Oil Prices and Inflation under Alternative Monetary Regimes: Evidence from Brazil

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Introduction and Research Strategy

1. **This paper examines the relationship between oil prices and inflation in Brazil during 1994-2008**. The period is particularly rich from a research standpoint because it spanned over two very distinct periods of monetary policy strategy: the exchange rate targeting (ERT) carried out in 1994-98 and the inflation targeting framework (IT) adopted in 1999. Therefore, besides providing an estimate of the overall impact oil prices on inflation in Brazil, this paper also investigates whether this impact has changed after the adoption of IT. In addition, interesting byproducts of the empirical work include estimates of the degree of persistence of inflationary shocks and the impact of economic activity, the exchange rate, and the interest rate on inflation under the alternative monetary regimes.

2. **The empirical investigation relies mainly on estimates of VARs and their associated impulse response functions.** Different model specifications generally include a measure of consumer prices, domestic wholesale fuel prices, the nominal exchange rate between the Brazilian real (BRL) and the US dollar (USD), a measure of economic activity, and a measure of interest rates. In addition, single equations provide estimates of the *pass-through* from international oil prices and the exchange rate to domestic fuel prices. The data set comprised quarterly data spanning the period 1994:3-2008:2.

3. **Empirical estimates suggest that although the pass-through from the cost of oil to domestic fuel prices has increased, the impact of fuel prices on inflation in Brazil has declined under IT**. This result is in line with international evidence that an increase in the forward looking component of inflation expectations and in the credibility of monetary policy has reduced the inflationary impact of higher fuel prices in recent years.[1] Anecdotal evidence of

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[1] Schmidt-Hebbel and Mishkin (2006), "Does Inflation Targeting Make a Difference?," presented at the 8th Annual Meeting of the Brazilian Central Bank.

4. this change in price dynamics includes the relatively small response of inflation in Brazil and in industrial countries following the surge in oil prices (and other commodities) since 2003. This recent experience contrasts with the widespread acceleration of inflation following the oil shocks of the 1970s.

5.

Preliminary Data Analysis

6. **Wholesale fuel prices have largely accompanied the increase in the cost of oil measured in BRL, being adjusted to broadly reflect higher international oil prices and/or a weaker exchange rate (Figure 1).** However, fuel prices have shown some downward stickiness: the main deviations between the two series occurred when wholesale fuel prices did not match temporary declines in oil prices expressed in domestic currency (Figure 2). First, during the ERT period, reflecting falling international oil prices; and later, during the IT period, reflecting periods of significant BRL appreciation, perhaps considered by the authorities as temporary.

Figure1. Wholesale Fuel Prices and Oil Prices (levels)

