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DOES HIGH INFLATION AFFECT GROWTH IN THE LONG AND SHORT RUN?

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This paper investigates the relationship between inflation and output in the context of an economy facing persistent high inflation. By analyzing the case of Brazil, we find that inflation does not impact real output in the long run, but that in the short run there exists a negative effect from inflation on output. These results support Sidrauski's (1967) superneutrality of money in the long run, but cast doubt on the short run implications of the model for separable utility functions in consumption and real money balances, as exposed by Fischer (1979). The results are more likely to support a class of utility functions in which real money balances and consumption are perfect complements.

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I. Introduction

The impact of inflation on growth, output and productivity has been one of the main issues examined in macroeconomics. Theoretical models in the

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money and growth literature analyze the impact of inflation on growth focusing on the effects of inflation on the steady state equilibrium of capital per capita and output (e.g., Orphanides and Solow, 1990). There are three possible results regarding the impact of inflation on output and growth: i) none; ii) positive; and iii) negative. Sidrauski (1967) established the first result, showing that money is neutral and superneutral[1] in an optimal control framework considering real money balances (M/P) in the utility function. Tobin (1965), who assumed money as substitute to capital, established the positive impact of inflation on growth; his result being known as the Tobin effect. The negative impact of inflation on growth, also known as the anti-Tobin effect, is associated mainly with cash in advance models (e.g., Stockman, 1981) which consider money as complementary to capital[2].

In this paper, we investigate the impact of inflation on growth and output for the case of Brazil, a country which faced a long period of high inflation rates until recently. We address this question through a statistical investigation of the relationship between inflation and real output during the period 1980-95. We impose minimal structure and make use of the idea that inflation shocks can be decomposed into permanent and temporary components, along the lines of Blanchard and Quah (1989). We use a bivariate vector autoregression composed of output growth and the change in inflation in order to test the hypothesis that inflation has long run effects on output (e.g., Bullard and Keating, 1995). Also we estimate a dynamic model to assess the short-run relationship between inflation and real output. Our results provide evidence against the hypothesis of non-superneutrality of money, showing that inflation

[1] Money is neutral when an increase in money supply leads to an equal increase in all prices and no real variables are affected. Money is superneutral when changes in the growth rate of money supply have no effect on the real variables of the economy (e.g. Romer, 1996). This role of money is very close to the one described by the quantity theory of money in the long run (see Lucas, 1996).

[2] For a detailed presentation of these models, their assumptions and implications see, *inter alia*, Wang and Yip (1992) and Andrade and Faria (1994).

has no long-run effects on real output, but that it can have short-run impacts. We believe that there is room to further theoretical work in order to build a model that yields both of these results, although this is beyond the scope of this paper.

The paper is organized as follows. Section 2 reviews some of the main findings in the related literature. Section 3 presents empirical evidence for the case of Brazil. Section 4 discusses the empirical results and presents the results for the short run. Section 5 presents our concluding remarks.

II. Related Work

More recently, the macroeconomics debate has concentrated on the impacts of inflation on real output. Another branch of the literature, however, is more concerned with the welfare costs of inflation. Papers under such motivation have typically examined how consumers spend their real resources with alternative means of exchange to avoid the inflation tax (e.g., Bailey, 1956). In this literature, inflation *a priori* has a negative impact on the economy, through its costs on welfare. Thus, the most relevant costs associated with unanticipated[3] inflation are: i) the distributive effects from creditors to debtors; ii) increasing uncertainty affecting consumption, savings, borrowing and investment decisions; and iii) distortions on relative prices (Briault, 1995)[4]. Some of the relevant references are Fischer (1981), Eckstein and Leiderman (1992), Gillman (1993), Simonsen and Cysne (1994), and Dotsey and Ireland (1996). Using the monetary base as the relevant definition for money, Fischer (1981) has computed the deadweight loss generated by an increase in inflation from zero to 10 percent as just 0.3 percent of GNP. Eckstein and Leiderman

[3] One referee has stressed the fact that inflation does have anticipated costs. Inflation taxes real money balances and therefore agents have to incur in higher costs to minimize the real balances they hold.

