Inflation and Economic Growth in an Open Developing Country: The Case of Brazil

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1. Introduction

Brazil passed through a long period of high inflation due to the external debt crisis in the 1980s. Despite several stabilization plans, inflation remained high. In 1994, Brazilian domestic inflation was reduced after opening trade and financial markets and implementing the Real Plan, thanks to an international context favourable to capital inflow into Brazil. Since then, Brazilian inflation has been relatively low. However, the Brazilian performance (both GDP growth and inflation) became more dependent on international trade and finance after the liberalising reforms.

This paper studies the relationship between tradable and non-tradable goods inflation, GDP growth, domestic inflation and international inflation measured in domestic currency in Brazil after trade and financial liberalisation. The links between economic activity and the price level of goods and services are complex (Arestis and Sawyer, 2005a): a better comprehension should consider how nominal wages and mark-ups are related to the economic activity and how both, together with the exchange rate, affect the level of domestic price. In an open developing economy,[1] tradable goods should be distinguished from non-tradable goods. Studying economic growth, on the one hand, and tradable and non-tradable goods' inflation, on the other hand, show the importance of the nominal exchange rate. This paper discusses all these relationships formally, complementing the previous works that relate the nominal exchange rate and inflation in Brazil such as Carneiro (2002), Farhi (2006), Braga (2010), Serrano (2010) and Prates et al. (2009).

The paper is organized in six sections including this introduction. Section two presents some stylised facts for the Brazilian economy that raises questions on the relationship between inflation and economic growth. Section three reviews the literature on the

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relationship between price level and economic activity that adopts the cost-based pricing approach. Section four suggests a model of domestic inflation for an open developing economy, especially the Brazilian economy. Section five presents and discusses the main results for the case of Brazil. Finally, section six concludes the paper.

2. Stylised Facts on Inflation and Economic Activity in Brazil

The Brazilian economy changed notably since the 1990s. These changes are related to the implementation of liberalising reforms that included opening trade and financial markets, liberalising the exchange market, privatizing state companies and public services and reducing the State intervention in the economy (Carneiro, 2002). These reforms aimed to expose the Brazilian economy to the international competition, therefore making Brazil more competitive and able to grow faster with lower inflation. Inflation was reduced, but Brazil did not become more competitive, because the economic openness seems to have made the performance of the economy (GDP growth and inflation) even more dependent on international trade and finance.

Table 1 shows the Brazilian GDP growth, domestic inflation (total, tradable sector and non-tradable sector) and the growth rate of the nominal exchange rate. Domestic inflation decreased after implementing the Real Plan in 1994. At this time, capital movements towards the country were high and the government did not control them (Belluzzo and Almeida, 2002; Carneiro, 2002). Consequently, and despite the high deficit in the current account of the balance of payments and the high volume of dollars bought by the Central Bank of Brazil to increase international reserves, the growth rate of the nominal exchange rate decreased in relation to the inflation rate.[2] Carneiro (2002), Farhi (2006) and Prates et al. (2009) argue that the decrease in the nominal exchange rate growth in relation to the domestic inflation rate (appreciating the national currency) decreased the growth rate of exported and imported goods' prices, helping to decrease domestic inflation in the period 1994-1998, as observed in Table 1.

Table 1: Brazilian GDP Growth, Domestic Inflation and Nominal Exchange Rate

	GDP Growth	Domestic Inflation	Tradable Sector Inflation	Non-tradable Sector Inflation	I (non-trad/trad)	Change in Nominal Exchange Rate
1993	4.7	1927.4	2004.4	1802.7	83.5	1860.0
1994	5.3	2075.8	2057.6	2190.9	88.6	1882.4
1995	4.4	66.0	53.7	89.3	109.2	43.7
1996	2.2	15.8	6.0	22.0	125.6	9.7
1997	3.4	6.9	2.0	7.7	132.6	7.3
1998	0.0	3.2	1.8	2.7	133.7	7.7
1999	0.3	4.9	6.0	0.7	127.0	56.4
2000	4.3	7.0	6.9	3.1	122.5	0.9
2001	1.3	6.8	4.7	4.9	122.8	28.4
2002	2.7	8.5	8.7	5.6	119.3	24.3
2003	1.1	14.7	16.7	8.6	111.1	5.4
2004	5.7	6.6	6.0	6.4	111.5	-5.0
2005	3.2	6.9	4.7	6.5	113.4	-16.8
2006	4.0	4.2	1.2	4.8	117.4	-10.6
2007	6.1	3.6	3.1	5.0	119.5	-10.5
2008	5.2	5.7	6.6	7.7	120.7	-5.8
2009	-0.6	4.9	4.4	5.9	122.4	8.9
2010	7.5	5.0	4.1	6.7	125.5	-11.9

Source: Central bank of Brazil (2011). Domestic inflation is the change in the IPCA Index (Broad Consumer Price Index), tradable inflation is the variation in the Broad Consumer Price Index (IPCA) for tradable goods, non-tradable inflation is the variation in the Broad Consumer Price Index (IPCA) for non-tradable goods and nominal exchange rate is the year average exchange rate Real/Dollar. Inflation is measured calculating the growth rate of IPCA monthly average of one year in relation to the previous year.

The implemented policy of monetary contention and high interest rates aimed at stimulating capital inflow and discouraging capital outflow, besides preventing increases in economic activity, especially in the non-tradable goods sector. If the non-tradable goods sector achieved higher economic activity, domestic inflation would not decrease and the national currency would appreciate even more. Capital inflow reducing the growth rate of the nominal exchange rate and, therefore, appreciating the national currency, was crucial to decreasing the Brazilian inflation. However, investment to improve the tradable goods' competitiveness was discouraged. This investment was necessary to decrease the country's vulnerability to international trade and finance. The country's vulnerability increased and the

international consequences of the Asian crisis in 1997 forced the change of the 1994 strategy to reduce inflation (Prates et al., 2009).

