ASSESSING EMPIRICAL RELATIONSHIPS BETWEEN OUTPUT GAP, INVESTMENT DECISIONS AND POTENTIAL OUTPUT FOR THE BRAZILIAN ECONOMY

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ABSTRACT: This work aims at identifying the long term effects of investment decisions, in consistence with the endogenous potential output growth hypothesis, according to which the potential output dynamics is endogenous by the demand side. It makes an empirical analysis for the Brazilian economy during the period from 1971 to 2010, through an implementation of the *Vector Autoregressive* (VAR) method. The results are consistent with the hypothesis under analysis and have important implications for the monetary policy in particular, and for the economic policy as a whole.

Key-words: Output gap. Investment decisions. Potential output. Brazil.

JEL Code: E24, E27

RESUMO: Este trabalho visa identificar os efeitos de longo prazo de decisões de investimento, de acordo com a hipótese de crescimento endógeno do produto potencial, segundo a qual a dinâmica do produto potencial é endógena pelo lado da demanda. É feita uma análise empírica para a economia brasileira durante o período de 1971 a 2010, utilizando o método de vetor autoregressivo (VAR).). Os resultados são consistentes com a hipótese em análise e têm importantes implicações para a política monetária, em particular, e para a política econômica como um todo.

Key-words: Hiato do produto. Decisões de investimento. Produto potencial. Brasil.

Código JEL: E24, E27

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I INTRODUCTION

There is an ancient controversy in the macroeconomic thought with regard to the determination of the potential output. In the conventional or mainstream theory, the potential output would be determined only by the real resources dynamics: basically the labor force and technological stocks, and the agents' preferences pattern. Under this perspective, "money does not matter"; it means that the monetary policy cannot affect the real economic side in the long term. It is important to explain more precisely this orthodox idea: monetary policies influence the output gap trajectory, however the mainstream theory considers this kind of effect as verified only in a transitory term. And the money's transitory real effect would be constrained in the term in which prices are relatively inertial or while another type of market or information imperfection exists.

On the other hand, conventional theory gives little attention to an intermediate effect that can make, if observed as significant, the neutrality hypothesis without sense. That is, almost nothing is studied about the impacts of money and output variations on the investment dynamics. If output path is able to determine fixed capital investments, so it would be natural to suppose at least an indirect, but fundamental, effect of money and output on the potential output formation forward. In such a case, money matters, and the potential output cannot be given as an exogenous variable in monetary policy evaluation models. By the contrary, the potential output dynamics has to be implemented in a way in which its determination is endogenous from money or output gap fluctuations through the time (as made, for instance, by SAWYER, 2002; LAVOIE, 2006; FONTANA & PALACIO-VERA, 2007; MOREIRA, 2011).

Then, what to say about the big amount of statistical evidences in confirming the neutrality hypothesis? These evidences are associated almost integrally with models and

regressions that test for the impacts of monetary variables on the real output or unemployment rate in the long run. They do not test for the mentioned indirect effect: they do not test for the effects of monetary variables or/and output gaps variations on the fixed capital formation decisions.

Statistically, it is possible to reject the preliminary hypothesis according to which the variable A is correlated to the variable B; and, at the same time, finding evidences that confirm the hypothesis of correlation between A and another variable, C for instance. If, however, the researcher finds that the variable C is correlated (or causes) the variable B, so (s)he can suggest a kind of effect of correlation or causality between A and B, thereby making the preliminary evidence (i.e. rejection of correlation between A and B) constrained to the data, sample or specific empirical method.

Hence, so as to answer the initial question: the big amount of statistical evidences that "confirm" the neutrality hypothesis is sensible to the data, sample or specific method and should not be given as the final word about the phenomenon under analysis. In its turn, such an answer is conditional on evidences that confirm the hypothesis of causality between output gap, investments decisions and potential output. And this is the main goal of this work, from the Brazilian experience and by using the *Vector Auto-regression* (VAR) technique.

II THEORETICAL APPROACH AND SOME EMPIRICAL EVIDENCE

Rowthorn (1999) and Sawyer (2002) have introduced endogenous capital accumulation and a kind of endogenous NAIRU (*Non Accelerating Inflation Rate of Unemployment*), under post-keynesian and kaleckian ideas, and have considered the implications for the economic dynamic. Rowthorn (op. cit.), so as to understand why European unemployment had remained

persistently high since the shocks of the 1970s, proposed a model in which investments are endogenous in a variety of ways, such as by real profit and interest rates. Its main conclusion was that "*a permanent reduction in the real interest rate leads to only a temporary acceleration in economic growth but a permanent fall in unemployment.*" (ROWTHORN, 1999, p. 423), breaking off with *mainstream* results.

