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

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This paper provides an empirical analysis of inflation dynamics in Brazil under alternative monetary policy regimes during 1994-2008. The period is particularly rich from a research standpoint because it covers two very distinct monetary policy strategies: the exchange rate targeting (ERT) carried out in 1994-98 and the inflation targeting framework (IT) with floating exchange rates that was followed after 1999. The empirical investigation relies mainly on estimates of Vector Autoregression (VAR) models and their associated impulse response functions. Estimates of the impact of unemployment, the exchange rate, and the policy interest rate on inflation suggest greater monetary policy credibility under IT. Empirical results also point to a decline in the impact of fuel prices on inflation under IT despite an increase in the pass-through from the cost of oil to domestic fuel prices.

Fields of Research: Monetary policy; Inflation; Vector Autoregressions

1. Introduction and Research Strategy

This paper provides an empirical analysis of inflation dynamics in Brazil under alternative monetary policy regimes during 1994-2008. The period is particularly rich from a research standpoint because it covers two very distinct monetary policy strategies: the exchange rate targeting (ERT) carried out in 1994-98 and the inflation targeting framework (IT) with floating exchange rates that was followed after 1999. Econometric models are used to compare the degree of persistence of inflationary shocks and the impact of economic activity, the exchange rate, and the interest rate on inflation dynamics under the alternative monetary regimes. Particular attention is given to the impact of oil shocks on inflation due to the relative homogeneity and importance of crude oil for consumer and businesses around the world.

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The empirical investigation relies mainly on estimates of Vector Autoregression (VAR) models 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 estimated through ordinary least squares 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.[1]

Estimates of the impact of unemployment, the exchange rate, and the policy interest rate on inflation suggest greater monetary policy credibility under IT. Impulse response functions indicate 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. 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 as monetary policy became gained credibility in an environment of forward-looking price formation.

Empirical estimates point to a decline in the impact of fuel prices on inflation under IT despite an increase in the pass-through from the cost of oil to domestic fuel prices. 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 decades.[2] Additional, anecdotal evidence of 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.[3]

2. Preliminary Data Analysis

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.

The degree of pass-through from oil costs to domestic fuel prices has increased in the since the floating of the currency and introduction of IT. 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, which is

particularly interesting given the escalation of international oil prices and greater exchange rate volatility observed more recently.

Figure1. Wholesale Fuel Prices and Oil Prices (levels)

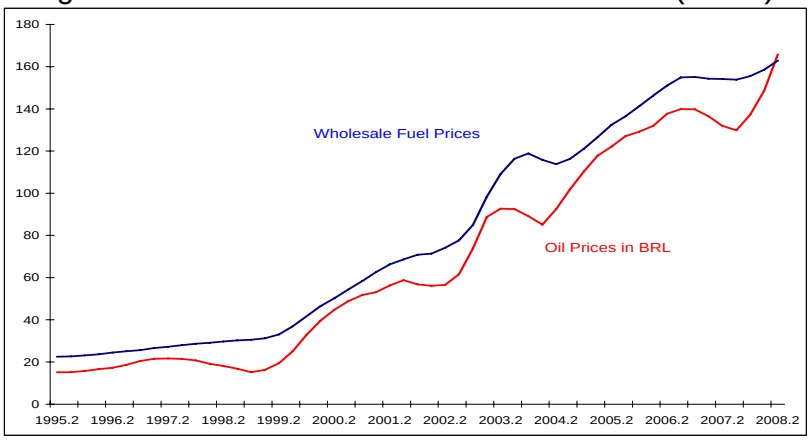


Figure 2. Wholesale Fuel Prices and Oil Prices (percentage changes)

