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EconomiA 18 (2017) 60–72
ECONOMIA
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Industrial pricing in Brazil in the 2010s: The pass-through effect

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Received 12 May 2016; received in revised form 10 October 2016; accepted 12 December 2016
Available online 21 December 2016

Abstract

The aim of this paper is to discuss the impact of costs on industrial inflation in Brazil. Assuming that inflation is mainly cost-push, this paper estimates the exchange rate pass-through on industrial prices. Based on Kalecki's price equation, the paper explores data from the producer price index from 2010 onward. One of the main findings is that more than 60% of the inflationary acceleration in the industrial prices can be explained by exchange rate devaluations. The econometric exercise also showed that when demand increases, even if labor unit costs do not change, firms increase their profit margin. Finally, the paper questions the effectiveness of the inflation targeting policy, when the diagnosis to the pressure on prices comes from the costs, and not from demand.
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JEL classifications: L 16; E 64

Keywords: Exchange rate pass-through; Industrial pricing; Cost inflation

Resumo

O objetivo deste artigo é discutir o impacto dos custos na inflação industrial no Brasil. Assumindo que a pressão de custos é mais importante para explicar o processo inflacionário, este artigo estima o efeito pass-through do câmbio para os preços industriais. Baseado na equação de preço de Kalecki, o artigo explora dados do índice de preços ao produtor a partir de 2010 e conclui que as desvalorizações do câmbio explicaram mais de 60% da variação do preço industrial no período. O exercício econométrico também mostrou que frente a um aumento da demanda, mesmo com queda no custo unitário do trabalho, as firmas aumentaram sua margem de lucro. Por fim, o artigo questiona a eficácia do regime de metas de inflação, quando o diagnóstico para a pressão sobre os preços advém dos custos, e não da demanda.
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Palavras-chave: pass-through do câmbio; preço industrial; inflação de custos

1. Introduction

The resilience of the inflation rates to decrease in 2015 has been shedding some doubts on the effectiveness of the inflation target regime in Brazil to deliver, mainly after the international financial crisis. Actually, looking in retrospect,

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one can argue that inflation targeting has been showing a poor result since its implementation in 1999 after the adoption of the flexible exchange rate regime. Indeed, in sixteen years the center of the target rate has been reached only in four (2000, 2006, 2007 and 2009), and Brazil still exhibits one of the highest interest rates in the world.[1]

In the conventional literature, inflation target and flexible exchange rate regime are seen as powerful mechanism in the administration of aggregate demand and price control. Inflation target regime, on one hand, should allow the reduction of inflation through the anticipation of any future inflationary pressures. Once inflation is stabilized, long-term growth rates should improve and expand potential output. Flexible exchange rate regime, on its turn, should overcome the well known 'impossible trinity' or 'trilemma' of economic policy, giving independence to the monetary policy. Under these assumptions, monetary policy is taken as the main instrument of macroeconomic policy, and fiscal policy loses its role as a powerful macroeconomic instrument. Actually, in this framework, fiscal policy should align with monetary policy (Arestis et al., 2009).[2] Recent evaluations on macroeconomic performance of developing economies that are financially integrated (see, for instance, Ocampo and Stiglitz, 2008), however, have shown that monetary policy independence is much constrained given the high volatility and pro-cyclical pattern of capital flows, and as a result, business cycles are much stronger in these economies, reducing their long-term growth rate.[3]

In this paper we will assume, following the Keynes–Kalecki literature on pricing,[4] that inflationary pressures in Brazil are mainly cost-push rather than demand-pull, as assumed in the inflation targeting literature.[5] In particular, we will be interested in investigating the impact of the nominal exchange rate on industrial inflation, that is to say, the pass-through effect on industrial prices.[6] Nominal exchange rate pressures can affect industrial prices in a direct and in an indirect way. In the first case, exchange rate variation has a direct impact on industrial prices via commodities. In the second case, the impact is via the price of traded goods and services, including the price of traded inputs used in nontraded goods. Therefore, the aim of this paper is to explain industrial inflation through the behavior of industrial costs. There is little literature on this topic, and this paper will exploit recently available statistics on producer industrial prices by the Brazilian Statistical Office.

In other to develop our arguments this paper is divided in three more sections. In the following section we briefly present the theoretical model based on Kalecki of price determination. In Section 3 we present our econometric model and results explaining the price behavior of manufacturing industry in the 2010–2015 period. A final section presents our conclusions.

2. A general approach to inflation

Inflation, in a generic definition, is a process of widespread and permanent increase in the general price level. Among its many causes, three sort of pressures can be identified: expectational inflation, demand inflation and cost inflation (Carvalho et al., 2007). Formally, the inflation rate can be expressed as:

$$\pi_t = \pi^e - \varphi\,(\mu - \mu_n) + \varepsilon \tag{1}$$

Where π_t is inflation rate in time t; π^e is the expectational component and $\phi(\mu - \mu_n)$ represents the demand-push component, where $\mu - \mu_n$ represents the full employment gap, μ measures the unemployment rate and μ_n the natural rate of unemployment and finally ε stands for the cost component.

[1] There is a large literature discussing the effectiveness of inflation targeting in Brazil. See, for instance, Arestis et al. (2009), Bresser-Pereira and Gomes (2010), Barbosa (2015), among many others.