[4] Tommasi (1994) examines the welfare effects associated to price variability due to the depreciation of the information about future prices contained in current ones.

(1992) and Gillman (1993), on the other hand, have obtained different estimates. While Eckstein and Leiderman have found that a 10% increase in inflation generates welfare costs of around 1% of GNP, Gillman has calculated this impact to be 2.19% of current income for a costly credit economy.

For the case of high inflation economies, Simonsen and Cysne (1994) have shown that the formula proposed by Bailey leads to higher welfare costs; they have estimated the welfare cost of a 10% inflation rate as 4.25 % of GDP. On the other hand, in a general equilibrium model, Dotsey and Ireland (1996) have shown that Bailey's approach captures only a fraction of the total costs of inflation. They have calculated the welfare cost of 10% of inflation as 0.915 % of output using the monetary base as the relevant definition for money; if M1 is used instead, the welfare costs become 1.7 %.

Recently many papers have estimated directly the impact of inflation on growth, output, investment and productivity. In this literature, the growth rate of the economy is considered as the dependent variable and the inflation rate as the explanatory variable. The empirical results have a clear policy implication: if inflation affects growth negatively, then monetary policy ought to stress price stability based on vigorous anti-inflationary policies targeting zero inflation.[5] Examples of papers that have attempted to follow this line of research are Smyth (1992, 1994, and 1995), De Gregorio (1993), and Barro (1995). Smyth (1992) has estimated a negative relationship between inflation and growth: for each one percentage point increase in the USA inflation the annual growth rate is reduced by 0.223%. Smyth (1994) has also shown that inflation acceleration impacts growth negatively in the USA, each one percentage point increase in acceleration causing a reduction of 0.158% in growth. For Germany, Smyth (1995) has estimated that a 10% increase in the rate of inflation reduces the rate of growth of total factor productivity by

[5] Thirlwall (1974) and more recently Sarel (1996) have shown from a non-linear relationship between inflation and growth that the zero inflation target could not be the best policy to be followed.

0.025%. Cameron et al. (1996) test the robustness of this kind of estimation and their results are suggestive that there is no connection between inflation and the level of productivity.

De Gregorio (1993), on the other hand, shows a significant negative effect of inflation and its variability on growth for Latin American countries. These effects on growth work through the effects of inflation on the productivity of investment. If inflation rates had been half of their levels in the 1950-85 period, the rate of growth of per capita GDP could have been 25% higher. Barro (1995) using data for about 100 countries for the period 1960 to 1990 has estimated that an increase in average inflation of ten percentage points per year lowers the growth rate of per capita GDP by 0.2-0.3 percentage points per year and reduces the ratio of investment to GDP by 0.4-0.6 percentage points.

Finally, Bruno and Easterly (1998) argue that the negative long-run relationship between inflation and growth found in the literature is only present with high frequency data and with extreme inflation observations, and that there is no cross-sectional correlation between long-run averages of growth and inflation. By examining discrete high inflation crises, they find that growth falls sharply during discrete high inflation crises, then recovers rapidly and strongly after inflation falls.

III. Empirical Evidence for the Case of Brazil

Recent empirical work on growth has typically either focused on a time series of a single country or investigated the determinants of growth in cross-sectional analysis. Some time series studies include Fisher and Seater (1993), Weber (1994), and Bullard and Keating (1995). While some authors have reported that inflation is negatively related to output growth (see Levine and Renelt, 1992), Bullard and Keating (1995) present evidence that such result is fragile. We investigate long-run neutrality for the case of Brazil, a country which has experienced persistent high inflation for a considerable length of time.[6]

[6] For a detailed analysis on the causes and characteristics of Brazilian inflation see Tullio and Ronci (1996), and Silva and Andrade (1996).

