

# Unemployment and Inflation: An Estimated Phillips Curve for Brazil (2002-2014)

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Received July 03, 2015; Revised September 14, 2015; Accepted October 08, 2015

**Abstract** The relationship between inflation and unemployment has been discussed in different economic levels seeking an understanding of the interrelationships existing in the Brazilian economy and how the information is passed on and used by the decision makers. Thus, this study's main objective is to analyze the ability of the Phillips curve to describe the dynamics of Brazilian inflation, using aggregate data from 2002 to 2014. After the estimated model it was possible to conclude that this can't either be considered well adjusted, nor a full explanation to the Brazilian inflationary dynamics. It was also verified that the inflation expectation had greater impact on the formation of the current inflation than the past inflation. This increased weight of future inflation in the formation of the current inflation can be explained in terms, by the theory of rational expectations. The effects of an exchange rate shock remains having direct influence on the formation of internal prices and, as a consequence, on the inflation.

**Keywords:** *unemployment, inflation, Phillips, curve, tradeoff, Brazil*

**Cite This Article:** Gustavo Antonio Ponzoni, and Julcemar Bruno Zilli, "Unemployment and Inflation: An Estimated Phillips Curve for Brazil (2002-2014)." *Journal of Finance and Economics*, vol. 3, no. 5 (2015): 77-85. doi: 10.12691/jfe-3-5-1.

## 1. Introduction

Economists dedicated to research in these areas try to understand how the components (level of growth or development; the labor market; purchasing power of the population; inflation; sustainable development; fiscal and monetary policies) behave individually and their interrelations with the other segments. Currently, another issue that has drawn the attention of Brazilians is the relationship between inflation rates above the established target with a low unemployment rate.

Despite being widely used, this relationship had some contradictions in certain moments of history. Even with some adaptations, the way the variables (unemployment and inflation) relate varies differently for each country and in accordance with the time period observed [6].

A similar equation to the Phillips curves, but increased by expectations, is entitled in the economic literature as "New Keynesian Phillips Curve" or NKPC. In these models with prices that do not change immediately, there is a positive relationship between the inflation rate and the level of output and therefore a negative relationship between inflation rate and the unemployment rate [36]. In summary, despite the adjustments and the level of econometric complexity, Phillips curves aim to describe the inflation dynamics of a country.

Therefore, does inflation have a dynamic relationship with the unemployment rate in Brazil? Thus, the hypothesis that there is a significant relationship between dynamic inflation and unemployment for Brazil is tested.

The main objective is to analyze the ability of the Phillips curve to describe the Brazilian inflation dynamics, using aggregate data from 2002 to 2014. Specifically, we studied the national and international literature review regarding the Phillips curve and we verified the existence of trade-off in the short term between inflation and unemployment with aggregated indicators at a national level.

The market economy has supported its growth in external and internal factors. As the government fully controls the external factors, it is its duty to provide a stable domestic environment that offers security for investments.

Inflation has been a recurring theme in many analyses about the Brazilian economy. Inflationary experiences are indeed bad since the implementation of the Real Plan, Brazilian economy is undergoing a period of a greater stability and satisfactory average growth. The unemployment rate remains low, with full employment characteristics in some areas.

Thus, this study is justified by the time of continuous low unemployment and persistently high inflation rate. Therefore, it is of real importance for both the academic society and the community at large, since a continuously high inflation significantly alters the stability of the economy.

Regarding the academic society, the relevance is to seek empirical evidence for the negative correlation between inflation and unemployment in the system of a post-decree period of inflation targeting, using econometric tools. For the community at large, the importance lies in showing that the inflationary dynamics,

which Brazil is going through, can be much more complex from what is shown by the press in general.

## 2. Brazilian Inflation

### 2.1. Historic

In 1993, Brazil ended a long period - about six decades - of living with inflation. This cycle began with the conclusion of the most difficult period of recession that the world economy faced as a result of the 1929 crisis in the United States.

In the 1940s, during the first half (1939-1945) an inflationary explosion was observed, with accumulated inflation of approximately 215,6% between 1940 and 1949, an average of 12,2% per year [39].

The following decade presented a significant increase in inflation indices, with a cumulative growth close to 460%, doubling the inflation recorded in the previous decade. Unlike the 1940s, the 1950s showed a high volatility of the indices, since the annual rates varied from 12% to 25% and closed the decade nearly with 40% in 1959. This decade was characterized by major structural change in Brazilian economy, as well as in the relationship with the rest of the world (CRUZ, 2007).

The 1960s brought new challenges to the economy. a large growth in inflation rates was observed from 30% recorded in 1960 to over 90% in 1964. These circumstances culminated in a military coup in 1964 and led the country to a period of major economic reforms [39].

In that year, the military took power and started stabilization policies based on price control, balancing public accounts and real wage cuts, known as Government Economic Action Plan (PAEG), implemented during Castelo Branco's government (1964-1967) that, in general, had the following objectives: accelerating the rhythm of economic development, containing the inflationary process, attenuating the sector and regional imbalances, increasing investment and, as a consequence, the employment, to further correct the external imbalance trend [20]. The program led to a decline in inflation rates of 35/40% in the 1965-66 biennium, that is, about 25% in the biennium of 1967-68, and around 19% per year at the end of the decade. According to Gremaud ([20], p. 393) the PAEG "[...] enabled a series of reforms that allowed the resumption of the economic growth."

Until 1973, various military governments had relative success reducing inflation, ranging from 92% in 1964, reaching an annual rate of more than 100% in April of 1964, to 15,5% in 1973 [5]. Since 1968, inflation, on a downward trend, was accompanied by a significant economic growth.

According to Baer ([4], p. 71):

These successful situations were the result of a mixture of standard measures of fiscal and monetary stabilization; a wage policy of containment; a review of controlled prices, that had previously fallen relative terms; the adoption of a stable system of exchange rates; and the introduction of indexation of financial instruments, whose purpose was to enable the government to raise funds from a non-inflationary manner, to encourage savings and, to

avoid various distortions that inflationary impulses, even though declining, could still produce.

For Baer [5], just as inflation accelerated during the 1970s, so did the debate about its origins, impacts and ways to control it: "Not surprisingly, the interpretive literature on inflation of the 70's and 80's can be broadly classified into two famous fields on the debate on inflation of the 50's and 60's: the monetarist versus the structuralist (p 30-31) ".