After 1997, the nominal exchange rate increased more than domestic inflation, generating doubts on the exchange rate as an anchor to the expectations of domestic prices. The exchange rate was then substituted by an inflation targeting framework, which became the reference for the policy of monetary contention and high interest rates. Increases in the nominal exchange rate higher than domestic inflation in the period 1999-2003 contributed to raising domestic inflation (Carneiro, 2002; Farhi, 2006; and Prates et al., 2009). The opposite outcome is verified in the period 2004-2008, when nominal exchange rate decreased as well as domestic inflation. The correlation between domestic inflation and the growth rate of the nominal exchange rate is the first stylised fact observed in Table 1.

Table 1 also reveals that periods of higher economic growth are periods of lower domestic inflation. At the beginning of the 1990s, the inverse relationship between economic growth and inflation is not totally clear. From 1992 onwards, the international financial situation fostered capital inflows to the country, a pre-condition to decrease inflation and boost GDP growth. GDP growth increased, but inflation took some time to get lower, reducing only after 1994, when the Real Plan was implemented. However, in the end of 1994, the Mexican crisis took place, negatively affecting the country´s economic growth. But inflation kept decreasing. The inverse relationship between economic growth and inflation emerged only after 1999.

The Asian and Russian crises affected capital movements to Brazil, influencing the country's balance of payments and resulting in a currency crisis. Domestic inflation increased, and the policy of high interest rates, increases in taxes and decreases in non-financial public expenditures, affected negatively the country's GDP growth. High inflation and low economic growth continued until the international boom of commodities, when the Brazilian balance of payments improved. The period 2004-2008 was, then, a period of higher economic growth and lower inflation. Finally, since the end of 2008, the world crisis affected Brazil. Despite the fact that the decrease in the GDP growth was modest and brief, the country has faced difficulties in terms of boosting GDP growth with low inflation.

Both stylised facts – the direct correlation between domestic inflation and the growth rate of the nominal exchange rate and the inverse correlation between GDP growth and inflation – show the influence of the balance of payments on the Brazilian economic performance (GDP growth and inflation). Another stylized fact exhibited in Table 1 is that in those instances of higher GDP growth and lower inflation, non-tradable goods price increase in relation to tradable goods price. Conversely, in instances of higher inflation and lower GDP growth, non-tradable goods price decrease in relation to tradable goods price.

The three stylised facts are related and the contribution of this paper is to show they suggest the liberalising reforms helped to reduce inflation, but the expected increase in the Brazilian economic competitiveness did not occur. Therefore, the country's performance in terms of GDP growth and inflation became even more dependent on international trade and finance.

The liberalising reforms increased the Brazilian economic dependence on international trade and finance, because capital movements, settled by the international situation for trade and finance, influenced the nominal exchange rate. This exogeneity of the nominal exchange rate determination has serious implications for the tradable goods sector's production. These implications have negative influence on investment to develop that production, crucial to make the economy less dependent on the international situation. A better understanding of the relationship between inflation and economic activity as well as the increase in the country's dependence on the international situation for trade and finance requires examining the dynamics of production and price of tradable and non-tradable goods sectors.

3. General Considerations on Inflation and Economic Activity

The demand for final consumption goods and investment determines the use of the existing productive capacity. The production and price reaction to this demand depends on: the composition of the demand vis-à-vis the existing production capacity; the effects of the use of the productive capacity on production costs (that depends on productivity, wages and prices of raw material and energy); the way suppliers compete for that demand; and its implications on costs transfers to prices (Arestis and Sawyer, 2005a).

The previous proposition assumes the cost-based pricing approach. In a macroeconomic analysis, this approach considers the different basic prices of the economy, such as nominal wages, exchange rate, interest rate, basic input prices and taxes. Changes in these basic prices can generate an increase in the level of domestic price. Arestis and Sawyer (2005a), Sawyer (1982) and Arestis and Skott (1993) use the cost-based pricing approach to analyse the relationship between inflation and economic activity.

Higher economic activity level may be followed by higher level of general prices because the greater use of raw materials, energy and wages increase their prices and they are not compensated by increases in productivity due to the greater use of the production capacity. Higher general prices as a consequence of greater economic activity produce higher costs of production, which are transferred to prices. In this case, greater effective demand causes higher production and employment as well as higher general price level.

In this sense, the study of the relationship between inflation and the economic activity should model the behaviour of the prices of raw materials, energy and nominal wages, highlighting their relation with the economic activity. Besides that it is also important to analyse the relationship between the economic activity, on the one hand, and productivity and the possibilities of cost transfers to prices, on the other hand.

Modelling nominal-wage behaviour, the purchasing power targets of workers may depend on the level of employment and the speed at which employment changes (Arestis and Sawyer, 2005a; Arestis and Sawyer, 2008; and Sawyer, 1982). Under this approach, changes in nominal wages depend on the level and rate of growth of employment, inflation expectations and the previous situation of wages in relation to wage targets. Considering that workers take into consideration past inflation to negotiate nominal wages and their claims in collective bargaining have to convince the other workers, the behaviour of nominal wages can be represented by relating its growth rate to the level and change in production, inflation and the degree in which the purchasing power of wages is close to the workers targets (Sawyer, 1982).

Workers achieve or not their nominal wage target depending on the willingness of firms to concede the intended wage increases (Sawyer, 1982). The model assumes that the degree of concession by firms depends on the state of the labour market, summarized by the

level of unemployment, and the ability to pay according to profitability. Sawyer (op. cit.) points to further constraints that reach a particular money wage, such as firms may limit money wage increases to the degree to which those extra costs can be passed on as prices increases, as well as firms may believe that there is an upper limit to price increases (op. cit.).[3]

This representation of the evolution of nominal wages has implications for the relationship between production and prices over time. High employment growth can lead to nominal wage increases higher than the previous inflation. If these wage increases are followed by increases in basic input prices, and at the same time increases in productivity is low and there is no change in mark-ups, inflation will probably increase together with production and employment. Increases in productivity depend on the previous evolution of investment. These increases of productivity can prevent possible acceleration in inflation**.** If increases in productivity are not able to impede increases in production costs and the suppliers' competition for the demand does not decrease transfers of costs to prices, inconsistency between workers purchasing power targets and the evolution of product prices occurs. Consequently, inflation increases with production and employment (Arestis and Sawyer, 2005a).

