Brazilian Inflationary Dynamics from 2000 to 2009: A Multisector Approach

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ABSTRACT
This work aims to analyze the Brazilian inflationary process between 2000 and 2009 from a multisector point of view. To do so, we present a structural decomposition analysis methodology to be applied to the Input-Output Price Model. Based on the assumption that under normal conditions of a market economy, inflation is largely caused by increases in production costs, we evaluate the results for the Brazilian economy in 2001–2009. We divide the period into three phases. In the first, 2001–2003, the major cause of Brazilian inflation is the nominal exchange rate. The second, 2004–2005, sees increases in the importance of commodity prices and wages. In the last phase, 2006–2009, labor cost exerts the most important influence on the inflation rate, and due to the behavior of income distributive variables, the service sector becomes an important factor in the explanation of the inflation rate in the Brazilian economy.

Keywords: Cost-Push Inflation, Structural Decomposition Analysis, Input-Output Price Model Matrix

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INTRODUCTION

In 2000–2009, Brazilian inflation behaved heterogeneously. From 2001 to 2003, the Brazilian inflation rate was high, with a double-digit average, and from 2004 on, it began to fall. This decline was more pronounced as of 2006. In addition, the factors responsible for the inflation dynamics were different throughout the decade.

From a heterodox perspective, the extension of the effective demand principle for the long term and its use to explain economic growth leads to the understanding that the productive capacity of the economy is endogenous. A logical consequence of this endogeneity is the understanding that under normal conditions of operation of a market economy, inflation is a phenomenon predominantly caused by increases in production costs.

To analyze the Brazilian inflationary dynamics, the structural decomposition methodology applied to the input-output price model matrix is presented. Then, the results of the application of this methodology are interpreted with the purpose of explaining the Brazilian inflationary process in the period 2000–2009, in the light of the so-called Surplus Approach, starting from the understanding that under normal conditions of functioning of a capitalist economy, inflation is predominantly costly. In the description of the inflationary process, the relationship between the factors responsible for the inflation dynamics and the behavior of the key distributive variables is discussed.

In the analysis, the effects associated with structural decomposition, which involve changes in the technical coefficients of production and the distributional variables associated with price formation, such as exchange rate, unit labor cost and profit margins, are evaluated.

The database used in the analysis consists of the System of National Accounts (SNA), made available by the Brazilian Institute of Geography and Statistics (IBGE, is the acronym in Portuguese). More precisely, we use the price model constructed from the database of the Input-Output Matrix (IOM). One difficulty associated with this database is the large time lag with which it is made available and the discontinuity of the matrices (and associated auxiliary tables) that are produced only once every five years. The work of Neves (2013) fills the gap associated with the discontinuity, because the author updates the matrices (and the auxiliary tables) from 2001 to 2009, both at current prices and at constant prices, within the parameters of the System of National Accounts Reference 2000 for the years in which the IOM is not made available by IBGE.

This work advances the application of structural decomposition; it covers a new field, associated with the input-output matrix price model, because this exercise is traditionally executed for the quantity model. In addition, it contributes to the discussion of the determinants of Brazilian inflation in the year 2000 by applying an unprecedented methodology in estimating the effect of the key distributive variables of the price system, taking advantage of an integrated database, which is the System of National Accounts.

The objective of working with the period 2000–2009 is to complement the explanation that has been reasonably consolidated for the inflationary process in the first decade of the century, showing that some elements can still be further developed.

From the point of view of structure, this work is divided into six sections beyond this introduction. Section 1 presents the theoretical basis. Section 2 presents the structural decomposition methodology of the inflation rate and profit margins. Section 3 explains the criteria used in the separation of activities in sectors with international prices and sectors with domestic prices. Section 4 describes the Brazilian inflation process based on the results of the structural decomposition and the theoretical framework used.

Section 5 presents the results of the decomposition of profit margins. In the last section, the conclusion is provided.

I – Inflationary Process

An open economy has two processes of price formation. The first is associated with goods that follow a domestic pricing process and depends predominantly upon the evolution of production costs. However, the second is related to goods that follow an international reference price, which depends upon the prices of the goods themselves in international reference currency and the nominal exchange rate (see Aukrust 1977, Frisch 1977 and Edgren et al 1969).

Thus, as a first approximation, we can represent the inflation rate as follows:

$$\pi_t^D = x.\pi_{t-1} + b(Y_t - Y_t^*) + h_t \quad (1)$$

$$\pi_t^I = g_{e_t} + \pi_t^* \quad (2)$$

where x is the coefficient of inertia, Y* is the potential output, and Y is the effective demand product. h_t represents a cost shock, π_{t-1} corresponds to the inflation rate of the previous period, π^*, the inflation rate in foreign currency of the goods that follow an international reference price, e represents the nominal exchange rate, and g_{e_t} represents the rate of growth of the nominal exchange rate.

Equation (1) shows that the current inflation rate of goods that follow a domestic pricing process (π_t^D) depends, in principle, upon the inertia component of inflation, the output gap (difference between the effective demand product and potential output) and changes in cost components[2]. Equation (2) shows that inflation for goods that follow an international pricing process (π_t^I) depends upon both the trajectory of the nominal exchange rate and the price of goods in the international market.

We can express the current inflation rate of the economy as follows:

$$\pi_t = d.\pi_t^D + (1-d).\pi_t^I \quad (3)$$

where d represents the share of goods with domestic prices in the economy as a whole, and (1-d) that of goods with international prices.

Thus, the current inflation rate can be expressed as follows:

$$\pi_t = dx\pi_{t-1} + db(Y_t - Y_t^*) + d.h_t + (1-d)g_{e_t} + (1-d).\pi_t^* \quad (4)$$

For goods with a domestic price, the factors that determine the offer price are labor productivity, nominal wage, profit margins, exchange rate and international commodity prices. The production costs plus the mark-up that characterizes each sector of economic activity determine the price of supply of this type of good, as will be evident later.

Starting from the idea that the growth process is fundamentally demand-led and that investment follows the logic of the capital stock adjustment principle[3], we can argue that the productive capacity of the economy is determined endogenously by the growth rate of aggregate demand[4,5]. One consequence is that

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[2] For a discussion of the distributional consequences of pursuing an inflation target from a structuralist perspective, see Barbosa-Filho (2014).

[3] This description of the growth process is based on the Sraffian Supermultiplier model. For an analysis of this type of model, see Serrano (1995a, 1995b), Freitas and Serrano (2007, 2015) and Serrano and Freitas (2016). Recently, some Kaleckian authors have used a version of the model; see Lavoie (2016) and Allain (2015). For an analysis of the inflationary process based on this type of approach and that stresses the endogeneity of the potential product in the long term, see Serrano (2006).

[4] This argument is based on the hypothesis that the main restriction of supply to the growth of the Brazilian economy is given by the stock of available capital. The presence of a large labor surplus (Lewis, 1954), coupled with mechanisms that tend to make the supply of labor endogenous, make the labor force not a relevant constraint to the growth process in the Brazilian economy. Among these mechanisms are the increase in labor-force participation rate in the expansive phases of the economic cycle, changes in immigration rules with the aim of inducing an increase in the supply of labor, and even an increase in the labor-force participation rate and birth in times of greater prosperity. Finally, the very growth of labor productivity tends to follow the growth of the economy, mitigating the pressures on the labor market.

[5] From this perspective, the main obstacle to demand-led growth in the Brazilian economy is the balance of payments constraint. Based on the Latin American structuralist tradition (see Prebisch, 1949), the balance of payments constraint is a financial constraint related to the fact that the Brazilian economy does not emit currency that is an international payment medium such as the US dollar, currently. The only means of paying off your foreign engagements is to obtain foreign

the output gap tends to disappear as long as the potential product adjusts in the long term to aggregate demand. Thus, the second term of equation (4) above tends to be zero, making aggregate demand not a source of permanent pressure on inflation in the long term. The counterpart to this point is that the core of inflation is explained by the evolution of production costs over time.