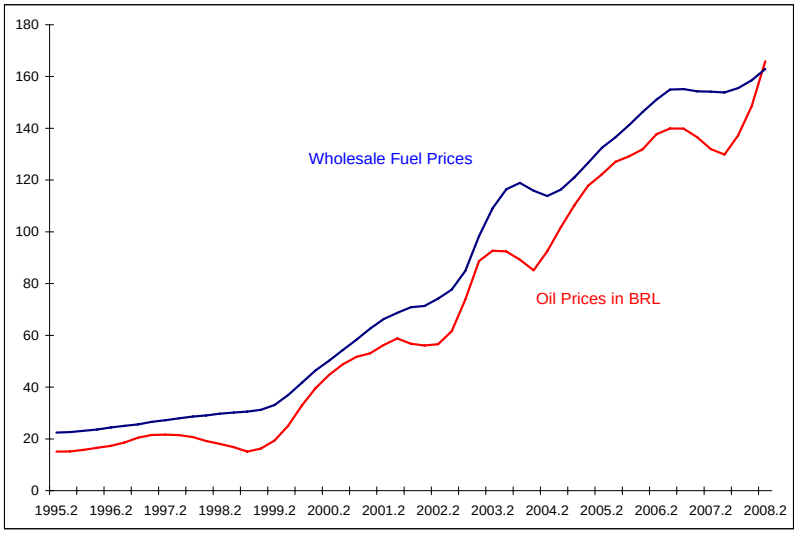
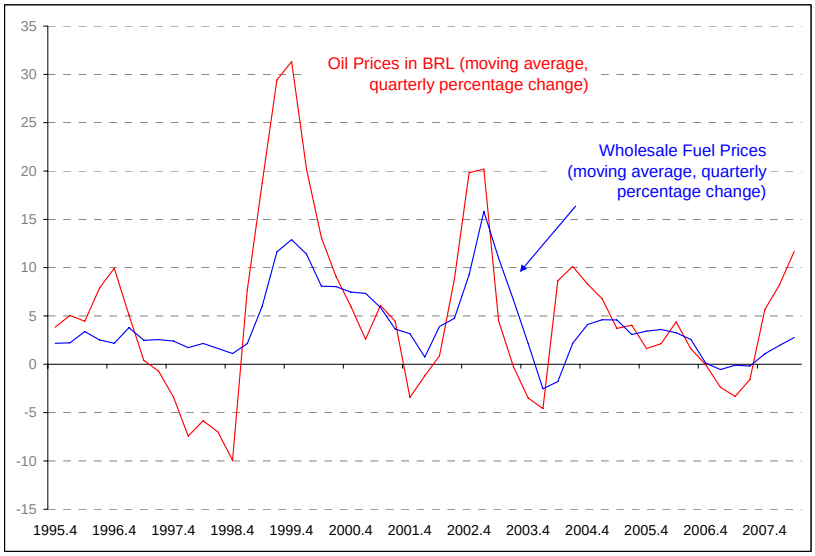
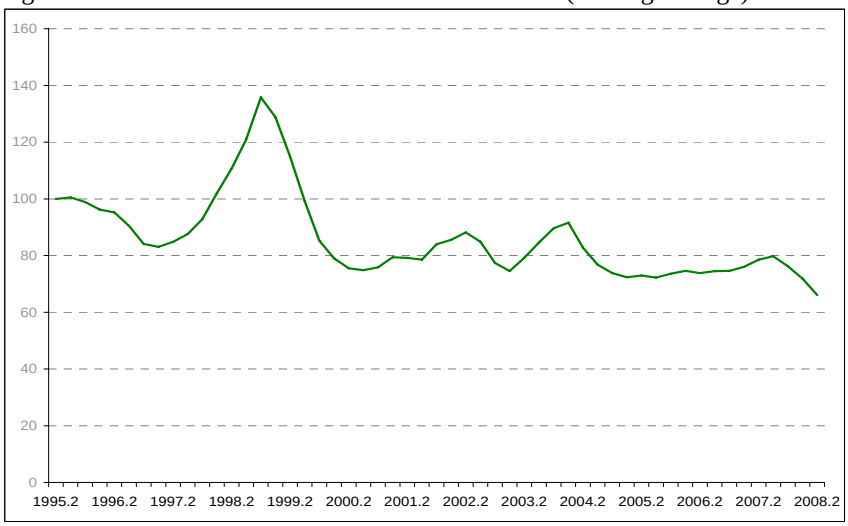


Figure 2. Wholesale Fuel Prices and Oil Prices (percentage changes)



7. The ratio of wholesale fuel prices to the cost of oil expressed in domestic currency has remained relatively stable in the last 8 years (Figure 3). This tendency contrasts with the wide fluctuation range observed during the ERT period and suggests that the degree of pass-through from oil costs to domestic fuel prices has increased in recent years. This is particularly interesting given the escalation of international oil prices and greater exchange rate volatility observed in the period.

Figure 3. Ratio of Wholesale Fuel Prices to Oil Prices (moving average)



8. Simple measures of correlation also suggest that the pass-through from the cost of oil to wholesale fuel prices has increased since the floating of the exchange rate and implementation of IT (Table 1). The correlation coefficient for the two series in levels increased from 0.20 during 1994-98 to about 0.95 after 1999. The correlation coefficient between the quarterly percentage changes in the domestic price of oil and wholesale fuel prices went from -0.10 to 0.50 in the same period comparison. Using 4-quarter moving averages of the series as way to smooth out short-term price fluctuations does not alter the basic result: the correlation

coefficient between changes in oil costs and fuel prices increases from 0.38 to 0.79 in the more recent period.

Table 1. Wholesale Fuel Prices and Oil Prices - Correlation

	Coefficient of Correlation	
	ERT	**IT**
Series in Levels	0.20	0.95
Percentage Changes	-0.10	0.50
Moving Average Percentage Changes	0.30	0.80

9. **Although domestic fuel prices have increased sharply during the IT period, more closely reflecting oil costs, the impact on consumer price inflation has been limited (Figure 4).** In fact, since the abandonment of the exchange rate peg in 1999, wholesale fuel prices have risen nearly 500 percent, whereas the accumulated inflation measured by the IPCA (the official target of the Central Bank) was about 90 percent. Episodes of particularly rapid fuel price increases seem to have had only a small impact on ensuing inflation, perhaps reflecting the credibility of the IT regime. In fact, the stronger response of inflation in early 2003 (to fuel prices and, more generally, to the earlier depreciation of the BRL) can be associated with speculation regarding the commitment of the new government to the IT framework. The behavior of core inflation - excluding administered prices - supports similar conclusions (Figure 5).