The conflict in the evolution of prices and wages is then related to the workers' capacity to increase their purchasing power aims, the changes in basic input prices, the insufficient increase of productivity and the transfer of costs to prices. If workers aim higher purchasing power targets when there is no increase in basic input prices and productivity increases due to previous investment, higher wage purchasing power can be materialised without increasing inflation.

Considerations of the relationship between economic activity and inflation can be extended by including the relationship between the economy under consideration and other economies.[4] International trade enables higher demand for products. The production capacity of a country is used to attend the domestic demand and exports, and there is the possibility of importing goods that are not produced by the existing productive capacity. International trade facilitates the influence of international prices and the nominal exchange rate on domestic prices.

International trade and finance affect the relationship between economic activity and inflation, influencing possible inconsistency on workers purchasing power targets and the effective behaviour of prices and wages. In particular, and as pointed by Arestis (1986) and Braga (2010), international inflation measured in national currency affect the price of imported and exported inputs through the nominal exchange rate. These inputs are used in the production of tradable and non-tradable goods. Besides that, international inflation measured in national currency may also condition transfers of costs to prices in the case of tradable goods.

The impact of the exchange rate on domestic inflation may be sharper in the case of developing economies, in a context of financial liberalisation. This is because the nominal exchange rate in developing countries tends to oscillate sharper than in developed countries due to the fact the developing countries' currencies do not perform their functions of account unit, means of payments and reserve of value in an international context.

The International Monetary System entails countries' currencies hierarchy, some of which occupy a central position, performing the three basic function of money in international context. Other currencies have a secondary importance, performing partially the money functions in international context, and the rest are not considered as currencies in the international arena (Prates, 2002).

The international use of the currency determines its international liquidity. According to Plihon (2001), liquidity is the capacity an asset has to be transformed in means of payments without capital loss, cost of transaction and delay. In an international scenario, a currency is liquid when it is able to function as an account unit, means of payments, and reserve of value. In the case of developing countries, their currencies do not perform their money functions in the international context. So, even if a currency of a developing economy is able to perform its functions in the national territory, in an international context the situation is different (Conti, 2011). Consequently, the assets denominated in these currencies also have low liquidity in the international context.

The Brazilian literature calls "inconvertible currency" the currencies that do not perform their money functions in an international context (see Prates, 2002 and Carneiro, 2008 for a deeper discussion on this topic). International contracts of residents of a country

with “inconvertible currency” tend to be fixed in a “convertible currency”. Besides that, assets with prices fixed in “inconvertible currencies” tend to be less attractive for residents in the country or in other countries than the assets with prices fixed in “convertible currency” (Carneiro, 2008).

The demand for assets in “inconvertible currencies”, then, depends on the higher returns they offer. However, high returns are not always enough; it also depends on the international scenario (Conti, 2011). If global investors are prone to risk, they may demand the assets of developing countries that offer high interest rates. According to Prates (2002), the volume and direction of developing countries’ capital flows are determined mainly by exogenous factors to these economies and they are related to the world demand for risky assets with high returns. This demand depends mainly on the conditions of the international financial market and a specific developing country does not influence these conditions.

Accordingly, these implications of “inconvertible currencies” generate very high oscillations in the nominal exchange rate[5]. Devaluing a “convertible currency” makes the assets with prices in this currency more attractive because they become cheap compared to the return they promise. This, in turn, tends to limit the decrease in the nominal exchange rate of the “convertible currency”.[6] There is no analogous mechanism for the case of assets in “inconvertible currency”.

The characteristic instability of the nominal exchange rate of an “inconvertible currency” creates the necessity for the country to have high international reserves in “convertible currency”. Without this reserve, the level of the nominal exchange rate becomes highly unstable, damaging the conditions for the determination of the economic activity. The exchange rate volatility for the case of an open developing country becomes a source of economic destabilisation and, therefore has an important impact on the country´s performance (domestic inflation and GDP growth).

Apart from the “currency inconvertibility”, the volatility of the nominal exchange rate is particularly high in a developing economy that opened to international trade and finance with no capital movement control and no stimulus to investment to increase the country’s competitiveness. This liberalising strategy was undertaken in many developing countries with

the belief that exposing the domestic production to international competition would stimulate the necessary investment to make the country more competitive.

In this type of economy, the behaviour of the nominal exchange rate tends to be highly dependent on the international trade and finance. This exogeneity of the behaviour of the nominal exchange rate affect differently the production and price dynamics of tradable and non-tradable goods sectors.

In favourable conditions to exports and/or capital inflow, the nominal exchange rate tend to increase less than domestic inflation, helping to decrease inflation and boost GDP growth. Greater GDP growth is a result of higher demand for tradable and non-tradable goods, due to higher exports. These exports, in turn, directly and indirectly influence the balance of payments, positively affecting consumption and investment, especially through better conditions for credit for consumption, production and investment.

Nominal exchange rate increasing less than domestic inflation tends to appreciate the national currency, thereby affecting negatively the production of tradable goods in which the country does not have international competitiveness. Therefore, exports and production diversification are negatively affected at the same time the domestic market competes with imports.

Increases in the production of non-tradable goods and tradable goods, in which the country has competitive advantage, increase the demand for labour and create conditions to accelerate nominal increases in wages. In the absence of a strict segmentation in the labour market, increases in nominal wages tend to occur in sectors that production increased as well as in sectors that the difficulties to export and the competition with imported products limit increases in production and employment.

Induced investment raises productivity in the economic activities in which higher demand stimulates more production. When the new production capacity materialises, higher nominal wages affect production costs less. Moreover, lower nominal exchange rate benefits the price of exported and imported inputs. In the case of non-tradable goods, eventual increases in costs may be transferred to prices. In this case, higher production and employment will be followed by increases in prices. Considering tradable goods in which the country has high competitive advantage, eventual increases in costs will result in lower mark-

ups, without hampering increases in production and employment. However, in the case of tradable goods in which the country does not have competitive advantage, increases in the demand stimulate imports. In this case, investment to increase productivity will not take place and increases in costs cannot be transferred to prices. In this case, production decreases, imports increase and inflation decreases.