In the same line, Sawyer (2002) focuses on the role of the aggregate demand for influencing the dynamic of capital stock and employment under a NAIRU context. By assuming non mainstream assumptions, Sawyer (op. cit.) argues that there are long run relationships between inflation and unemployment, and between this last one and capital accumulation. The author wants to demonstrate that a reduction in the NAIRU can be achieved with a sustained increase in the level of aggregate demand, in order to stimulate investments.

Besides, Lavoie (2006) presents an *amendment* to the new consensus or mainstream model by taking into account that "*The natural rate of growth is ultimately endogenous to the demand-determined actual rate of growth*" (SETTERFIELD, 2002, p. 5). Lavoie (op. cit.) argues that, as León-Lesdema and Thirlwall (2002) have shown in an empirical study for fifteen developed countries over the post-war period, when the actual demand growth diverges from the natural rate of growth it creates a change in the natural rate that will make its value to converge to the actual demand growth.

This idea is consistent with "*the possibility of multiple equilibria, that make long-run supply forces dependent on short run disequilibrium adjustment paths induced by effective demand.*" (LAVOIE, 2006, p. 177). And with the assumption posed by León-Lesdema and Thirlwall: "*growth creates its own resources in the form of increased labour force availability and higher productivity of the labour force*" (LESDEMA and THIRLWALL, 2002, p. 452).

Empirical evidences on the endogenous natural growth rate are also found in Lanzafame (2010). The author studies the relationship between the actual and natural growth rate in twenty Italian regions over the period 1977-2003 and presents evidences that support the endogeneity hypothesis: a faster actual growth raises the natural rate of the average Italian regions by about 3-3.7 percentage points. Libanio (2009) also finds empirical evidences that support that hypothesis, but by adopting a different sample and another methodology. Twelve Latin American countries are tested from using panel data and the results suggest that: a) there are persistent effects in the gross domestic product when the economy is under shocks; b) the potential output in Latin American countries has been influenced by the actual growth rate. Both results give support for the hypothesis in which aggregate demand has long effects on the potential output. Additionally, Vogel (2009) also tests for the endogenous natural rate in Latin American countries and finds evidences on the causality from the output growth to the input growth.

Moreover, Fontana & Palacio-Vera (2007) study the implications of alternative assumptions, such as *unit root processes*, *hysteretic systems* and *multiple equilibria*, along with demand-led growth models, for the economic dynamic and the monetary policy strategy; they found that "*monetary policy does have long-run effects on output and employment*" (Fontana & Palacio-Vera, op. cit., p. 294) and "*the demand side of the market does matter in both the short and the long run*" (idem).
I present the following structural model as pointed out in Moreira (2011). Let the *gross investment rate* be:

(1) $i_t = I_t/Y_t - (I_t/Y_t)^* = \upsilon (Y_{t-1} - Y^p_{t-1})$

Equation (1) shows that gross investment rate deviations (i_t) are a positive function of the lagged output growth gap,

given $\upsilon > 0$ and let (Yt-1 – Y^pt-1) be the divergence between the effective output growth (Yt-1) and the potential output growth (Y^pt-1) in t-1; in its turn, It/Yt – (It/Yt)* is the difference between the actual gross investment rate (It/Yt) in t and the normal or desired gross investment rate (It/Yt)* in the same period.

That is, there is an accelerator effect in the determination of the investment, and on the other hand these same gross investments are determining, one period ahead, the capital or potential output formation, thereby:

(2) Y^pt = Y^pt-1 + it-1 + δt

Equation (2) illustrates the role of investments in causing the potential output growth. Potential output growth in period t is a function of its value in period t-1, of the lagged gross investment rate deviation (it-1) and of the potential output growth shock (δt), defined as a stochastic process with zero mean and fixed variance (*white noise process*), which represents productivity changes and investments innovations.