To better discuss the inflationary process, which consists of the rate of growth of the price level, we must first understand how the price level is explained. Using the specification adopted by Gomes (2016), we can express the production price as follows:

$$P_t = \mu_t . C_{t-1} \quad (5)$$

where P = price, μ = *mark-up*, and C = unit cost.

$$P_{t-1} = \mu_{t-1} . C_{t-2} \quad (6)$$

Prices are formed based on a mark-up on unit costs observed from the previous period. This mark-up is a reflection of the characteristics of each sector and the process of capitalist competition[6].

$$(1 + \pi) . P_{t-1} = (1 + g_\mu) . \mu_{t-1} . (1 + g_c) . C_{t-2} \quad (7)$$

The unit cost depends upon the intermediate consumption of goods with domestic prices, goods with international prices and unit labor costs (i.e., nominal wages and labor productivity).

$$C = [(a . P + m . e . P^*)(1 + T)] + \left[\frac{w(1 + t_w)}{b}\right] \quad (8)$$

The taxes on products (T) also affect the price, because they also constitute the costs. In the model, taxes on the payroll (t_w) are embedded in the unit labor cost.

To facilitate the understanding of the model and, in particular, to make some results more explicit, the expression denoting the unit cost will be modified.

$$C = \tau . [(a . P + m . e . P^*) + \left(\frac{w}{b}\right)] \quad (9)$$

$$\tau = 1 + \left[\frac{(a . P + m . e . P^*)}{(a . P + m . e . P^*) + \left(\frac{w}{b}\right)} . T + \frac{\left(\frac{w}{b}\right)}{(a . P + m . e . P^*) + \left(\frac{w}{b}\right)} . t_w\right] \quad (10)$$

The variable τ works as a sort of mark-up related to the effect that the taxes imposed on both domestic and imported intermediate consumption and the unit cost of labor exerted on the (unit) costs of production. The tax rate depends upon taxation on intermediate consumption, the share of intermediate consumption in the unit cost, taxation on the unit labor cost and the share of the unit labor cost in the unit cost of the product. Any change in taxation affects production costs. Just as the aliquot is different between the intermediate consumption and the unit labor cost, any change in their share of the unit cost (total) will also affect the final tax rate on the good.

Assuming that the coefficient associated with intermediate (m) and household consumption (a) remains unchanged, from (11), we can express the rate of change of costs that can be approximated as follows:

$$g_C = g_\tau + \sigma_a . \pi^D + \sigma_m . (\pi^* + g_e) + \sigma_w . (g_w - g_b) \quad (11)$$

where σ_a = share of the intermediate consumption of goods with domestic price in the cost in the previous period; σ_m = share of the intermediate consumption of goods with international prices (in domestic currency) in the cost in the previous period; σ_w = share of the unit labor cost in the cost in the previous period; π^D = rate of inflation of the intermediate consumption of goods with domestic prices; π^* = rate of inflation of the intermediate consumption of goods with international prices in foreign currency; and g_i = rate of growth of variable i.

Because prices are formed by a mark-up on the production costs of the previous period, we have the following:

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exchange (dollars) you can use for your actual and financial transactions with the rest of the world. Thus, during currency shortages, the economy might be forced to slow down its growth rate and/or devalue the exchange rate. In the latter case, we would have an important source of inflationary pressure. For an analysis of the external constraint hypothesis, see, among others, Medeiros and Serrano (1999), and for an analysis of the role of this restriction in the case of the Brazilian economy, see Medeiros and Serrano (2001).

[6] As discussed above, coupled with the trend of price gravitation around the offer price, we have the process of capital migration equalizing the returns. The determinants of mark-up will be discussed later.

$$\pi_t^D = g_{\mu_t} + g_{\tau_{(t-1)}} + \sigma_a . \pi_{(t-1)}^D + \sigma_m . \left(g_{e_{(t-1)}} + \pi_{(t-1)}^*\right) + \sigma_w . \left(g_{w_{(t-1)}} + g_{b_{(t-1)}}\right) \quad (12)$$

Therefore, for goods that follow a domestic pricing process, the evolution of costs, such as taxes on products, prices in domestic currency of goods that follow an international pricing process and the unit labor cost (nominal wage and productivity), and the sector mark-up explain the increase in prices.

The second "type" of price relates to goods on which prices are formed internationally, such as iron ore. The price of these commodities depends upon the dominant technique[7], the wages and the interest rate, expressed in currency of international circulation (dollar), in the countries that produce these products using the dominant technique. The quotation in the domestic market depends upon the nominal exchange rate (e) and the price prevalent in the international market (P*). In this case, the price that exerts the gravitational power is the price that prevails in the international market in units of the domestic monetary standard.

Here is an important qualification. In the case of these goods, it does not appear very reasonable to imagine that a change in the international price in local currency (e.P*) will not affect the price charged by domestic suppliers of such goods. Because of the attempt to equalize the yields, the price set in the domestic market by domestic producers tends to match the international price. Even when in the domestic market, most of the supply is supplied by domestic producers, products that have the characteristic of price formation in the international market, such as commodities, tend to follow the observed price behavior of the international market. If producers set a market price lower than the international reference price, they would waste profitability because they could export to an infinitely elastic demand; after all, they set a price lower than the market price. In the case of a fall in international prices, to imagine that the domestic producers would maintain the constant price also appears unlikely, because all buyers could import the cheaper good at an initially infinitely elastic (or simply very elastic) price. Thus, whenever a good has the characteristic of having an international reference price, the long-term trend is that the price prevailing in the domestic market is the price that is in force in the international market converted into local currency (e.P*).

The distributive consequence of accompanying an international reference price and the consequent discrepancy between the market price and the unit costs are that the mark-up is determined endogenously. Price formation is not performed by adding a mark-up on production costs; in fact, the mark-up is "residual", determined by the difference (or more precisely, by reason) between the price in local currency of the asset and the cost of production (in the current period).

$$P_t = e_t . P_t^* = \mu_t . C_t \quad (13)$$

$$\mu_t = \frac{e_t . P_t^*}{C_t} \quad (14)$$

If the offer price of the domestic producers is lower than the market price, they have the competitiveness to produce and sell in the domestic and international market. Excessive demand can be met by imports. For domestic demand or supply to affect international prices, the country's economy must be "large." In this case, the international supply would not be as elastic at a given market price, as discussed above, due to the size of the domestic economy. Note that even so, the proposition that the price in the domestic market accompanies international prices continues to be valid. Moreover, a contraction of aggregate demand with the aim of generating even a small effect on the prices of these commodities might be innocuous, because some change at the international level, such as an expansionary policy in another country, can cancel out this effect.

Returning to equation (2),

$$\pi_t^I = g_{e_t} + \pi_t^* \quad (2)$$

Instead of the evolution of the price level being determined by the evolution of production costs, it is the evolution of profit margins that is determined by the evolution of costs (see Edgren et al, 1969). The evolution of the price of goods with international prices depends exclusively upon the exchange rate

[7] These commodities can therefore suffer zero or almost zero influence on the demand for them in a particular country.

and the international reference price. Thus, we can obtain an equation to explain variations in profit margins, as follows:

$$g_\mu = g_e + \pi^* - g_C$$
$$g_\mu = g_e + \pi^* - [g_\tau + \sigma_a.\pi^D + \sigma_m.(\pi^* + g_e) + \sigma_w.(g_w - g_b)]$$
$$g_\mu = (1 - \sigma_m).(\pi^* + g_e) - g_\tau - \sigma_a.\pi^D - \sigma_w.(g_w - g_b) \quad (15)$$

The increase of goods with international prices in domestic currency has two effects: the increase in revenue and the increase in production costs. Because production is achieved through the acquisition of internationally priced inputs, the exchange devaluation and/or the increase in international prices raise the cost of production. However, as seen in equation (15), the revenue growth is greater than the increase in production costs because σ_m is less than one unit. The increase in the price in local currency of goods that follows a world reference value, even under cost pressure, expands from profit margins.

Although for goods with domestic prices, costs determine the evolution of the price of the final good, for goods with international prices, the trajectory of costs affects the evolution of the profit margin.

II – Structural Decomposition Methodology

The methodology used to analyze the Brazilian inflationary dynamics from 2000 to 2009 was the structural decomposition applied to the Input Product (I-O) Price Model. The construction of the I-O Price Model is based on the data present in the Input-Output Matrix. As Miller and Blair (2009) show, it is possible to measure the effect of each component of the cost of production on the price of each sector of activity. The application of structural decomposition to the Price Model allows us to perform the (structural) decomposition of the growth rate of the price level, that is, the decomposition of the inflation rate. The objective is to isolate the effect of each of the elements of cost to evaluate the influence of each of them in the inflationary process.