Lower increases in the nominal exchange rate in relation to domestic inflation tend to reduce increases in the price of tradable and non-tradable goods; however, the decrease is higher in the case of tradable goods. This increase in relative price of non-tradable goods can be accentuated if investment does not increase productivity (as it can take place in some type of services) or the production of non-tradable goods use few imported or exported inputs.

So, favourable international situations to exports and/or capital inflow tend to decelerate increases in the nominal exchange rate and in domestic inflation, accelerating at the same time GDP growth and increasing the relative price of non-tradable goods. In this process, the composition of production and employment is modified: the share of the non-tradable sector increases as well as the part of the tradable sector with absolute comparative advantage; and the share of the tradable sector that does not have absolute comparative advantage decreases. The increase in the global level of employment and the decrease in the unemployment rate favour increases in nominal wages in all economic activities and the decrease in inflation contributes to increase the purchasing power of workers. The improvement in the terms of international trade facilitates the increase in the purchasing power of wages, which does not cause inconsistencies in the behaviour of prices. The continuity of this process, however, depends on the international conditions to maintain exports and/or capital inflow favourable to the country.

A negative international situation to exports and/or capital inflow tend to accelerate increases in the nominal exchange rate and domestic inflation, decelerating at the same time GDP growth and reducing the relative price of non-tradable goods. The decrease in employment and the increase in the unemployment rate contribute to dampen nominal increases in wages and the increase in inflation can reduce the purchasing power of workers. The stimulating effects of the national currency devaluation compensate partially the tendency to decrease the demand for tradable and non-tradable goods, but the decrease in the production growth is higher in the non-tradable sector and the upward acceleration of the

nominal exchange rate allow the recovery of the mark-ups in the tradable sector, thereby increasing its relative price.

The exogenous behaviour of the nominal exchange rate and its differing effects on the dynamics of production and the prices of tradable and non-tradable goods explain the stylised facts discussed in section two. At the same time, theses stylised facts reflect the dependence of the national economy (GDP growth and inflation) on the international situation for trade and finance. An indiscriminate openness to international trade and finance from a developing country with "inconvertible" currency, with no capital movements control and without stimulating investment to increase the production competitiveness of the tradable sector, deepens the country's dependence.

4. The Model

Domestic inflation is measured in Brazil by the Broad Consumer Price Index (IPCA). The products included in the Index are classified in three types: tradable, non-tradable and administered prices. The model presented in this section highlights the influence of tradable and non-tradable goods prices on the determination of domestic inflation[7]. The relationship between domestic inflation (p_t) and the growth rate of tradable and non-tradable goods prices can be expressed as:

$$p_t = k_1 + c_1\sigma_{1t} + c_2\sigma_{2t} \qquad (1)$$

Where σ_1 is the growth rate of tradable products price, σ_2 is the growth rate of non-tradable goods price and k_1, c_1 and c_2 show the degree of influence of the growth rate of tradable and non-tradable goods prices on domestic inflation. The relative influence of the evolution of tradable and non-tradable goods prices on domestic inflation show the effects of the Brazilian economic structure that has been modified by the liberalizing reforms, including the effect of administered goods prices, some of them indexed to IGP (General Price Index) during the privatization of public utility services.

The share of tradable goods in the IPCA increased when the economy was opened to international trade and finance. The price of public utility services were linked to an index highly sensible to changes in international commodity prices measured in national currency;

thereby increasing the influence of changes in the nominal exchange rate on the IPCA. These influences can be seen in equation 1 through $c_1 > c_2$.

The model then defines equations that relate the growth rate of tradable and non-tradable goods prices to the growth rate of nominal wages in each sector, the national GDP growth rate and international inflation measured in national currency:

$$\sigma_{j,t} = k_{j,2} + c_{j,3}y_t + c_{j,4}w_{j,t} + c_{j,5}(p_{i,t} + er_t) \qquad (2)$$

where y is the growth rate of the economy, w_j is in the growth rate of nominal wages in each sector, p_i is international inflation, er is the growth rate of the nominal exchange rate, defined here as domestic currency units per foreign currency, and j = 1 or 2, where 1 refers to tradable goods and 2 refers to non-tradable goods.

The coefficients $c_{j,4}$ and $c_{j,5}$ show the repercussion of increases in nominal wages of each sector and international inflation measured in national currency on the cost of production of each sector. Comparing the magnitude of the sectors' coefficients, it is possible to verify the impact that different cost structures has on the relative influence of nominal wages and exported and imported input prices on the sectors' inflation.

The coefficient $c_{j,3}$, in turn, shows how domestic economic growth influences each sector's inflation. The effect of economic growth on productivity and mark-ups of each sector can be verified comparing the magnitude of the sectors' coefficient, what, in turn, affect the sector's prices in relation to the behaviour of input prices. Equation 2 shows the effect of input prices' behaviour on the sectors' inflation through the other two independent variables: sectors' nominal wages and international price measured in national currency.

The basic difference between the two sectors is, by definition, the degree they are exposed to the international competition. Therefore, given the behaviour of the sectors' input prices, the relationship between changes in the sectors' price and GDP growth depends mainly on the evolution of the real exchange rate. So, for example, if higher economic growth takes place at the same time the national currency appreciates, as a consequence of increases in the nominal exchange rate lower than the difference between domestic and international inflations, GDP growth leads to high increases in imports and cheap imports decrease the tradable sector's mark-ups. Conversely, if lower economic growth takes place at the same time the national currency depreciates, as a consequence of increases in the nominal

exchange rate higher than the difference between domestic and international inflations, GDP growth leads to low increases in imports and expensive imports are followed by increases in tradable sector's mark-ups. Considering this hypothesis of an inverse correlation between GDP growth and real exchange rate, higher GDP growth will affect more the growth rate of non-tradable goods' price ($c_{13} < c_{23}$). The contrary hypothesis of a direct correlation between GDP growth and real exchange rate leads to higher effect of GDP growth on changes in the tradable goods price than in the non-tradable goods price ($c_{1,3} > c_{2,3}$).

