 5.1 percent (1985–05).

44. **The administration of prices in Mauritius is implemented either through a ceiling on the retail price level or the mark-up**. Fixed prices are communicated to the public in the mass-media and to the importers through written correspondence. Retail prices set up by maximum mark-up are determined on the basis of shipment arrivals, depending on the CIF value and the exchange rate. The Price Control Unit of the Ministry of Industry, Small & Medium Enterprises, Commerce and Cooperatives oversees price controls. Some goods, such as petroleum products, ration rice, and wheat flour, are entirely imported through the parastatal State Trading Corporation (STC), which handles government interventions in the market. The STC and the privately-owned Mauritius Portland Cement Company Ltd. share the importation of cement. The Meat Authority is in charge of meat imports while the Agricultural Marketing Board oversees imports of food products that compete with domestically produces ones, for which there are administered prices (primarily onions, garlic, and potatoes). The enforcement agency is the Consumer Protection Unit which checks prices in the market.

45. **As of end-2006, around 21 percent of the CPI basket (by value) was subject to price controls** (Table 1). All fuel products and around one third of tradable goods have administered prices. Under the maximum price regime fall the following ten product categories: bread, cement[19], sugar, fertilizer, rice (excluding basmati), flour (including wheat flour), onions, cooking gas, iron/steel bars, and petroleum products (including kerosene). The mark-up regime is applied to imported fresh fruit, milk powder, pharmaceutical products, some drugs, timber, tires and tubes, corned beef, corned mutton, and pilchards (sardines).

[19] All of Mauritius' cement requirements are imported. In 2005, cement imports represented around 1 percent of total imports (CSO, 2006).

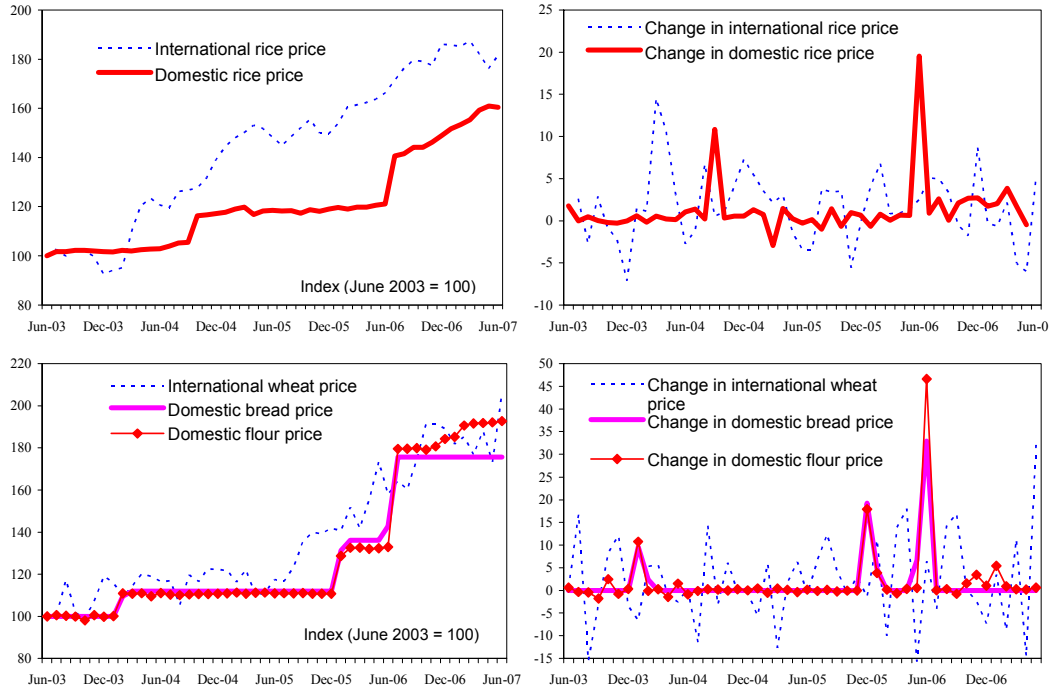
Table 1. Classification of 163 CPI items

	overall	fuel	non-fuel	food	non-food	tradable	non-tradable
Administered	29	5	24	12	17	26	3
% weight in CPI	*21*	*5*	*16*	*9*	*12*	*20*	*2*
Free	134	0	134	40	94	100	34
% weight in CPI	*79*	*0*	*79*	*26*	*53*	*55*	*24*

Source: Mauritius Central Statistics Office, Price Control Unit, and authors' estimates.

46. **In Mauritius, the price control mechanism—notably for staple foods—is characterized by infrequent, large price adjustments**. This is a consequence of maximum retail prices being determined on a yearly basis for rice, wheat flour, bread, cooking gas, and cement. Figure 2 compares international and domestic prices for imported staples, namely rice and wheat (using the bread and flour CPI for the latter). It shows that the two series generally comove, but often domestic prices lag behind world prices (left panels). Furthermore, in contrast to the international price series which exhibit steady volatility, domestic prices are characterized by large and infrequent adjustments (right panels).