[2] According to the authors when explaining inflation target regime (p. 4), "indeed, monetary policy is viewed as the most direct determinant of inflation, so much so that in the long run the inflation rate is the only macroeconomic variable that monetary policy can affect. Monetary policy cannot affect economic activity, for example output, employment etc., in the long run."

[3] Weeks (2013, p. 66) argues that 'With a fixed exchange rate, governments face the Trilemma; with a flexible exchange rate it can become a Dilemma'.

[4] Keynes (1936, chapter 21) argues that prices are function of costs. Kalecki (1956) presents a mark-up pricing model. See also Sylos-Labini (1969), Eichner (1976), Davidson (1978), among others.

[5] Kregel (2004, p. XXX) At the same time, high interest rates may have a direct impact on inflation, and in countries that use inflation targeting may create a second self-perpetuating cycle by which high interest rates that are used to create foreign investor confidence generate cost inflation, and then through low investment produce supply shortages, and thus demand imbalance.

[6] There are few studies about the pass through effect in Brazil. For an estimation of the exchange rate elaticity of the consumer in Brazil in the period 1980–2003, see for instance Mántey (2006).

The expectational component captures the ability of economic agents to influence the value of the inflation rate today (t) through the past and/or future values of the same variable. In case the inflation rate (t) is affected by its past values it implies the existence of a kind inertia in the inflationary process. The second category is related to the idea of pressures on the demand side, that is, the fact that the economy is working at full employment (or very close to it) in such a way that any rise in aggregate demand level translates into increases in the general price level.[7] The third category is related to the restrictions imposed on the supply side (cost inflation). This is of special interest in this paper, as our concern is to discuss how changes in industrial costs affect industrial inflation, in particular the role of exchange rate.

2.1. Kaleckian pricing model and post Keynesian assumptions

Conventional literature, based on the New Macroeconomic Consensus (NMC), assumes that inflation is a monetary phenomenon. From this assumption it follows that inflation can be controlled with the manipulation of the interest rate.[8] In the Keynes and Kalecki tradition, on the other hand, it is assumed that prices are also determined by costs, and so, when short-term interest rate rises, besides cooling off aggregate demand, it also raises the relative prices of goods in which interest payments are an especially important 'ingredient' (Hannsgen, 2006). Moreover, in developing economies financially integrated, we should also consider that the movements in the interest rate affect capital flow (which tend to be volatile and pro-cyclical), with significant impact on the exchange rate.[9] Therefore, monetary policy following the NMC is not distributional neutral on the supply side, because movements in the interest rate and in the exchange rate change the distribution of income among those whose incomes are affected by these macroeconomic prices. For instance, highly indebted firms (in domestic or in foreign currency) or high technological firms that depend more on imported inputs will be hit more severely than others by interest rate increases and exchange rate devaluations, affecting their expenditures decisions. In both cases the rise of interest rate aiming at fighting inflation can lead not only to price increases, via impact on production costs, but, most important, it can also change the composition and the amount of aggregate output. To put it in other words, monetary policy, according to the Keynes–Kalecki literature, has permanent effects on the real side of the economy through its impact on pricing decisions of firms.

Kalecki (1956) presents a pricing model identifying two sectors in the economy.[10] One sector is described as a competitive sector, essentially agriculture and commodity producers, in which prices are determined by supply and demand as in the conventional microeconomic pricing model under competition. The other sector, which is the dominant in industrial economies, is named cost determined price sector, basically manufacturing and services sectors. In the cost determined price sector, prices are set according to a stable mark-up over average variable costs. Prices are, thus, administered on the basis of some expected normal rate of capacity utilization.[11] This mark-up over costs, given an expected capacity utilization, should be sufficient to cover fixed costs and other discretionary expenditures.[12] It is also assumed that in each market, the price leaders set their prices to yield their target-profits. The other firms should follow the price leaders and the size of their profits will depend on their average costs. It should be remarked that interest is a cost and must be passed on if firms are to achieve their profit targets to finance their discretionary expenditures.

In the post Keynesian literature, the cost determined price sector is assumed to operate under oligopolistic competition and, in this case, when markets are functioning under full capacity, a change in demand shall impact production, and not prices. However, given the market power of the firms, they may decide that when demand changes, price may change accordingly to their strategy of capital accumulation in the long run. In this case, by assumption, there will be

[7] The demand inflation occurs when the [full] employment gap is no longer positive. At this stage, government spending increases, investment or consumption cause inflation, *cet.par.* (Sicsu, 2003, p. 126).

[8] See, for instance, Arestis (2009) for a critical presentation of the NCM model.

[9] For a discussion about the link among the monetary policy, the exchange rate regime and the capital account convertibility in the BRIC economies, see de Paula and Ferrari-Filho (2010). For a discussion about monetary policy in Brazil see, among others, Carvalho (2005).

[10] See also López and Assous (2010), chapter 4.

[11] It is assumed that firms operate with excess capacity because, according to Steindl (1952), firms respond to the increase in demand increasing investment in capacity aiming at keeping the 'optimal' rate of capacity utilization as a strategy to deter entry and obtain 'super' normal profits in oligopolistic markets. For a discussion about practical measures of capacity utilization, see Feijo (2006).