Indexes for changes in nominal wages for tradable and non-tradable sectors do not exist in Brazil. The purpose of this paper is to consider that in each sector, the growth rate of nominal wages depend on the GDP growth and lagged domestic inflation. So, the equation for changes in nominal wages is:

$$w_{j,t} = k_{j,3} + c_{j,6}y_t + c_{j,7}p_{d,t-1} \qquad (3)$$

The equation for changes in nominal wages has the same format for tradable and non-tradable goods. This does not mean that both sectors have the same growth rate of nominal wages; the differences on the impact of GDP growth and lagged inflation are accounted on each sector's nominal wage growth.

Inserting equation (3) into equation (2), we have the final equation for tradable and non-tradable goods inflation:

$$\sigma_{j,t} = (k_{j,2}+c_{j,4}k_{j,3}) + (c_{j,3}+c_{j,4}c_{j,6})y_t + c_{j,5}(p_{i,t} + er_t) + c_{j,4}c_{j,7}p_{d,t-1} \qquad (4)$$

Comparing the coefficients for GDP growth, international inflation in national currency and lagged domestic inflation on tradable and non-tradable goods inflation contribute to understand the performance of the Brazilian economy (GDP growth and inflation) since the liberalising reforms.

The influence of lagged inflation takes place through changes in nominal wages of each sector. The high share of services in the non-tradable sector suggests that the influence of lagged inflation is higher on the prices of this sector compared to the prices of the tradable sector ($c_{2,4}c_{2,7} > c_{1,4}c_{1,7}$), probably due to $c_{j,4}$ rather than $c_{j,7}$. The Brazilian economy was able to face a long period of high inflation by creating a tradition of indexation, suggesting that the influence of lagged inflation is also high in the tradable sector.

The influence of international inflation measured in national currency is probably high in both sectors, because the prices of imported and exported inputs affect the costs of the whole economy. In this case, $c_{1,5}$ can be similar to $c_{2,5}$. However, the influence of international inflation measured in national currency is possibly higher than the influence of lagged domestic inflation in each sector ($c_{j,5}>c_{j,4}c_{j,7}$). This is because the level of wages is very low and mark-ups are very high in the Brazilian economy and transfer of costs to prices is very quick. The fast transfers of costs to prices in the Brazilian economy is a consequence of a long period of high inflation, the importance of self-financing, and the scarcity of, high cost and short term financing of production and investment. Besides that, fluctuations in the nominal exchange rate is much higher than changes in nominal wages due to the national currency "inconvertibility" and both fluctuations occur in opposite direction since the liberalising reforms. In other words, when GDP growth is greater, wage adjustments are facilitated and, at the same time, the nominal exchange rate tends to grow less than lagged domestic inflation, contributing to decreasing inflation and increasing the purchasing power of wages. Conversely, when GDP growth is lower, adjustments in wages are negatively affected and, at the same time, the nominal exchange rate tends to increase faster than lagged domestic inflation, decreasing the purchasing power of wages (Baltar, 2011).

Finally, the influence of GDP growth is probably higher on the non-tradable goods inflation than on tradable goods inflation. Higher GDP growth may have a greater influence on the nominal wages of the non-tradable sector ($c_{2,4}c_{2,6}>c_{1,4}c_{1,6}$ and this difference is due to $c_{j,4}$ rather than $c_{j,6}$). Besides that, there are the negative effects of GDP growth on the tradable sector's mark-ups due to a possible negative correlation between GDP growth and the real exchange rate. It is even possible that the influence of GDP growth on the tradable goods inflation is negative, and at the same time it has a positive influence on non-tradable goods inflation. In this case, $c_{1,3} + c_{1,4}c_{1,6}<0$, $c_{1,3}<0$ and $|c_{1,3}|>c_{1,4}c_{1,6}$, and $c_{2,3} + c_{2,4}c_{2,6}>0$.

In short, the magnitude of the coefficients of equation 4 for tradable and non-tradable goods inflation is very important for the study of economic growth, inflation and relative prices of tradable and non-tradable goods. The analysis of these coefficients provides a better understating of the economic performance (inflation and GDP growth) of a developing economy in the context of trade and financial liberalisation.

5. Estimation and Discussion of Results

Trade and financial openness started in Brazil at the beginning of the 1990s. Data series for all the variables of equations 1 and 4 are available since 1993. So, the period of analysis is from 1993 to 2010. All data series employed are quarterly, so the number of observations for the estimations is seventy-two. The data base is built with information collected from the Central Bank of Brazil (2011) and from the IMF (2010).

The Central Bank of Brazil (2011) has a series for the evolution of the real exchange rate in this country and inflation is measured in Brazil by IPCA. So, it is possible to deduce international price changes from the evolution of the real exchange rate and inflation in Brazi.l[8]

The estimation of the coefficients of equations 1 and 4 should take into account the fact that the explanatory variables are not exogenously determined and depend on the dependent variable. An alternative to obtain consistent estimates of the parameters that indicates correctly the influence of explanatory variables on dependent variables is to use the Generalized Method of Moments (GMM) technique.[9]

GMM estimation is based upon the assumption that the disturbances in the equations are uncorrelated with a set of instrumental variables. One possibility for these instruments is to use predetermined variables that are lagged endogenous variables (Wooldridge, 2003).

Two procedures are undertaken in order to test the relevance of the instruments. First, a statistic proposed by Shea (1997) is estimated. This statistic gives a 'partial R^2' that takes the intercorrelations among the instruments into account. If an estimated equation yields a small value of the Shea (1997) measure, one may conclude that the instruments lack sufficient relevance to explain all the endogenous regressors, and the model may be essentially unidentified. Conversely, higher values of the Shea (1997) measure indicate that the instruments are relevant. Second, the J-statistic of Hansen (1982), the minimized value of the objective function, will be used to carry out hypothesis tests from GMM estimation. An application of the J-statistic is to test the validity of over-identifying restrictions when more instruments than parameters are present in the estimation procedure. Under the null hypothesis that the over-identifying restrictions are satisfied, the J-statistic times the number

of regression observations is asymptotically χ^2 with degrees of freedom equal to the number of over identifying restrictions.