The methodology of the structural decomposition of the inflation rate from the Price Model is presented in Gomes (2016). In this work, all difficulties are also registered for the execution of the decomposition and some differences in relation to the decomposition of the quantity model. The objective of this work is to show the final format of the decomposition to discuss the inflationary process in Brazil.

Starting from Gomes (2016), we can decompose the inflation rate as follows:

$$\boldsymbol{\pi} = \mathbf{A}\boldsymbol{\pi} + \hat{\boldsymbol{\pi}} + \hat{\mathbf{q}} + \widehat{\mathbf{pm}} + \hat{\mathbf{r}} + \hat{\mathbf{t}} + \hat{\mathbf{m}} + \hat{\mathbf{s}} \quad (16)$$

where $\mathbf{A}$ is the (transposed) matrix of domestic technical coefficients; $\boldsymbol{\pi}$ is the column vector[8] with the inflation rates of each activity; $\hat{\boldsymbol{\pi}}$ is a vector that captures the relative price change of national intermediate consumption; $\hat{\mathbf{q}}$ is a vector that captures the relative volume change of national intermediate consumption; $\hat{\mathbf{t}}$ is a vector that reflects the influence of taxes on products; $\widehat{\mathbf{pm}}$ is a vector that captures the influence of the variation of profit margins; $\hat{\mathbf{r}}$ is a vector that reflects the influence of unit labor cost, mixed income and other subsidy-free taxes; $\hat{\mathbf{m}}$ is a vector with the rate of inflation of the imported intermediate consumption and with the change of relative volume of each activity; and finally, $\hat{\mathbf{s}}$ is a vector with interaction terms involving the previously defined variables.

As discussed in the previous section, an economy obeys two processes of price formation, the pricing of goods that follow an international reference value and a strictly domestic pricing process. Although for goods with internal pricing, production costs determine the price of the final good, for goods that follow an international reference price, the variable to be determined by production costs is profit margins.

First, we will solve the system for inflation rate, that is, to execute the decomposition for the goods that follow a domestic pricing process, as follows:

$$\boldsymbol{\pi} = (\mathbf{I} - \mathbf{A})^{-1}\hat{\boldsymbol{\pi}} + (\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{q}} + (\mathbf{I} - \mathbf{A})^{-1}\widehat{\mathbf{pm}} + (\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{r}} + (\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{t}} + (\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{m}} + (\mathbf{I} - \mathbf{A})^{-1}\hat{\mathbf{s}} \quad (17)$$

where $(\mathbf{I} - \mathbf{A})^{-1}$ is the impact matrix of the Leontief price model.

[8] All vectors involved are column vectors.

To illustrate the meaning of each of the matrices and to allow the understanding of the meaning of the structural decomposition and of each of its elements, a simplified 2x2 (two products and two activities) model was assembled. The Brazilian Input-Output Matrix, which is the basis for the construction of the I-O price model, is a 55x55 model.

$$\begin{bmatrix}\pi_1\\ \pi_2\end{bmatrix} = (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}\hat{\pi}_{11}a_{11}(0)+\hat{\pi}_{21}a_{21}(0)\\ \hat{\pi}_{12}a_{12}(0)+\hat{\pi}_{22}a_{22}(0)\end{bmatrix} + (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}\hat{q}_{11}a_{11}(0)+\hat{q}_{21}a_{21}(0)\\ \hat{q}_{12}a_{12}(0)+\hat{q}_{22}a_{22}(0)\end{bmatrix}$$
$$+ (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}\hat{g}_{PM1}pm_1(0)\\ \hat{g}_{PM2}pm_2(0)\end{bmatrix}$$
$$+ (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}\pi_{ULC1}ulc_1(0)+\hat{q}_{ULC1}ulc_1(0)+\hat{g}_{MI1}mi_1(0)+\hat{g}_{OT1}ot_1(0)\\ \pi_{ULC2}ulc_2(0)+\hat{q}_{ULC2}ulc_2(0)+\hat{g}_{MI2}mi_2(0)+\hat{g}_{OT2}ot_2(0)\end{bmatrix}$$
$$+ (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}\pi_{t1}t_1(0)+\hat{q}_{t1}t_1(0)\\ \pi_{t2}t_2(0)+\hat{q}_{t2}t_2(0)\end{bmatrix} + (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}\pi_{m1}m_1(0)+\hat{q}_{m1}m_1(0)\\ \pi_{m2}m_2(0)+\hat{q}_{m2}m_2(0)\end{bmatrix}$$
$$+ (\mathbf{I}-\mathbf{A})^{-1}\begin{bmatrix}s_{11}a_{11}(0)+s_{21}a_{21}(0)+s_{ulc1}ulc_1(0)+s_{m1}m_1(0)+s_{t1}t_1(0)\\ s_{12}a_{12}(0)+s_{22}a_{22}(0)+s_{ulc2}ulc_2(0)+s_{m2}m_2(0)+s_{t2}t_2(0)\end{bmatrix}$$

with

$$s_{11} = \pi_1\hat{\pi}_{11} + \pi_1\hat{q}_{11} + \hat{\pi}_{11}\hat{q}_{11} + \pi_1\hat{\pi}_{11}\hat{q}_{11}$$
$$s_{21} = \pi_2\hat{\pi}_{21} + \pi_2\hat{q}_{21} + \hat{\pi}_{21}\hat{q}_{21} + \pi_2\hat{\pi}_{21}\hat{q}_{21}$$
$$s_{m1} = \pi_{m1}\hat{q}_{m1}$$
$$s_{t1} = \pi_{T1}\hat{q}_{T1}$$
$$s_{ulc1} = \pi_{ULC1}\hat{q}_{ULC1}$$
$$s_{12} = \pi_1\hat{\pi}_{12} + \pi_1\hat{q}_{12} + \hat{\pi}_{12}\hat{q}_{12} + \pi_1\hat{\pi}_{12}\hat{q}_{12}$$
$$s_{22} = \pi_2\hat{\pi}_{22} + \pi_2\hat{q}_{22} + \hat{\pi}_{22}\hat{q}_{22} + \pi_2\hat{\pi}_{22}\hat{q}_{22}$$
$$s_{m2} = \pi_{m2}\hat{q}_{m2}$$
$$s_{t2} = \pi_{T2}\hat{q}_{T2}$$
$$s_{ulc2} = \pi_{ULC2}\hat{q}_{ULC2}$$

where $\hat{\pi}$ = change in relative prices of the variable in question[9]; $\hat{q}$ = relative volume variation of the variable in question; $\hat{g}$ = nominal growth divided by the volume growth of the total output (TO); $a_{ij}(0)$= intermediate consumption of product i by activity j divided by the TO of activity j in the base year; $pm_j(0)$ = profit margin of activity j in the base year; $ulc_j(0)$ = unit labor cost in activity j in the base year; $mi_j(0)$= mixed income divided by the TO of activity j in the base year; $ot_j(0)$= other taxes free of subsidies divided by the TO of activity j in the base year; $t_j(0)$ = product taxes divided by the TO of activity j in the base year; and $m_j(0)$ = imported intermediate consumption divided by the TO of activity j in the base year.

With the inflation rate of each activity, to arrive at the inflation rate of the whole economy, we simply multiply each activity by its respective participation in the TO and add their respective contributions. Thus, we will have the contribution of each effect, in each of the activities, to the rate of inflation of the economy (that is, the inflation rate of the TO at basic price).

It is important to try to interpret the economic significance of each of the effects associated with the decomposition of the inflation rate.

The combination of inputs used in production consists of a basket, which can change in price differently from the evolution of the general level of prices or the quantities required for production differing from the evolution of the total production of the economy.

The relative price effect is associated with the increase or reduction of the input basket used in production due to the input-basket price path (cost) distinct from the total economy production-price trajectory. If the relative price effect is positive (negative), the price of the input basket grows more (less) than does the price of the TO, raising (reducing) the technical coefficient.

[9] In matrix algebra, the symbol "^" is often used to refer to the vector diagonalization operator in a matrix whose elements on the main diagonal are the elements of the original vectors. The symbol here bears no relationship to this usage.

The relative volume effect is associated with changes in the input basket toward the more or less intensive use of domestic intermediate consumption per unit produced. This effect modifies the value (cost) of the input basket. Therefore, whenever the participation (at constant prices) of the intermediate consumption in the final product increases, the relative volume effect is positive and the cost of production increases, and whenever input participation is reduced, the relative volume effect is negative and the cost is reduced.