[12] See, for instance, Feijo (1993). It is assumed that mark-ups are chosen to produce a level of retained profits, after depreciation, interest, and dividend payments, sufficient to provide for the required internal finance as dictated by planned investment expenditure. For an empirical discussion on mark-up pricing in Brazil in the 1990s see Feijo and Cerqueira (2010, 2013).

no automatic mechanism linking price changes due to changes in demand. Under the same token, changes in costs may not be fully passed on prices. Although prices depend on costs, it is assumed that there is no automatic transmission mechanism in costs to prices, either. This means to say that prices depend on the mark-up (a strategic decision), as well as on costs.[13] According to Davidson (1978), the concept of cost that matters is the 'normal' cost, defined as the one that is considered under the assumption of a 'normal' level of capacity utilization. Temporary changes in costs or in demand do not influence prices, and the level of demand determines the level of production, under full capacity.

Therefore, post Keynesian literature emphasizes that mark-ups should be understood as a strategic variable to the firms, and so prices are determined by production, and not by demand. Costs, on the other hand, are the second major determinant of prices. Prices, in this sense, cannot be treated as functions of the resource allocation and income distribution process only, they must also be related to: (a) the need to generate funds that will make the capital accumulation process possible, (b) make payments of debts feasible, (c) induce and partly finance investments and (d) make the acceptance of new financial obligations possible.

Formally, Kalecki (1956) presents his pricing equation for industrial firms as follows:

$$p = mc + np_m \quad n < 1 \tag{2}$$

Where: p = price, c = unit cost, p_m = average price in the industry, and m and n express the pricing policy followed by the firm.

The mark-up pricing model as described allows us to observe two situations. Let us assume an increase in unit costs (c). In this case, if nothing else changes, prices will move accordingly. Now, let us assume that demand increases. In this case, as the firm operates below full capacity, it can either maintain its level of capacity utilization and increase its prices ($p > np_m$) or it can increase the degree of capacity utilization without raising prices ($p < np_m$.). The firm's choice will depend on the firm's strategy to keep its market-share in the medium and long-term. When the firm increases its price in excess to the average price (p_m), it risks losing market-share; in the opposite case it might increase its profits if demand for its products increase, compensating higher production costs. It follows that the overall result on the aggregate industrial price level of an increase in costs and/or in demand, depends on how firms react adjusting their capacity utilization and eventually their mark-ups. In any case, the reaction will depend on how they perceive the macroeconomic context and the future evolution of their markets.

In sum, a practical conclusion of this brief exposition is that according to the Keynes–Kalecki literature, the inflationary process has multiple causes, and therefore the fighting inflation should rely on as many policy instruments as needed to address each specific source of inflationary pressure. Or to put in other words, it matters to identify the correct inflationary pressures, and the policy 'one solution fits all', as envisage in the inflation target regime, might not be the most appropriate one.

3. The econometric estimation

In this section we will present our econometric estimation to show how industrial costs and demand affect industrial prices; that is our contribution to the better understanding of the current inflationary process in Brazil.

A first exploratory analysis shows that a close relationship between industrial inflation and exchange rate path could be observed in Brazil since, at least, 2009[14] and the recent evidence reinforces the perception that exchange rate pass-through has been a key variable in determining the industrial inflation. In 2015, the manufacturing industrial prices increased 9.5% while the domestic currency devaluated in more than 46% — the inflation rate remained adherent to the exchange rate path despite the strong increase in the basic interest rate (22.2%) and the slowdown in industrial activity (−12,2%) at the same period.

Fig. 1 shows the evolution of the official inflation index (IPCA), the industrial producer price index (PPI) and the real industrial output. In this comparison, a first observation is that it is clear that industrial prices run below the consumer price index most of the period. This is an expected result of the inflation targeting policy, because the increases in the interest rate tend to appreciate the real exchange rate[15] that impacts demand for tradables, on one hand and exports, on

[13] As presented by Sylos-Labini (1969), the price equation can be written as: $p = v + qv$, where p is the unit price, v represents direct operational costs, and qv represents the overhead (over a standard production volume) and an acceptable profit margin per product unit.

[14] The series for industrial producer price index are available from December 2009 onwards (IBGE, 2011).

[15] For a recent discussion on the trend to overvaluation of the real exchange rate, see Nassif et al. (2015).

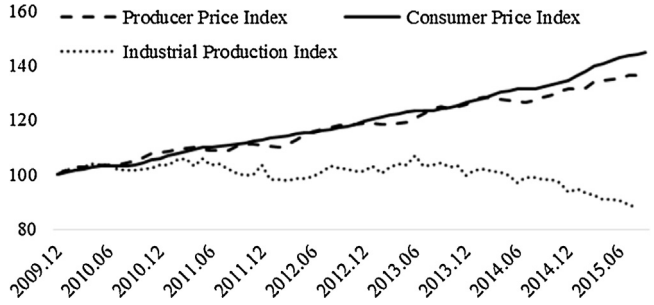

Fig. 1. Inflation, industrial producer price and industrial production (December 2009 = 100).
Source: Brazilian Statistical Office (IBGE, 2016b), Monthly Surveys of the Consumer Price Index (IPCA), Industrial Producer Price Index (PPI) and Industrial Physical Production for the Industry.

