THE BRAZILIAN OUTPUT GAP - 1980-2019

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Abstract

The present study analyses the evolution of the output gap in the Brazilian economy and its activities, between 1980 and the real time estimated gap for the second quarter of 2019. To calculate potential output, methods of Production Function, linear, quadratic and exponential trend extraction, moving averages of 4 and 8 quarters and the Hodrick-Prescott (HP) Filter are used. The mean of all statistical metrics is used for analysis of the activity output gap. It was found that Brazil passed through one of its worst recessions between 2014 and 2016, which left the country in a more distant position from its potential output, with strongly negative output gaps in output and activity.

Keywords: Output Potential, Output Gap, Hodrick-Prescott (HP) Filter, Production Function, GDP.

JEL classification: E00, E17, E66.

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1 INTRODUCTION

Brazil suffered one of its largest recessions in history between 2014 and 2016 and recorded, after said crisis, low rates of growth resulting in the highest levels of negative output gap in the historical data series, which began in 1982. However, the output gap results diverge significantly between estimation methods, demonstrating the uncertainty and fragility of its calculation.

The present study proposes, through calculation of the output gap through six statistical metrics and the production function, to bring greater robustness to the analysis of potential output by contextualizing it within Brazilian economic history, particularly that related to economic cycles. Besides the calculation of the output gap for the aggregate economy, an innovation of the present article is the calculation of the output gap for activities presenting greater relevance in the composition of GDP on the side of supply.

The article is divided into five sections, including the introduction. The second section presents the estimation methods used to elaborate potential output, to measure the output gap calculated for Brazil since 1980. In the third section, a historic-economic analysis of the output gap in Brazil is carried out in order to contextualize fluctuations in the output gap within Brazilian cycles. The fourth section presents measurement of the output gap for certain activities relevant to GDP and, finally, the fifth section contains the conclusion.

2 POTENTIAL OUTPUT ESTIMATION METHODS[1]

Measurement of potential output is not a consensus among academics, as it is a non-observable variable with various estimation methods. It is commonly defined as maximum growth of the economy without generating inflation acceleration. As it is defined and estimated in different ways, its result will depend on the conceptual approach and methodology used.

In the present study, seven methods were used for estimation of the output gap, which were consolidated into two results: (i) through production function (Cobb-Douglas with constant returns to scale); and, (ii) means of six statistical metrics. The decision to estimate output gap through seven metrics was made to eliminate any disparities in their measurement, besides making the analysis more robust, since characteristic biases of the statistical methods can be minimized with the combination of

[1] For details of the various potential output estimation methods see Elisa Carvalho de Andrade, "POTENTIAL OUTPUT: An analysis for Brazil (1980-2018) (PRODUTO POTENCIAL: Uma análise para o Brasil (1980 – 2018)), Monography presented to the Economic Sciences Course at the Fluminense Federal University (Ciências Econômicas da Universidade Federal Fluminense) as a partial requirement for the Bachelor's Degree in Economic Sciences (Grau de Bacharel em Ciências Econômicas)", 2018, mimeo.

the six metrics estimates. The output gap series calculated in the present study can be found below; along with a comparison between their results.

2.1 – Output gap through production function

The output gap, estimated through the Production Function, was calculated with reference to Study for Discussion no. 17 of the Central Bank (Trabalho para Discussão nº 17, do Banco Central) (SILVA FILHO, 2001)[2]. The adopted Production Function was that of Cobb-Douglas with constant returns to scale. Besides the quarterly Brazilian GDP, the following variables were used to estimate potential output through this method: de-seasonalised GDP at constant price; quarterly Gross Fixed Capital Formation (GFCF), at de-seasonalised constant price; quarterly, de-seasonalised Installed Capacity Utilization Rate of the manufacturing industry (ICUR); Economically Active Population (EAP); and, unemployment rate.