We use a bivariate time series model including the inflation rate and real output for the period January 1980 to July 1995. Our methodology follows the Blanchard and Quah (1989) decomposition[7] and so the primary concern of our paper is to estimate the long-run response of output to a permanent inflation shock. In sum, the Blanchard and Quah decomposition allows one to assess the effects of temporary and permanent shocks on a variable in a bivariate VAR. They construct this decomposition by assuming that one type of disturbances has no long-run effect on one of the endogenous variables to decompose transitory from permanent components. In particular, they develop a model such that real GDP is affected by demand-side and supply-side shocks and use the natural rate of unemployment hypothesis to impose the assumption that the demand-side disturbances have no long-run effects on real GDP. On the supply side, productivity shocks have permanent effects. The assumption that one shock has temporary effects allows them to complete the identification of the structural VAR. In our framework, one shock is associated with permanent changes in inflation and one is restricted to have only temporary effects on inflation. The permanent shock is assumed to be the result of permanent changes in the growth rate of the money supply. The temporary shock to inflation, however, is allowed to have a permanent effect on output.

The data are from the *Brazilian Institute of Economics and Geography (IBGE)* data base. The series we use are the monthly indices of real output and consumer prices. For our VAR to be applicable, the time series must be characterized by permanent shocks to the inflation rate and to the level of output; in other words, we require that each series be integrated of order one. We have investigated the integration properties of the data using the standard Dickey-Fuller and Augmented Dickey-Fuller unit roots tests. Table 1 shows that both tests fail to reject the hypothesis of a unit root for both inflation and output. An important caveat at this point, however, regards the power of unit root tests in the presence of a relatively short span of the data (e.g., Campbell

[7] See Enders (1995) for an introduction to this methodology.

and Perron, 1991). As argued by Hakkio and Rush (1991), though, the relevant issue is the length of the sample period relative to the length of what might be considered the long run. In Brazil, severe inflationary conditions have necessitated frequent index rebasing and lead to the complications of periodic introductions of new currencies. Consequently, the extremely truncated time horizons brought about as a result of persistent high inflation means that in economic terms a period of 15 years may constitute a long run (see Figure 1). The results of the tests presented in Table 1 are also compatible with previous findings about the order of integration of prices and industrial output in Brazil during the period analyzed (e.g., Cati et. al., 1999, and Campelo and Cribari-Neto, 2000). Thus, we proceed to investigate the long-run response of output to a permanent inflation shock[8].

Table 2 gives estimates of variance decompositions for the VAR we have estimated. The VAR is estimated with the change in the inflation rate and output growth, and the change in the inflation rate is ordered first implying that the second shock (interpreted as a temporary inflation shock) has no long-run effect on inflation. Variance decompositions exhibits the contribution of each source of innovation to the variance of the k-year ahead forecast error for each of the variables included in the system. In other words, variance decomposition refers to a breakdown of the change in the value of the variable in a given period arising from changes in the same variable as well as other variables in previous periods. The results indicate that by the end of 24 months about 84% of the variation of real output are accounted for by past changes in prices while only 16% are accounted for by past changes in real output.

Figure 2 presents two sets of impulse response functions for Brazil. We report standardized responses, whereby the impulse responses of each variable

[8] As we have pointed out in the introduction, in the money and growth literature built up on the Sidrauski framework, the steady state equilibrium (the long run equilibrium) relates inflation with output, consumption and capital per capita, since the growth rates for all of these variables are assumed to be zero in the steady state. In particular, Sidrauski's model preserves the modified golden rule, what means that in the steady state inflation does not affect any real variable, as output, consumption or capital per head.

Table 1. Unit Roots Tests

	P	ΔP	LIND	ΔLIND
Dickey-Fuller	17,790	-3,266**	-3,066**	-15,839**
Augmented Dickey-Fuller	3,030	-3,613**	-2,495	-10,844**

Note: The sample period is 1980-1 to 1995-7; (**) means significant at 1% and (*) means significant at 5%. The equations were estimated on 13 lags, according to the method suggested by Perron (1991).