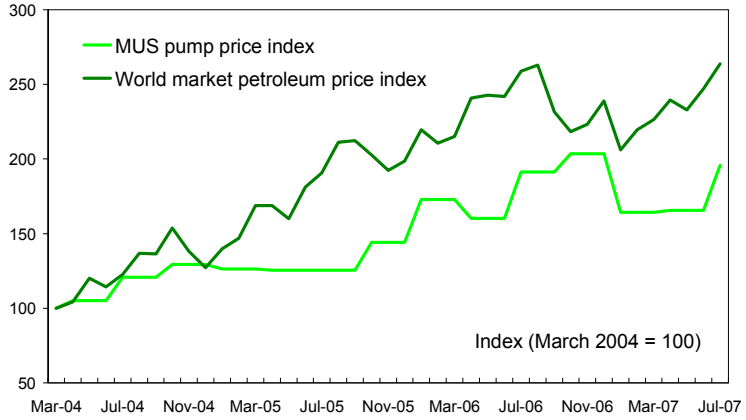
Figure 2. Domestic and International Commodity Prices, 2003-07



Note: The world rice price is for Thailand milled white rice (5 percent broken) in MUR per metric tonne. The international wheat price is for No.2 hard wheat (Kansas) in MUR/Bu. The small amount of monthly volatility in the domestic rice price is caused by different types of rice being accounted for in the domestic CPI. Only the price of government imported ration rice is administered in Mauritius.
Source: Mauritius Central Statistics Office, IMF *World Economic Outlook* , DataStream, and authors' estimates.

47. **Starting in April 2004, petroleum product prices have been regulated through the APM and imported under a sole license by the STC**. Through the APM, the pump prices of gasoline and diesel—the bulk of petroleum products consumed—are adjusted to reflect the most recent contractual conditions negotiated by open tender. Retail prices of petroleum products are adjusted on a more frequent, quarterly basis, but have too been lagging behind world petroleum prices (Figure 3).

Figure 3. Domestic pump price and world petroleum price, 2004-07



Note: Pump price index is a CPI weighted nominal price index for gasoline and diesel; the world market petroleum price index is the MUR average of 3 international market crude oil prices (Dated Brent, West Texas Intermediate, and Dubai Fateh) per
Source: Mauritius Central Statistics Office, WEO, and Staff estimates.

48. **In its 2006/07 budget the government announced a series of changes to administered prices**. While price controls were not abandoned, existing subsidies on food items were reduced, fees increased, and petroleum prices raised. The savings on reduced rice and flour subsidies were used to finance the primary school feeding program, a targeted income support program, and the Empowerment (re-training) program for workers formerly employed in the sugar sector. Excise duties on tobacco were raised by 20 percent, and duties on imported alcohol were brought in line with those for imported products (also reflecting higher taxation for higher alcohol content).[20] Finally, excise taxation was applied to PET bottles which are used in the soft drinks industry. The government further announced its intention to abandon traditional price fixation in favor of an appropriate competition framework.

Inflation Developments in the Wake of Price Liberalization

49. **Following the mid-2006 liberalization, major price increases were observed for a large number of goods including food, soft drinks, cigarettes, and alcoholic beverages** (Table 2). Other commodities affected were clothing, electricity, and taxi fares. The price of government imported flour and kerosene almost doubled, while that of items such as bread, rice, diesel oil, and gasoline rose by around 50 percent. After the initial shock, CPI inflation eased in the first half of 2007, with end-June inflation rates coming down for most product items and overall inflation falling by 2 percentage points.

[20] A partially offsetting measure was the reduction of customs duties for alcoholic beverages and cigarettes.

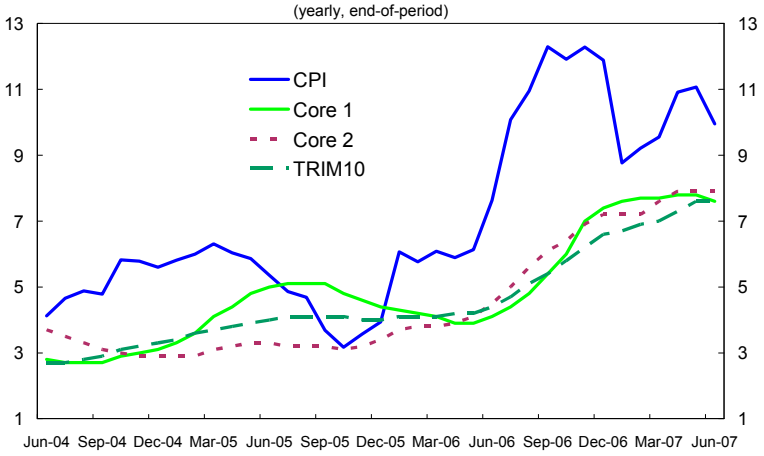
Table 2. Yearly inflation rates (end-of-period) for specific items, 2004–07

	Dec-05	Dec-06	Jun-07		Dec-05	Dec-06	Jun-07
Individual product items							
Bread	0.0	56.8	23.1	Electricity	0.0	9.4	0.0
Government imported rice	…	54.3	…	Gasoline	11.1	40.0	3.8
Government imported flour	0.0	66.2	45.0	Diesel oil	14.8	52.5	-0.5
Flour preparations	-2.9	24.1	13.5	Motor oil	16.6	10.5	9.3
Cigarettes	5.4	17.8	4.8	**Component CPI**			
Rum	3.9	17.9	3.2	Food and non-alcoholic beverages	6.2	13.7	19.9
Whisky	22.6	20.0	9.9	Alcoholic beverages and tobacco	4.9	18.2	3.9
Beer and stout	0.7	25.4	1.8	Transport	-3.0	15.3	4.1
Beef	3.4	25.1	24.4	Electricity/gas/fuels/housing/water	6.1	10.4	4.5
Frozen beef	12.1	21.2	30.8	Restaurants and hotels	6.5	20.2	10.3
Cooking gas	16.8	26.0	14.5				
Korosene	131.4	90.6	5.2	**Overall CPI**	**3.9**	**11.9**	**9.9**

Source: Mauritius Central Statistics Office and staff estimates.

50. **As a consequence, inflation accelerated** (Figure 4). High inflation was reflected not only in the overall CPI, but also in three measures of core inflation, which the Bank of Mauritius (BoM) began compiling in 2006. Core 1 inflation strips out food and alcoholic beverages. Core 2 also removes energy and administered price products. Trim10 is calculated by symmetrically trimming 5 percent of the distribution of CPI changes (BoM, 2007). According to the CPI, inflation pressures reached a maximum (of 10 to 12 percent) in the second half of 2006.