To monetarists, the main factor responsible for the high rate of inflation was excessive liquidity, caused by the lack of control of the public budget and the accumulation of foreign exchange reserves. To Lemgruber ([30], p.70) "[...] advancement and retraction policies should be avoided, and, at the same time, a low rate and a constant monetary growth should be aimed, in order to refrain inflation". It's considered that, after a certain time, inflation acquires certain autonomy, or, in other words, it assumes inertial behavior, where the inflation of the last period determines the current inflation rate.

Structuralists sought a different explanation for Brazilian inflation. This search was prompted mainly by the fact that the significant rate increase occurred both in times of growth, stagnation and negative growth. In opposition to the monetarists, who believed that inflation was generated by the excess supply of currency, structuralists saw the currency as a dependent variable, or, the growth as a result of price increases [10]. For this school, inflation is seen primarily as a result of monopoly company power, trade union and state.

The decline in the exchange rate led the government, already in 1980, to adopt an orthodox policy, called voluntary adjustment, since the country had not yet requested money to the International Monetary Fund and the renegotiation of the debt, which would occur later [20]. The increasing difficulty to renew foreign loans, added to the rising cost of debt rollover led the internal policy to be guided by reducing the need for foreign exchange by the strict controls on imports. The success of this action was conditional on the size of the resulting recession and/or the successful reorientation of production factors to the exporting activity [20].

Even after reaching the external balance, from 1985-1986, inflation began to experience increasingly higher levels, reaching close to 1.800% between December/1998 to December/1989 [39].

According to Bresser Perreira [9] the stabilization plans that had been tried before the Real Plan, failed due to the combination of two reasons: lack of political support for fiscal adjustment and incompetence on the implementation of the plan. Still, according to the author, five plans were dominantly heterodox, five were orthodox and two (the Delfim I Plan, 1979, and the Dornelles Plan, 1985) were indeterminate. So, all this price instability would only be resolved with the implementation of the Real Plan on July/1994.

The Real Plan was implemented in three phases. The first phase was represented by the creation of the Social Emergency Fund. The second phase was the introduction of the URV (Real Value Unit) a currency index pegged to the dollar that served to disconnect the economy, or, in other words, end the automatic fixed prices and wages, which were automatically adjusted for inflation in the previous period, technically known as the end of the

inflationary inertia. On June 1994, the exchange rate ended the day with the dollar at CR\$ 2.750,00. Therefore, on June 30, 1994, all the Cruzeiro Real should be divided by 2.750 in order to get the Real.

The regime of inflation targeting was implemented in Brazil under a scenario of strong devaluations arising from speculative attacks. The scheme had as the main points [8]: (i) setting targets for inflation based on annual changes of a known price index; (ii) leave the responsibility of determining inflation targets, their respective ranges of variation and the price index to be quoted to the National Monetary Council; (iii) delegate to the Central Bank the task of making the targets be met, using the necessary tools. Seeking the transparency of the policy used and of its results, a quarterly publication named Quarterly Inflation Report was created.

To Fraga ([16], p. 2) "the choice of a target system for inflation in time of crisis and uncertainty reflected a huge concern regarding the risk of losing control over inflation expectations [...]". According to the author:

In a country with our inflation history, such deficiency would bring with it the threat of re-indexing and the return of the nightmare of the instability that existed before the Real Plan. The explicit goals seemed to us as a good way to compromise the government's actions with their medium and long-term goals and, if successful, start accumulating a precious asset of credibility. Despite this assessment, the immediate adoption of the system in its final formal version seemed very risky to us. The balance of payments was living a panic atmosphere at that moment and the dispersion of inflation expectations was huge. If the chosen target proved to be too ambitious quickly, we would run the risk of missing the mark by far, demoralizing the new model. On the other hand, if the initial target were too broad, we would almost by definition, give up quick return to the acceptable levels. Our solution to this dilemma was to introduce the system gradually. We soon announced that we would work to bring inflation to an annualized rate of one digit in the last quarter of 1999 ([16], p. 2).

Figure 1 shows the annual change in the current official rate of inflation after the implementation of the Real Plan. The relative stabilization of the index in the period and the reduction of annual fees are evident. It is observed, particularly in 2002, the large increase in the rate resulting from the uncertainties of an election year.

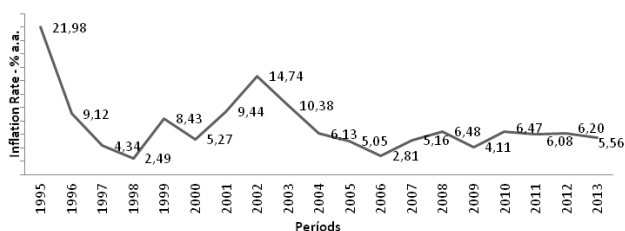


Figure 1. INPC - National System of Consumer Price Indices - 1995-2013

Source: Ipeadata [27].

Since the beginning of the Target System in Brazil, according to the Central Bank (BACEN, 2014) and the Brazilian Institute of Geography and Statistics [26], inflation was above the target for 80% of the time, that is, in 12 of the 15 years of the targets existence, inflation was

above the central goal set. Inflation remained below the central target in 2006, 2007 and 2009. In those years, respectively, the IPCA accumulated 3,14%, 4,46% and 4,31%. In all the other years, the IPCA was above the central target. Considering their respective tolerance intervals, inflation was above the target in 2001, 2002 and 2003. In these years accumulated IPCA was 7,67%, 12,53% and 9,30%, respectively.

## 2.2. Brazilian Labor Market

The unemployment rate can be characterized as the result of the dynamics of the labor market, or, in other words, by supply and demand. On one side, there are the employed people, who are actually working, which would represent the demand. On the other side, the offer is the economically active population (EAP). According to IBGE ([26], p.1) the economically active population "comprises the potential of labor-work you can count on in the productive sector, that is, the employed population and the unemployed population [...]".

In recent years the unemployment rate showed significant decrease in the country. In the 1980s the rate was relatively low; approximately 5,8% per year. From the 1990s, the unemployment rate reached a maximum of 8,93% in March/1998, recording an average of approximately 6,07% per year.