Table 2. Proportion of Forecast Error Variance k Periods Ahead Produced by Each Innovation

Period	S.E.	LIND	P
1	6,547522	3,747133	96,25287
2	9,130312	3,911057	96,08894
10	13,22725	12,98197	87,01803
20	13,51242	15,79220	84,20780
21	13,51705	15,84662	84,15338
22	13,52056	15,88805	84,11195
23	13,52320	15,91952	84,08048
24	13,52519	15,94337	84,05663

are divided by the standard error for the variable's residual. In the case of temporary inflation shock, the initial response of inflation is positive and significantly different from zero, but ultimately the response is zero, reflecting the identifying assumption. As for the case of output, on the other hand, initially the effect is negative but is ultimately zero. A very similar pattern is found for the case of a permanent shock to inflation. Cumulative plots are given in

Figure 1. Industrial Output (panel a) and Price Inflation in Brazil (panel b) in the Period 1980-1995

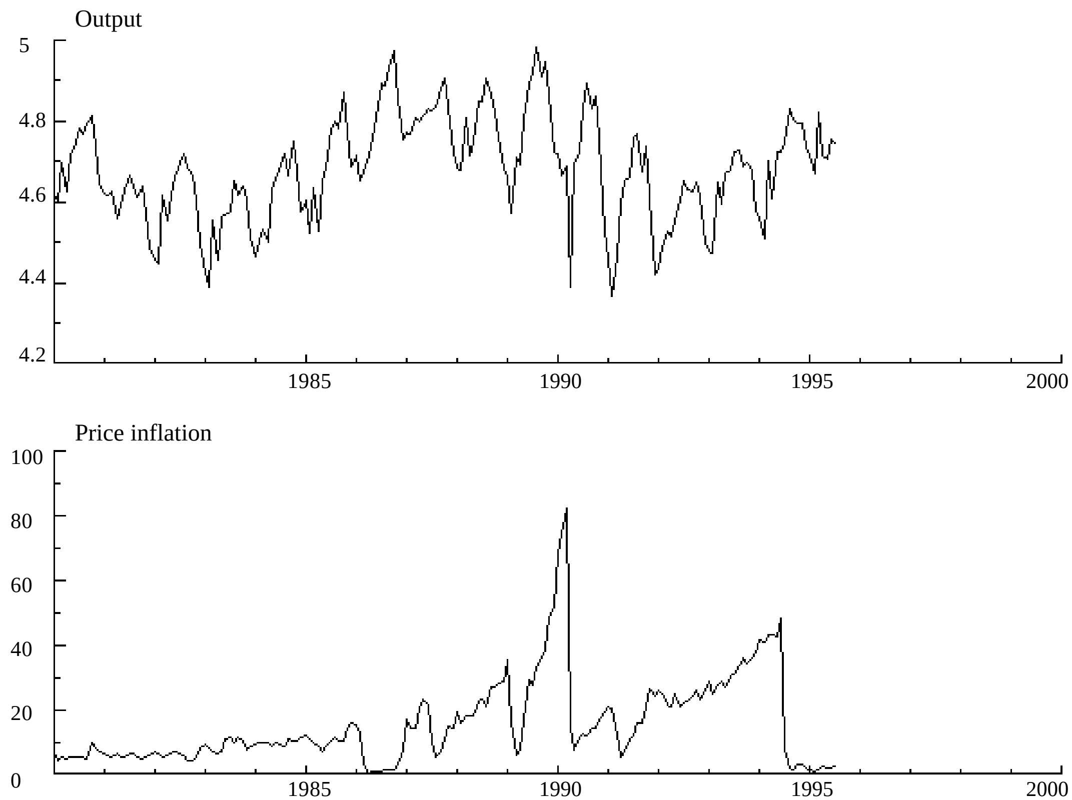

Figure 2. Response to One S.D. Innovations ± 2 S.E.