One more element to explain the rate of inflation is the cost of labor. The unit labor cost effect can be broken down into two parts[10], the growth of the nominal wage (the "price" of the wage bill), which increases the costs of production; and the evolution of the unit labor requirement (the "relative volume" of the wage bill), which is nothing more than the inverse of productivity growth. Thus, when production per employee, productivity, increases (decreases), the unit labor requirement falls (increases) and the unit labor cost decreases (increases).

The increase in inputs and the increase in their relative volume also pressure production costs. The nominal growth of profit margins, mixed income and other subsidy-free taxes divided by the growth in the volume of TO, that is, the nominal expansion per unit produced of the variables in which growth cannot be broken down into price and volume[11], are the last elements with economic value of decomposition. As mentioned, the terms of interaction are recorded to obey the identity behind the decomposition of the inflation rate, even when they are not interpreted.

All effects associated with the decomposition of goods with domestic prices are effects from the perspective of vertically integrated sectors. Thus, for example, the effect of unit labor cost (ULC) can be divided between the increase in the average wage of all links in the productive chain and the productivity effect of all stages of the production process. The ULC effect measures the contribution to the inflation rate of the labor increase in all stages of production and not only in the last stage.

As discussed above, for goods that follow an international reference value, the increase in production costs explains the evolution of profit margins, because the price in the domestic market depends upon the international price and the nominal exchange rate. Thus, instead of solving the system for the rate of inflation, as in equation (16), we can solve the system for profit margins.

$$\widehat{\mathbf{pm}} = \boldsymbol{\pi} - (\mathbf{A}\boldsymbol{\pi} + \hat{\boldsymbol{\pi}} + \hat{\mathbf{q}} + \hat{\mathbf{r}} + \hat{\mathbf{t}} + \hat{\mathbf{m}} + \hat{\mathbf{s}}) \qquad (18)$$

To solve the system for growth rate of profit margins, we must pre-multiply the two sides of the equation by a diagonal matrix such as the following:

$$\mathbf{f} = \begin{bmatrix} \dfrac{1}{\mathrm{pm}_1(0)} & 0 \\ 0 & \dfrac{1}{\mathrm{pm}_2(0)} \end{bmatrix}$$

The matrix **f** is used so that we can solve the matrix equation (18) for the proportional variation of the profit margins of the internationally traded sectors. Each cell in the main diagonal must be filled with the corresponding profit margin of the activity in the denominator and the value one in the numerator, and all other cells must be filled with a value of zero.

Solving the system for profit margins,

$$\mathbf{f}.\widehat{\mathbf{pm}} = \mathbf{f}.\boldsymbol{\pi} - \mathbf{f}.(\mathbf{A}\boldsymbol{\pi} + \hat{\boldsymbol{\pi}} + \hat{\mathbf{q}} + \hat{\mathbf{r}} + \hat{\mathbf{t}} + \hat{\mathbf{m}} + \hat{\mathbf{s}}) \qquad (19)$$

Equation (19) allows us to solve the system for the economy as a whole (55 activities). Represented in our 2x2 model,

[10] The IBGE discloses the wage bill and the number of workers employed by activity, allowing the calculation of the average salary and the level of employment by sector.

[11] For gross operating surplus, mixed income and other subsidy-free taxes, National Accounts data provided by the Brazilian Institute of Geography and Statistics (IBGE) do not present series at prices of the current year and at the price of the previous year, preventing the dismemberment of the nominal variation in price and volume variation.

$$\begin{bmatrix}\hat{g}_{PM1}\\ \hat{g}_{PM2}\end{bmatrix} = \mathbf{f}.\begin{bmatrix}\pi_1\\ \pi_2\end{bmatrix} - \mathbf{f}.\begin{bmatrix}a_{11}(0) & a_{21}(0)\\ a_{12}(0) & a_{22}(0)\end{bmatrix}\begin{bmatrix}\pi_1\\ \pi_2\end{bmatrix} - \mathbf{f}.\begin{bmatrix}\hat{\pi}_{11}a_{11}(0) + \hat{\pi}_{21}a_{21}(0)\\ \hat{\pi}_{12}a_{12}(0) + \hat{\pi}_{22}a_{22}(0)\end{bmatrix}$$
$$- \mathbf{f}.\begin{bmatrix}\hat{q}_{11}a_{11}(0) + \hat{q}_{21}a_{21}(0)\\ \hat{q}_{12}a_{12}(0) + \hat{q}_{22}a_{22}(0)\end{bmatrix}$$
$$- \mathbf{f}.\begin{bmatrix}\pi_{ULC1}ulc_1(0) + \hat{q}_{ULC1}ulc_1(0) + \hat{g}_{MI1}mi_1(0) + \hat{g}_{OT1}ot_1(0)\\ \pi_{ULC2}ulc_2(0) + \hat{q}_{ULC2}ulc_2(0) + \hat{g}_{MI2}mi_2(0) + \hat{g}_{OT2}ot_2(0)\end{bmatrix}$$
$$- \mathbf{f}.\begin{bmatrix}\pi_{t1}t_1(0) + \hat{q}_{t1}t_1(0)\\ \pi_{t2}t_2(0) + \hat{q}_{t2}t_2(0)\end{bmatrix} - \mathbf{f}.\begin{bmatrix}\pi_{m1}m_1(0) + \hat{q}_{m1}m_1(0)\\ \pi_{m2}m_2(0) + \hat{q}_{m2}m_2(0)\end{bmatrix}$$
$$- \mathbf{f}.\begin{bmatrix}s_{11}a_{11}(0) + s_{21}a_{21}(0) + s_{ulc1}ulc_1(0) + s_{m1}m_1(0) + s_{t1}t_1(0)\\ s_{12}a_{12}(0) + s_{22}a_{22}(0) + s_{ulc2}ulc_2(0) + s_{m2}m_2(0) + s_{t2}t_2(0)\end{bmatrix}$$

The evolution of profit margins depends upon the growth rate of the good in the international market and the variation of the nominal exchange rate, which determine inflation in local currency and the growth of all cost variables. The decomposition as proposed in equation (19) does not work with vertically integrated sectors for two reasons. The first is that the system solution for profit margins does not produce a result such as the decomposition of the inflation rate, and the second is the fact that the analysis is performed for goods with international prices. Because the goal is to evaluate the behavior of profit margins, working with the vertically integrated sectors is not the most productive alternative. For example, let us suppose that the unit cost of labor grew in the production of goods with international prices that are used as input in the "last round" of the production of a given final good with an international price. Like the final good, the inputs also present international prices; therefore, it is most important to observe the increase in intermediate consumption for the "last round" of the production process. Working with vertically integrated sectors, the increase in the unit labor cost in the earlier stages of the production process would be mixed with the increase in the last stage. We would not therefore analyze the evolution of the margins properly. Although for domestic goods, the most interesting is to analyze the behavior of the inflation rate thinking in vertically integrated sectors, to analyze the evolution of the margins of profit of goods with international prices is more interesting to observe what occurs to the costs in the last step of the productive chain. Thus, we can separate everything that occurred in the previous steps – within the effect called intermediate consumption, of everything that occurred in the last step. All of the effects that were already present in the structural decomposition of domestically priced goods remain present, but their influence is restricted to the direct effect and is no longer the direct and indirect effects combined. As stated previously, the indirect effect will be all within the increase of intermediate consumption.

III – Separation of Goods in Domestic Price and International Price

To analyze the Brazilian inflationary dynamics, it is necessary to separate the activities according to the common characteristics of price formation. Therefore, we chose to work with two classifications: goods that follow an international reference value (eP*) and goods with domestic pricing, in which the domestic price is unrelated to the international price[12], depending upon the variables of cost, as in equations (5) and (8).

To implement the classifications, we initially collected data from the world and Brazilian exports available on the World Bank – Comtrade (WITS – *World Integrated Trade Solution*)[13] platform from 1989 to 2013. To enable the reading of the data and their subsequent analysis through the SNA, data extracted using the six-digit classification (HS6) were aggregated using an HS6xSNA translator provided

[12] There is not even a product on the international market that can be considered analogous to that of the domestic market, such as for some services.

[13] Available at https://wits.worldbank.org/. Access 10/01/2015.

by the Industry and Competitiveness Group (GIC/UFRJ is the acronym in Portuguese). Aggregation reduced the number of products from over 5000 in the HS6 classification to 85 SNA products[14].