Figure 4. Wholesale Fuel Price Increases and IPCA Inflation

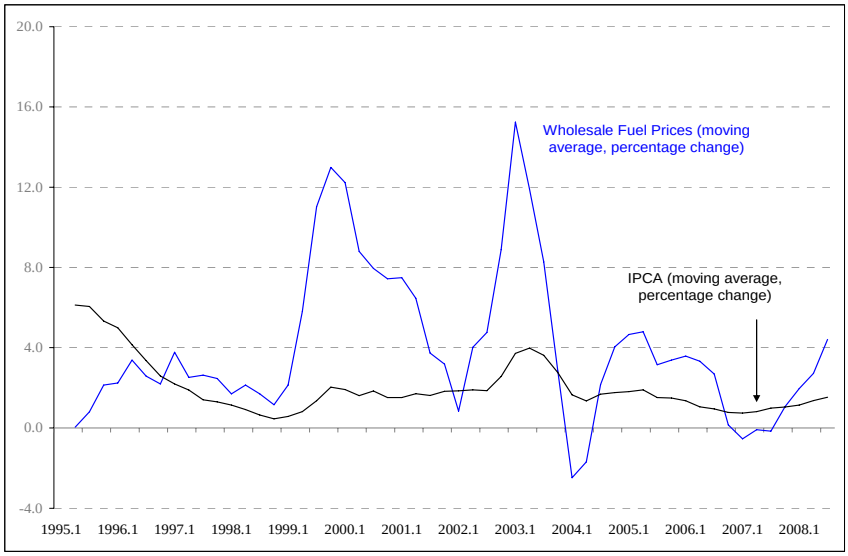
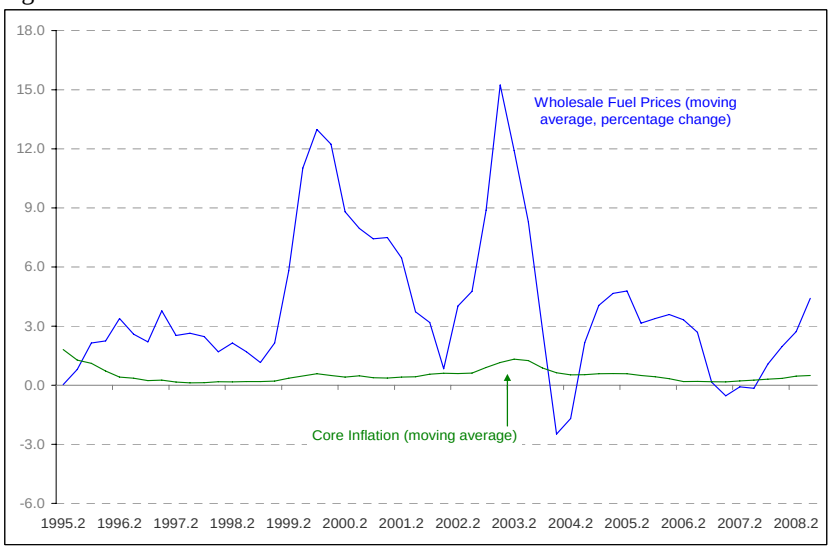


Figure 5. Wholesale Fuel Price Increases and Core Inflation



Empirical Modeling

10. **The data set comprises quarterly data for the period 1994:3 – 2008:2**. It includes the following series: the consumer price index (IPCA); an index of wholesale fuel prices (IPAFUEL); the exchange rate expressed in BRL per USD (ER); international oil prices expressed in USD per barrel (POIL); the policy interest rate (SELIC); the real interest rate (RSELIC); the unemployment rate (UNEMP); the output gap (GAP); and a measure of core inflation that excludes energy and other administered prices (CORE).

11. **The VARs that support the main findings of this paper were estimated using stationary series.**[2] When necessary, the original series were transformed to achieve stationarity. Augmented Dickey-Fuller tests for unit roots and a 5-percent significance level underpinned the process. Lag lengths of the VARs were chosen to minimize the Schwarz information criteria. The preferred VAR specification had one lag and included the following variables: IPCA, IPAFUEL, ER, UNEMP, and RSELIC. The stationary unemployment variable was obtained by de-trending the original series using an HP filter.