If the results of the previous two tests indicate the instruments are relevant, then it is assumed that the error is uncorrelated with current exogenous variables and all past endogenous and exogenous variables. Therefore, each lagged endogenous variable is considered uncorrelated with the error term. Accordingly, for the estimation of the equations, lagged endogenous variables are used as instruments, if the result of the two tests suggests the proposed instruments are relevant.

The econometric analysis follows the Hendry and Richard (1983) approach. Accordingly, the first step is to check whether the data is coherent. For that, the Augmented Dick-Fuller (ADF) test is undertaken to check the variable stationarity. If the variable has a unit root, this variable is non-stationary and, if the variable does not present a unit root, this variable may be stationary. To reassure stationarity, the Durbin Watson (DW) test is also verified. The DW statistics detect the presence of autocorrelation. If the value of DW is close to two, there is no autocorrelation. Conversely, if the value is very different from two, first-order autocorrelation is indicated and the variable in question may not be stationary (Wooldridge, 2003).

After checking the date coherence, the next step is to evaluate the quality of the estimation (Hendry and Richard, 1983). The Wald test is used to verify the true value of the parameters based on the sample estimate. This test indicates whether the fitted model describes well the relevant data. The inclusion of lagged dependent and independent variables is also considered in the estimation, to verify whether these variables in the past have an influence on current values. The Root Mean Square Error and the R-squared statistics are also considered to measure the goodness of fit of the statistical model.

The first estimated equation is domestic inflation that relates tradable and non-tradable goods inflation, as shown in Table 2.[10]

Table 2: Estimation of Domestic Inflation (GMM)

Equation for : p_t

	GMM	
Variable	Coef.	Std Error
Constant	-0.67*	0.0451
$p_{d,t-1}$	0.37*	0.0176
$p_{d,t-2}$	-0.20*	0.0024
$\sigma_{1,t}$	0.42*	0.0057
$\sigma_{1,t-2}$	0.06*	0.0011
$\sigma_{2,t}$	0.02*	0.0100
$\sigma_{2,t-1}$	0.27*	0.0051

Notes: * significant at 1%, ** significant at 5%

Instruments: $\sigma_{1,t-3}$, $\sigma_{1,t-4}$, $\sigma_{1,t-5}$, $\sigma_{1,t-6}$, $\sigma_{1,t-7}$, $\sigma_{2,t-2}$, $\sigma_{2,t-3}$, $\sigma_{2,t-4}$, $\sigma_{2,t-5}$

Observations: 72

Period: 20 years between 1991 and 2010, with quarterly data

R-squared: 0.87

Root MSE: 14.3

Wald stat: 4600000 (prob.=0)

Durbin Watson d-stat = 1.7

J-test: 2.3373 (p=0.9930)

Shea's (1997) Partial R-sq: 31% for $\sigma_{1,t}$, 32% for $\sigma_{1,t-2}$, 25 % for $\sigma_{2,t}$ and 10 % for $\sigma_{2,t-1}$

The variable σ_1 is the tradable goods inflation and σ_2 is the non-tradable goods inflation. The coefficients of each variable are significant at the 1% level. The inclusion of lagged dependent and independent variables followed Hendry and Richard (1983) approach and four lags for these variables were included and eliminated the non-significant ones. The R-squared statistics shows that the estimated line approximates the real data points in 87% and the Root Mean Square Error (MSE) statistics indicates the measure of accuracy is 14.3. The instruments used for the GMM estimations were lagged endogenous variables up to three lags, as indicated in the Table. The Shea's partial R-squared test shows that the instruments are relevant to explain all endogenous regressors. This result is reinforced by the J-statistic tests, which show that the over identifying restrictions are satisfied, so the instruments as a group can be used as exogenous variables. The Wald test indicates the value of the parameters based on the sample estimate is true and the Durbin Watson test is close to two.

The estimation of the equation for domestic inflation shows that the influence of tradable goods price on the domestic inflation is much higher than the influence of non-tradable goods prices and the effect of the latter has a lag. This result confirms that the economic openness and the public utility price indexation influence the dynamics of the Brazilian inflation, illustrating the influence of changes in the nominal exchange rate. The next step is then to estimate tradable and non-tradable goods inflation separately.

Table 3 shows the results for the estimation of the equation for tradable goods inflation. The coefficients of each variable were significant at 1% and the inclusion of lagged dependent and independent variables improved the result of the estimation. The R-squared statistics shows that the estimated line approximates the real data points in 75% and the Root MSE indicates the measure of accuracy is 23.7%. The instruments used for the GMM estimations were lagged endogenous variables, as indicated in the Table. The Shea's partial R-squared test and the J-statistic tests indicate that the instruments as a group can be used as exogenous variables.

Table 3: Estimation of Tradable Goods Inflation (GMM)

Equation for: σ_1

		GMM
Variable	Coef.	Std Error
Constant	3.06*	0.0234
lagged $\sigma_{1,t}$	-0.33*	0.0021
y_t	-0.61*	0.0061
y_{t-1}	-0.70*	0.0030
$(p_i + er)_t$	0.78*	0.0036
$(p_i + er)_{t-2}$	0.05*	0.0015
$p_{d,t-1}$	0.49*	0.0063

Notes: * significant at 1%, ** significant at 5%
Instruments: y_{t-2}, y_{t-3}, y_{t-4}, $(p_i + er)_{t-3}$, $(p_i + er)_{t-4}$, $(p_i + er)_{t-5}$, $p_{d,t-3}$, $p_{d,t-4}$, $p_{d,t-5}$, $p_{d,t-6}$
Observations: 72
Period: 20 years between 1991 and 2010, with quarterly data
R-squared: 0.75
Root MSE: 23.7
Wald stat: 7000000 (prob.=0)
Durbin Watson d-stat = 2.05
J-test: 2.3802 (p=0.9986)

Shea's (1997) Partial R-sq: 47% for $y_{t,}$ 57% for y_{t-1}, 10% for $(pi + e)_t$, 59% for $(pi + e)_{t-2}$, 18% for $p_{d,t-1}$

The estimated coefficients of the equation for tradable goods inflation show that the influence of lagged domestic inflation is significant, even in this sector in which the share of wages is relatively lower in the structure of direct costs of production (basically wages, raw material and energy).[11] The influence of international prices measured in national currency is higher than the influence of lagged domestic inflation in the tradable goods inflation ($c_{1,5}>c_{1,4}c_{1,7}$). This is because in Brazil, the level of wages is relatively low, mark-ups are very high and transfers of costs to prices are very quick. Consequently, the share of wages in the direct costs of production is relatively low vis-à-vis the processed inputs, causing a relatively high influence on increases in prices of imported and exported raw materials.