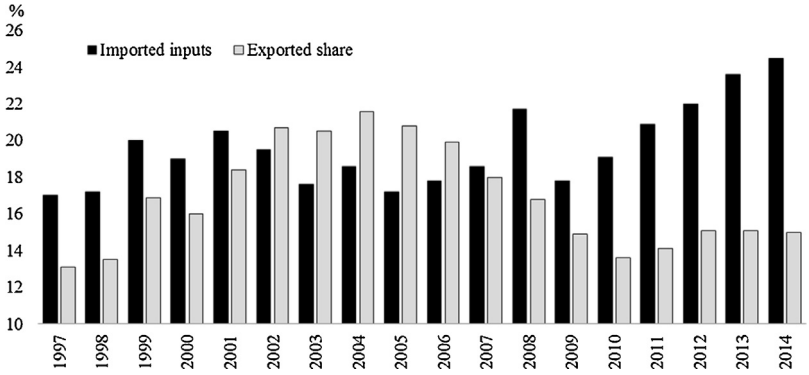

Fig. 2. Share of imported inputs in total industrial inputs and export share of total manufacturing output (%): 1997–2014.
Source: National Industrial Confederation (CNI, 2016a).

the other. In the first case, the domestic market for manufacturing products tend to be reduced, and in the second case, manufacturing exports lose competitiveness. The other observation is that the deceleration in industrial prices is more intense from mid-2013 on, when industrial output decreases steadily. The real exchange rate, on its turn, reverted its appreciation trend, impacting negatively the cost of imported inputs. The recent performance of industrial output can be seen as a perverted combination of decreasing domestic demand, an increase in costs, and an external context of constrained external trade.[16]

The impact of the exchange rate changes on industrial prices can also be seen by the increase in the weight of imported inputs on total inputs consumed by manufacturing industry. Fig. 2 reveals the increasing dependence of the Brazilian manufacturing industry on imported inputs and also the loss of dynamism of exported manufacturing goods after the international financial crisis. The evolution of both statistics suggests that exchange rate devaluations might have a bigger impact on industrial costs than immediate benefits on exports.

When we focus the analysis in the sectorial contributions for the aggregate industrial price index, it should be remarked that around 60% of the index variation in 2105 was due to higher prices of only four of the 23 investigated industrial activities (IBGE, 2016a, p. 8). Fig. 3 shows how the prices of these activities closely followed the exchange rate over time.

The evolution of the prices of at least three of the main activities that influenced the industrial inflation in 2015 has significant adhesion to the exchange rate (‘Food’; ‘Paper and Cellulose’ and ‘Other Transports Equipment’). In this

[16] Several authors have called attention to the recent deepening of the deindustrialization process of the Brazilian industry, due in a great extent to the overvaluation trend of the real exchange rate since price stabilization. The long overvaluation period of the domestic currency reduces domestic market for domestic firms, even for the most efficient ones, and increases the degree of specialization (in opposition to increase in diversification) of the industrial structure. See, for instance, Bresser-Pereira (2008), Oreiro and Feijo (2010), Feijo and Lamônica (2012), among others.

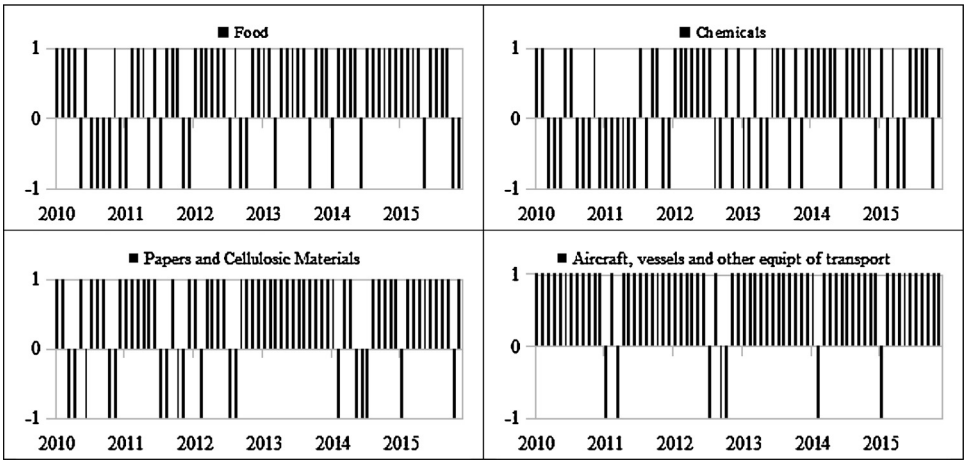

Fig. 3. Relation between exchange rate and sectorial prices.
Note: The series has a value equal to 1 when the exchange rate in the month has the same sign of change in industry prices; otherwise the value of the series in the month is equal to −1. Series not seasonally adjusted.
Source: See Table A1, in the Appendix.

sense, the contribution of 'Other Transports Equipment' is remarkable, although this sector having a reduced weight in determining the overall index (less than 2.7%), it alone responds for the fourth largest contribution to inflation of manufacturing industry in that year. Not surprisingly, the changes in the prices of this sector rarely have deviated from the signals of the changes in exchange rate over time.

3.1. The econometric model

Specifically, in order to investigate the relation between industrial costs and industrial prices, we use the following statistical series, all of them referring to the manufacturing industry: the variation of the producer price index (*ppi*), the variation in unit labor cost (*ucl*) and the variation in the level of capacity utilization (*u*). In addition, we use a series of nominal exchange rate (*exc*) and the variation of the Brazilian basic interest rate (*selic*). We use monthly data from January 2010 to October 2015 seasonally adjusted by the X13-Arima software (US Census Bureau, 2015). Fig. 4 displays the series that are used in the econometric estimation.