If the investment rate deviation is zero, and the shock is also zero, there exists a constant potential output growth between two periods. By including (1) in (2), an endogenous potential output growth function is specified, such as:

(3) Y^pt = Y^pt-1 + υ (Yt-2 – Y^pt-2) + δt

Equation (3) shows that the output growth gap affects the potential output growth two periods ahead. It assumes that the output gap is caused by demand fluctuations, thereby inducing higher gross investment rates above that level considered desirable in past periods. Obviously, the model with an endogenous potential output growth from the demand side assumes $\upsilon > 0$.

On the other hand, it is natural to say that an impact of investments on the potential output growth can be understood as necessarily a kind of endogeneity from the demand side, as investments are an intrinsic part of aggregate demand. Hence, the model with exogenous potential output ($\upsilon = 0$) may be regarded as a particular case of analysis. The conventional growth theory would be attached to the particular case in which there are no correlations between output gaps and the potential output, that is, to the long term money neutrality hypothesis[1].

From (1) – (3), a kind of *cumulative causation* between the potential growth and investments is clear: changes in the last one affect the first one ahead, and on the other hand this last effect has an ultimately impact on investments again ahead.

These mutual relationships between both the variables imply opportunities for a better monetary policy's calibration, under a non-conventional Central Bank. According to Moreira (2011, p. 315), "*[…] if potential output is really under an effect of output gaps, interest rate responses should be adjusted, that is, if there is endogenous potential output from the demand side, the central bank should take into account, within the model for policy evaluation, the effects of lagged interest rate variations on potential output. On the other hand, if the central bank does not take these causal relationships into account, there will be real losses in the long term, translated by potential output losses*".

And by developing the argument, "*If the central bank estimates this channel of transmission, increases in interest rates will be lower than the increase if central bank does not*

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[1] The conventional theory also assumes that the potential output is endogenous, but not by the demand side. The potential output would be determined only by the supply side, or through real factors such as resources stocks and factors productivity. This perspective is implicit in Kohn's (2003) words: "*assessments of the level and growth of potential GDP must be revised frequently, and of course these variables are not under the control of the central bank*".

take endogenous potential output into consideration. It is not necessary to impose integral reduction of future inflation through future output contractions because current output gaps will impose potential output gains ahead. This channel of transmission requires an adjusted instrument rule for monetary policy under inflation targeting regime" (MOREIRA, 2011, p. 316).

III DATA AND EMPIRICAL METHODOLOGY

It makes an empirical analysis based on the annual rate of real change of both the *gross fixed capital formation (I_t)* and the *gross domestic product (Y_t),* for the Brazilian economy during the period from 1971 to 2010 (Source: Brazilian Institute of Geography and Statistics or IBGE – *www.ibge.gov.br*).

It is well known that the potential gross domestic product is not observed directly, thereby requiring the implementation of proxies or statistical filters, which allow the behavior of this growth trend to be inferred.

The *Hodrick-Prescott Filter (HP)* was adopted as a method of extracting both the *potential* annual growth of the gross domestic product (Y^p) and the annual growth *gap* of the gross domestic product (Y^c) from Y_t. It is important to say that the HP Filter has been broadly applied in several empirical macroeconomic studies. After Y^p and Y^c time series are extracted, the time interdependent relationships between Y^c and I_t, and between I_t and Y^p, are tested under the sample period, through adopting two *Vector Autoregressive* (VAR) models.

The methodology of implementation has the following structure: a) *unit root tests* are made so as to verify the integration order of each series (Y^p, Y^c and I_t); b) it identifies the *optimal lag structure* for the VAR models, in separate sections; c) it defines the *Cholesky's ordering*, by applying *Granger-*

causality tests, for each VAR model; d) it analyzes the *variance decomposition* and the *impulse responses* for each VAR model.

IV EMPIRICAL RESULTS

4.1 Descriptive statistics and unit root tests

Descriptive statistics of both I_t, Y_t, Y^p_t and Y^c_t, for the sample period, as well as their graphical behavior are presented below (Table 1 and Graph 1):

Table 1 – Descriptive Statistics

| Statistics	I_t	Y_t	Y^p_t	Y^c_t
Mean	3.98	4.11	4.11	-4.57E-14
Median	4.32	4.36	2.98	0.01
Maximum	22.59	13.97	12.22	5.17
Minimum	-16.33	-4.35	1.86	-7.86
Std. Dev.	9.85	4.16	2.70	3.05

Source: Own elaboration from E-views 6 outputs.

It is possible to verify a smooth and evident reduction of Y^p_t from 1971 to 1991; after that, the annual growth of potential gross domestic product increases marginally until 2010. This behavior, obviously, depends on the Y_t dynamics, given the first one is extracted through applying the HP filter on the last one.