The main result, however, is the negative influence of economic growth on the tradable goods inflation ($c_{13} + c_{14}c_{16}<0$)[12] due to the inverse correlation between GDP growth and the real exchange rate. In moments of high GDP growth, the national currency appreciates and the nominal exchange rate increases less than the difference between domestic and international inflations. Domestic inflation decreases due to lower increases in prices of imported and exported inputs. In the tradable sector, the national currency appreciation has the additional effect of reducing mark-ups. So, higher GDP growth tend to decrease tradable goods inflation, despite its positive effect on the sector's nominal wages. Higher GDP growth, followed by national currency appreciation, reduces increases in the costs of the sector as well as the effect of higher costs on prices, decreasing the sector's inflation.

Table 4 shows the results for the estimation of the equation for non-tradable goods inflation. The coefficients of each variable were significant at 1%. The R-squared statistic indicates that the estimated line approximates 75% of the real data and the Root MSE statistic shows that the measure of accuracy is 23.2. The Shea's partial R-squared test shows that the instruments are relevant to explain all endogenous regressors and the J-statistic test shows that the over-identifying restrictions are satisfied. The Wald test indicates the estimation explains well the relevant data and the Durbin Watson test is close to two.

Table 4: Estimation for Non-Tradable Goods Inflation (GMM)

Equation for: σ_2

	GMM	
Variable	Coef.	Std Error
Constant	2.32**	0.0277
$\sigma_{2,t-1}$	-0.37*	0.0022
$\sigma_{2,t-1}$	-0.15*	0.0013
y_t	0.10*	0.0066
y_{t-2}	0.87*	0.0064
$(p_i + er)_t$	0.72*	0.0049
$(p_i + er)_{t-2}$	0.13*	0.0016
$p_{d,t-1}$	0.64*	0.0070

Notes: * significant at 1%, ** significant at 5%
Instruments: y_{t-3}, y_{t-4}, y_{t-5}, $(p_i + er)_{t-3}$, $(p_i + er)_{t-4}$, $(p_i + er)_{t-5}$, $(p_i + er)_{t-6}$, $(p_i + er)_{t-7}$, $p_{d,t-3}$, $p_{d,t-4}$, $p_{d,t-5}$, $p_{d,t-6}$
Observations: 72
Period: 20 years between 1991 and 2010, with quarterly data
R-squared: 0.75
Root MSE: 23.2
Wald stat: 33000000 (prob.=0)
Durbin Watson d-stat = 1.98
J-test: 2.4294 (p=0.9999)
Shea's (1997) Partial R-sq: 76% for yt, 66% for yt-2, 11% for $(p_{i,} + er)_t$, 69% for $(p_{i,} + er)_{t-2}$, 23% for $p_{d,t-1}$

The estimated coefficients for the equation of the non-tradable goods inflation show that the influence of lagged domestic inflation is higher in this sector than in the tradable goods sector ($c_{2,4}c_{2,7}>c_{1,4}c_{1,7}$).[13] On the other hand, the influence of international inflation measured in national currency is similar in both sectors. The influence of changes in wages are similar to the influence of imported and exported input prices on the non-tradable goods sector inflation compared to the tradable goods sector, reflecting basically the higher share of wages in the cost structure due to the high share of services in the non-tradable goods sector.

The main result is the positive influence of GDP growth on the non-tradable goods inflation, an opposite outcome compared to the tradable goods inflation. The estimated equation also shows the positive impact of lagged GDP growth on inflation of tradable goods.[14] Since this sector is not exposed to the international competition, the negative

correlation between economic growth and real exchange rate does not imply a decrease in the non-tradable goods sector's mark-up.

6. Summary and Conclusions

Brazil opened its trade and finance at the beginning of the 1990s. Three stylised facts characterized the Brazilian economic performance (GDP growth and inflation) in the considered period: the direct correlation between the growth rate of the nominal exchange rate and inflation; the inverse correlation between inflation and GDP growth; and the direct correlation between GDP growth and the relative price of non-tradable goods. These three stylised facts are better understood when analysing the relationship between tradable and non-tradable goods inflation, GDP growth, past domestic inflation and international inflation measured in national currency.

In favourable international conditions for the Brazilian economy (trade and finance), when the country accumulates international reserves, the growth rate of the country's nominal exchange rate decrease. Consequently, the growth rate of international prices measured in domestic currency reduce as well as domestic inflation. Lower nominal exchange rate growth reduces the growth rate of exported and imported inputs' price, decreasing the cost growth rate of tradable and non-tradable goods production.

Favourable international scenario also improves the conditions for domestic credit to consumption, production and investment. Consequently, lower growth rate of tradable and non-tradable goods production costs occurs together with higher demand for those goods. The consequent higher GDP growth creates conditions to raise the growth rate of nominal wages on both sectors.

The high share of services in the non-tradable goods sector implies a cost structure with high share of wages compared to other inputs. So, a decrease in the growth rate of raw material inputs and an increase in the growth rate of nominal wages tend to raise more the cost of production of non-tradable goods than the tradable goods. Besides that, lower growth rate of the nominal exchange rate tend to reduce tradable goods mark-ups, reinforcing the tendency to increase relative price of non-tradable goods. The increase in the non-tradable goods price causes inflation higher than the growth rate of the nominal exchange rate,

appreciating the national currency. Better conditions for international trade and finance create more possibilities to import, maintaining the growth rate of GDP with lower inflation and higher relative price of non-tradable goods.