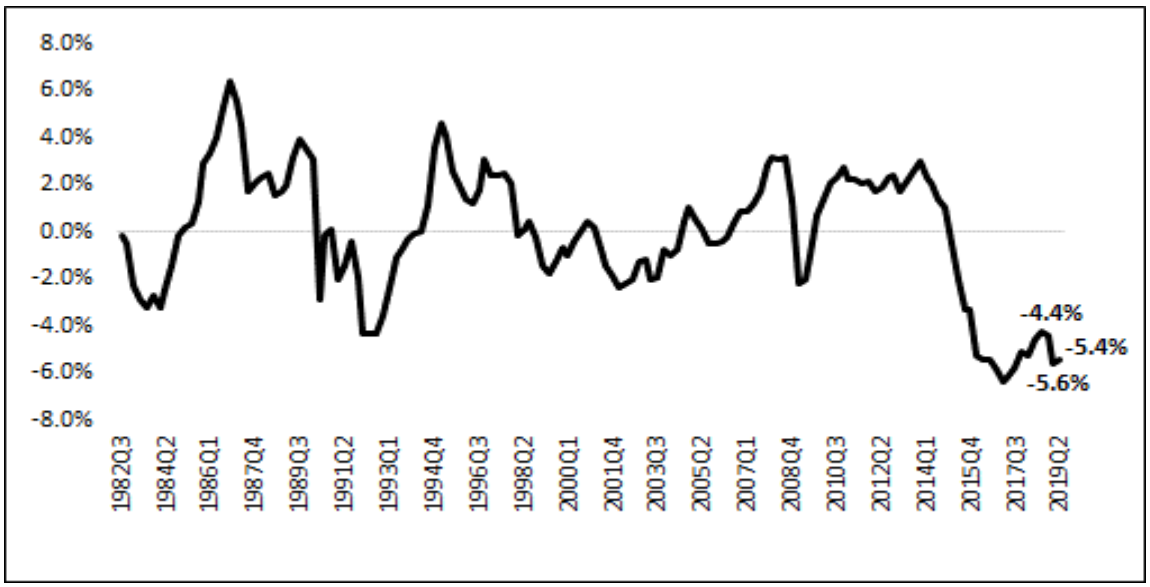
For the result of the second quarter of 2019, projections were made for the information for June, which were obtained by combining the effective data already published for April and May. The projection was only unnecessary for the ICUR of the manufacturing industry, given that the result for June 2019 has already been published.

In the first quarter of 2019, output gap through the Production Function method presented an extremely negative result (-5.6%), which was even more negative than that observed up to the fourth quarter of 2018 (-4.4%). This paints a picture of stagnation in growth of potential output and a fall in effective output, with the poor contribution of Total Factor Productivity (TFP). With the projection data for the second quarter of 2019, despite still being very negative, a slight closure in the output gap to -5.4% is indicated.

A possible exercise that can be done using the Production Function is the analysis of effective output and potential output through breaking down of the portion related to the contribution of TFP, of capital and of labour. Graph 2 first portrays the evaluation of effective output for the entire available period and then separated into smaller periods.