The Brazilian economy experimented a strong annual rate of real change of GDP (Y_t) in the 70's, but the 80's were the "lost decade" in economic activity terms. Hence, the mean Y_t was from the richest 8.61% between 1971 and 1979, to the poorest 2.24% between 1980 and 1991. And in the 1992-2010 period, the mean Y_t was the modest 3.16%. As Table 1 shows,

the 1971-2010 period presents mean Y_t of 4.11%, but one can say this rate is caused broadly by the 70's years.

Graph 1 – Time series behavior in the sample 1971-2010
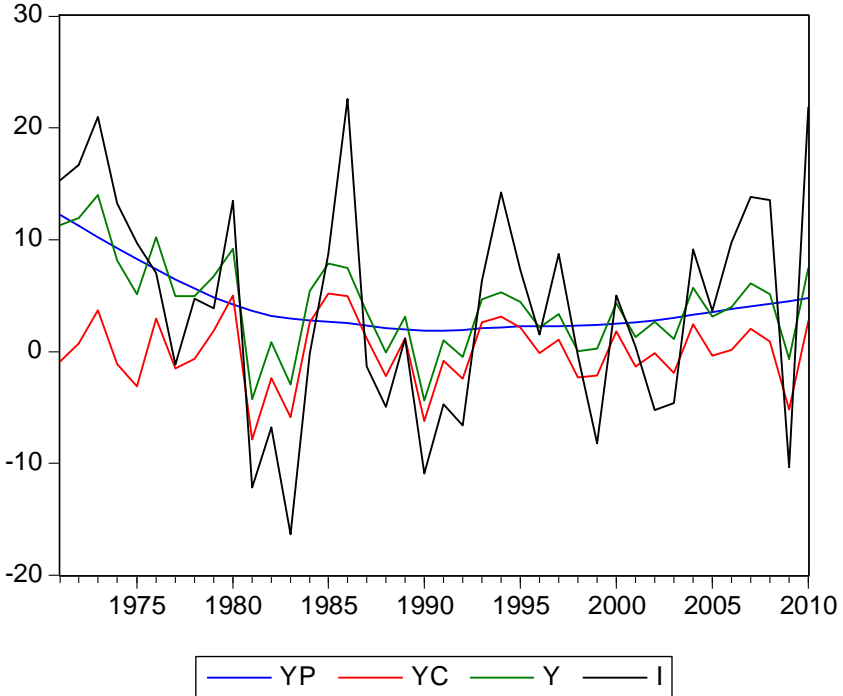
In its turn, the annual rate of real change of *gross fixed capital formation (I_t)* is clearly more volatile than Y_t, and so than Y^p_t, what is showed by the standard deviation for these variables; this remark is consistent with the styled fact according to which investment cycles present higher volatility than output cycles. Unit root tests were made and their statistics are in Table 2. The *Augmented Dickey-Fuller* (ADF) and *Phillips-Perron* (PP) tests were chosen as means of verifying the integration order of I_t, Y^p_t and Y^c_t (it is not necessary to apply the tests on

Y_t, because it will not be used in the VAR exercises). These previous unit root tests are fundamental in order to prevent time series analysis from generating spurious results (Granger & Newbold, 1974). All the variables are considered stationary through ADF and PP tests. In the first one, the null hypothesis of unit root is rejected with significance at 1% for I_t and for Y^c_t, and at 10% for Y^p_t. In the PP test, on the other hand, the null hypothesis of unit root is rejected with significance at 1% for all the variables.

Table 2 – Unit Root Tests - ADF and PP

Variable	Tests			
	ADF	Critical Value	PP	Critical Value
I_t (I)	-3.926339***	1%(-2.62)	-3.850543***	1%(-2.62)
Y^p_t (II)	-3.367302*	10%(-3.20)	-5.775296***	1%(-4.21)
Y^c_t (II)	-6.152349***	1%(-2.62)	-8.374512***	1%(-2.62)

Source: Own elaboration from E-views 6 outputs.
Notes: (I) Significant model: without constant and trend; (II) Significant model: constant and trend with significance at 5%; (***) significance at 1%; (*) significance at 10%.