According to Santos ([49], p. 2), the low economic growth in Brazil, in most of the 80's and 90's, favored the high unemployment and underemployment in these two decades:

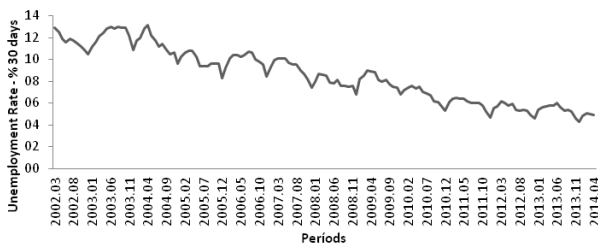
In addition, there are indications that privatization in the late 90's also contributed to increasing the unemployment rate due to layoffs caused by the restructuring programs through which companies passed before or after privatization. This effect may have had long impacts on the labor market if we consider that many of the laid-off workers could not have the skills to perform functions other than those that were carried out in public companies. This is one of the common causes of a phenomenon known in the literature as hysteresis.

In 2003, the average unemployment rate estimated from the monthly survey of employment (PME) reached 12,44%. Yet, in 2012, the same rate registered an average of 5,42%. With this labor incorporation, the repressed consumption of many years became the great engine of the economy.

Figure 2 shows the level of national unemployment, according to the new methodology of the Monthly Employment Survey (PME) calculated by IBGE, from March/2002 to April/2014. It is highlighted here the continuous downward trend of the rate in the last 10 years, until registering an unemployment rate of 4,9% nowadays.

At first, the industry, for years working with idle capacity, had benefits from the increased utilization of the existing manpower. After a few years, structural and regulatory problems, financial and operational difficulties in the public and private sectors, added to the lack of qualification of the workers, pulled productivity down, making space for imported products, with lower value, which led the economy to be, in a certain way, a "hostage" of the exchange rate volatility. According to Bacha [3],

"the integrating global production chains will lead to the productivity shock that the country needs."



**Figure 2.** Unemployment Rate –30 days – March/2002 to April/2014

Source: Ipeadata (2014).

Several discussions have been raised about the lack of productivity of sectors in Brazil's economy, one of which is related to the continued increase in the real value of the minimum wage. This factor would, hypothetically, be generating a disconnection between wage growth and productivity of Brazil's economy in recent years. Thus, generating increased inflation in the service sector and weakening the industrial sector, that couldn't pass this cost increase along to the final prices, because it faces strong foreign competition, reflecting the fall in the sector's investment capacity [38].

Menezes Filho ([38], p.1) concludes that it doesn't seem that there is a mismatch between real wages and productivity. The author highlights some important points in his analysis: i) productivity only grew, between 1996 and 2012, in the agriculture; ii) the industrial sector and the service sector have maintained the same level of productivity of 1996, despite receiving many incentives for innovation; iii) wages that increased were those of unskilled workers, on the other hand, the average wage of skilled workers had real reduction in recent times, and; iv) the low innovation rate in the Brazilian economy decreases the rate of absorption of the skilled workers, which led to the decrease in their wages [38].

Given the exposed, it can be seen that the structure of Brazil's labor market is much more complex to analyze. Although there have been advances in education, inadequacies in several specific areas have generated negative impacts on the economy. This is reflected in the increase of wages of unskilled workers, and the decline in productivity in the industrial sector and the service sector that can impact directly and indirectly on the inflation rate.

### 2.3. Phillips Curve

The story of the Phillips curve started - from empirical evidence - which was extended to pursue a theoretical explanation. According Sachsida ([46], p. 10), "specifically, the Phillips curve seeks to determine whether the apparent tradeoff between inflation and unemployment has causal relationship or is just a spurious correlation."

Phillips curve appeared for the first time in an A.W Phillips study that relates the inflation rate to the unemployment rate with the rate of nominal wage change. The higher the unemployment rate, the lower the rate of inflation. According to Dornbusch and Fischer ([12], p. 552) "[...] there is a gap between wage inflation and unemployment."

Phillips curve shows that wage inflation rate decreases with the unemployment rate [12]. Using  $W_t$  as the wage

for the period,  $W_{t-1}$  as the wage in the previous period, and wage inflation rate expressed by  $g_w$ , it can be written as

$$g_w = \frac{W_t - W_{t-1}}{W_{t-1}} \quad (1)$$

With  $u^*$  representing the natural rate of unemployment, it's possible to write the theoretical model of the Phillips curve as

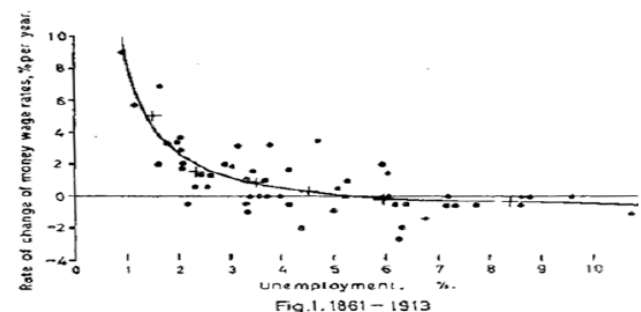
$$g_w = -\alpha(u - u^*) \quad (2)$$

where  $\alpha$  measures the sensitivity of wages to unemployment. According to Dornbusch [12], this equation states that wages are falling while the unemployment rate exceeds the natural rate, that is, when  $u > u^*$ , and increases when the unemployment rate is below the natural rate.

Despite Phillips curve relating the rate of increase in wages or wage inflation to unemployment as the theoretical model (2), the term Phillips curve gradually started being used to describe the original Phillips Curve and also a curve related to the rate of increase in prices [12].

The Phillips curve quickly became a benchmark for macroeconomic policy analysis. In this sense, Samuelson and Solow [50], using data for the USA economy, also found that there is a tradeoff, which means, an exchange relationship between inflation and unemployment. Thus, the authors indicated that the government could pursue a lower unemployment rate at a cost of higher inflation. But in 1975 and in 1980, also in the United States, unemployment and inflation increased at the same time.