Figure 4. CPI and core inflation, 2004-07
(yearly, end-of-period)



Source: Mauritius Central Statistics Office.

51. **This wave of price liberalization is estimated to have directly contributed around one half of overall inflation three months later** (Table 3). There are two ways to measure the direct effect of liberalization on overall inflation: one is to focus on the administered price increases for individual goods, and another is to use the observed CPI subindices for the categories to which the individual goods belong, together with CPI weights.[21] First, we consider

[21] Neither of the two methods for computing the average rise in prices is without shortcomings. In the first case, we use actual price increases, but the weights may correspond to broader categories of goods. This is the case with PET bottles which are used in the soft drinks industry: while we observe the administered price increase (4.9 percent), the weight of PET bottles in the CPI is not known. Instead, we use the weight of soft drinks in the CPI. In the second case, neither the price increase nor the weight is "correct", but they are good approximations. In our example, the weight and the CPI inflation rate for soft drinks is imputed to determine the contribution of PET bottle price increase to the overall inflation rate.

the administered price increases of all goods subject to liberalization in mid-2006, and find that the post-liberalization (weighted) average price increase was 13.3 percent, corresponding to 2.8 percentage points of CPI inflation. If we look at the inflation rates based on corresponding CPI categories, the average price increase is 13.8 percent, or 3.2 percentage points. This implies that price liberalization added between 48 and 54 percent to the overall inflation rate (representing the increase in the CPI between May and September 2006) of 5.9 percent.[22]

Table 3. Direct effect of price liberalization on overall inflation[1/]

	Weight	Price change		Estimated effect	CPI sub index		CPI change	Observed effec
	(%) (I)	Date	(%) (II)	(I) * (II)	May-06	Sep-06	(%) (III)	(I) * (III)
Cigarettes	4.8	10-Jun-06	17.8	0.9	132.2	155.7	17.8	0.9
Alcoholic beverages	3.8	10-Jun-06	12.1	0.5	133.0	151.2	13.7	0.5
Vehicles	4.2	Jun-06	-6.1	-0.3	101.6	96.6	-5.0	-0.2
Rice (overall)	2.1		12.9	0.3	120.6	144.2	19.6	0.4
of which: Rice (grn imported)	0.5	3-Jul-06	54.0	0.3	…	…	…	…
Flour (overall)	0.3		32.7	0.1	140.0	190.2	35.9	0.1
of which: Flour (grn imported)	0.2	3-Jul-06	49.0	0.1	…	…	…	…
Bread	1.7	3-Jul-06	23.1	0.4	147.9	191.0	29.1	0.5
Flour based products	0.5	3-Jul-06	49.0	0.2	129.2	143.9	11.3	0.1
PET bottles	1.2	Jul-06	4.9	0.1	113.5	134.1	18.1	0.2
Cooking Gas	1.4	3-Jul-06	9.1	0.1	130.6	142.5	9.1	0.1
Gasolene	2.7	3-Jul-06	20.0	0.5	157.7	189.2	20.0	0.5
Diesel	0.4	3-Jul-06	15.0	0.1	245.7	282.3	14.9	0.1
Sum / weighted average	21.4		13.3	**2.8**			13.8	**3.2**
Overall CPI					124.3	131.7	**5.9**	
Contribution to overall inflation				48%				54%

1/ Measured as the change in the CPI before the liberalization (May 2006) and two months after the liberalization (September 2006)
Source: Mauritius Central Statistics Office and staff estimates.

52. **Second-round effects may have played a role in driving overall inflation at least through mid-2007**. Second-round effects are changes in those CPI subcategories that are indirectly affected in the first round of price adjustments. For example, while the increase in taxi fares in the month subsequent to an adjustment in fuel prices could still be considered a first round, direct effect, adjustments in other prices that will follow the increased taxi fare would be considered of higher order, and can be symptomatic of changes in long-run inflation expectations. Second-round effects are an endogenous response to inflation, and often arise through wage bargaining (for a theoretical contribution, see Hledik, 2003). In the case of Mauritius, public sector wages are only adjusted in response to inflation every five years, the last such adjustment having taken place in May 2003. Estimating second-round effects is difficult in this context without further assumptions. Nevertheless, they are likely to have also played a role in driving up prices.

53. **Exchange rate movements have also affected inflation**. Since 2004 the Mauritian rupee (MUR) has depreciated against the Euro and, to a smaller extent, against the U.S. dollar. The

[22] The contribution of the June 2006 price liberalizations to September inflation (yearly, end of period) was 45 percent. We do not extend the analysis beyond September 2006 because October witnessed another wave of price adjustments for petroleum products.

nominal effective exchange rate (NEER) has depreciated steadily since 2004 at an average annual rate of 5.9 percent, while the real effective exchange rate (REER) depreciated on average by almost 1 percent per annum (Table 4). The BoM has intervened in the foreign exchange market solely to smooth exchange rate fluctuations rather than alter the trend. Consistent with the existence of administered prices, the pass-through of the nominal exchange rate to changes in domestic prices in Mauritius has been found to be limited (with an elasticity of 0.23 over the period 1977 to 2004).[23]

Table 4. Exchange Rate Developments (annual percentage change), 2004–07

	2004	2005	2006	2007[1/]	2004-2007 2/
NEER	-4.3	-7.4	-7.0	-3.2	-5.9
REER	-2.5	-3.9	-0.8	2.3	-0.8
US$/MUR	1.8	-6.9	-6.9	1.7	-4.1
EUR/MUR	-7.4	-7.1	-7.6	-5.6	-6.7