4.2 Analysis of Y^c_t and I_t

It was applied the identification of the optimal lag length for the VAR model (Y^c_t and I_t), based on information criteria, such as *Akaike Information Criterion* (AIC), *Schwarz Criterion* (SC) and *Hannan-Quinn Criterion* (HQ), which are generally adopted as measures of good fitness to the data.

The Table 3 (Appendix) presents AIC, SC and HQ statistics for each of the tested VAR models – from the VAR (0) to the VAR(6), that is, from the VAR with the lag order equal to zero to the VAR with the lag order equal to six, each of them with

and without a constant. The lower the statistics the better the fitness or adherence to the data. Although the VAR(0) with a constant has presented the lower values for all the criteria, the estimation sample showed that the best VAR model with Granger-causality from Y^c_t to I_t was the VAR(5) without a constant. Hence, the VAR model can be expressed through the following specification:

$$(4)\ X_t = \alpha + A \sum_{i=1}^{k} X_{t-1} + \nu_t$$

Given X the endogenous variables vector (Y^c_t and I_t), α the equations' constants vector (which in this specification does not exist), A the coefficients vector and ν the white-noise shocks vector, given moreover $k = 5$ the VAR model's lag order. Therefore, it generates the following vector equations system:

$$(I.1)\ I_t = a_1 I_{t-1} + a_2 I_{t-2} + a_3 I_{t-3} + a_4 I_{t-4} + a_5 I_{t-5} + b_1 Y^c_{t-1} + b_2 Y^c_{t-2} + b_3 Y^c_{t-3} + b_4 Y^c_{t-4} + b_5 Y^c_{t-5} + \nu_{1t}$$

$$(I.2)\ Y^c_t = c_1 Y^c_{t-1} + c_2 Y^c_{t-2} + c_3 Y^c_{t-3} + c_4 Y^c_{t-4} + c_5 Y^c_{t-5} + d_1 I_{t-1} + d_2 I_{t-2} + d_3 I_{t-3} + d_4 I_{t-4} + d_5 I_{t-5} + \nu_{2t}$$

Before testing impulse-response functions between both the variables, it is important to identify the *Cholesky ordering[2]*, which imposes restrictions on the VAR specification and by doing so it influences on the impulse-response results. The identification of the Cholesky ordering was made just as it is

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[2] The Cholesky order establishes the exogenous/endogenous sequence between variables into a VAR model. That is, by making the Cholesky ordering, it imposes a sequence from the more exogenous variable to the more endogenous variable, under a contemporaneous causality sense.

commonly in the literature, by applying the Granger-causality test on both the variables in the VAR(5) model (Table 4).

Table 4 – Granger-Causality Tests for VAR(5) model

	Dependent variable				
		Y^c_t		I_t	
		Chi-sq	Prob.	Chi-sq	Prob.
Cause	I_t	1.33361	0.9314	Y^c_t 13.68527	0.0177

Source: Own elaboration.

The Granger-causality test rejected the null-hypothesis of a non-Granger causality from Y^c_t to I_t, but not from I_t to Y^p_t.

4.3 Analysis of I_t and Y^p_t.

The Table 5 (Appendix) presents AIC, SC and HQ statistics for each of the tested VAR models – from the VAR (0) to the VAR(6) – and the results suggest a VAR(4) with a constant as the best specification. Moreover, this last one showed a mutual Granger-causality between both the variables.

Hence, the VAR model can be expressed through the following specification:

$$(II.1)\ I_t = \alpha_1 + a_1 I_{t-1} + a_2 I_{t-2} + a_3 I_{t-3} + a_4 I_{t-4} + b_1 Y^p_{t-1} + b_2 Y^p_{t-2} + b_3 Y^p_{t-3} + b_4 Y^p_{t-4} + \nu_{1t}$$

$$(II.2)\ Y^p_t = \alpha_2 + c_1 Y^p_{t-1} + c_2 Y^p_{t-2} + c_3 Y^p_{t-3} + c_4 Y^p_{t-4} + d_1 I_{t-1} + d_2 I_{t-2} + d_3 I_{t-3} + d_4 I_{t-4} + \nu_{2t}$$

The Table 6 presents the Granger causality tests for the VAR (4) model. It rejected the null-hypothesis of a non-Granger causality from Y^p_t to I_t, and also from I_t to Y^p_t; in other words,

the variables are considered as determining themselves mutually through the time[3].