[2] Available at: < https://www.bcb.gov.br/pec/wps/port/wps17.pdf>

Graph 1 – Output gap through the Production Function

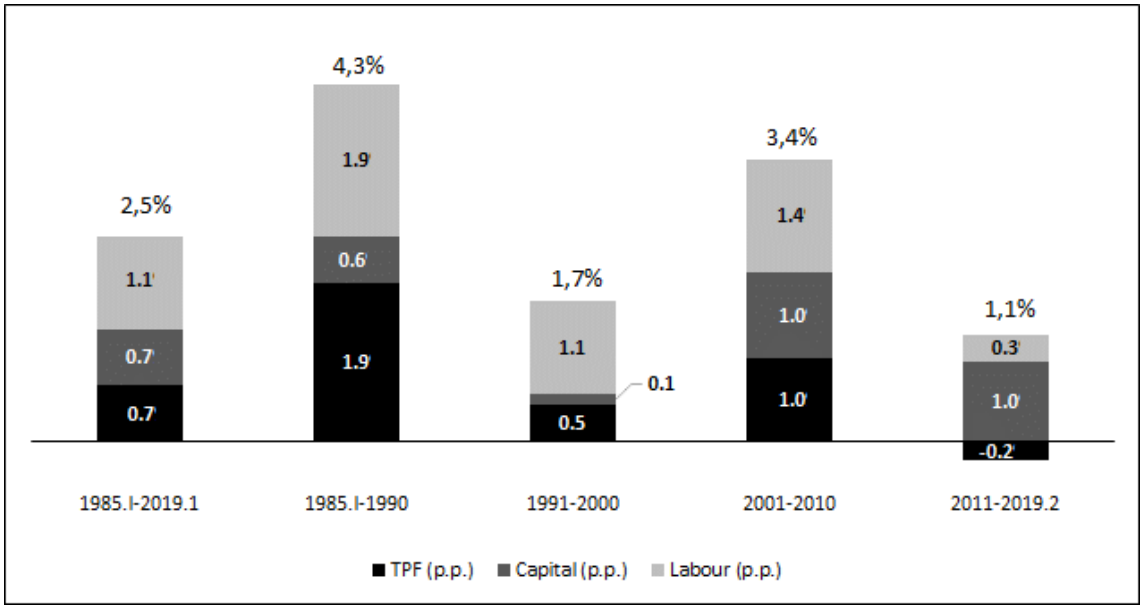


Primary Source: IBGE, Cunha (2017). Own elaboration (2019)

In the estimates of the last thirty-three years, Brazilian output grew 2.5% per year with the principal contribution of the labour factor (1.1 p.p.), with capital and TFP contributing equally with 0.7 p.p. Such growth being heavily based on the labour factor is not sustainable in the long-term, given that the increase in this factor reflects the increase in the demographic bonus during the period associated with growth in the EAP. It is expected that with aging of the population and a reduction in the birth rate, the tendency is for the labour factor to contribute negatively to output growth.

These contributions fluctuate in accordance with the fragmentation of the analysis period. As showed in Graph 2 below, the period of major growth was 1985-1990 (mean of 4.3% per year), with a strong contribution from TFP (1.9 p.p.). From 2001 to 2010, the GDP grew 3.4%, labour being that which most contributed and TFP that which presented the lowest contribution (1 p.p.). The most disastrous time of the period under analysis was between 2011 and 2019.1, with TFP contributing negatively (-0.2 p.p.), labour with only 0.3 p.p. and capital with 1 p.p., emphasizing the bad allocation of capital resources, which did not help TFP at all. This performance is alarming as it demonstrates the unsustainability of growth, since rich economies have sustainable growth based on increased productivity, not only on the accumulation of production factors.

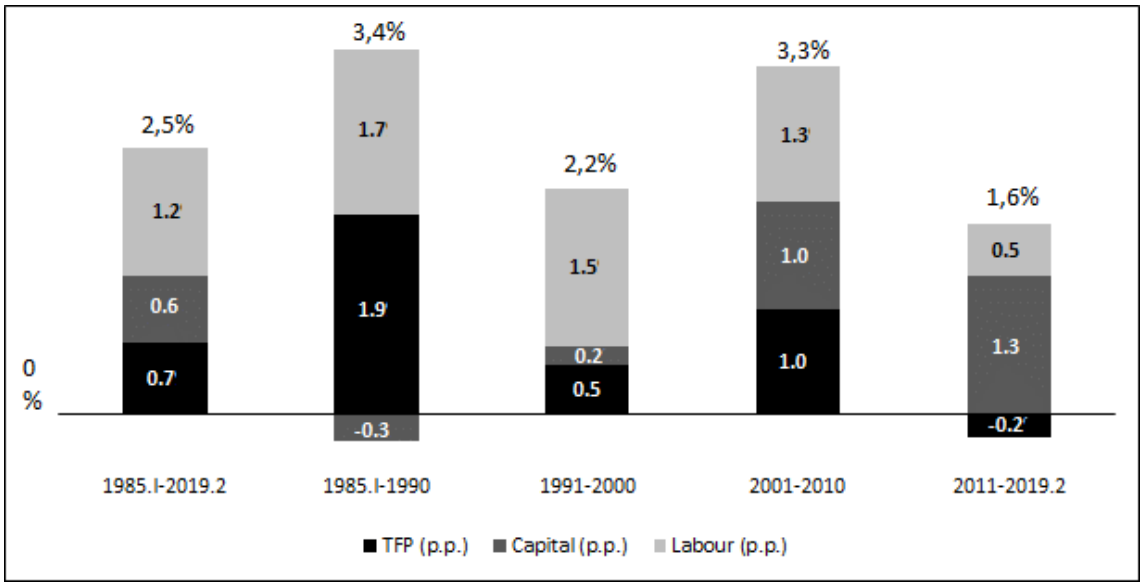
Graph 2 – Analysis of actual GDP – Annual averages – Contribution at p.p.