In order to check the interdependence and the dynamic relationship between the selected variables, we estimate a VAR structural model (SVAR) with *ppi*, *ucl*, *exc*, *u* and *selic* as endogenous variables. Unit root tests (ADF-GLS and KPSS) were performed, indicating that all series are stationary with statistical significance of at least 10% (the test statistics are in the Appendix A).

The VAR lag order was determined based on Akaike, Schwarz and Hannan–Quinn information criteria and on error final prediction for models with maximal lag length of seven and including a deterministic constant. All the criteria indicate a VAR specification with only one lag and Breusch–Godfrey tests (Edgerton and Shukur, 1999) do not reject (at the 1% significance level) the absence of residual autocorrelation up to the 11th lag. All the roots of the characteristic polynomial of the VAR (1) lie inside the unit circle.

In the estimation of contemporaneous impacts of the endogenous variables, it was imposed ad hoc restrictions on matrices *A* and *B* of a SVAR model as below:

$$Ay_t = C_{t-1}y_{t-1} + \cdots + C_{t-p}y_{t-p} + D_t d_t + B\varepsilon_t \tag{3}$$

Where:

y_{t-p} is a vector of the endogenous variables in the period $t-p$;
A is the matrix of contemporaneous relations between endogenous variables;
C_{t-p} is the matrix of the lagged coefficients $t-p$;
D_t is the matrix of the coefficients of deterministic terms (d_t); and

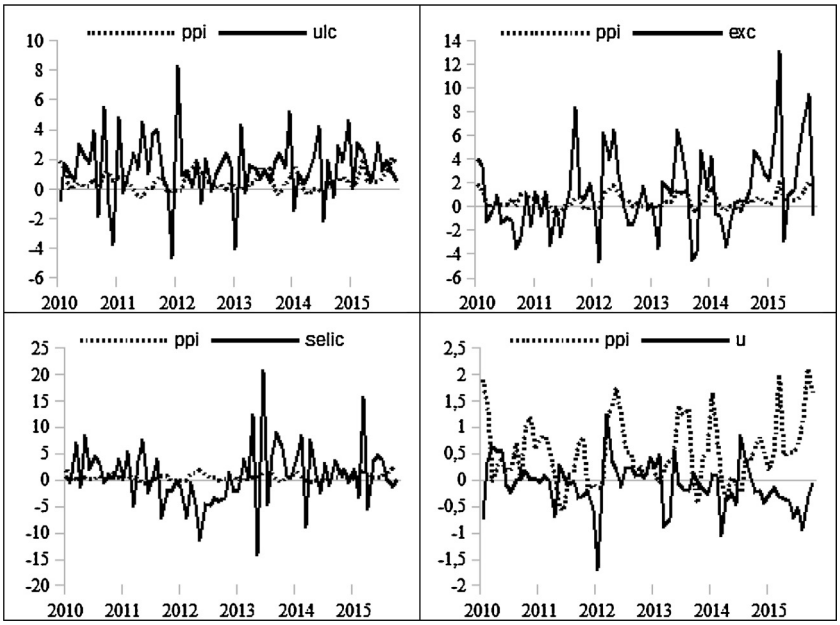

Fig. 4. Series used in the empirical investigation.
Source: See Table A1, in the Appendix.

Table 1
Matrix *A*.

	ppi	*ulc*	*exc*	*selic*	*u*
ppi	1	−0.028 −0.023	−0.11 −0.013	−0.002 −0.007	−0.148 −0.098
ulc	0	1	0	0	0.5601 −0.518
exc	0	0	1	−0.031 −0.071	0
selic	0	0	0	1	0
u	0	0	0	0	1

Note: The LR over-identification test does not reject the restrictions imposed upon matrix *A*.

B is the diagonal matrix of the coefficients of the structural shocks (ε_t).

The ordering of contemporaneous shocks and the restrictions imposed upon matrix *A* respected the principles of economic theory and the estimated coefficients are shown in Table 1 (standard errors in brackets).

The identification proposal (Table 1) admits that *u* and *selic* are not contemporaneously affected by shocks in the other variables. In the first case, it is understood that firms plan the level of capacity utilization in month *t* based on information about prices and costs relatively to previous months.[17] In the second case, it is assumed that the Monetary Authority has no information about unpublished statistics in period *t*, therefore the basic interest rate is controlled by means of daily open market interventions throughout the month — following a Taylor rule that could be estimated only with basis on lagged values of the other variables (or projections based on them).

Since the variation in unit labor cost (*ucl*) is calculated based on the variation of the index of industrial production, the level of capacity utilization (*u*) affects contemporaneously that variable. The wage adjustment in Brazil is largely

[17] The expected unit labor costs for the month *t* can be calculated by firms according to their own expected capacity utilization and based on wages levels previously signed in the labour contracts (in Brazil, wages have a certain rigidity due to the frequency of adjustments negotiated by unions).

done on a specific annual date ('data-base'), based on the accumulated inflation in past twelve months. Therefore, we assume that the wage level does not respond immediately to changes in prices in the current month; it means that *ppi*, *exc* (which affects the price of imported goods) and *selic* (instrument of monetary policy and financial cost indicator at month *t*) do not affect contemporaneously the unit labor costs.[18]

We also assume that the variation in the exchange rate (*exc)* suffers contemporaneous impact of the basic interest rate: in the context of free capital movement, the exchange rate varies throughout the month in response to the capital flows, which in its turn, varies following the daily change in the remuneration of the referenced financial assets based on the *selic*.