Table 6 – Granger-Causality Tests for VAR(4) model

|		Dependent Variable				
		I_t			Y^p_t	
		Chi-sq	Prob.		Chi-sq	Prob.
Cause	Y^p_t	38.14733	0.0000	I_t	35.15944	0.0000

Source: Own elaboration.

4.4 Impulse-response and variance decomposition analysis

The Figure 1 shows the response of I_t from positive shocks in Y^c_t – in the second line and first column – for 10 years forward. The annual rate of real change of *gross fixed capital formation (I_t)* stays above its normal value until the second year after the positive shock. From the second to around the seventh year, on the other hand, I_t stays below its normal value, and walks above its normal value again from around the seventh to the tenth year from the Y^c_t positive shock. It is important to note that this kind of investment cycle is a styled fact and so it is expected by the theoretical approach. This *a posteriori* negative response can be explained by the firms' fixed capital stabilizing decisions, that is, the initial increase in the potential output growth is translated by firms as a reduction in their capital marginal efficiency, which leads to a lower amount of new investments.

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[3] Although both the variables rejected the null-hypothesis, and so are regarded as Granger-causes of the other, it was chosen the Cholesky ordering $Y^p_t - I_t$, that is, Y^p_t was considered technically more exogenous than I_t, as the first one obtained the lower Chi-square statistics.

Figure 1 – Impulse Responses from VAR(5) model through 10 years

$(I = I_t$ and $YC = Y^c_t)$
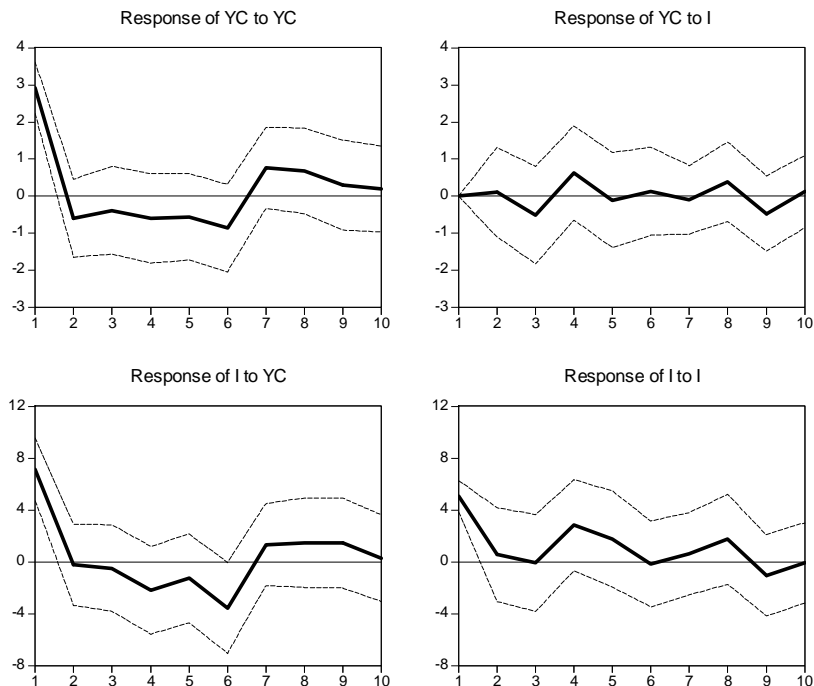
Source: Own elaboration.

In its turn, the Table 7 (Appendix) presents the variance decomposition of both I_t and Y^c_t. See that after 10 years from the occurrence of shocks, 35.2% of the I_t variance are determined by variations in itself, while approximately 64.7% depend on Y^c_t changes, thereby showing that investment decisions are highly correlated with output gaps in the short term. As it was verified, Y^c_t Granger-causes I_t and it means that Y^c_t shocks are followed with time lags by I_t variations. Such a behavior is useful in confirming the hypothesis of an endogenous potential output as it was exposed in the theoretical section. However, before

saying this last one is a good hypothesis for the Brazilian recent case, it is necessary to assess empirical relationships between I_t and the potential output growth.

Therefore, the Figure 2 shows impulse-response functions between I_t and Y^p_t. Firstly, it was observed that fixed capital investments annual changes Granger-cause, in a positive direction, the potential output real change, that is, under the adopted sample, positive shocks on the annual rate of real change of *gross fixed capital formation* (I_t) are followed, with time lags, by an increase in the annual growth of potential gross domestic product (YPT) (see in the second line and first column).