Primary Source: IBGE, Cunha (2017). Own elaboration (2019)

Graph 3, below, breaks potential output down into portions related to growth in TFP, potential capital and potential labour. The interpretations regarding the graph are similar to the interpretation of Graph 2, given that the proportions of the contribution to output are basically the same.

Graph 3 – Analysis of potential GDP – Annual averages – Contribution at p.p.



Primary Source: IBGE, Cunha (2017). Own elaboration (2019)

2.2 - Output gap through statistical metrics

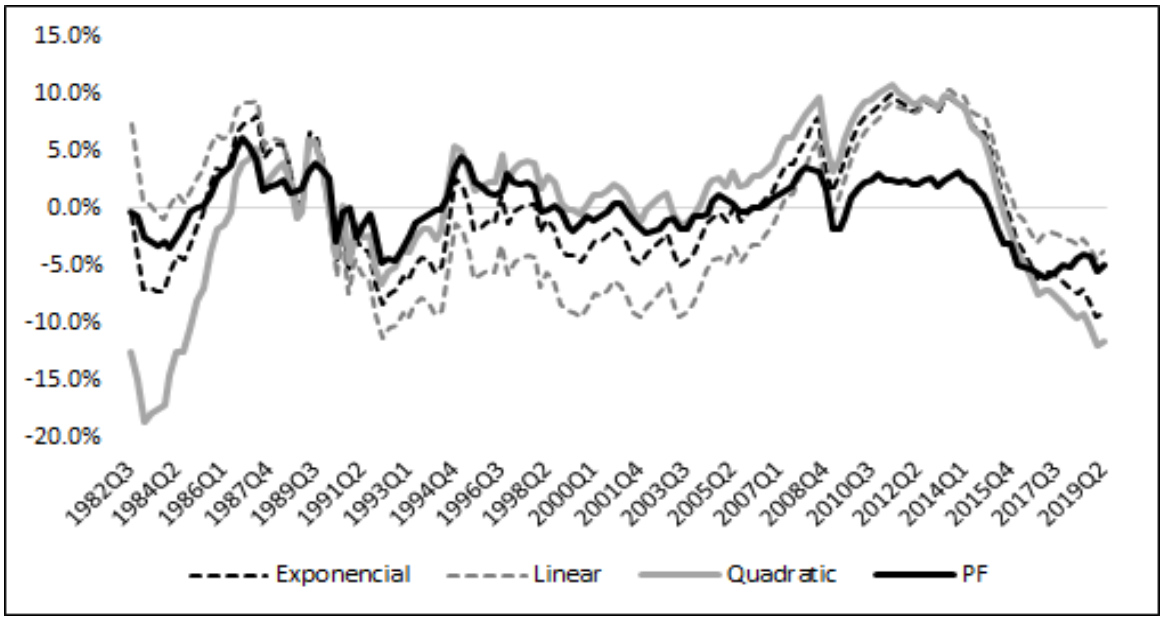
The output gap can also be calculated using statistical methods. The output gap, known as the "mean of statistical metrics" was calculated from estimation of the following metrics: (i) linear trend extraction, (ii) quadratic trend extraction, (iii) exponential trend extraction, (iv) moving averages of four quarters, (v) moving averages of eight quarters and (vi) the Hodrick-Prescott (HP) Filter. For the estimation of potential output using statistical metrics, quarterly Brazilian GDP information since 1980 was used. The output gap was obtained through the difference between effective output and potential output, estimated by the mean of statistical metrics.

For the result of the second quarter of 2019, projections were made for all GDP activities on the side of supply composing aggregated GDP. The projections for the second quarter incorporate effective data already available for April and May into their models.

To eliminate the effects of over or under estimation of the tails, characteristic of statistical filters, projections were made up to the fourth quarter of 2020. The projections for the 3rd quarter of 2019 to the 4th quarter of 2020 were calculated using ARIMA models.