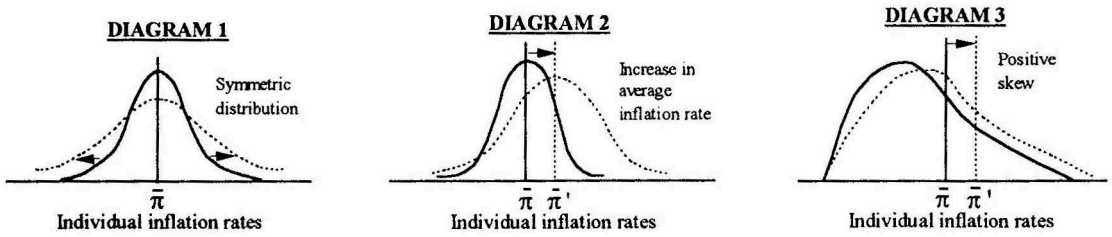
1/ Until June 2007.
2/ Average annual percentage change.
Source: Authors' estimates.

C. Relative Price Variability and Inflation

54. **Several contributions have formalized the relationship between inflation and relative price variability**. For example, Ball and Mankiw analyze firms' responses to supply shocks in a setting where adjusting firms incur "menu costs" (Ball and Mankiw, 1994, 1995). Menu costs, a form of transaction costs, refer to the cost of updating menus, price lists, brochures, etc. by firms when prices change in an economy. The authors use a one-period theoretical set-up to analyze the relationship between the distribution of unobserved real sectoral shocks (which can be proxied in empirical applications by actual price changes) and inflation in the presence of menu costs. Once these are taken into account, the model predicts that: (1) firms react more to positive shocks than they do to negative ones when the cross-sectional price distribution is skewed to the right; and (2) relative shocks that raise some prices (while lowering others) will induce more upward than downward adjustment. An increase in the cross-sectional dispersion of price changes (variance) is associated with higher inflation because of price rigidity caused by the presence of menu costs. Furthermore, a simultaneous increase in skewness (caused by a few large price increases in some goods accompanied by small price increases or reductions for other goods) will also be associated with inflation. The interplay between the mean, variance, and skewness of the price change distribution are illustrated in Figure 5.

[23] See Schumacher (2006).

Figure 5. The variance, mean, and skewness of the inflation distribution



Source: Coorey, Mecagni, and Offerdal (1997).

55. **The empirical literature has generally identified a positive relationship between relative price variability and inflation rates**.[24] Early studies include Okun (1971) and Vining and Elwertowski (1976) who analyze for the first time the link between the standard deviation of relative price changes and inflation using a cross-sectional and time series approach, respectively. More sophisticated econometric analyses have subsequently been undertaken by Engle (1982) who popularized conditional variance approaches to analyzing the link between relative price variability and inflation. Numerous country studies have since then been undertaken.[25] The typical finding has been that changes in administered prices affect the general price level and therefore inflation, as in Ball and Mankiw's models (see, for example, Coorey, Mecagni, and Offerdal, 1996, 1997; Wozniak, 1999; Uzagalieva, 2003).

56. **We find that in Mauritius changes in administered prices have contributed substantially to the (cross-sectional) variance of relative price changes**. Figure 6 shows the results of a variance decomposition into within- and between-group components: the variation arising due to price changes for products whose prices are free (within-group), that arising due to price changes for products whose prices are administered (within-group), and that caused by the interaction between free and administered prices (between-group). We find that around 40 percent of the time changes in administered prices were responsible for at least a quarter of the total monthly variance. In 2006, four consecutive petroleum product price adjustments in January, April, July, and October contributed 50 to 60 percent to the total cross-sectional variance in those months. Furthermore, the variation in administered prices driven by sharp changes exceeded that in free prices (in 7 of 59 months) and did so by a large margin. Thirty-eight percent of the cross-sectional variance observed during these 7 peaks together is accounted for by variation in administered prices compared to 25 percent by free prices.[26] It follows that

[24] For exceptions and evidence consistent with a negative relation between relative price variability and inflation, see, e.g., Cecchetti (1985), Blinder (1991), and Lach and Tsiddon (1992).

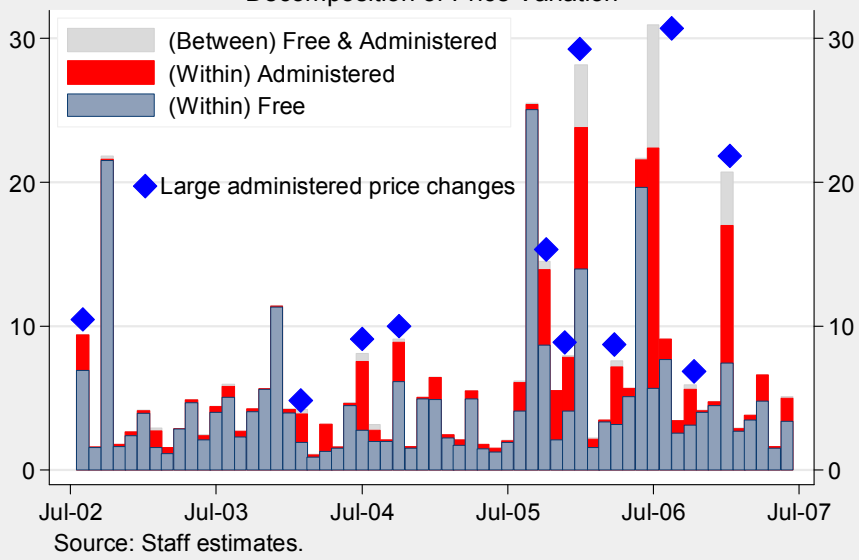
[25] See, e.g., Ghosh and Whalley (2004) for Vietnam, and Clements, Jung, and Gupta (2003) for Indonesia.