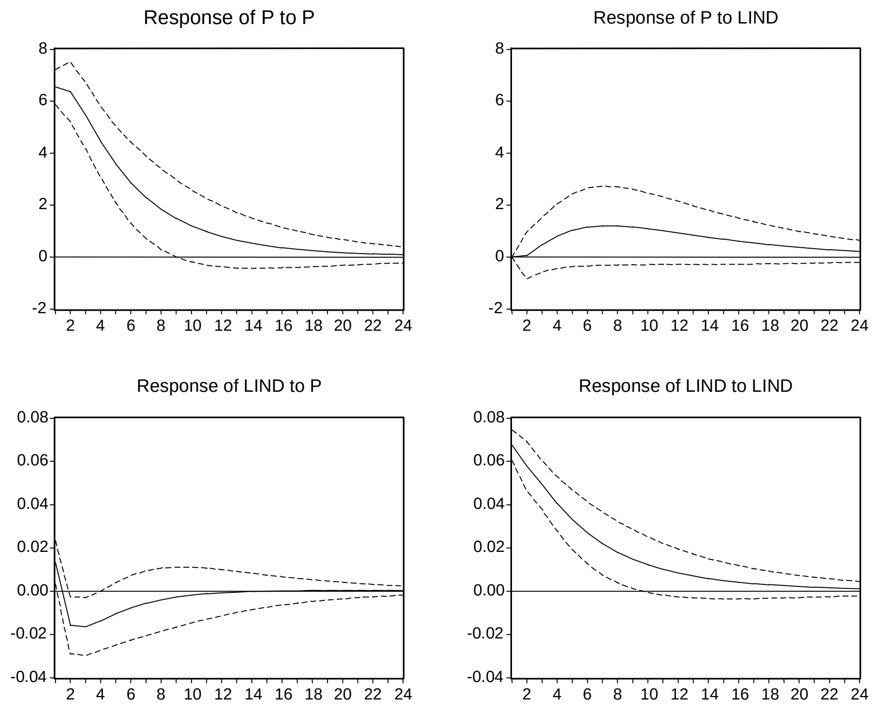

Figure 3. Response of Inflation and Output to a Permanent Inflation Shock

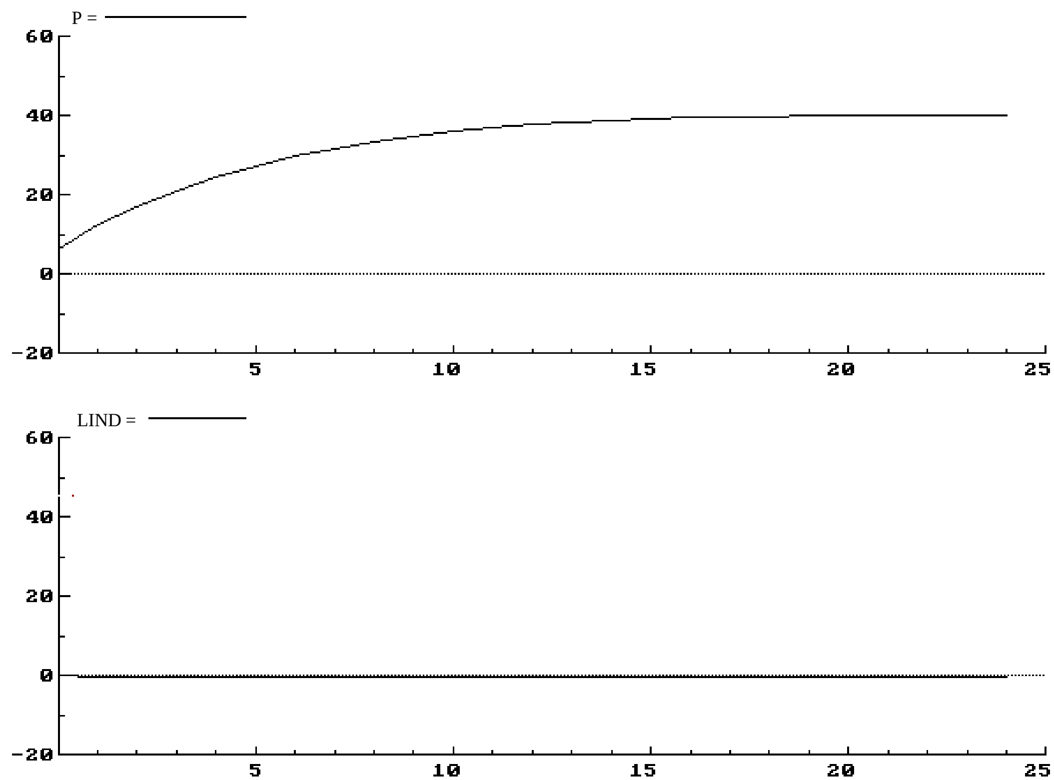

Figure 3. The effect of a permanent inflation shock on the inflation rate cumulates to a permanent positive shock. This is consistent with superneutrality, which refers to the effect of a change in the growth rate of money so that a permanent increase in the growth rate of money ought to permanently raise the rate of inflation. In terms of output, the general finding is that output responds in a not quite statistically significant way to a permanent inflation shock at moderate long horizons.