Figure 3 presents the original Phillips curve for the UK, which was based on data from the years 1861 to 1957. These factors have led to a significant change in the perception that the Phillips curve is a rule. For Friedman [18] and Phelps [42], the simple Phillips curve would move over time, when workers and firms become settled and, thus, they expected for continued inflation. Based on the time, in the economic theory, the authors concluded that the notion of long-term tradeoff between inflation and unemployment was illusory and that, while there may be a short-term gap between inflation and unemployment, there is not one for the long term.



**Figure 3.** Original Phillips Curve for UK

Source: Phillips (1958).

The International Monetary Fund (IMF) concludes that during recessions - general downturn in economic activity - the relationship between the change in the inflation rate and the rise in unemployment is different [14]. The effect of the difference between the unemployment rate and its natural level seems to have now a much smaller

deflationary effect than in the past. According to the study, with the current institutional conditions in the labor market, a reduction in the inflation rate seems to require a significantly larger increase in unemployment than before [14].

In general, Phillips curve can be estimated by equation 3:

$$\pi_t = \beta_1\pi_{t-1} + \beta_2E(\pi_{t+1}) + \beta_3A_t + \beta_4P_t + \varepsilon_t \quad (3)$$

where  $\pi_t$  is the inflation rate in the period;  $E(\pi_{t+1})$  is the mathematical expectation of inflation for the next period;  $A_t$  is the unemployment rate or a variable that represents the marginal cost of the company;  $P_t$  is a supply shock (usually represented by an exchange rate shock); and  $\varepsilon_t$  is the error assumed to be independent and identically distributed (*iid*).

According to Sachsida ([46], p 20-21) despite having a simple equation, the Phillips curve presents difficulties for its estimation:

The first difficulty relates to which set of variables should be adopted as a proxy for inflation, inflation expectations, marginal cost of the enterprise and supply shock. This choice is not trivial, and several studies choose different sets of variables, there is no methodology of choice to suggest which variables should be adopted. In Brazil, this difficulty is even superior due to the limited number of statistical series, added to the economic instability that characterized the beginning of the 1990s.

Other difficulties related to Phillips curve refer to which method is more appropriate to estimate equation 4, and also the number of lags that should be chosen for certain variables, as some economic variables only affect the others after a few time slots.

### 3. Materials and Methods

The research base is defined as the aggregated data of Brazil, from January/2002 to April/2014, obtained through secondary sources, such as: IBGE (Brazilian Institute of Geography and Statistics), Ipeadata, Central Bank of Brazil (BACEN) and Getúlio Vargas Foundation (FGV). As the supply of historical data series is scarce, the ones that covered the largest possible period of time were chosen, following the same methodology. Thus, the variables defined in the econometric model are: inflation rate represented by the General Price Index (IGP-M/FGV); unemployment rate represented by the Monthly Employment Survey (PME/IBGE); supply shock represented by the monthly rate for dollar (R\$/US\$) recorded on the last day of the month and; inflation expectations represented by the median forecast of agents, for the next month, published in Focus Newsletter - Central Bank Market Report.

For the estimation of the econometric model, it is necessary to do the "Unit Root Test". According to Nelson and Plosser [40], most economic series have a Unit Root and, therefore, it becomes extremely important to determine the order of integration of these variables. To Alencar ([1], p. 171) if "the unit root hypothesis is true for a number, the random shocks it suffers would generate a permanent effect. Fluctuations would not be transient, knocking, for example, the theories that the business cycle would be temporary fluctuations around a trend".

The presence of a unit root in the data may take an econometric relationship estimated to be spurious, that is, a spurious regression is a meaningless regression, where it is observed that a relationship does not actually exist. In other words, by estimating a regression, even if the respective values of *t-tests* are significant and the regression coefficient of determination, also known as  $R^2$ , is high, it still runs the risk of obtaining a regression with no meaning in economic terms [19].

After the completion of the Unit Root Tests in proxy's variables, Phillips curve was estimated through the following equation 4:

$$\pi_t = \beta_1\pi_{t-1} + \beta_2E_t\pi_{t+1} + \beta_3A_t + \beta_4P_t + \varepsilon_t \quad (4)$$

where:  $\pi_t$  is the inflation of the period represented by the IGP-M/FGV;  $E_t$  is the expectation of inflation;  $A_t$  is the unemployment rate represented by PME/FGV;  $P_t$  is a supply shock represented by the exchange rate; and  $\varepsilon_t$  is the error term assumed to be independent and identically distributed (*iid*).

In the event that two variables are co-integrated, it is said that there is a long-run equilibrium relationship between them, which may cause unbalance in the short term. In this case, it's possible to refer to the relationship between these variables as balance error, and then this error term can be used to connect the estimated regression of behavior in the short term to long term [7]. This unbalance can be corrected by the Vector Error Correction model (VEC).

The Vector Error Correction Model is a more complete version of the VAR. The basic idea is that the VAR with unit root variables, but was stationary, suppresses relevant variables. The VEC fixes this problem.

## 4. Results and Discussion

### 4.1. Descriptive Statistics

The descriptive statistics indicates the IGP-M (FGV), averaged over the period analyzed, at 0,64%, with a standard deviation of 0,83%. The maximum adjustment observed in a month, 5,17%, was registered in November/2002. The minimum monthly adjustment of -1%, in this case deflation, was observed in July/2003 (See Table 1).

Compared to the average exchange rate (trade R\$/US\$), it fluctuated, during this period, between a minimum of R\$ 1,5631 and a maximum of R\$ 3,8051, with standard deviation of R\$ 0,5091 and an average of R\$ 2,24.

The proxy representing the marginal cost of the company or unemployment - PME/IBGE - presented their behaviors. The first fluctuated between a monthly unemployment rate from 4,3% to 13,1% with a standard deviation of 2,47% and an average of 8,50%.

**Table 1. Descriptive statistics of the variables used (07/1994 - 07/2013)**

Variable	Average	Standard Deviation	Minimum	Maximum
IGP-M	0.64	0.8311	-1.00	5.19
Exchange	2.24	0.5091	1.5631	3.8051
PME	8.50	2.4720	4.30	13.10
Inflation Expectation	0.52	0.3578	0.10	3.00

Source: Developed by the authors (2014).

Regarding the inflation expectation index calculated by the Central Bank of Brazil, it showed a standard deviation of 0,3578% and an average of 0,52%. In terms of minimum and maximum points, it fluctuated between 0,10% and 3,00% in September/2005 and December/2002, respectively.