The data are presented in value and by weight (Kilogram – Kg), allowing the calculation of the price per kg. To evaluate the evolution of the price of the products, Laspeyres price indexes were defined. Each of the 85 SNA products constituted a basket of goods, with the share being defined by the share of the HS6 products in the product resulting from the aggregation, that is, their respective basket. To illustrate, let us assume the following example. Three products (products 1, 2 and 3) in the HS6 classification are aggregated through the translator for the SNA product A. The weight of products 1, 2 and 3, by value, are 25%, 35% and 40% of product A, respectively, in the base year (Laspeyres Index). Thus, it is possible to set the price evolution of product A by means of the participation of products 1, 2 and 3 in the base year (1989) and the price evolution observed for these products throughout the analyzed period. The objective of working with a longer period than the one used in the study was to observe the presence or absence of a long-term tendency for the price of Brazilian exports vis-à-vis world exports[15].

Thus, two series were constructed with 85 price indices each, one for world exports and another for Brazilian exports from 1989 to 2013. With the available price indices, the price-level growth rates for each of the products were calculated from 1990 to 2013. The four largest dispersions found for growth rates were replaced by the average growth of the product for the entire period, i.e., the outliers were replaced by interpolation.

Next, the 85 products were analyzed graphically, comparing the evolution of the series of prices with SNA classification of the world exports with the same series for the Brazilian exports in the period 1990–2013. Twenty-five products were identified with international prices, and 60 products were identified with domestic prices.

The structural decomposition of the inflation rate works with the analysis of the sectors (activities) and is not based on the classification by product. Thus, for the analysis of the price formation in terms of the 110 products of the National Accounts, the classification by sector of activity had to be applied. There are 55 sectors. To perform this application, the participation of each product in the total production activity for the years 2000 to 2009 was determined, and the average was calculated. Thus, it was possible to visualize which sectors of activity were composed of products characterized by international pricing and which were characterized by domestic pricing. All activities in which more than 40% of the production was concentrated in products that followed the respective international reference price were classified as sectors with international prices, and the others were classified as sectors with domestic prices. That is, all of the activities in which the 25 products in which the price indices indicated the monitoring of an international reference price represented more than 40% of the TO were classified as world-priced activities, activities in which their pricing process is associated with the monitoring of a world reference value. The activities in which the participation of the TO of the 25 products with international prices represented less than 40%[16] of the production were classified as domestic pricing[17].

Of the 55 sectors of activity of the National Accounts, six were classified as sectors with international prices: "Iron Ore", "Food and Beverages", "Alcohol", "Manufacture of resins and

[14] Although the SNA has 110 products, only 85 of them presented international trade according to the Comtrade data.

[15] In the Brazilian export data, for some 110 SNA products, the share of 1989 was nil and positive thereafter. In these cases, the participation of the year 2013 was used. In addition, some products had no HS6 classification (empty field) for the first years of the series and then for some isolated years, resulting in a zero-value SNA product. To solve this problem, the series was interpolated. The first subsequent positive data amount was divided by the average growth of the whole period for the product in question.

[16] Of the activities classified as international prices, "Food and Beverage" presented the lowest participation, with 49% of the TO made up of products with international prices; all others had 86% or more.

[17] A third classification was also applied for public services ("Public Education", "Public Health" and "Public Administration and Social Security"). This group presents the characteristic of the good (service) not being bought by consumers (provided to the citizens) for payment; that is, they do not present monetary prices. Thus, they were removed from the analysis of Brazilian inflation dynamics. All operations required for structural decomposition were performed with the 55 activity sectors (square matrix). However, these three activities were later withdrawn. The total of the economy (aggregate) was calculated considering the sum of the first two groups as 100% of the Brazilian economy.

elastomers", "Chemical products and various preparations" and "Manufacture of steel and its derivatives"[18].

Before we discuss the results of decomposition, a qualification is required. The figures provided by IBGE and updated by Neves (2013) are always presented, both for current prices and for prices of the previous year, based on the concept of average annual price. Therefore, considering the period 2000–2009, it is not possible to calculate the price index for the year 2000. This difference is important in relation to the methodology used by the IBGE for the calculation of the Extended Consumer Price Index (IPCA is the acronym in Portuguese). In calculating the IPCA, the price of a good is observed on a given day of each month, and it is therefore possible to calculate monthly and then annual price indices. Using the average price metric, it takes two years to be able to calculate the price index. Generally, in a series with n years, it is possible to calculate n - 1 price indices. Based on the methodology developed for the execution of the structural decomposition of the inflation rate, we should use the technical coefficients of the base year in the MIP assembly and the rates of growth of the volume and the level of prices, starting, of course, from the base year.

A further consequence of the methodology of structural decomposition is the importance of properly dividing the analysis period into phases with common characteristics. Let us suppose that in year 1, the wages double, and in year 2, they are reduced to one-half, returning to the level of year 0. By the execution of the decomposition, if we compare the average value of year 2 with the average value of year 0, we would decompose a null variation, although wages made a significant contribution to the increase in costs and prices in year 1 and to the reduction in year 2. In that example, it would be necessary to make the decomposition for the two sub-periods separately to capture the upward pressure in the first year and the deflationary pressure in the second. Therefore, to take full advantage of the information that the structural decomposition of the inflation rate is capable of providing, it is important to divide the analysis period into phases that present common trajectories for the key variables of the price system.

IV – Brazilian Inflationary Process from 2001 to 2009

The analysis of the period 2001–2009 was divided into three phases following the narrative about the Brazilian inflationary process from the point of view of cost-push inflation of the Surplus Approach. Following Bastos and Braga (2010), Braga (2011), Summa and Braga (2013), Braga (2013) and Summa (2014), we can divide the period 2001–2009 into three phases. In the 2001–2003 sub-period, the nominal exchange rate depreciated and commodity prices fell in dollars in 2001 and 2002, and grew in 2003, nominal wages rose less than labor productivity did, and real wages fell. In 2004, the nominal exchange rate (annual average) started a strong appreciation movement, coupled with accelerated growth in the price of commodities in foreign currency. Additionally, from 2004, the real wage began to grow. In addition, the growth pattern of the Brazilian economy began to change, when compared with the previous three years. In 2006, the nominal wage began to grow faster, causing the unit labor cost to explain the greater part of the inflationary dynamics. This wage growth was the beginning of a moderate wage inflation in the Brazilian economy. In the period 2006–2009, the exchange rate dynamics were more irregular, largely due to the effect of the international crisis on the world and the Brazilian economy in the last quarter of 2008. In that quarter, the nominal exchange rate depreciated rapidly, and the international price of commodities fell rapidly. In 2009, both variables returned to showing their behavior immediately prior to the fall of the American bank Lehman Brothers; however, the change of level at the end of 2008 affected the average prices of 2009. The average nominal exchange rate of 2009 was higher than the 2008 rate, and the commodity prices were lower. From the beginning of the sub-period to its end, i.e., the base to the realization of the structural decomposition, the exchange appreciated and the price of commodities

[18] The activity "Oil and Natural Gas" was classified as an industry with internal pricing because the adopted price policy for the main product of the activity, also called "oil and natural gas", which accounts for 99% of the TO in the sector, did not show a trajectory compatible with international prices.

increased, in dollars. Therefore, in the third phase, the nominal exchange maintained its appreciation trajectory, as well as commodities prices; the variable demonstrating new behavior was unit labor cost, which presented the highest growth. Additionally, the year 2006 marks a moderate inflection in economic policy (Serrano and Summa, 2011).

The decomposition shows cumulative results for the sub-periods chosen, i.e., the cumulative inflation rate from 2001 to 2003, from 2004 to 2005, and from 2006 to 2009. Because the three periods have distinct extensions, with the objective of making the results of the decomposition comparable, from the cumulative rate for each sub-period, the (geometric) average rate for each of the three phases was calculated. Therefore, all of the results presented for the decomposition refer to the average (annual) contribution to the inflation rate.