Specifically, this shock in I_t leads to an growth of YPT that will be verified only after three years. This expressive effect lag is due, for supposition, to the fixed capital investments' maturity time. Moreover, even after ten years YPT is above its natural level, as a consequence of the positive I_t shock. This kind of effect is in convergence to the endogenous potential hypothesis, as YPT is determined through I_t in a permanent way.

On the other hand, YPT positive shocks are followed by short term reductions in I_t (see second column and first line). This initial negative response attains a floor after two years, and it can be explained by means of the firms' fixed capital stabilizing decisions, as it was mentioned above. Keynes (1936) argued that this type of stabilizing decisions, among others, is fundamental to the general stability of the economic system.

However, after three years I_t begins to be above its natural level, which occurs until the ninth year. It is easy to observe the higher volatile behavior of I_t, as a consequence of a YPT shocks, in comparison with the last one dynamics from a I_t shock. The higher volatility in I_t responses can be explained by the firms' expectations changes (the animal spirits component).

Another way of identifying this higher inertial behavior of YPT, in comparison with I_t, can be found in the responses of

both the variables from shocks in themselves. The response of I_t from a positive shock in itself (first line and column) presents a well-behaved cycle, while the YPT response from a positive shock in itself (second line and column) does not: even after ten years it is above its normal value.

The Table 8 (Appendix) shows the variance decomposition of both I_t and YPT. After 10 years from the occurrence of shocks, 62.5% of the I_t variance are determined by variations in itself, while approximately 37.4% depend on YPT changes. This variance pattern also reveals the more volatile behavior of I_t in comparison with YPT. After 10 years from shocks, only 5.6% of the last one's variances are explained through fixed capital investment changes, while approximately 94.3% are determined by YPT changes.

These evidences suggest an important proposition: although positive shocks in I_t lead to increases in YPT with permanent effects, YPT change is higher when it is impacted by shocks in itself. Shocks in YPT can be understood, for instance, as changes in productive forces through labor and capital quantity/quality variations and *via* knowledge modifications. This proposition does not make the money and monetary policies less important for a country that aims at improving its potential output dynamics. On the other hand, the economic policy can become more efficient as it implements monetary decisions and strategies along with policies in other important areas such as labor upgrade, technological, educational and scientific development.

Figure 2 – Impulse Responses from VAR(4) model through 10 years
(I = I_t and YPT = Y^p_t)

| Response of I to I | Response of I to YPT |
| Response of YPT to I | Response of YPT to YPT |
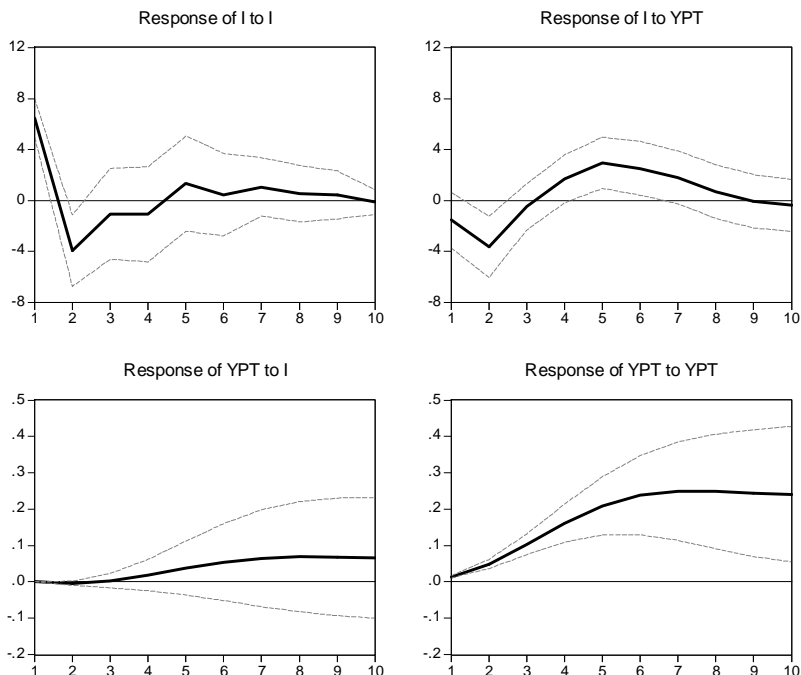
Source: Own elaboration.