#### 4.2. Unit Root

As for the econometric tests used in this article, in order to assess whether the variables follow a stationary stochastic process, the Unit Root Test was performed. Table 2 shows the results of the Unit Root Test.

The null hypothesis that the tested series have a unit root (not stationary) is accepted to the exchange variable and the PME variable, i.e., they have a unit root. On the other hand, for the variable of Inflation Expectation, represented by the average IPCA removed from the Focus Market Report and IGP-M it rejects the null hypothesis, that is, the series is stationary.

Ng-Perron (2001) test is considered an excellent test option when taking into account the existence of the trade-off between size and power [53]. The Ng-Perron test indicated that the IGP-M and inflation expectations series have stationary behavior and the unit root is present in the exchange and PME series.

However, it may be more reasonable to think that breaks occur over a number of periods and display smooth transition to the new level. Saikkonen and Lütkepohl [51] and Lanne, Lütkepohl and Saikkonen [29] develop such a model which adds to the deterministic term shift of the functions of the general nonlinear form. The analysis of UR with structural break showed similar results to the observed in the other tests, confirming the identification that the exchange series and the SMEs did not have a unit root of rejection and, in another sense, the IGP-M series and the expected inflation rejected the unit root hypotheses.

Table 1. Unit Root Tests.

Variable	ADF	UR	Ng-Perron modified			
			MZ $\alpha$	MZ $\tau$	MSB	MPT
IGP-M	-2,5**	-3,0*	-28,3***	-3,7***	0,1***	3,4***
Exchange	-1,0 <sup>ns</sup>	-2,1 <sup>ns</sup>	-7,4 <sup>ns</sup>	-1,9 <sup>ns</sup>	0,3 <sup>ns</sup>	12,4 <sup>ns</sup>
PME	-0,7 <sup>ns</sup>	-0,9 <sup>ns</sup>	-6,1 <sup>ns</sup>	-1,7 <sup>ns</sup>	0,3 <sup>ns</sup>	15,0 <sup>ns</sup>
Expe	-3,4**	-2,8*	-19,6**	-3,1**	0,2**	4,7**

Source: Authors' calculations based on the research (2014).

Selection of lags based on the criteria of Akaike information (AIC).

\*\*\* Significance level at 1%

\*\*Significance level at 5%

\* Significance level at 10%

<sup>ns</sup> No significance.

As two variables have a Unit Root, it was performed Johansen cointegration test. Through that, it was found the presence of cointegration in the model between the proxies that represent a supply shock and unemployment - Exchange and PMEs. Therefore, it can be concluded that there is a equilibrium error. Thus, this unbalance was corrected with estimates of VEC.

The analyses of the econometric results for the New Keynesian Phillips Curve (NKPC) using inflation as the dependent variable (IGP-M) presented the following results. The constant was not included in the regression. According to Mendonça, Sachsida and Medrano [37], the

exclusion of the constant in the estimation of the NKPC is customary on related studies and corresponds to the structural form shown in equation (4).

#### 4.3. Phillips Curve

According to the statistics to verify the ability of the instruments ( $R^2$  and F-test), such toolkit could not be considered as well adjusted. This means that this group cannot fully explain Brazilian inflation dynamics.

Regarding the result of the unemployment rate, the variable had the expected negative sign, which confirms the existence of an exchange relationship between the inflation rate and the unemployment rate, thus validating the Phillips Curve. The coefficient is statistically significant both for one and for two lags. Here, it is highlighted its growth in parallel with the increasing lag number. With one lag the estimated coefficient is -0,007. Yet, with two lags, the estimated coefficient is -0,12, namely, much more influential regarding the formation of inflation. Table 3 shows the estimation results of the Phillips Curve already with Vector Error Correction.

Mendonça [36] believes that scheme targets validated the exchange ratio, or tradeoff, between unemployment and inflation. From a data analysis of a group of eight countries, taking into account the three years before and three years after the adoption of the targets, the author confirmed empirically that the implementation of the inflation targeting regime was effective in reducing inflation and responsible for the increased level of unemployment.

Cysne [11], in one of the early works on the Phillips Curve for Brazil, concluded that there is not an exchange relationship between unemployment and inflation for the period from 1950 to 1983. On the other hand, using Brazilian quarterly data for the period 1982-1998, Portugal, Madalozzo and Hillbrecht [43] found an exchange ratio or a tradeoff between inflation and unemployment that has statistical significance. The authors found a statistically significant coefficient of -1,75 for unemployment.

Mendonça, Sachsida and Medrano [37] also validated the existence of this trade-off, but only when they included, within the model, a commodity price index. Sims [52] apud Mendonca, Sachsida and Medrano [37] suggests the use of a commodity price index to estimate the structural VAR as a means of eliminating the so-called "price puzzle" because this variable would bring information as to the conduct of future inflation. Thus, the Central Bank could use this indicator to form its expectations about future inflation.

Table 3. Phillips Curve Estimates by VECM.

	D(IGPM)	Significance
<b>CointEq1</b>	0.034317	Significance at 5%
<b>D(IGPM(-1))</b>	-0.157059	Significance at 5%
<b>D(IGPM(-2))</b>	-0.311541	Not Significant
<b>D(EXPECT(-1))</b>	0.232815	Significance at 5%
<b>D(EXPECT(-2))</b>	-0.170671	Significance at 5%
<b>D(PME(-1))</b>	-0.007376	Significance at 5%
<b>D(PME(-2))</b>	-0.121289	Significance at 5%
<b>D(EXCHANGE(-1))</b>	1.780218	Not Significant
<b>D(EXCHANGE(-2))</b>	0.171163	Significance at 5%

Source: Authors' calculations based on the research (2014).

Regarding past inflation of the previous month ( $IGPM_{t-1}$ ), the sign was contrary to expectations, but the coefficient of -0,15 has statistical significance. On the other hand, the two last inflation lags ( $IGPM_{t-2}$ ), or from the two previous months, have no influence on the present inflation. Analyzing just the sign of the coefficients it can be considered contrary to what was expected, since the inflation of the last month is usually understood, in Brazil, as a kind of inflationary memory that regulates or positively influences the definition of the present inflation. This positive influence is called inertial inflation [9]. According to Lopez (1985) the basic idea is that because of the chronically inflationary environment that Brazil faced for several decades, the economic agents developed a strong defensive behavior in the formation of prices, which, under normal conditions, is an attempt to restore the previous peak of the real income at the time of each periodic adjustment of prices. When multiple agents follow this trend, past inflation is passed on to the present inflation.