Table 1 – Selected Variables 2000–2009

	Goods with International Prices	Goods with Domestic Prices	Total
Participation in TO (base year 2000)	10.5%	89.5%	100.0%
Annual average inflation rate 2001–2003	18.1%	12.7%	13.3%
Average contribution to the inflation rate (pp.) 2001–2003	1.90	11.36	13.27
Participation in TO (base year 2003)	11.6%	88.4%	100.0%
Annual average inflation rate 2004–2005	9.9%	7.1%	7.4%
Average contribution to the inflation rate (pp.) 2004–2005	1.15	6.25	7.40
Participation in TO (base year 2005)	10.7%	89.3%	100.0%
Annual average inflation rate 2006–2009	6.9%	5.9%	6.0%
Average contribution to the inflation rate (pp.) 2006–2009	0.73	5.27	6.00

Source: SNA/IBGE and Neves (2013). Self-elaboration

The first thing to note from Table 1 is that the rate of inflation narrows noticeably over the decade. Although in the first sub-period, the (average) rate of inflation reached 13.27% per year (p.y.), it fell in the second sub-period to 7.4% p.y., and in the third, to 6% per year, less than one-half that observed for the first triennium. One more observation is that the contribution of goods with domestic prices is always much higher than the contribution of goods that follow a world reference value due to the much larger share of the category in the Brazilian economy (measured from the TO). The third finding is that the inflation rate of goods with international prices was higher in the three sub-periods and that the difference decreased over the years. Therefore, the contribution of goods with domestic price was only higher due to their participation in the TO, because the growth rate of the other category was higher.

In 2001–2003, international goods price inflation was 18.1% per annum and promoted a (average) contribution to the (total) inflation of the Brazilian economy of 1.9 percentage points (p.p.) per year. Inflation of goods with domestic prices was 12.7% p.y. and promoted an annual contribution of 11.36 p.p. to the inflation rate, which was 13.27% (p.y.).

During the first three years, the price of commodities fell in 2001 and 2002 and increased in 2003. Comparing 2003 with 2000, reference to structural decomposition, the price of commodities fell in the first sub-period. At the same time, the nominal exchange rate went through an average devaluation of 19% per annum, that is, the inflation of goods with external price (e.P*) was essentially due to the exchange devaluation. In the second sub-period, the price of commodities already presented an opposite trend of high growth, whereas the exchange also reversed its trajectory and started to appreciate. In the years 2004–2005, the decrease in inflation of the goods with international prices was only possible due to the exchange appreciation because the international quotation rose. In the last four years, despite the oscillation of the trajectory over the four years, there was an appreciation of the exchange rate, albeit

milder, and also a milder growth in international prices. Inflation in the category continued to decline. Compared with the first three years, we can repeat the fact that once international prices had risen, it was only possible to reduce the inflation rate due to the appreciation of the exchange rate. The inflation rate of 6.9% corresponds to approximately two-fifths of the rate of 18.1% observed for 2001–2003. Compared with 2004–2005, the reduction was made possible by a smoother combination between world quotation growth and exchange appreciation.

Understanding the factors that explain the trajectory of goods with international prices, we can analyze the determinants of the inflation rate of goods that have a strictly domestic process of price formation. This second category, which represents a much larger part of the economy, measured by the participation in the TO, also presented declining inflation rates over the years. The inflation rate of domestically priced goods fell by 12.7% p.p. in the first three years, to 7.1% p.p. in 2004–2005 and to 5.9% p.p. in the last four years. Although it was a less intense decline, the overall downward trend in the inflation rate for each sub-period was maintained.

The structural decomposition of the inflation rate provides an exhaustive (complete) description of the elements responsible for the increase in prices. Although for internationally priced goods, evolution depends upon the nominal exchange rate and the international reference price, for goods with domestic prices, the inflation rate depends upon all of the effects identified in table 2. Because decomposition is performed to explain how each effect affects the dynamics of inflation, the dimension of effects is associated with the participation of each category in the TO of the economy.

Table 2 shows the influence of each of the effects associated with structural decomposition on the total inflation rate of the economy. Examining the first sub-period, from the contribution of 11.36 p.p. of goods with domestic prices, 0.48 p.p. corresponds to the relative price effect, 0.29 p.p. to the negative (deflationary) contribution of the relative volume effect of domestic intermediate consumption, 0,08 p.p. to the negative contribution of the relative volume effect of imported intermediate consumption, and so on. The sum of all effects corresponds, of course, to the contribution of this category to the Brazilian inflation rate, 11.36 percentage points.

Table 2 – Contribution of Domestic Price Goods to the Inflation Rate

	2001–2003	2004–2005	2006–2009
Domestic inputs – effect relative prices	0.48	0.51	0.15
Domestic inputs – relative volume effect	-0.29	-0.56	-0.01
Imported inputs – relative volume effect	-0.08	0.30	0.39
Imported inputs – price effect	1.77	0.15	0.05
Taxes on products – relative volume effect	0.10	-0.04	-0.04
Taxes on products – price effect	0.74	0.46	0.24
Other Taxes and Subsidies	0.23	0.16	0.15
Subtotal of Taxes	1.06	0.59	0.36
Average salary	2.58	2.48	3.09
Labor Productivity	0.47	0.05	-0.25
Unitary Labor Cost	3.05	2.53	2.85
Mixed Income	4.66	2.88	1.55
Interaction Terms	0.94	0.16	0.23
Other Taxes and Subsidies	-0.22	-0.29	-0.31
Total	11.36	6.25	5.27

Source: SNA/IBGE and Neves (2013). Self-elaboration

The breakdown of the inflation rate allows us to observe that the increase in imported intermediate consumption contributed 1.77 p.p. per year. The price of imported inputs depends upon the nominal exchange rate, international prices, as the final goods with international reference prices. Recall that we

are analyzing the contribution of each of the effects in terms of vertically integrated sectors; therefore, the increase in imported intermediate inputs in question is related to the increase in inputs at not only the immediately previous stage of production but also all stages of the production process. The contribution of 1.77 p.p. is the cumulative contribution of the exchange devaluation added to the change in the international quotation of the inputs on the sectors with domestic prices from the first stage of the production process until the last one.

If we want to analyze the influence of the combined effect of nominal exchange rate variation and international quotation of imported inputs and final goods on the Brazilian economy as a whole, we must add the contribution of 1.77 p.p. to 1.90 (p.p.). The result is a contribution of 3.67 percentage points. This (average) contribution of 3.67 p.p. per year corresponds to 27.7% of all of the (average) inflation of the period, reinforcing Braga's (2013) proposal that the trajectory of the nominal exchange rate added to the dynamics of the commodities in the international market is a key variable to explain the Brazilian inflationary process[19].

The evolution of the relative volume of taxes on products also influences the trajectory of prices. In the three-year period 2001–2003, we noticed that this phenomenon produced an effect of 0.10 percentage points, on average, on the Brazilian inflation index, an influence that might be considered small. Conversely, the evolution of the "price" of the tax, i.e., the increase in the price level of the tax base, raised the price level by an average of 0.74 percentage points.

Increases in mixed income and other subsidy-free taxes per unit produced contributed 0.94 and 0.23 p.p., respectively. The total promoted by the taxation consists, then, of the price and relative effects of taxes on products and of the increase of other taxes free of subsidies per unit produced. Taxation thus contributed, on average, to 1.06 p.p. per year for the inflationary process from 2001 to 2003.

The effects that remain to be analyzed are the effects associated with the gross operating surplus and the wage bill (plus social contributions on the payroll). As already discussed, the IBGE makes available both the wage bill and the number of employees employed per activity. Thus, it is possible to separate the evolution of the cost of the wage bill per unit produced by the average nominal wage effect (or average wage cost) and relative volume effect (or labor productivity effect). The two combined tell us about the influence that the growth of the wage bill per unit produced, that is, the unit labor cost (ULC) exerted on the inflationary dynamics. For the gross operating surplus, it is not possible to perform this separation because we only have the effect of the gross operating surplus expansion (in value) per unit produced. This point represents nothing more than the attempt to re-establish the profit margin on the part of the income from capital based on some profitability goal to be achieved, which can be frustrated or successful. Therefore, the profit margin effect consists of the influence on the inflationary dynamics of capital's attempt to achieve certain profitability.

In the years 2001–2003, the average nominal wage effect contributed 2.58 p.p. (p.y.) to the Brazilian inflation rate, and because labor productivity fell in Brazil during the three-year period, the productivity effect was positive, that is, cost of production promoted a contribution of 0.47 p.p. per year. The profit margin effect contributed 4.66 p.p. per year to the inflation rate.