Higher GDP growth followed by national currency appreciation stimulates investment in the production of non-tradable goods and in the production of tradable goods in which the country has comparative advantages. The continuity of this economic growth rate requires favourable international conditions for trade and finance, because domestic investment do not develop the domestic production in a way to diversify exports and compete better with imports.

A less favourable international scenario to the country causes an inverse process in which the growth rate of imported and exported input prices increase, domestic conditions for credit to consumption, production and investment are negatively affected, GDP growth is reduced and domestic inflation increases. The increase in the growth rate of nominal wages tends to be limited in both sectors, but the growth rate of production costs tends to increase more in the tradable goods sector. Increases in mark-ups is also verified in the tradable goods sector, reducing the relative price of non-tradable goods and devaluing the national currency.

Unfavourable international conditions for trade and finance, lower GDP growth and higher domestic inflation generates an unfavourable scenario for investment in the production of tradable goods, despite the national currency depreciation, therefore postponing these investments. The latter would be necessary to develop production, enabling to reduce the country's dependency in relation to international trade and finance.

To conclude, the analysis of the relationship between tradable and non-tradable goods inflation, GDP growth, lagged domestic inflation and international inflation measured in national currency, provide elements to understand why trade and financial openness contributed to deepen the Brazilian economic dependence (GDP growth and inflation) on international trade and finance. It is important to highlight that trade and financial openness occurred with no capital movement controls and no deliberate incentive to develop the production of tradable goods through a specific industrial policy.

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Footnotes:

[1]Open developing economy is characterised by a "small" economy in the open macroeconomic sense along with some further particularities that are specified in the paper.

[2]The nominal exchange rate is defined here as domestic currency units per foreign currency unit.

[3]In an open economy, firms also take into consideration their international competitiveness when considering passing those higher wage costs to prices. This issue is included in the model developed in this paper.

[4]Another important extension, that is not included in this paper, is the consideration of higher interest rates that put an upward pressure on production costs. This extension is considered in the literature as cost-push channel of monetary policy. See Lima and Setterfield (2011) for a discussion in this topic.

[5]Conti (2011) shows that the exchange and interest rates of developing countries tend to be more volatile than the ones from central countries that possess convertible currencies.

[6]The nominal exchange rate is defined as foreign units per domestic currency in countries with convertible currency. For the case of developing countries with inconvertible currency, the nominal exchange rate is defined as domestic units per foreign currency. The latter definition is the one adopted in this paper.

[7]Some administered prices have political determination. Others, such as privatized public utility services, were indexed to the General Price Index (IGP). Commodities have a high share in the composition of IGP. Because of this, changes in prices of public utility services

are related to changes in the nominal exchange rate. Instead of considering domestic inflation as a weighted average of changes in tradable, non-tradable and administered prices, the model opted for a domestic inflation equation that highlights changes in tradable and non-tradable prices and the influence of administered prices are included in the coefficients of the equation.

[8]Real exchange rate is defined as P_iER/P_d, where P_i is international price, ER is the nominal exchange rate and P_d is domestic price. So, changes in the real exchange rate can be defined as $(1+rer) = [(1+p_i)(1+er)]/(1+p_d)$, where rer are changes in the real exchange rate, p_i is international inflation, er are changes in the nominal exchange rate and p_d is domestic inflation. The Central Bank of Brazil has information on changes in the real exchange rate, changes in the nominal exchange rate and domestic inflation. So, it is possible to deduce international inflation as $(1+p_i) = [(1+rer)(1+p_d)]/(1+er)$.

[9]Another possibility could be the Vector Error Correction (VEC) model. However the variables did not present a unit root form – the results are available from the author upon request. Therefore, this method would not be appropriate.

[10]The inflation rates for 1993 and 1994 are very high, reducing considerably after 1995. The estimation including a dummy to separate the periods and the estimation without these outliers provided less significant coefficients and the dummy was not significant. Therefore, the option of the paper was to calculate the whole period 1993 to 2010, when there are available data and the results are more satisfactory".

[11] The non-existence of quarterly data for tradable and non-tradable goods inflation precluded the estimation of the effects of changes in nominal wages on the sectors' inflation; it also precluded the estimation of the coefficients of equation 3 that relate changes in nominal wages to GDP growth and lagged domestic inflation. These estimations would enable the calculation of $c_{1,4}$ and $c_{1,7}$ and verify whether the influence of lagged inflation on the price of tradable goods is a result of the high influence of lagged inflation on changes in nominal wages of this sector (high magnitude of $c_{1,7}$), despite the relatively moderate effect of changes in nominal wages on the sector's price (low magnitude of $c_{1,4}$).

[12] The non-existence of a series for tradable goods wages does not make it possible to calculate $c_{1,3}$ and verify that the negative effect of GDP growth on the sector's inflation occurs despite the positive effect of GDP growth on wages ($c_{1,6}$). The latter, however, have

relatively low repercussions on the sector's inflation due to the relatively lower share of wages in the direct costs of the sector's production ($c_{1,4}$ relatively low).

[13] The non-existence of a series for nominal wages for tradable and non-tradable goods precludes verifying whether the difference on the impact of lagged inflation on the inflation of non-tradable goods is mainly due to the difference in $c_{j,4}$. The latter shows the different cost structures of both sectors rather than compensating a possible difference in $c_{j,7}$ due to higher effect of GDP growth on changes in nominal wages of tradable goods sector.

[14] The non-existence of a series for nominal wages of both sectors does not make it possible to verify the hypothesis that a negative impact of GDP growth on the inflation of tradable goods is due mainly to changes in mark-ups. The latter would be associated with a negative correlation between GDP growth and real exchange rate that, together with the lower share of wages in the cost structure of the tradable goods production, more than compensate a possible higher impact of GDP growth on wages in the tradable sector. This higher impact on wages would be associated with a greater purchasing power of workers in this sector.