[26] The 7 months over the sample period when the variation in administered prices exceeded that in free prices (and the main goods whose prices were subject to change) are: February 2004 (bread, flour, cooking gas), April 2004

(continued…)

administered price changes account for a large share of the overall cross-sectional variance, especially during episodes of sharp price adjustment.

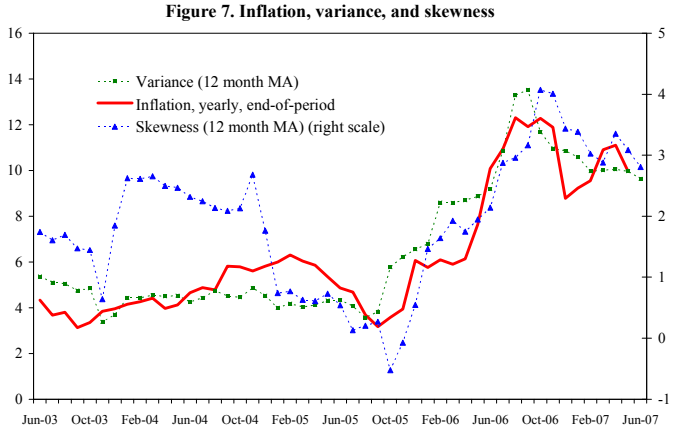
Figure 6
Decomposition of Price Variation



Source: Staff estimates.

57. **The (Theil) variance and skewness are positively correlated with inflation over time** (Figure 7).[27] Based on moving-average (monthly) data, the correlation coefficients are 0.88 (0.61) between variance and inflation, and 0.69 (0.31) between skewness and inflation; and are highly statistically significant. Figure 6 also shows that skewness has been positive, and notably higher during fiscal year 2006/07. This suggests that large price spikes for several goods have co-existed with downward price rigidity for other goods. The variance and skewness of the

Figure 7. Inflation, variance, and skewness



Source: Mauritius Central Statistics Office and Staff estimates.

(gasoline and Diesel oil), July 2004 (gasoline and Diesel oil); November 2005 (cooking gas, kerosene, and Motor oil); April (gasoline and Diesel oil); July 2006 (see Table 2); and January 2007 (kerosene, gasoline, Diesel oil, and Motor oil).

[27] In our analysis, the variance and skewness are weighted by the CPI basket weights. For formulas, see, e.g., Appendix I in Coorey, Mecagni, and Offerdal (1996).

price distribution are likely to have driven the inflationary process over the period, an issue we investigate econometrically in the next section.

D. An Empirical Analysis of the Inflation Process

58. **We undertake an empirical analysis of the factors affecting inflation in Mauritius, focusing on basic relationships between inflation, monetary policy variables, and the nominal exchange rate**. All data are drawn from the IMF *International Financial Statistics*, *World Economic Outlook*, and various issues of the BoM Monthly Bulletin. The sample contains monthly data for two periods: June 2003 to December 2006, and June 2003 to June 2007.[28]

59. **The model includes the traditional regressors such as monetary variables and nominal exchange rate**. First, we explain the inflationary process using monetary variables (shown in Appendix Figure 1): nominal interest rates and the growth rate of money supply (M2 net of offshore bank deposits). For interest rates, we consider the key policy rate (Lombard) and two de facto intervention rates (the interbank money-market rate and the average T-bill rate).[29] Dynamics in the effect of broad money growth and the interest rate on inflation are accounted for with lags on these variables. For broad money growth, the most robustly significant lag is at 12 months. For the interest rates, we also consider a one year lag.[30] Second, we account for the effect of the nominal exchange rate by including the rate of change of the NEER. This helps assess the impact of the exchange rate pass-through to changes in domestic prices.

60. **In addition to standard variables, the model accounts for relative price variability through two indicators: the variance and skewness of the inflation distribution**. The general specification is as follows:

$$\pi_t = \alpha + \beta_1 Var_t + \beta_2 Sk_t + \beta_3 i_{t-12} + \beta_4 \left(\Delta M2\right)_{t-12} + \beta_5 \left(\Delta NEER\right)_t + \varepsilon_t \qquad (5)$$

where π represents the yearly end-of-period inflation rate, Var and Sk are the cross-sectional variance and skewness of the price change distribution (expressed as 12 month moving averages), i_{t-12} is the interest rate lagged 12 months, $\left(\Delta M2\right)_{t-12}$ represents the rate of growth of

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[28] Our sample period starts in June 2003 to avoid the use of linking coefficients in deriving comparable end-period inflation figures prior to that date, as the CPI basket was changed in June 2002 based on the 2001/02 Household Budget Survey. The second sample period (June 2003 – June 2007) is also considered because it overlaps with a period of monetary policy transition, notably from the use of the Lombard rate and the repo rate for intervention.

[29] The Lombard rate is a standing facility introduced in 1999 as a lender of last resort for commercial banks to meet unexpected liquidity shortfalls. Until 2002, the T-bill rates moved in tandem with the Lombard rate, suggesting that the latter was an effective signal of monetary policy. As this relationship gradually broke down, the Lombard rate was replaced in December 2006 by the repo rate, which targets the overnight interbank money market rate.

[30] See Goodhart (2001) for a discussion of the expected length of monetary policy transmission lags.

broad money lagged 12 months, and $\Delta NEER$ represents the rate of change in the NEER. Unit root tests suggest that the series are difference-stationary (Appendix Table 1).

61. **Strong unconditional relationships are apparent for inflation and the explanatory variables considered** (Appendix Table 2). The matrix of unconditional correlation coefficients suggests a strong a positive relation between inflation and relative price variability (variance and skewness). Although the correlation coefficients between inflation and the various interest rates are not statistically significant, they have the expected sign. Moreover, a nominal effective exchange rate appreciation is correlated with a reduction of inflation.