We note that profit margins have been the main cause of the price increase. The second most pressing effect of prices was the ULC, and the third effect was the price effect of imported intermediate consumption. Recall that the increase in the final products of goods with international prices was also important to explain the inflation (average) rate of the period. Thus, we can conclude that the expansion of the nominal wage (and the fall in labor productivity), the exchange devaluation and the evolution of the profit margins were the main factors responsible for the inflationary dynamics in the period 2001–2003.

Analyzing the biennium 2004–2005, we observed that the inflation rate dropped significantly to 7.4% p.y. due to a contribution of 1.15 p.p. of goods with international prices and 6.25 p.p. of goods with domestic prices.

[19] Because the price readjustment of the monitored goods was very sensitive to the nominal exchange rate in the first half of the decade, due to the linkage to the exchange rate-sensitive indexes, the influence of the exchange rate devaluation was possibly higher than that measured by these two effects. For a discussion of the effects of the change in the rules for readjustment of monitored assets, see Braga (2011, 2013) and Martinez and Cerqueira (2013).

The relative price effect contributed 0.51 p.p., the relative volume effect of imported intermediate consumption 0.30 p.p., and the relative volume effect of the domestic intermediate input promoted a deflationary contribution of 0.56 per year. In addition, the three effects associated with taxation together contributed 0.59 p.p. to the Brazilian inflation rate.

We also noticed that the contribution of the price increase of the imported intermediate inputs dropped sharply to only 0.15 p.p., a figure well below the previous period. This result is due to the appreciation of the exchange rate, because international prices started to rise at high rates. Adding the price effect of imported intermediate consumption to the contribution of goods with international prices, we reached the combined contribution of the exchange rate and the international quotation of 1.3 p.p., which was also well below that observed previously (of 3.67 p.p.)[20]. The exchange appreciation, therefore, was able to offset the great growth of international prices in foreign currency and helped reduce the rate of inflation in Brazil.

The evolution of ULC continued to push prices. The average growth rate of the nominal wage (along with the employer's contributions) was similar to that observed in the previous triennium. The contribution to the price change was less, due to the decrease of participation of the ULC in the TO and the less intense fall in labor productivity. Despite the fall in the ULC (average) contribution from 3.05 p.p. to 2.53 p.p. per year, the steeper decline in the inflation rate caused the ULC to account for a larger share of the Brazilian inflation rate in the years 2004–2005. The wage inflation became more important to explain the dynamics of prices in the Brazilian economy[21].

The effect of the margins was also reduced. The contribution fell from 4.66 p.p. to 2.88 p.p. in the second sub-period. Already the relative importance of the margins rose slightly from 35.1% in 2001–2003 to 38,9% in 2004–2005. Although it remained larger, the attempt to (at least) recompose capital income pressured the price level in magnitude more closely to the pressure exerted by the attempt to increase the income of the labor force. Finally, mixed yield growth per unit produced pushed prices by 0.16 p.p. per year, significantly less than in the previous triennium (0.94 pp).

In the final four years of our analysis, the inflation rate of internationally priced goods fell by approximately three-fifths from that observed in the years 2001–2003, and that of domestic goods declined by more than one-half.

In this period, we can observe that the relative volume effect of imported inputs was higher (0.39 p.p.) and accounted for the larger portion of the inflation rate. The relative price effect contributed 0.15 p.p. per year, and the relative volume effect of domestic intermediate consumption was practically null. The first three effects present in Table 2 are quite distinct in nature, and it is difficult to group them through some common element. The only thing that can be said is that the three are associated with the change in the technical coefficients of production. In 2001–2003, these three effects together accounted for 0.8% of inflation in Brazil, or 0.11% per year. In 2004–2005, they accounted for 3.3% of the entire inflation rate, or 0.24 percentage points per year. In 2006–2009, they accounted for 8.8% of the price dynamics, with a contribution of 0.53 p.p. per year. Thus, if we group these three effects, although they are of such a distinct nature, we note that the change in technical coefficients began to press production costs more intensely throughout the decade.

Taxation contributed 0.36 p.p. per year to the Brazilian inflation rate and was the variable that presented greater stability throughout the period. Although its three effects vary a little more throughout the phases, the relative importance of the total associated with the taxation has oscillated little, being different from all of the other elements.

Following a process initiated in the previous phase, the price effect of imported intermediate consumption continued to fall and reached the lowest contribution of the whole period, only 0.05 p.p. per year. The combined effect of exchange rates and international prices was 0.79 p.p. per year, representing not only the lowest phase of the three but also the lowest percentage of the inflation rate. In this four-year period, the price effect of imported inputs and the price variation of the final internationally priced goods

[20] This difference corresponds to more than two-fifths of the entire deceleration of the average inflation rate between 2001–2003 and 2004–2005.

[21] Although in the years 2001–2003, the average wage effect added to the productivity effect explained 23% of the total inflation of 13.27% per year in 2004–2005, these combined effects went on to explain 34.2% of the inflation of 7.4% per year.

together account for just over one-eighth of all Brazilian inflation. In the phase of exchange rate devaluation (2001–2003), these added effects accounted for more than one-quarter of the total[22]. Even with the reversal of the commodity price trajectory compared with the beginning of the decade, the real price of these goods grew at lower rates, reinforcing the importance of exchange rate appreciation as a central instrument in containing Brazilian inflation.

The effect associated with the growth of the average salary reached its highest contribution for the whole period, 3.09 p.p. per year. A new result for the 2006–2009 series is that productivity finally showed positive growth, containing the rise of ULC. The productivity effect contributed to inflation being 0.25 p.p. lower. This result is especially important because it made the ULC effect smaller than that observed in 2001–2003. Even with a higher average nominal wage growth, the favorable evolution of labor productivity has eased the pressure on production costs. As the rate of inflation continued to decline, the relative importance of this effect rose again[23].

As a counterpoint, the pressure exerted by the increase in profit margins was the lowest in the series, with an average contribution of 1.55 p.p. per year. Even considering relative importance[24], the relevance of the profit margin effect has narrowed over the decade.

Therefore, in 2006–2009, the fall in the inflation rate was associated with the maintenance of the nominal appreciation of the exchange rate and the reduction of the effect associated with the profit margins. The pressure exerted by the ULC increased and began to explain a larger portion of the inflationary dynamics. Associated with the change in the behavior of the distributive variables, and thus of the effects controlling the behavior of the inflation rate, we also noticed a change of composition in the sectors that presented the ten largest contributions to the Brazilian inflation rate.

Table 3 – Top Ten Contributions to Inflation Rate in Sub-period by Activity

2001–2003	2004–2005	2006–2009
Trade	Trade	Trade
Food and Beverages	Food and Beverages	Food and Beverages
Financial Intermediation and Insurance	Transport, Storage and Mail	Construction
Transport, Storage and Mail	Information Services	Transport, Storage and Mail
Oil and Coke Refining	Oil and Coke Refining	Business services
Agriculture and Forestry	Construction	Real Estate Services and Rental
Construction	Manufacture of steel and its derivatives	Agriculture and Forestry
Electricity and Gas, Water, Sewage and Urban Cleaning	Oil and Natural Gas	Accommodation and Food Services
Business services	Electricity and Gas, Water, Sewage and Urban Cleaning	Information Services
Manufacture of steel and its derivatives	Financial Intermediation and Insurance	Other services

Source: SNA/IBGE and Neves (2013). Self-elaboration

[22] The increase in goods that follow an international reference price, both as final goods and through imported intermediate consumption, accounted for 27.7% of the inflation rate in 2001–2003 (or 3.68 p.p. per year), 17.5% % in 2004–2005 (or 1.3 percentage points per year) and 13.1% in 2006–2009 (or 0.79 percentage points per year).

[23] The ULC accounted for 23% of all Brazilian inflation in 2001–2003 (or 3.05 percentage points per year), 34.2% in 2004–2005 (or 2.53 percentage points per year) and 47.5% in 2006–2009 (or 2.85 percentage points per year). The relative importance of wage inflation doubles in the last sub-period when compared with the first. This result is compatible with that observed by Summa and Braga (2013). As of 2006, the process of wage inflation intensifies in the Brazilian economy.

[24] The effect of profit margins accounted for 35.1% of the inflation rate in 2001–2003 (or 4.66 percentage points per year), 38.9% in 2004–2005 (or 2.88 percentage points per year), and 25.9% in 2006–2009 (or 1.55 percentage points per year).