The negative sign resulting from the model can tell that this mechanism, in the period covered, did not influence the inflation indicator, perhaps because it has been created by the financial market and is more independent and free from governmental interference.

The expected inflation showed the expected sign and a coefficient of 0,23, statistically different from zero to a 5% significance level. Thus, it is observed that the expectation has greater weight than the past inflation on inflationary process. With respect to these two variables, Mendonça, Sachsida and Medrano [37] obtained similar results, where the inflation expectations had greater impact on the formation of the current inflation than past inflation. For the model estimated by the authors for the period from January 2002 to March 2012, both past inflation and the expectation presented the expected sign. However, the authors incorporated a commodities price index within the model.

This increased weight of future inflation in the formation of the current inflation can be explained, in terms, by the theory of rational expectations. The emergence of the theory of rational expectations raised the question of how expectations are formed in a more controversial way [32]. For the author, this theory tells us that the expectations, rather than being formed from the variable values observed in the past, results on an intuition of economic agents about the future trajectory of the balance of the economy.

Regarding the variable which represents an exchange shock ( $EXCHANGE_{t-2}$ ), it has the expected sign and the coefficient 0,17 is statistically different from zero at the significance level of 5%. On the other hand, the variable with only one lag ( $EXCHANGE_{t-1}$ ) is statistically equal to zero to the significance level at 5%. Separately analyzing the positive sign of the coefficient, it can be considered appropriate, therefore, that an increase in the value of the Dollar or a depreciation of the Real leads to an increase in the cost of goods and supplies for consumers. It's also considered that the producers selling to both the domestic market and exporting receive more with currency increase, and expect to receive more for the domestic market product too, thus increasing its price. Fonseca Neto [13] also obtained similar results for the variable exchange rate shock, a positive sign, but showing a more representative coefficient in the model estimated for the period from

2000 to 2008. Mendonça, Sachsida and Medrano [37] also reached similar results to the ones found in this paper, but only after incorporating data from the Focus Bulletin as the inflation expectation proxy variable.

Mazali and Divine (2010) estimated the Phillips curve for the Brazilian economy using quarterly data for the period from January/1995 to April/2008. All variables were previously logarithmic. The authors used, as proxies, IPCA inflation, the open unemployment rate, seasonally adjusted for the Metropolitan Region of São Paulo (DIEESE) for unemployment. Moreover, the expectation of inflation is estimated by instrumental variables. The authors estimated the parameters of the Phillips curve by GMM with robust standard errors. The econometric results presented are consistent with the theory, showing a good degree of adjustment of the Phillips Curve. The coefficients found were 0,59 for past inflation, 0,44 to future inflation, and -0,13 for unemployment.

Table 4 summarizes the results of the research of other authors. From that, it is evident that many different results can be found in the estimation of the Phillips Curve for the Brazilian economy.

**Table 4. Results on the Brazilian Phillips Curve.**

Authors	$\pi_{t-1}$ *	$\pi_{t+1}$ **	$A_t$ ***	Periods
Cysne (1985) <sup>3</sup>	0.97	-	0.21	1950-1983
Portugal, Madalozzo and Hillbrecht (1999) <sup>3</sup>			-1.75	Mar.1982- Abr.1998
Sachsida, Ribeiro and Santos (2009) <sup>1</sup>	0.38	0.39	-0.01 <sup>2</sup>	Jan.1995- Abr.2008
Sachsida and Mendonça (2009)	0.089	0.906	0.001 <sup>2</sup>	Mar.2002- Fev.2009
Mazali and Divino (2010)	0.59	0.44	-0.13	Jan.1995- Abr.2008
Fonseca Neto (2010)	0.51	0.34	0.11	Abr.2000- Dez.2008
Mendonça, Sachsida and Medrano (2012) <sup>3</sup>	0.65	0.39	-0.003	Jan.2002- Mar.2012

Source: Authors' calculations based on the results obtained by the authors (2014).

Notes: \* Last Inflation.  
\*\* Expected inflation.  
\*\*\* Unemployment.  
<sup>2</sup> Not significant.

One of the major difficulties encountered in the model estimation was to select the most appropriate proxy variables, as well as econometric instrumentation. Sachsida, Ribeiro and Santos [47] estimated Phillips curve by nonlinear models, showing that the results are extremely sensitive to both the proxies adopted to represent unemployment, and the linearity specifications adopted.

In short, the evidence obtained through the estimation of the New Keynesian Phillips Curve (NKPC) through the VEC method suggests that, for the period analyzed, even with low impact, there is a trade-off between unemployment and inflation rate. It was observed by the analysis that the expected inflation weighs more than the past inflation in the formation of the current inflation and the exchange rate fluctuation still impacts the pricing internally, even though these impacts are decreasing.

## 5. Conclusion

This study estimated the New Keynesian Phillips Curve for Brazil from January/2002 to April/2014. In general, it

can be observed that this research reviewed briefly the Brazilian inflationary history, as well as market domestic labor development in recent decades. The study also presented the results found by several authors who have attempted to estimate the Phillips Curve, both for Brazil and for other countries over several periods of history. Over the years, several datasets were used as proxies, and many econometric methodologies were used.

Using as reference the  $R^2$  and F-test statistics for the ability of the instruments, it can be concluded that the set of econometric instruments used in this work for the selected proxies cannot be considered well adjusted. This means that this group cannot fully explain, but it partially explains Brazilian inflation dynamics.

Regarding the results obtained from the model, it is possible to establish a trade-off relationship between inflation and unemployment. This tradeoff is represented by the opposite sign of the coefficient of the variables inflation and unemployment, which validates the hypothesis of the existence of the Phillips Curve for Brazil.

Some key points regarding the estimation of the model can be highlighted. First, the inflation expectation had greater impact on the formation of the current inflation than the past inflation. This increased weight of future inflation in the formation of the present inflation can be explained in terms, by the theory of rational expectations. Second, the effects of an exchange shock directly influences the formation of inflation. This influence should be taken into consideration, since the imported inputs are highly demanded internally.