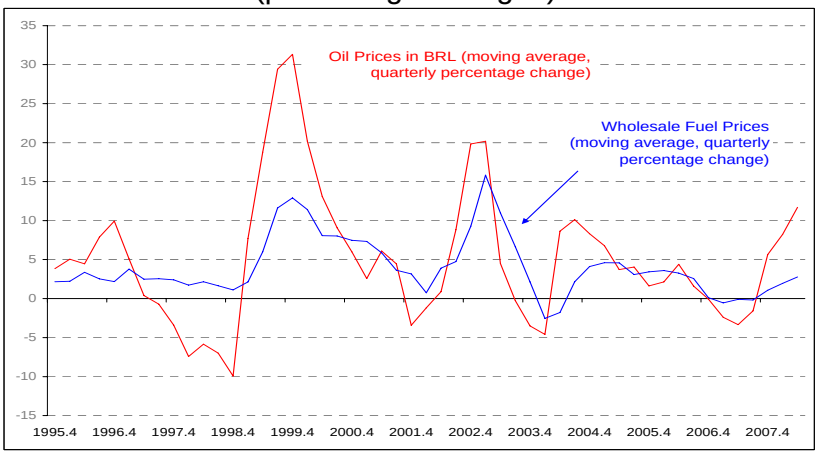
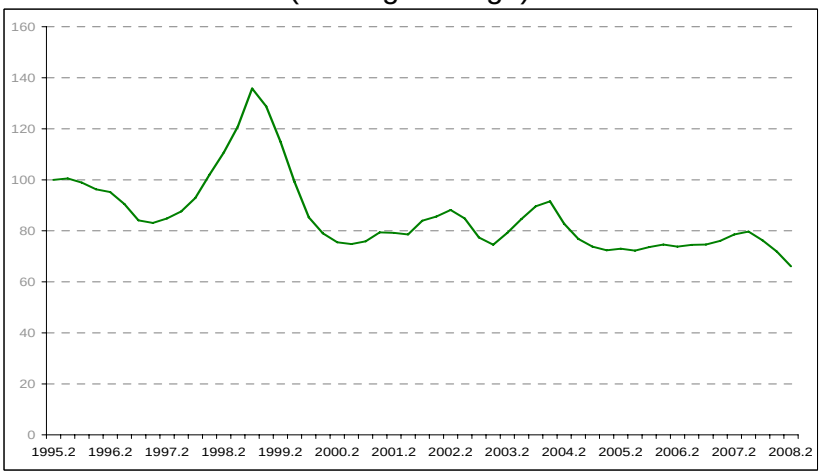


Figure 3. Ratio of Wholesale Fuel Prices to Oil Prices (moving average)



Simple correlation analysis also point to an increase in the pass-through from the cost of oil expressed in domestic currency to wholesale fuel prices (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 went from -0.10 to 0.50 in the same period comparison. Using 4-quarter moving averages as way to smooth out short-term price fluctuations does not alter the basic result: the correlation coefficient 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

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). Since the abandonment of the exchange rate peg in 1999, wholesale fuel prices have risen nearly 500 percent, whereas the accumulated consumer (IPCA) inflation was about 90 percent.[4] Episodes of particularly rapid fuel price increases seem to have had only a small impact on ensuing inflation, probably 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 preceding depreciation of the BRL) can be associated with speculation regarding the commitment of the new government to the IT framework. As doubts were short-lived and credibility quickly regained, inflation subsided and remained little affected by escalating oil prices for the rest of the period. The behavior of core inflation – that excludes administered prices - supports similar conclusions (Figure 5).

Figure 4. Wholesale Fuel Price Increases and IPCA Inflation

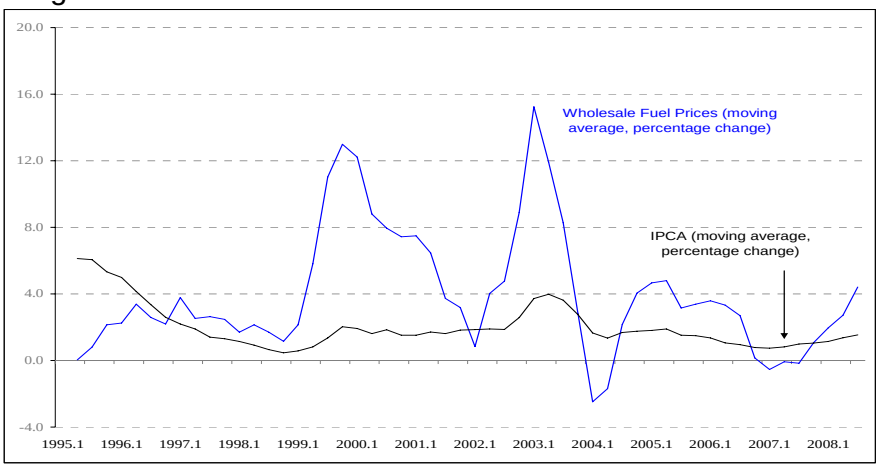
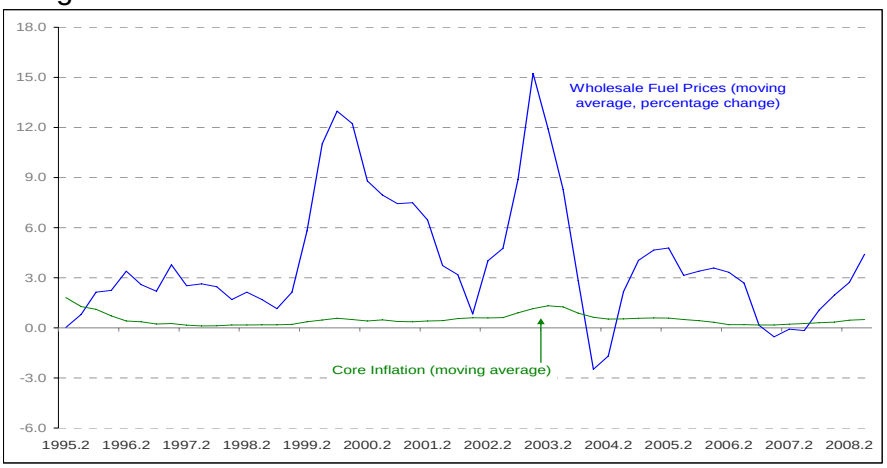