In the last sub-period, seven of the ten largest contributions were from activities belonging to the service sector, whereas in the previous two phases, only three contributions came from the sector. The greater change in the composition of the list of the ten largest contributions in 2004–2005 to 2006–2009 compared with the one observed between 2001–2003 and 2004–2005 suggests that the behavior change of the distributive variables and the contribution of each of the effects to the rate is directly associated with the relative price change in the Brazilian economy.

Particular attention should be focused on the entry of the "Other services" activity in the top-ten list. This activity in the Input-Output Transactions Table, released annually, is divided into "Services provided to families" and "Domestic services". These activities are known to be influenced by the behavior of the unit labor cost and associated with low productivity growth, that is, the evolution of its price is directly associated with the behavior of the nominal wage.

Beyond the period of analysis of this work, from 2010 to 2014, the Brazilian economy began to live with higher wage inflation, which materialized in higher inflation in the services sector (Braga and Summa, 2013). This point suggests that the sector's share of the top ten contributions to the inflation rate might have increased further and/or the magnitude of its contributions might have increased. Perhaps the symbolic sector of this process, "Other services", continued to rise in the list of major contributions to the inflation rate.

V – Decomposition of the Margins of Profit of Goods with International Prices

As already discussed, although for domestic price goods, cost evolution is crucial to determining price dynamics, for goods with an international price, the evolution of costs is paramount in determining profit margins. Table 4 shows the contribution that each of the effects had on the profit margin of the goods that follow an international reference price over the last decade, dividing the full term into three sub-periods. All effects with a positive sign contributed to the increase of the margins, whereas all of the effects with a negative sign contributed to the reduction of them. Thus, the effects that raised the cost of production appear with a negative sign. An important difference in relation to the decomposition of the inflation rate shown in Table 2 is that in the decomposition of profit margins, the effects include only their direct influence; the indirect dimension is not contemplated. In fact, the intermediate consumption effect absorbs all of the effect that the increase of the costs in the previous stages of the productive chain exerted. All of the increases in inputs due, for example, to the increase in imports, tax changes or expansion of the ULC in the previous stages of the production process are within the intermediate consumption effect.

The combined variation of the international price (P*) and the nominal exchange rate (e) determines the evolution of the domestic price. The price variation in the domestic market (e.P*) also contributes to the increase in profit margins. Because price dynamics are not determined by production costs, we can say that the higher the price in the domestic market, the higher are the margins. As seen in table 4, the positive price variation over the whole period 2001–2009 has made a positive contribution to the increase in profit margins in the three sub-periods.

Based on table 4, we can develop findings. The first is that by encompassing all previous stages of the production process, the main effect of production costs is always the intermediate consumption effect. The evolution of the margins is positive in the first two sub-periods. They grew, on average, 20.04% p.y. in the first triennium and 12.87% p.y. in 2004–2005. In 2006–2009, profit margins fell, on average, by 1.67% per year. The deceleration in inflation of goods with an international price from 18.1% to 11.6% and then 6.9% per year was decisive for this result because production costs pushed profit margins less and less throughout the decade. This situation can also be observed through the contribution of the price change to the evolution of the margins, from 168.12 p.p. in 2001–2003 to 77.29 p.p. in 2004–2005 and 61.4 p.p. in 2006–2009.

Table 4 – Average Contributions to the Evolution of Profit Margins of Goods with International Prices

	2001–2003	2004–2005	2006–2009
Intermediate Consumption Effect	-113.97	-35.45	-41.27
Domestic inputs – effect of relative prices	-6.88	-11.65	-3.73
Domestic inputs – relative volume effect	3.58	-3.98	-0.05
Imported inputs – relative volume effect	0.95	1.73	-1.36
Imported inputs – price effect	-11.90	-0.37	-1.57
Taxes on products – relative volume effect	-0.38	0.70	0.48
Taxes on products – price effect	-5.04	-2.67	-2.45
Other Taxes and Subsidies	-1.73	-0.77	-1.00
Subtotal of Taxes	-7.15	-2.74	-2.96
Average salary	-8.39	-6.39	-9.50
Labor Productivity	-1.48	-3.72	-1.30
Unitary Labor Cost	-9.87	-10.10	-10.80
Mixed Income	-0.52	-0.04	-0.11
Interaction Terms	-2.31	-1.80	-1.22
Total Production Costs	-148.08	-64.42	-63.07
Contribution of Price Variation	168.12	77.29	61.40
Change in Profit Margins	20.04	12.87	-1.67

Source: SNA/IBGE and Neves (2013). Self-elaboration

The evolution of the unit labor cost increasingly pushed profit margins over the period. The influence of the average wage effect was increasing, resulting from the growth of the nominal wage progressively accelerated in the sectors producing goods with international price. Labor productivity in these sectors fell in the three sub-periods, pushing the margins. However, the smaller decline in the last four years mitigated its negative effect, partially offsetting the effects of faster wage growth. The influence of labor cost expansion in the previous stages of the production chain is present in the intermediate consumption effect.

The price effect of the imported intermediate inputs exerted a lower pressure on margins in the last two sub-periods than in the first one, a result similar to that observed for goods with domestic prices, even with the important difference being only the direct effect. This result is associated with the influence on the cost of production of the exchange rate and the international quotation.

In general, the distributive variables that caused the increase in costs, and their effect on the price dynamics and on profit margins, showed a very similar behavior during the decade in the two large groups into which the Brazilian economy was divided in this work.

CONCLUSION

Brazilian inflation presented very heterogeneous behavior over the period 2001–2009. The heterogeneity was expressed not only in the difference between the rates observed at the beginning of the decade and those at the end but also by the factors responsible for the increase in the price level.

The structural decomposition executed in this work reached its objectives of separating and demonstrating the influence of each element present in the cost of production and of estimating the magnitude of each of them on the Brazilian inflationary dynamics. In addition to evaluating the behavior of cost variables, it was possible to analyze the behavior of profit margins for goods that follow an international reference value.

From the results of the structural decomposition, we noticed that in the years 2001–2003, the increase in the price of goods with international prices significantly affected production costs. Even with the mild behavior of commodities in the international scenario, the nominal exchange rate devaluation raised Brazilian inflation. Wage earners, trying to regain their purchasing power by raising nominal wages in a context of falling labor productivity, have raised the unit labor cost, which has further pressured production costs.

In 2004–2005, the behavior of several variables began to change. First, the inflation rate declined, as did the influence of commodities, even in a scenario of faster growth in international prices. This growth was the beginning of an expressive process of appreciation of the nominal exchange rate. Additionally, the attempt to recompose the profit margins began to place pressure on the price level. The unit labor cost reduced its contribution to the inflation rate. However, because the fall in the inflation rate was higher, the relative importance of the unit labor cost to explain Brazilian inflation increased.

In the years 2006–2009, a series of results started in 2004–2005 intensified. The rate of inflation fell again, and the price of goods with international prices in Brazilian currency had an even smoother trajectory than in the previous phase. Again, this result was only possible due to the nominal appreciation of the exchange rate, because commodity prices continued to increase in the world economy. The contribution promoted by the attempt to recompose the nominal profit margins was the lowest of all three phases and helped reduce Brazilian inflation. Although labor productivity moderated the evolution of the unit labor cost, it started to contribute more to the rate of inflation. As inflation fell again, the relative importance of unit labor cost increased again. For the first time, there was a drop in profit margins in sectors with international prices.

As complementary elements, we can highlight the relative importance of taxation, which remained stable throughout the decade, and the behavior of the technical coefficients, which contained the inflation rate in the first years and started to pressure production costs at the end of the period.

In other words, the reversal of the behavior of nominal profit margins, coupled with the smoothing of the trajectory of commodities in domestic currency and productivity growth in the last phase, was sufficiently strong to contain nominal wage growth and the production costs associated with productive techniques in operation in Brazil, reducing Brazilian inflation to less than one-half of that observed for the first three years of the series. The smoothing of the behavior of internationally priced goods draws particular attention to the fact that this period became known as the super cycle of commodities in the world economy, reinforcing the importance of the exchange rate in explaining Brazilian inflation in this period.

Directly associated with the change in the behavior of the distributive variables is the change in the composition of the main contributions to the Brazilian inflation rate by activity. Although in the years 2001–2003 and 2004–2005, the services sector had only three activities among the ten largest contributions, in the period 2006–2009, seven of the ten largest contributions belonged to the sector. This result is a consequence of the increasing importance of the unit labor cost in explaining Brazilian inflation.

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