IV. Discussion

As noted before, we are able to reject the hypothesis of a unit root in output growth. We interpret this as evidence that Brazil has experienced permanent inflation shocks. Thus, our results suggest that permanent inflation shocks do not have significant permanent effects on output growth rates. Previous work using a cash-in-advance framework has found that the effects of higher inflation on the output growth rates are negative (see Gomme, 1993). We note, however, that the predicted growth rate effect will be small for the range of inflation that has been observed in Brazil in the period analyzed (see Figure 1). Thus, our findings support Sidrauski's superneutrality of money in which inflation has no real impact in the long run.

Fischer (1979), however, has shown that the rate of capital accumulation is not invariant to the rate of monetary growth in the Sidrauski's model, and that investment and inflation are related positively in the short run. Nevertheless, Fischer has shown that for a class of utility function in which consumption and real money balances are separable, inflation has a negative impact on consumption, which leads to a nil net effect of inflation on output (see also Walsh, 1998). We test this hypothesis below.

In fact, estimating a short-run model for changes in output ($\Delta\, Lind$) against changes in inflation ($\Delta\, p$) yielded the following results:

$$\Delta\, Lind_t = -0.0025\, \Delta\, p_{t-1} - 0.19\, \Delta\, Lind_{t-1} + seasonals + dummies$$
$$\quad\quad (-5.620) \quad\quad\quad\quad (-3.233)$$

$R^2 = 0.78$, t-*statistics in parentheses*

AR 1-7 $F(7,161) = 1.2954$ [0.2558]

ARCH 7 $F(7,154) = 0.450273$ [0.8688]

Normality $Chi^2(2) = 0.48082$ [0.7863]

X_i^2 $F(19,148) = 1.4305$ [0.1207]

RESET $F(1,167) = 0.244985$ [0.6213]

Note that all test statistics are satisfactory and that only the first lag of inflation enters the model.[9] We have also tried an error correction specification for the equation above, but the ECM term was not significant and its inclusion did not improve the explanatory power of the model. Estimating the same model for the rate of change in labor productivity yielded very similar results (which are therefore not reported here). This result suggests that inflation has real effects on output in the short run, contrasting with the implications of Sidrauki's model in the short run, as shown by Fischer.

V. Concluding Remarks

The results presented in this paper find a zero long-run response of output

[9] We have included monthly seasonal dummies and impulse dummies for the 1986-3; 1990-4; 1990-12; and 1991-4, which corresponded to major interventions in the Brazilian economy in the context of past attempts at controlling inflation (see Silva and Andrade, 1996, for details).

to a permanent inflation shock in the context of a high inflation country. Thus, our results could be considered as further evidence against the view that inflation and output growth are reliably related in the long run. This could also be considered as evidence in favor of the superneutrality of money hypothesis, in line with the framework proposed by Sidrauski (1967).

However, as Fischer (1979) has pointed out, even in the Sidrauski model, inflation can impact real variables in the short run. Fischer has shown that inflation impacts investment positively and consumption negatively, but that it does not impact output in the short run for a class of utility functions in which consumption and real money balances are separable. Our results show that there is a negative impact of inflation on output in the short run. Thus, despite the fact that our long-run results support Sidrauski's superneutrality of money, our short-run results cast doubt on the short-run implications of Sidrauski's model for separable utility functions. However, Asako (1983) has shown that inflation can lead to slower capital accumulation during the transition, from one steady state to another under certain conditions, if consumption and real money balances are perfect complements. In this sense, our results suggest that if the Sidrauski model has any empirical appeal, its utility function has to take consumption and real money balances as perfect complements.

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