Figure 5. Wholesale Fuel Price Increases and Core Inflation



3. Empirical Modeling and Results

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).

The VARs that support the main findings of this paper were estimated using stationary series.[5] When necessary, the original series were transformed to achieve stationarity. Augmented Dickey-Fuller tests for unit roots with a 5-percent significance level guided 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.

Impulse response functions and the associated pass-through coefficients are used to assess the impact of economic activity, exchange rate, interest rate, and fuel price shocks on inflation. Alternative impulse response functions were estimated using Choleski decomposition (CHO) and generalized impulses (GI) in order to check the robustness of the results; for simplicity, only the first set of impulse responses functions is shown here (Figure 6).[6] Having estimated the VARs and associated impulse response functions, cumulative pass-through coefficients were calculated as the ratio of the cumulative response of inflation to the cumulative response of fuel prices after *i* quarters following a shock to fuel prices in period *t*:

$$CPTI_{x,t+i} = \frac{CRI_{x,t+i}}{CX_{t+i}}$$

where

CPTI is the cumulative inflation pass-through coefficient vis-à-vis variable X
CRI is the cumulative response of inflation after *i* periods when there is a shock to variable X in period *t.*
CX is the cumulative response of X after *i* periods to a shock received in period *t*

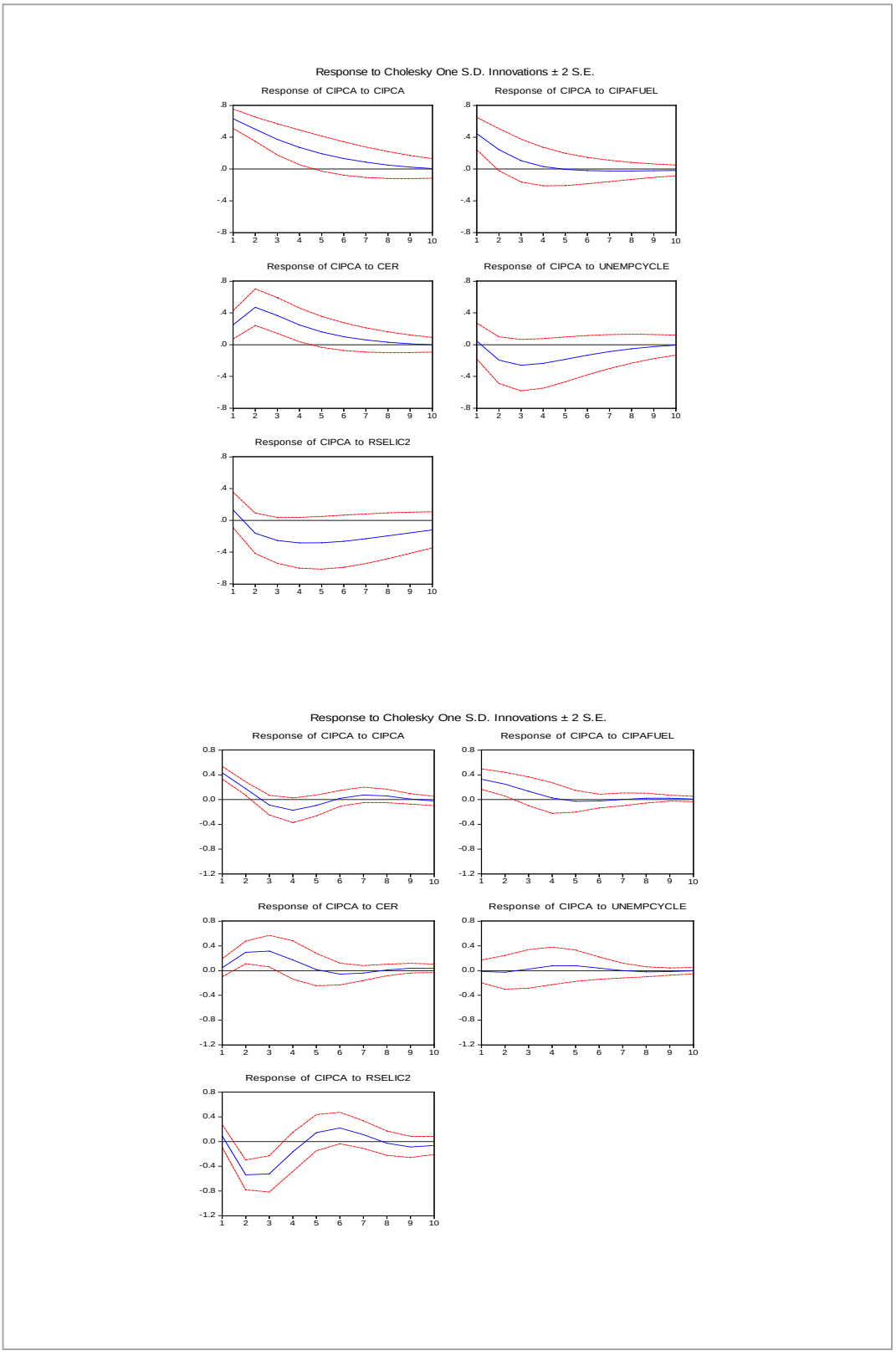
The estimations suggest that a 10-percent increase in fuel prices raises inflation by almost 1½ percentage point after one year (Table 2). This finding is broadly in line with Le Blanc and Chinn (2004) who estimate the impact of a similar increase in oil prices on inflation after a year to be between 0.1 percentage point and 2½ percentage points for a group of industrialized countries over the period 1980:1 – 2001:4.[7]