Finally, it is assumed that *ppi* responds to contemporaneous shocks in all the other variables. Assuming a mark-up rule, the change in unit labor costs, in the cost of financing (measured by *selic*) and imported input prices (measured by *exc*) are transferred to prices in the current month.[19] The contemporaneous impact of *u* on *ppi*, in turn, is justified by demand pressures, that is to say, the variation in the output gap in *t* reflects the entrepreneurial expectations for demand in the current period.[20]

Based on the structural model, we calculated the impulse response functions (IRFs) and the forecast error variance decomposition (FEVD) that allow inferences about the behavior of industrial inflation caused by costs pressures and demand shocks. The results are shown in Fig. A1 and Table A3 in the Appendix A.

3.2. Results: the dynamics of the industrial inflation

The innovation account analysis (IFRs and FEVD) reinforces the results of the estimated coefficients of the matrix *A*, and confirms that *ppi* is positively impacted by all variables tested. More than that, it indicates the exchange rate pass-through as the most important variable to explain the forecast error of industrial inflation.[21]

The response of *ppi* to a shock of one unit change in *exc* is expressively higher than to a shock on the other variables (0.36 pp in t_0), and the FEVD indicates that more than 60% of the inflationary acceleration can be explained by exchange rate devaluations. After the contemporaneous shock, the positive response of inflation to the exchange rate continues up to the fourth month, which is an indication that the immediate change in the prices of goods traded in international currency is reinforced a posteriori by the impact of exchange rate devaluation over the cost of imported inputs.[22]

According the FEVD analysis, the importance of the other variables in explaining the industrial inflation dynamics is not as strong as found for exchange rate. However, the estimated IRFs have the expected signals.

The IRF shows that an increase in *ulc* has a positive effect in *ppi* that tends to stability after four periods, confirming the hypothesis that industrial prices are formed by applying a margin over unit costs.

Another interesting finding of our econometric exercise is that the *ppi* response facing a shock in the interest rate can be seen as a further evidence of the mark-up hypothesis, once the immediate acceleration observed in inflation rate can be understood as response to rising financing costs of firms. This positive impact of *selic* over prices is only reversed from the first period after the contemporaneous shock. According to Modenesi and Araujo (2013), who found similar results for the Brazilian economy, the reversion in IRF signal is related to the contractionary effects of higher interest rates on economic activity.[23]

[18] Such specification implies that the wage level varies faster in face of changes in labor demand than in face of inflationary pressures, which is compatible with the observed seasonal pattern of this series.

[19] The exchange rate pass-through also occurs immediately, in month *t*, for those products priced in foreign currency.

[20] Demand pressures also justifies the contemporaneous impact on prices of the basic interest rate used as inflationary control instrument by the monetary authority.

[21] It is worth quoting the conclusions of López et al. (2012, p. 652) about the exchange rate pass-through in the case of Mexico, which goes in the same direction that our findings: "It has been argued that in a semi-industrialized economy, local currency depreciation has a large inflationary effect because domestic firms' market power is entrenched in imported capital goods; and because this inflationary response induces tight credit policies that raise interest rates".

[22] In the questionnaire of the survey for the construction of the industrial price index it is allowed that firms inform the product price in the foreign currency (US$ and €) and these prices are automatically converted into their equivalent in reais (R$). So, the pass-through is immediately computed in the month of reference (IBGE 2011, p. 26).

[23] An additional effect of a positive shock in *selic* in t_0 is a devaluation of the local currency (only reversed the following month), which in turn is, also, related to the contemporaneous increase in *ppi*.

Finally, we found that a shock to the level of capacity utilization (u) is positively related to the acceleration of industrial inflation, indicating that firms, facing a higher demand, respond with price increases. This means that, at constant costs, firms take advantage of an increase in demand to increase their profit margins. In fact, *ulc* has a negative response to contemporary shock in u (which stabilizes after eight periods), that is to say, there is a reduction in unit labor costs, given an increase in capacity utilization. This observation confirms the hypothesis about the increase in the profit margins in t_0.

To sum up, we found that the importance of the interest rate to explain the industrial inflation (according FEVD) is small. This is so because the increase in the basic interest rate *selic* does not immediately reduce the exchange rate, which is the main explanatory variable of changes in *ppi*. The IRFs analysis shows that, at first, a shock in the *selic* depreciates contemporaneously the local currency, which in turn increases the prices in t_0. Only a period after the observed shock is that there is an appreciation in the currency, that can be related to capital inflows.

4. Concluding remark

The upsurge in the inflationary process in Brazil became clear in 2015. This upsurge is explained in a great deal (but not exclusively) by the devaluation of the currency and its impact on production costs. In spite of that, the Brazilian Central Bank keeps the basic interest rate at high level (it is one of the highest real interest rate in the world) to control the inflationary process, and the economy is diving into a severe recession (GDP decreased 3.8% in 2015).