62. **The estimation is performed through OLS in a simple cointegrating framework** (Table 5). To preserve degrees of freedom, the models discussed do not include seasonal dummies. As a robustness check, models with the seasonal dummies were estimated and the results held up (Appendix Table 3). For each model, we report the results of diagnostic residual tests—including serial correlation, normality, and unit roots—to ensure that statistical inference is valid.[31]

63. **The main messages that emerge from the empirical analysis can be summarized as follows**:

a. Relative price adjustment has a significant impact on inflation, as illustrated by the cross-sectional variance and skewness of price changes being strongly and positively correlated with inflation.[32]

b. Interest rates generally have significant and negative coefficients in the model, and work with a lag of 12 months. The Lombard rate, however, loses its effectiveness in the longer sample, whereas the de facto rates of intervention—the interbank and T-bill rates—tend to reduce inflation in both samples considered.

c. Broad money growth is associated with higher inflation with a lag of around 12 months.

d. An appreciation of the nominal effective exchange rate has a dampening effect on inflation, as illustrated by the negative and significant coefficient. A 1 percentage point NEER appreciation is associated with a 0.2 percentage point reduction in inflation.

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[31] We emply the Cochrane-Orcutt transformation to correct for serial correlation; the residuals therefore pass the serial correlation test. Similarly, the Jarque-Bera test indicates that there is no evidence against the null hypothesis of normality. Finally, the Philipps-Perron and the Augmented Dickey-Fuller (ADF) tests reject the hypothesis of unit roots in the residuals.

[32] We have also considered models in which each measure of relative price variation has been included in the model alone, but the main result—i.e., that each variable is strongly and positively correlated with inflation—holds up despite the high correlation between the two.

e. These findings suggest that monetary control, including by allowing nominal appreciation, can help reduce inflation.

64. **The results are generally stronger for the period before the abolishment of the Lombard rate (June 2003–December 2006) than the sample extended to July 2007**. A possible explanation is that structural shifts in the model which may have occurred during 2007 are affecting the results. For example, in early 2007, the BoM announced several measures to improve the transparency and effectiveness of monetary policy, including the set-up of a Monetary Policy Committee (MPC) which held its first meeting in April 2007, and the initiation of conceptual work on the measurement of core inflation.

Table 5. The Determinants of Inflation: OLS Estimates

(Dependent variable: Yearly end-of-period rate of change in the CPI)

Sample period:	June 2003 – December 2006			June 2003 – June 2007		
Variance	**0.461**	**0.458**	**0.403**	**0.517**	**0.529**	**0.452**
	(14.30)* **	**(12.41)*** **	**(8.15)*** **	**(6.54)*** **	**(7.07)*** **	**(6.69)*** **
Skewness	**0.924**	**0.834**	**0.946**	**0.745**	**0.710**	**0.857**
	(8.48)* **	**(9.39)*** **	**(6.91)*** **	**(3.92)*** **	**(3.91)*** **	**(4.68)*** **
Lombard, t-12	-0.632			-0.283		
	(4.21)***			(0.61)		
Interbank rate, t-12		-0.193			-0.223	
		(4.48)***			(1.97)*	
T-bill rate, t-12			-0.259			-0.275
			(2.61)**			(2.04)**
ΔM2, t-12	0.426	0.425	0.317	0.217	0.211	0.186
	(8.12)***	(8.11)***	(4.54)***	(2.24)**	(2.21)**	(1.72)*
ΔNEER	-0.184	-0.179	-0.191	-0.170	-0.167	-0.167
	(9.46)***	(9.72)***	(9.04)***	(3.94)***	(4.22)***	(4.15)***
			Residual diagnostic tests			
Serial correlation						
Durbin Watson	1.986	2.017	1.980	1.957	1.908	1.909
Normality						
Jarque-Bera p-value	0.5386	0.3484	0.766	0.0824	0.1195	0.0827
Unit root tests						
Phillips-Perron p-value	0.0000	0.0000	0.0000	0.0257	0.0081	0.0056
ADF p-value	0.0000	0.0000	0.0000	0.0346	0.0114	0.0078
Observations	41	41	41	47	47	47
R-squared	0.97	0.98	0.96	0.74	0.82	0.81

Notes: t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are robust to heteroskedasticity of unknown form. Seasonal dummies are not included.

Source: Staff estimates.

E. Conclusions

65. **In this paper we have analyzed some aspects of inflation in Mauritius, focusing on an episode of sharp administered price changes in fiscal year 2006/07**. Using monthly data for the period June 2002–July 2007 we have found that marked rises in administered prices of foods and fuels initiated in June 2006 led to increased relative price variability. This was reflected in the higher variance and positive skewness of the cross-sectional inflation distributions. Our estimate of the direct effect of this wave of price liberalization on inflation three months later is around 50 percent of total.

66. **An empirical model of the determinants of inflation was estimated to understand the factors that drove inflation over the period**. We find that nominal exchange rate appreciation dampens inflation. Furthermore, broad money growth and interest rates (the key policy Lombard rate, the interbank money-market, and the T-bill rate) affect inflation with a lag of approximately one year. The effectiveness of the Lombard rate is less evident in the second half of 2006, before a number of steps were taken to improve monetary policy, including the set-up of the Monetary Policy Committee and conceptual work on core inflation.

67. **A key result is that relative price variability—to which sharp administered price changes are an important contributor—is strongly and positively correlated with inflation**. Discrete price adjustments—common to administrative price regimes—change the shape of the individual price distribution. Depending on the relative magnitude of the individual price changes, the skewness and variance of the inflation distribution increase, driving up the overall inflation rate. The results suggest that the large discrete price changes associated with the administered price regime in Mauritius affect inflation through higher relative price variability. Frequent price adjustments could reduce the contribution of administered prices to overall price variability and the inflationary pressures associated with it.