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

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 also 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.

Figure 6: Impulse Response Functions



More importantly, estimates of the impact of unemployment, the exchange rate, and the policy interest rate on inflation also suggest greater monetary policy credibility under IT.[8] Impulse response functions and the associated cumulative pass-through coefficients show that shocks to economic activity and the exchange rate have had less impact on inflation since the implementation of IT, thereby improving the growth-inflation trade-off. At the same time, the impact of the policy interest rate on inflation has increased (Table 3). This is consistent with the interpretation that the policy interest rate has affected inflation more directly through the expectations channel than indirectly through economic activity, allowing for better control of inflation with more modest losses in production and employment.[9] Moreover, the pass-through from the exchange rate to inflation has declined after the abandonment of ERT as the exchange rate lost its power to coordinate price expectations.

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

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. Final Remarks

Vector Autoregression models and their associated impulse response functions were used to compare the degree of persistence of inflationary shocks and the

impact of economic activity, the exchange rate, and the interest rate on inflation dynamics under alternative monetary regimes in Brazil. The results show that the impact of oil prices on inflation seems to have declined after the introduction of inflation targeting, being now broadly similar to that experienced in some industrialized countries. Estimates of the impact of unemployment, the exchange rate, and the policy interest rate on inflation also suggest that monetary policy has gained credibility since the introduction of inflation targeting in Brazil.

Endnotes

1. The choice of the sample's starting point reflected the beginning of ERT and the end of hyper-inflation in Brazil.
2. See, for instance, Schmidt-Hebbel and Mishkin (2006); Bernanke, Gertler, and Watson (1997); and Hunt, Isard, and Laxton (2002).
3. Noriega and Ramos-Francia (2009) provide recent empirical evidence of the decline in inflation persistence in the U.S. over the last few decades.
4. The IPCA is the consumer price index that serves as the official target for the Brazilian Central Bank.
5. The only exception is an alternative VAR model that includes the unemployment rate (I1) rather than the de-trended series (I0).
6. The Choleski ordering was the following: UNEMP, RSELIC, IPAFUEL, ER, IPCA.
7. Le Blanc and Chinn use a different approach by ignoring cross-relations among variables, assuming inflation to be the only endogenous variable in the group, and thus using ordinary least squares (OLS) to estimate the impact of oil prices on inflation.
8. This does not imply that inflation targeting is always superior to other monetary arrangements. See, for instance, Carlson and Valev (2001) for an analysis of the benefits of the currency board implemented in Bulgaria.
9. For a broad discussion of the impact of external shocks on Latin American economies with different exchange rate arrangements, see Berg, Borensztein, and Mauro (2002).

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