Inflation targeting in Brazil has been applied since 1999, and in this paper, based on recent data on industrial producer index, we have argued about its appropriateness to control inflation subject to cost pressures. In particular cost pressures have been amplified in the recent period in response of the pass-through of exchange rate variations to inflation. The magnified response on the exchange rate pass-through can be seen as a result of the deepening of the deindustrialization process in Brazil, which increases the propensity to import of the industrial sector. It should be recalled that the structuralist literature has shown long ago that technological dependence, oligopolistic competition and unequal international trade greatly contribute to a higher pass-through effect of the exchange rate in developing economies. The more recent debate about the new developmentalism has shown that the exchange rate is the most important macroeconomic price to be looked over by monetary authorities, because developing economies that are financially integrated tend to show an overvaluation trend of their currencies.[24] The main reason is because monetary policy autonomy is greatly constrained by the dependence on capital flows, and as a consequence business cycles tend to be more severe in developing economies, narrowing their policy space.[25] In this sense, our aim in this paper was, assuming that the inflationary process in Brazil should be understood as cost-push driven rather than demand pull driven, to present an estimate of the pass-through effect on industrial inflation from 2010 onwards. A general conclusion is that, different from the mainstream assumptions for open developed economies, stabilization policies in developing economies should consider that the use of the interest rate as the main instrument to control inflation may not be effective and impose a too heavy cost on the real side of the economy to overcome the inflationary process.

In our econometric exercise, based on the recent available data on producer price index, we were able to show that movements in the exchange rate explain more than 60% of the increase in the industrial inflation from 2010 onward. The interest rate, on its turn, as a financial cost to firms, showed little impact on the dynamics of the industrial inflation, but its impact is positive to control industrial prices via its effect on demand. Our exercise also showed a positive impact of the degree of capacity utilization and industrial price, what means to say that in the period firms tend to increase their profit margin, even if labor unit costs do not change.

Appendix A.

See Tables A1–A4, and Fig. A1

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[24] See, for instance, Bresser-Pereira et al. (2014), in special chapter 6 where the authors show how the overvaluation trend of the real exchange rate limits the access of industrial firms to their markets.

[25] See, for instance, Ocampo (2011).

Table A1
Data sources (December 2009 = 100).

Series	Details	Font
ppi	Producer price index—manufacturing industry	IBGE (2016b)—Brazilian Statistical Office
wbill	Nominal wage bill—manufacturing industry	CNI (2016b)—National Confederation of Industry
exc	Brazilian Real/US Dollar exchange rate: daily average of biding and offer closing quotations	Bacen (2016a)—Brazilian Central Bank
y	Production (volume) index—manufacturing industry	IBGE (2016b)—Brazilian Statistical Office
selic	Referencial interest rate—Selic accumulated in the month (annual equivalent)	Bacen (2016b)—Brazilian Central Bank
u	Installed capacity utilization—manufacturing industry	CNI (2016b)—National Confederation of Industry

Board A1: Seasonal adjustment models

Series	Mode	ARIMA	Regressors	Choice
ppi	Multiplicative	(1 1 0)(0 0 1)	None	User
wbill	Multiplicative	(0 1 1)(0 1 0)	Constant	Auto
exc	Multiplicative	(0 1 1)(0 2 1)	None	User
y	Multiplicative	(0 1 0)(0 1 1)	1-Coefficient trading day + easter[1] + user-defined holiday + automatically identified outliers	Auto
selic	Additive	(1 1 2)(0 1 1)	Leap year + 1-coefficient trading day	Auto
u	Multiplicative	(1 0 1)(0 1 0)	Trading day + easter[8] + user-defined holiday	User

Notes: (i) When the selected model via "*automodel selection criteria*" was not able to avoid residual autocorrelation or residual seasonality, the ARIMA model was determined by the user (choice = user); (ii) The unadjusted data is described in Table A1 (Indexes, December 209 = 100); (iii) Data span: December 2009–October 2015.

Table A2
Weights for movable holidays: 'Carnival' and 'Corpus Christi' (adjustment of *u* and *y*).

Year	Carnaval		Corpus Christi	
	Month			
	February	March	May	June
2010	0,222222	−0,222222	−0,222222	0,222222
2011	−0,777778	0,777778	−0,222222	0,222222
2012	0,222222	−0,222222	−0,222222	0,222222
2013	0,222222	−0,222222	0,777778	−0,777778
2014	−0,777778	0,777778	−0,222222	0,222222
2015	0,222222	−0,222222	−0,222222	0,222222

Note: Weights estimated via WinGenhol software (US Census Bureau, 2015).

Table A3
Unit root tests.

Series	ADF-GLS test[a]		KPSS test[b]
	Statistic	adf_lags	Statistic
ppi	−2,539	0	0,132
ulc	−8,393	0	0,062
exc[a]	−1,576	7	0,473
exc[b]	−1,698	5	–
selic	−1,725	4	0,226
u	−4,216	0	0,350

Notes: (i) *ADF-GLS test*: kmax = 10 (criter: Mod AIC), lags 7 and 6 are not significant in exc[a] test → exc[b] test kmax = 5., (ii) *KPSS test*: lag truncation = 3.
[a] Critical values: 1% = −2.6; 5% = −1.95; 10% = −1.62.
[b] Critical values: 1% = 0,729; 5% = 0,462; 10% = 0,350.

Table A4
Forecast error variance decomposition (%).