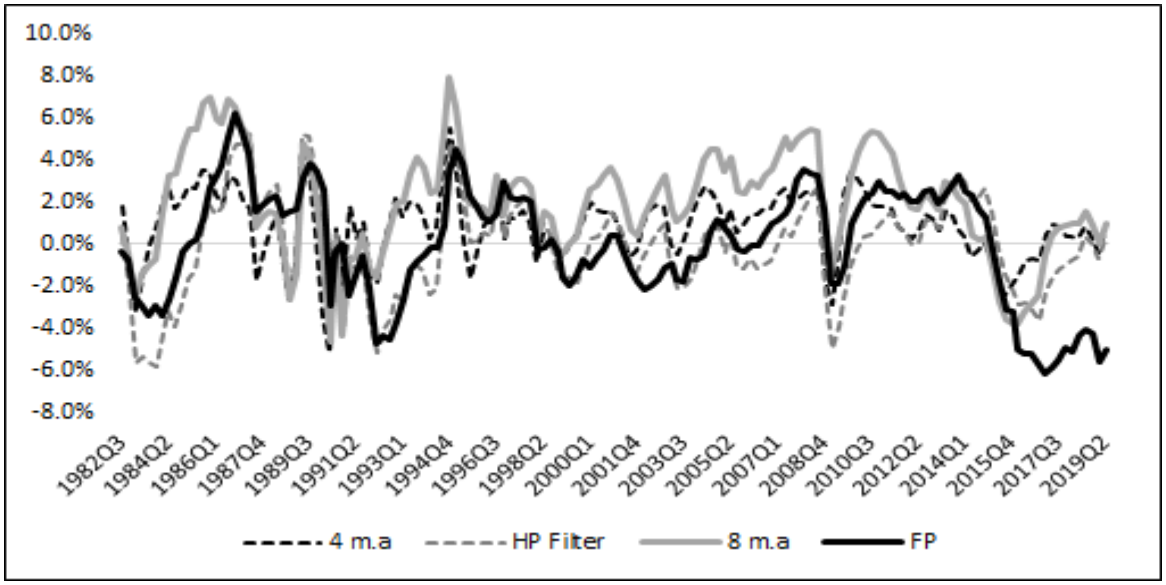
It can be observed in Graph 4 that the gaps calculated through linear, exponential and quadratic trends presented downward bias, in the recent period, indicating an effective output further from potential output. In turn, the gaps found through quarterly moving averages (4MM and 8MM) and the HP Filter in Graph 5, presented upward bias in the same period, indicating an effective output closer to its potential.

Graph 4 – Output gap through Production Function, exponential, linear and quadratic trends



Primary Source: IBGE, Cunha (2017). Own elaboration (2019)

Graph 5 – Output gap through the Production Function, moving averages of 4 and 8 quarters and HP Filter



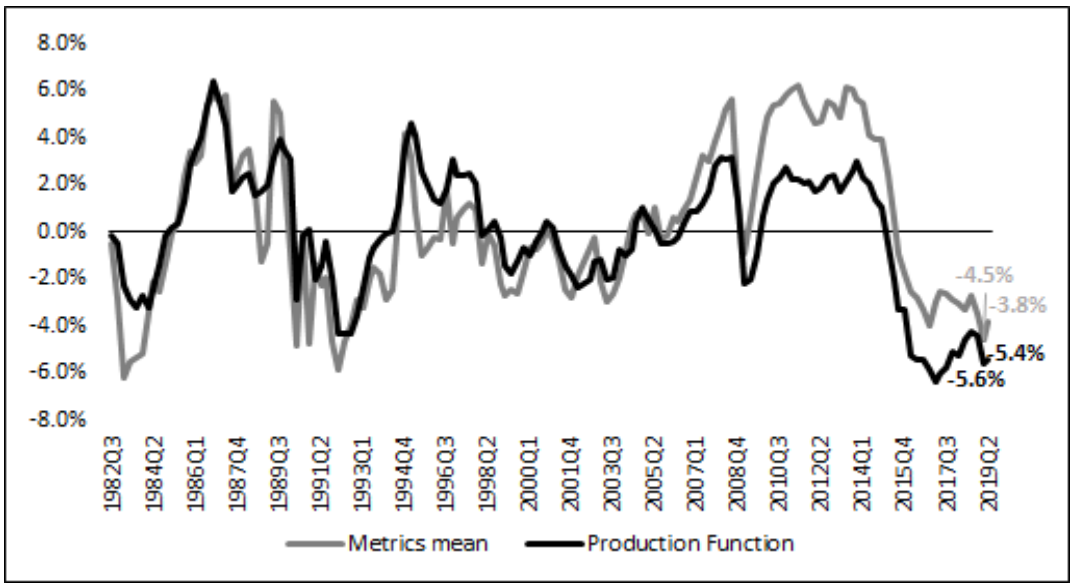
Primary Source: IBGE, Cunha (2017). Own elaboration (2019)