68. **The results underscore the importance of accounting for relative price variability in both inflation estimation and forecasting exercises**. The BoM will need to incorporate the impact of expected price liberalizations in its inflation monitoring calculus. This can be achieved by coordinating the schedule of price liberalizations with the government, so as not to hamper the effectiveness of monetary policy in an environment of administered prices.

69. The analysis could be expanded by looking at a longer time span (especially to more recent periods after the monetary policy change), including additional explanatory factors, and using more sophisticated modeling. A longer time span would be necessary to better estimate monetary transmission lags and enrich the model with additional explanatory factors, such as world commodity prices. Furthermore, an analysis of level (cointegrating) relationships between the variables of interest and a vector error correction representation would be useful to assess short- and long-run dynamics. Impulse response functions in a vector autoregressive framework would also help investigate the projected inflation path for different monetary policy scenarios.

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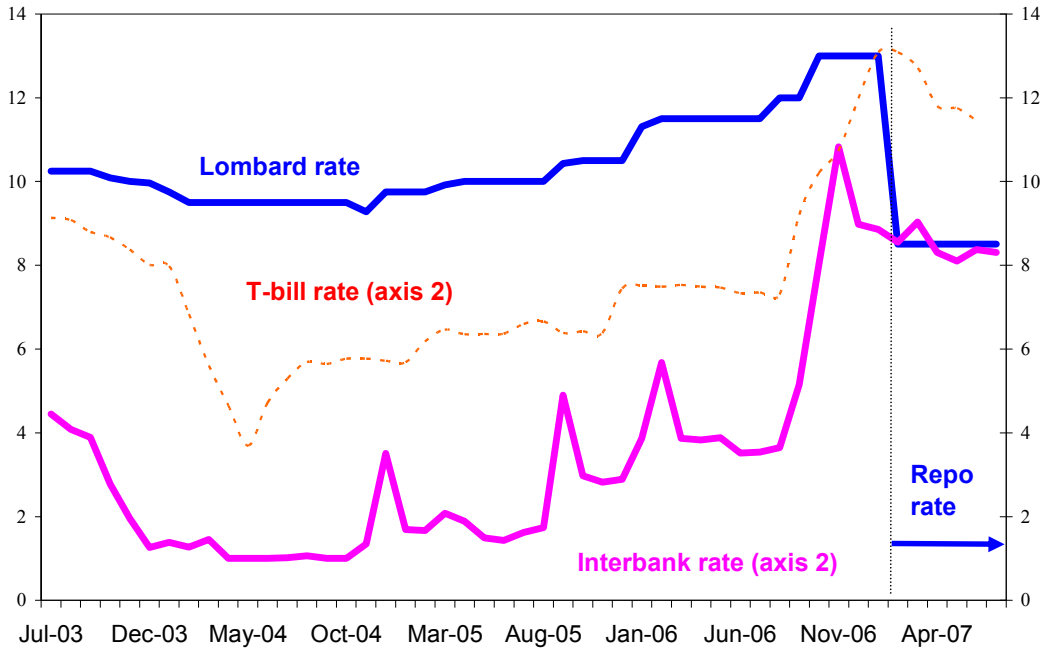
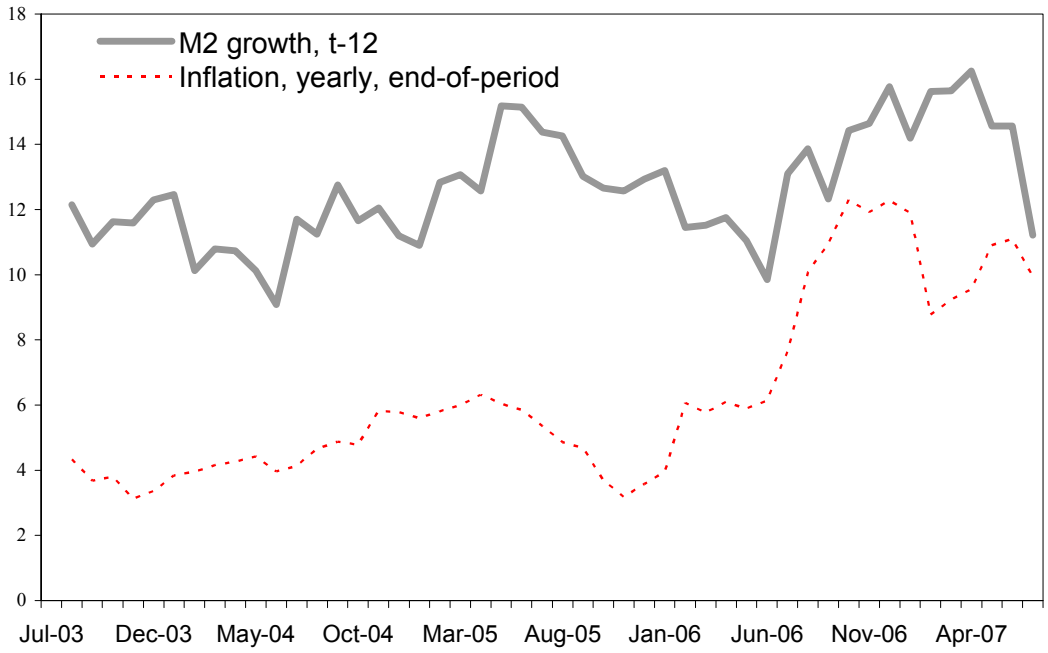
Appendix

Figure 1. Monetary Policy Variables: Interest Rates and Broad Money Growth, 2003-07





Source: Bank of Mauritius Monthly Bulletin; Mauritius Central Statistics Office, IMF *International Financial Statistics;* and Staff estimates.