Period	Series	*ppi*	*ulc*	*exc*	*selic*	*u*
1	*ppi*	46,21	1,01	51,23	0,30	1,25
3		33,46	1,37	60,14	2,72	2,31
6		33,22	1,36	60,31	2,75	2,36
12		33,22	1,36	60,31	2,75	2,36
1	*ulc*	0,00	98,33	0,00	0,00	1,67
3		6,12	87,23	1,41	2,66	2,57
6		6,17	86,50	1,70	3,01	2,62
12		6,17	86,50	1,70	3,01	2,62
1	*exc*	0,00	0,00	99,72	0,28	0,00
3		2,34	0,17	95,86	1,55	0,08
6		2,59	0,17	95,58	1,56	0,10
12		2,59	0,17	95,58	1,56	0,10
1	*selic*	0,00	0,00	0,00	100,00	0,00
3		0,04	0,07	0,57	99,32	0,00
6		0,04	0,08	0,57	99,31	0,00
12		0,04	0,08	0,57	99,31	0,00
1	*u*	0,00	0,00	0,00	0,00	100,00
3		2,39	1,36	1,56	0,80	93,88
6		2,71	1,41	1,81	0,86	93,20
12		2,71	1,41	1,82	0,86	93,19

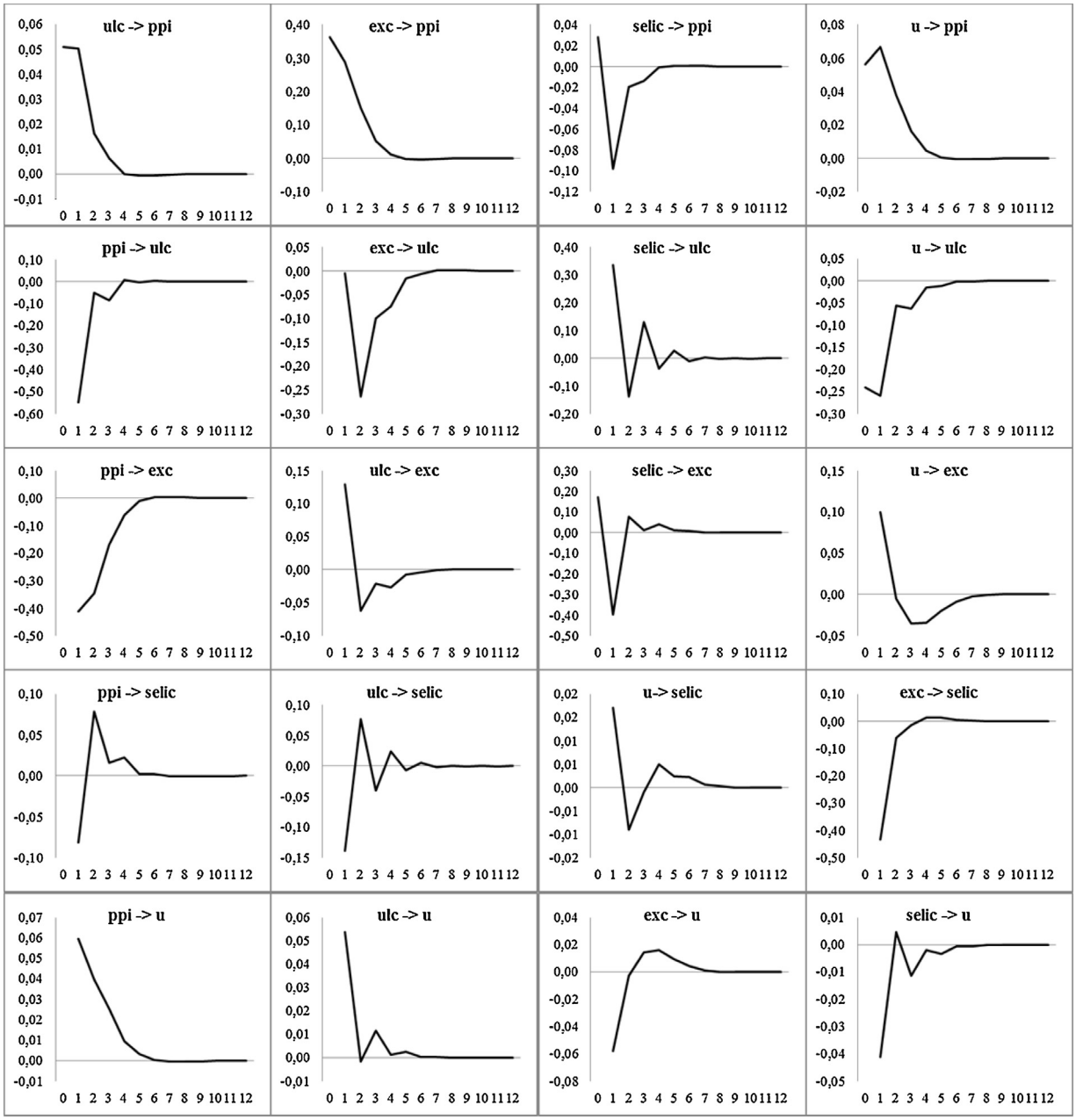

Fig. A1. Impulse response functions (IRFs). *Note*: The estimated IRFs does not lies outside the 95% CI (500 bootstrap replications).

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