V CONCLUDING REMARKS

Some propositions can be summarized for the Brazilian economy in particular: i) The Brazilian Central Bank should take the endogenous potential relationships into account when setting its policy interest rate and strategy in offsetting shocks on the economy. It can be made broadly through an interest rate rule that calibrates for the effects of output gap and investments changes on the potential output ahead, following Moreira (2011); ii) A strategy for continuous and sustainable improvements of the potential output growth should be made coordinately among monetary policies and other important policies, such as fiscal, labor, educational and technological

policies, which are able to impose positive shocks directly on the potential output.

This work can be thought as a first draft of a broad research. Then, some initial limitations and ways by which it can be improved are natural. Firstly, the empirical method can be changed in order to test for the sensibility and robustness of the main evidences, along with an implementation on other countries and time samples. Moreover, it is important to test for other types of potential output proxies, as the adopted proxy in this work is not the unique available method. At last, the evidences of an endogenous potential output have to give an informational foundation that stimulates new developments in the economic policy theory, which has impact in the policymakers' practice. However, the lag between the theory and the operational implementation of its insights is not so simple. In many cases, difficulties require approximations and developments in other areas. For instance, developments in YPT growth estimation techniques and in data availability are an important step in supporting the Central Bank's decisions when taking the hypothesis of this work into account.

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Appendix

Table 3 – Lag Length Criteria for the VAR model (Y^c_t and I_t)

Lag	AIC	SC	HQ
	With Constant		
0	11.27771*	11.36750*	11.30833*
1	11.38702	11.65637	11.47887
2	11.48911	11.93804	11.64221
3	11.56377	12.19228	11.77811
4	11.6916	12.49967	11.96717
5	11.57674	12.56439	11.91356
6	11.47571	12.64293	11.87376
	Without Constant		
1	11.41977*	11.59935*	11.48101*
2	11.48283	11.84197	11.6053
3	11.50712	12.04584	11.69084
4	11.62523	12.34352	11.87018
5	11.51437	12.41223	11.82057
6	11.45476	12.53219	11.82219

Source: Own elaboration.

Table 5 – Lag Length Criteria for the VAR model (I_t and Y^p_t)

Lags	AIC	SC	HQ
With constant			
0	10.4749	10.56469	10.50552
1	7.595981	7.865339	7.68784
2	2.780571	3.229501	2.933669
3	2.061409	2.68991	2.275746
4	1.439616*	2.247689*	1.715192*
5	1.585149	2.572794	1.921964
6	1.697615	2.864832	2.09567
Without constant			
1	7.877483	8.057055	7.938722
2	2.7819	3.141044	2.904378
3	2.009889	2.548605	2.193607
4	1.547994*	2.266282*	1.792951*
5	1.726382	2.624241	2.032577
6	1.836704	2.914135	2.204138

Source: Own elaboration.

Table 7 – Variance Decomposition through 10 years (I_t and Y^c_t)

Variance Decomposition of Y^c_t		
Year	Y^c_t	I_t
1	100	0
2	99.8767	0.123343
3	97.0058	2.994215
4	93.3621	6.637913
5	93.4444	6.5556
6	93.7373	6.262754
7	93.962	6.037982
8	93.0313	6.968739
9	91.4568	8.543221
10	91.3782	8.621825
Variance Decomposition of I_t		
Year	Y^c_t	I_t
1	66.5126	33.48736
2	66.2595	33.74051
3	66.3568	33.6432
4	62.2318	37.76821
5	60.8147	39.18533
6	65.3863	34.61371
7	65.719	34.28101
8	64.6366	35.3634
9	64.6915	35.30847
10	64.713	35.28699

Source: Own elaboration.

Table 8 – Variance Decomposition through 10 years (I_t and Y^p_t)

Year	I_t	Y^p_t
Variance decomposition of I_t		
1	94.6312	5.368799
2	78.5487	21.45126
3	78.6071	21.39291
4	76.0418	23.95822
5	69.0631	30.93688
6	64.5339	35.4661
7	62.8152	37.18483
8	62.6174	37.38257
9	62.6843	37.3157
10	62.5985	37.40152
Variance decomposition of Y^p_t		
1	0	100
2	0.58373	99.41627
3	0.19635	99.80365
4	0.9368	99.0632
5	2.14442	97.85558
6	3.2912	96.7088
7	4.25352	95.74648
8	4.9506	95.0494
9	5.39706	94.60294
10	5.64097	94.35903

Source: Own elaboration.