Finally, more broadly, there still seems to be the question of the Phillips Curve to fully describe the national inflation dynamics. These questions remain especially because the model is very sensitive to the econometric methodology used, and also to the proxies used.

## References

- [1] ALENCAR, Leonardo Soriano de. Raízes unitárias e cointegração: uma introdução. Boletim do Banco Central do Brasil, Brasília, v.34, n.4, p.171-210, abr. 1998.
- [2] ANDRADE, Maria Margarida de. *Como preparar trabalhos para cursos de pós-graduação: noções práticas*. 5. ed. São Paulo: Atlas, 2002.
- [3] BACHA, Edmar. 'Para escapar do pibinhos, o caminho é a abertura', diz Edmar Bacha: depoimento [15 de março, 2014]. São Paulo: O estado de São Paulo. Entrevista concedida a Alexa Salomão e Vinicius Neder.
- [4] BAER, Werner. *The Brazilian Economy: Growth and Development*. 2. Ed. Nova Iorque: Praeger, 1983.
- [5] BAER, Werner. A retomada da inflação no Brasil: 1974-1986. Revista de Economia Política, vol. 7, nº 1, janeiro-março, 1987.
- [6] BLANCHARD, Olivier. *Macroeconomia*. 3. ed. São Paulo: Pearson Prentice Hall, 2005.
- [7] BUENO, Rodrigo de Losso da Silveira. *Econometria de série temporais*. 2 ed. São Paulo: Cengage Learning, 2011.
- [8] BRASIL. Decreto nº 3.088, de 21 de junho de 1999. Brasília, 1999. Disponível em: <[http://www.planalto.gov.br/ccivil\\_03/decreto/D3088.htm](http://www.planalto.gov.br/ccivil_03/decreto/D3088.htm)>. Acesso em: 01 jun. 2014.
- [9] BRESSER-PERREIRA, Luiz Carlos. A economia e a política do Plano Real. Revista de Economia Política, vol. 14, nº 4 (56), 1994.
- [10] BRESSER-PERREIRA, Luiz Carlos; NAKANO, Yoshiaki. Política administrativa de controle da Inflação. Revista de Economia Política, vol. 4, nº 3, 1984.
- [11] CYSNE, Rubens Penha. A Relação de Phillips no Brasil: 1964-66 x 1980-84. Revista Brasileira de Economia, v. 39, n. 4, p. 401-22, out/dez 1985.
- [12] DORNBUSCH, Rudiger; FISCHER, Stanley. *Macroeconomia*. 5. Ed. São Paulo: McGraw-Hill do Brasil, 1991.
- [13] FONSECA NETO, Fernando de Aquino. Persistência inflacionária e curva de Phillips novo-Keynesiana para o Brasil. Revista de Economia Política, vol. 30, nº 2 (118), 2010.
- [14] INTERNATIONAL MONETARY FUND. *World economic outlook: a survey by the staff of the International Monetary Fund*. Washington, DC, Abril, 2013. Disponível em: <<http://www.imf.org/external/pubs/ft/weo/2013/01/>>. Acesso em: 25 jun. 2014.
- [15] FURTADO, M.B. *Síntese da economia brasileira*. 7. ed., Rio de Janeiro, Livros Técnicos e Científicos, 2000, 281 p.
- [16] FRAGA, Arminio. Dez anos de meta para inflação. Ipeecdg, 2009. Disponível em: <[http://ipeecdg.com.br/Arquivos/ArtigosArminio/090522\\_arminio\\_valor metas.pdf](http://ipeecdg.com.br/Arquivos/ArtigosArminio/090522_arminio_valor metas.pdf)>.
- [17] FRANCO, Gustavo. 20 anos do Plano Real. Instituto Millenium, 2014. Disponível em: <<http://www.imil.org.br/artigos/20-anos-plano-real/>>. Acesso em: 24 mai 2014.
- [18] FRIEDMAN, Milton. *The role of monetary policy*. American Economic Review, 1968. Disponível em: <<http://www.aeaweb.org/aer/top20/58.1.1-17.pdf>>. Acesso em: 25 jun. 2014.
- [19] GRANGER, Clive; NEWBOLD, Paul. Spurious regressions in econometrics. Journal of Econometrics, Nottingham, v.2, p. 111-120, Jul. 1974.
- [20] GREMAUD, Amaury Patrick. *Economia brasileira contemporânea/Amaury Patrick Gremaud, Marco Antonio Sandoval de Vasconcellos, Rudinei Toneto Jr.* 6ª ed. São Paulo: Atlas, 2006.
- [21] GIL, Antonio Carlos. *Métodos e técnicas de pesquisa social*. 5.ed. São Paulo: Atlas, 1999.
- [22] GALÍ, Jordi.; GERTLER, Mark.; LÓPEZ-SALIDO, J. David. European inflation dynamics. European economic review, v. 45, n. 7, p. 1.237-1.270, 2001.
- [23] GALÍ, Jordi; GERTLER, Mark. Inflation dynamics: a structural econometric analysis. Journal of monetary economics, v. 44, n. 2, p. 195-222, 1999.
- [24] HENZEL, Steffen; WOLLMERSHAEUSER, Timo. The new Keynesian Phillips curve and the role of expectations: evidence from the IFO World Economic Survey. Munich: CESifo, March 2006. (CESifo Working Paper, n. 1.694). Disponível em: <[http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=895044](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=895044)>. Acesso em: 13 abr. 2014.
- [25] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. 2013. Disponível em: <[www.ibge.gov.br](http://www.ibge.gov.br)>. Acesso em: 18 ago. 2013.
- [26] INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. Pesquisa Mensal de Emprego (Antiga Metodologia). 2014. Disponível em: <<http://www.ibge.gov.br/home/estatistica/indicadores/trabalhoemprego/pme/pmemet2.shtm>>. Acesso em: 01 jun. 2014.
- [27] INSTITUTO DE PESQUISA ECONÔMICA APLICADA - Ipeadata. Ipeadata Macroeconômico. Disponível em: <<http://www.ipeadata.gov.br/>>. Acesso em: 21 mai. 2014.
- [28] KEYNES, John Maynard. *Teoria Geral do Emprego, do Juro e da Moeda*. São Paulo: Saraiva, 2012.
- [29] LANNE, M.; SAIKKONEN, P; LÜTKEPOHL, H. Comparison of unit root tests for time series with level shifts. Journal of Time Series Analysis, Vol. 23, p. 667-685, 2002.
- [30] LEMGRUBER, Antonio Carlos. *Real Output – Inflation trade-off, monetary growth and rational expectations in Brazil – 1950/79*, Brazilian Economic Studies, nº 8, IPEA/INPES, 1984.
- [31] LOURENÇO, Gilmar Mendes. Uma década de Real: da hiperinflação à ausência de crescimento. Análise Conjuntural, v. 26, nº 5-6, p. 2, mai/jun 2004.
- [32] LOPEZ, Francisco Lafaiete. Inflação inercial, hiperinflação e desinflação: notas e conjecturas. Revista de Economia Política, vol. 5, nº 2, 1985.
- [33] MANKIW, N. Gregory. *Introdução à economia: princípios de micro e macroeconomia/N. Gregory Mankiw; tradução da 2ª ed. Original Maria José Cyhlar Monteyro*. Rio de Janeiro: Elsevier, 2001.
- [34] MANKIW, N. Gregory; REIS, Ricardo. *Sticky information versus sticky prices: a proposal to replace the new Keynesian Phillips curve*. Quarterly journal of economics, v. 117, p. 1.295-1.328, Nov. 2002.