12. Impulse response functions and the associated pass-through coefficients are used to assess the impact of fuel prices on inflation. Two alternative impulse response functions were estimated using Choleski decomposition (CHO) and generalized impulses (GI).[3] Cumulative pass-through coefficients were then calculated as the ratio of the cumulative response of inflation to the cumulative response of fuel prices after $t+i$ quarters when there is a shock to fuel prices at t.

Table 2. Cumulative Pass-through of a 10-percent Increase in Fuel Prices to Inflation

	Full Sample		Inflation Targeting Period	
Quarter	Choleski	GI	Choleski	GI
1	1.0	0.9	0.7	0.7
2	1.1	1.1	0.8	0.8
3	1.2	1.3	0.9	0.9
4	1.3	1.4	1.0	1.0
5	1.3	1.5	1.0	0.9
6	1.3	1.6	0.9	0.9
7	1.2	1.7	0.9	0.9
8	1.2	1.7	0.9	0.9

13. The estimations suggest that a 10-percent increase in fuel prices raises inflation by almost 1½ percentage point after one year (Table 2). This finding is broadly in line with Le Blanc and Chinn (2004) who estimate the impact of a similar increase in oil prices on inflation

[2] The only exception is an alternative VAR model that includes the unemployment rate (I1) rather than the de-trended series (I0).

[3] The Choleski ordering was the following: measure of activity (UNEMP

after a year to be between 0.1 percentage point and 2½ percentage points for a group of industrialized countries over the period 1980:1 – 2001:4.[4]

14. The impact of fuel prices on inflation seems to have declined after the introduction of inflation targeting. The one-year inflationary impact of a 10-percent increase in fuel prices is estimated at 1 percentage point when the sample is restricted to the period 1999:3 – 2008:2. Since the share of fuel prices in the consumer price index remained the same and the energy intensity of the economy is likely to have remained broadly the same, the lower inflationary impact of fuel prices may be attributed greater monetary policy credibility and lower persistence of inflationary shocks in general.

15. Estimates of the impact of unemployment, the exchange rate, and the policy interest rate on inflation also suggest greater monetary policy credibility under IT. Impulse response functions and the associated cumulative pass-through coefficients show that the impact of economic activity and of the exchange rate on inflation have declined whereas the impact of the policy interest rate on inflation has increased under IT (Table 3). This is consistent with the interpretation that the policy interest rate has acted more through the expectations channel than through economic activity to affect inflation and that, as expected, the pass-through from the exchange rate to inflation has declined after the abandonment of ERT.

Table 3. Cumulative Impact of Other Variables on Inflation
(impact of a 1-percentage point increase after one year)

	ER	UNEMP	RSELIC
Full Sample	0.21	-0.39	-0.04
IT period	0.12	0.04	-0.24

16. Alternative VAR specifications corroborate the main finding of a lower pass-through from fuel prices to inflation. When the original unemployment series is included rather than its de-trended series, the one-year inflationary impact of a 10-percent increase in fuel prices is estimated at 1.2 percentage point (Cho) and 1½ (GI) for the full sample and only 0.6 for the IT period (Table 4). When the output gap is used as the measure of economic activity, the one-year inflationary impact of the same 10-percent fuel price shock is estimated at about 1½ percentage point for the full sample and 1 percentage point for the IT period.

Table 4. Inflationary Impact of a 10-percent Increase in Fuel Prices
Under Alternative VAR Specifications

	Full Sample		IT Period	
	Choleski	GI	Choleski	GI
VAR with Original Unemployment	1.2	1.5	0.6	0.6
VAR with Output Gap	1.4	1.5	1.0	1.0

[4] "Do High Oil Prices Presage Inflation? The Evidence from G-5 Countries." Le Blanc and Chinn use a different approach than mine, assuming inflation to be the only endogenous variable and thus estimating a single equation (for each country) through OLS

17. Econometric estimates confirm that the pass-through from oil costs to domestic fuel prices has increased after 1999. Simple OLS estimates show that the long-term pass-through coefficient from the cost of oil in BRL to fuel prices increased by 20 percent to 0.6 in the recent period. This makes it all the more important that IT has succeeded in reducing the persistence of inflationary shocks – including that of rising fuel prices.