Table 1. Unit root tests

Series:	Inflation	Variance	Skewness	Lombard	Interbank	T-bill	M2	NEER
	Sample: June 2003 - December 2006 (T=42)							
Augmented Dickey-Fuller								
level	0.699	-0.054	-0.972	-1.272	-1.866	-1.647	-2.575	-0.705
p-value	0.990	0.954	0.763	0.642	0.348	0.459	0.098	0.846
1st difference	-4.615	-4.670	-5.343	-4.223	-7.270	-3.421	-8.195	-3.974
p-value	0.000	0.000	0.000	0.001	0.000	0.010	0.000	0.002
Phillips-Perron								
level	0.159	-0.201	-1.181	-1.357	-1.751	-1.667	-2.554	-1.401
p-value	0.970	0.938	0.682	0.603	0.405	0.448	0.103	0.582
1st difference	-4.672	-4.526	-5.288	-4.513	-7.429	-3.441	-8.437	-3.893
p-value	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.002
	Sample: June 2003 - June 2007 (T=46)							
Augmented Dickey-Fuller								
level	-0.759	-0.576	-1.301	-0.869	-2.062	-1.764	-2.632	-1.938
p-value	0.831	0.876	0.629	0.798	0.260	0.399	0.087	0.314
1st difference	-5.255	-4.931	-5.875	-5.643	-7.943	-4.347	-8.349	-4.908
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Phillips-Perron								
level	-0.996	-0.730	-1.464	-1.064	-1.927	-1.790	-2.604	-2.307
p-value	0.755	0.839	0.551	0.729	0.319	0.385	0.092	0.170
1st difference	-5.256	-4.787	-5.839	-5.706	-8.187	-4.357	-8.379	-4.816
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Deterministic intercept and trend are included. Both tests' null hypothesis is that of a unit root. In both cases, the MacKinnon approximate p-value is reported.
Source: Staff estimates.

Table 2. Correlation matrix

Sample: June 2003 - December 2006

	Inflation	Variance	Skewness	Lombard rate	Interbank rate	T-bill rate	Δ M2	Δ NEER
Inflation	1							
Variance	0.8532*	1						
Skewness	0.6290*	0.5776*	1					
Lombard rate	-0.001	0.0947	0.4817*	1				
Interbank rate	-0.2112	-0.0691	0.2486	0.9046*	1			
T-bill rate	-0.3541	-0.3069	0.3468	0.7780*	0.7845*	1		
Δ M2	0.5386*	0.302	-0.0958	-0.2656	-0.31	-0.6019*	1	
Δ NEER	-0.5899*	-0.2316	-0.1875	0.0343	0.1375	0.1864	-0.4717*	1

Sample: June 2003 - June 2007

	Inflation	Variance	Skewness	Lombard rate	Interbank rate	T-bill rate	Δ M2	Δ NEER
Inflation	1							
Variance	0.8762*	1						
Skewness	0.6941*	0.6620*	1					
Lombard rate	0.2748	0.3185	0.5905*	1				
Interbank rate	-0.099	0.024	0.3006	0.8296*	1			
T-bill rate	-0.3074	-0.2753	0.3166	0.6416*	0.7644*	1		
Δ M2	0.5907*	0.4262*	0.1138	0.0661	-0.1526	-0.4961*	1	
Δ NEER	-0.5747*	-0.2603	-0.1795	-0.1133	0.0568	0.1719	-0.5307*	1

Note: * indicates significance at the 1 percent level. Interest rates and broad money growth are lagged 12 periods.
Source: Staff estimates.

Table 3. The Determinants of Inflation: OLS Estimates (Robustness check)

(Dependent variable: Yearly end-of-period rate of change in the CPI)

Sample →	June 2003 – December 2006			June 2003 – June 2007		
Model →	1	2	3	1'	2'	3'
Variance	**0.458**	**0.451**	**0.342**	**0.502**	**0.518**	**0.452**
	(13.56)***	**(14.07)*****	**(6.36)*****	**(6.36)*****	**(7.29)*****	**(5.45)*****
Skewness	**0.936**	**0.853**	**1.117**	**0.726**	**0.731**	**0.840**
	(7.54)***	**(9.26)*****	**(7.43)*****	**(3.75)*****	**(4.26)*****	**(3.97)*****
Lombard, t-12	-0.666			-0.157		
	(3.82)***			(0.30)		
Interbank rate, t-12		-0.219			-0.222	
		(4.74)***			(1.70)*	
T-bill rate, t-12			-0.418			-0.241
			(3.84)***			(1.23)
ΔM2, t-12	0.426	0.409	0.200	0.205	0.205	0.175
	(8.13)***	(8.29)***	(2.99)***	(1.77)*	(1.82)*	(1.29)
ΔNEER	-0.189	-0.188	-0.212	-0.194	-0.188	-0.190
	(8.61)***	(10.51)***	(15.74)***	(4.47)***	(4.51)***	(4.36)***
			Residual diagnostic tests			
Serial correlation						
Durbin Watson	2.0128	2.1175	2.0191	2.0023	1.9667	1.9871
Normality						
Jarque-Bera p-value	0.3594	0.3778	0.0107	0.7861	0.0909	0.0812
Unit root tests						
Phillips-Perron p-value	0.0000	0.0000	0.0000	0.0145	0.0037	0.0049
ADF p-value	0.0000	0.0000	0.0000	0.0172	0.0052	0.0061
Observations	41	41	41	47	47	47
R-squared	0.98	0.99	0.98	0.77	0.85	0.83

Notes: t statistics in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The standard errors are robust to heteroskedasticity of unknown form. Seasonal dummies are included.
Source: Staff estimates.