- [35] MAZALI, Antonio Alberto; DIVINO, José Ângelo. Real wage rigidity and the new Phillips curve: the Brazilian case. *Revista Brasileira de Economia*, 2010, vol.64, n.3, pp. 291-306.
- [36] MENDONÇA, Helder Ferreira de. Metas para inflação e variáveis macroeconômicas: uma avaliação empírica. *Anais do XXXIII Encontro Nacional de Economia*, dez. 2005. Disponível em: <<http://www.anpec.org.br/encontro2005/artigos/A05A040.pdf>>.
- [37] MENDONÇA, Mário Jorge Cardoso de; SACHSIDA, Adolfo; MEDRANO, Luis Alberto Toscano. Inflação versus desemprego: novas evidências para o Brasil. *Revista Economia Aplicada*, v.16, n.3, p. 475-500, 2012.
- [38] MENEZES FILHO, Naercio Produtividade e Salários. Insper, 2014. Disponível em: <<http://www.insper.edu.br/conhecimento/politicas-publicas/produktividade-e-salarios/>>. Acesso em: 7 set. 2014.
- [39] MUNHOZ, Dercio Garcia. *Inflação Brasileira: Os ensinamentos desde a crise dos anos 30*. *Economia Contemporânea*, nº 1, janeiro-junho, 1997.
- [40] NELSON, Charles .R.; PLOSSER, Charles I. Trends and random walks in macroeconomic time series. *Journal of Monetary Economics*, North Holland, v.8, n.10, p.139-62, 1982.
- [41] NG, Serena; PERRON, Pierre. Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica*, 69, v.6, 1519-1554, 2001
- [42] PHELPS, Edmund. *Phillips Curve, expectations off inflation and optimal unemployment over time*. *Econômica*, 1967. Disponível em: <<http://www.columbia.edu/~esp2/PhilipsCurvesExpectationsofInflationandOptimalUnemploymentOverTime.pdf>>. Acesso em: 25 jun. 2014.
- [43] PORTUGAL, Marcelo. S.; MADALOZZO, Regina. C.; HILLBRECHT, Ronald. O.. Inflation, unemployment and monetary policy in Brazil. In: *ENCONTRO BRASILEIRO DE ECONOMETRIA*. Rio de Janeiro: SBE, 1999.
- [44] RICHARDSON, Roberto Jarry. *Pesquisa social: métodos e técnicas*. São Paulo: Atlas, 1989.
- [45] SAID, E. Said; DICKEY, David A. "Testing for unit roots in autoregressive moving average models of unknown order". *Biometrika*, v. 71, n. 3, p. 599-607, Dez. 1984.
- [46] SACHSIDA, Adolfo. Inflação, desemprego e choques cambiais: uma revisão da literatura sobre a curva de Phillips no Brasil. *Texto para discussão/Instituto de pesquisa Econômica Aplicada*. – Brasília: Rio de Janeiro: IPEA, 2014.
- [47] SACHSIDA, Adolfo.; RIBEIRO, M.; SANTOS, C. H. A curva de Phillips e a experiência brasileira. Brasília: IPEA, 2009. Disponível em: <[http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td\\_1429.pdf](http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td_1429.pdf)>.
- [48] SACHSIDA, Adolfo. Reexaminando a curva de Phillips brasileira com dados de seis regiões metropolitanas. Brasília: IPEA, 2009. Disponível em: <[http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td\\_1430.pdf](http://www.ipea.gov.br/portal/images/stories/PDFs/TDs/td_1430.pdf)>. Acesso em: 20 abr. 2014.
- [49] SANTOS, Fernando Siqueira. Ascensão e queda do desemprego no Brasil: 1998-2012. ANPEC, 2013. Disponível em: <[http://www.anpec.org.br/encontro/2013/files\\_I/13-a25aa641e3de121884a9966e761431c0.pdf](http://www.anpec.org.br/encontro/2013/files_I/13-a25aa641e3de121884a9966e761431c0.pdf)>. Acesso em: 24 ago 2014.
- [50] SAMUELSON, Paul. A.; SOLOW, Robert. M. Analytical aspects of anti-inflation policy. *American economic review papers and proceedings*, v. 50, n. 2, p. 177-194, 1960.
- [51] SAIKKONEN, Pentti; LÜTKEPOHL, Helmut. Testing for a unit root in a time series with a level shift at unknown time. *Econometric Theory*, v.18, p. 313-348, 2002.
- [52] SIMS, Christopher A. Interpreting the macroeconomic time series facts: the effects of monetary policy. *European Economic Review*, p. 974-1011, 1992.
- [53] STOCK, J.H. Unit roots, structural breaks and trends. In: *Engle and McFadden Handbook of Econometrics*, v.4. Elsevier, p. 2740-2841, 1994.