2.3 – Statistical metrics and the Production Function

It is possible to conclude that, depending on the metric used to measure potential output and its gap, different values will be observed, leading to different results. This fact shows the high degree of uncertainty associated with estimating this variable. Despite such disparities between the methods, all seven evaluated models follow the same trajectory.

The Production Function (PF) method obtained the mildest result, without presenting very positive or very negative behaviour, being one of the least negative on Graph 3 and the least positive on Graph 4. The moving averages method and the HP Filter method indicate that the gap would be closing in the projected period of the 2nd quarter of 2019. The linear, exponential and quadratic trends methods indicate negative amplitude for this gap, demonstrating that the economy will be well below its potential, and historically so, with continuation of its negative trajectory. The Production Function also indicates a negative gap, albeit milder than the trend methods, despite also being at one of the lowest points of the entire historical series.

Graph 6 – Output gap through the Production Function and mean metrics



Primary Source: IBGE, Cunha (2017). Own elaboration (2019)

According to the Production Function method, the lowest output gap values prior to the last recession were -3.5% in 1983.3 and 1984.2, and -4.7% in 1992.1, with quick recovery in the following quarters at both points. However, in analysing the entire series, for the two years from 2016.1 to 2018.1, which includes the last recession, the Brazilian economy operated at lower levels than the previous lowest point in the series (-4.7%), recorded in 1992.1, reaching -6.4% in 2017.1.

All the methodologies present advantages and disadvantages, but the Production Function approach manages to efficiently incorporate the possible changes that occur in the economy into its structure. Its result is in amongst the other metrics, indicating that it presents as a result that is linked with the mean of the other metrics. It can be seen that there is good adherence of the mean of the metrics to the estimate of the Production Function. The correlation between the two series is 0.83.

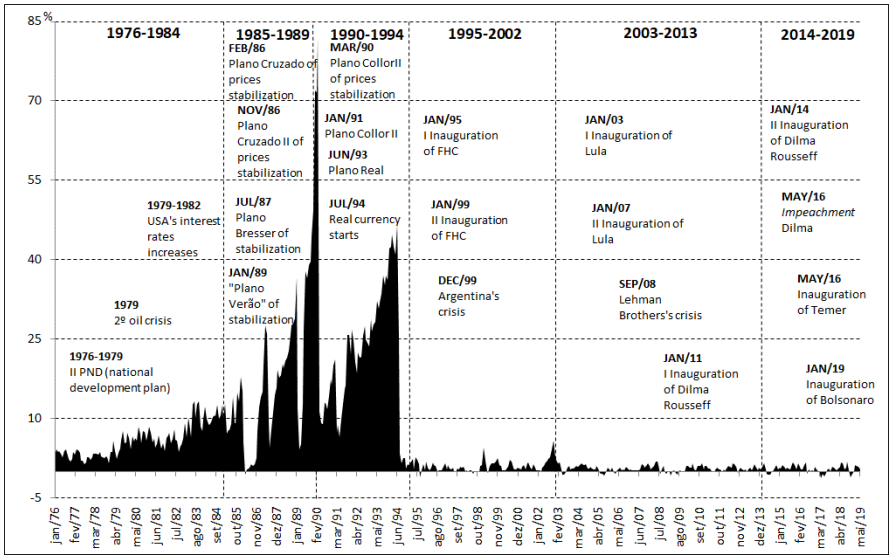
3 BRAZILIAN HISTORICAL CONTEXT

Contextualization of Brazilian output gap data with the national economic history enables better understanding of the evolution of economic activity in the country. This section aims to clarify how output gap analysis gained importance in Brazil from the mid-1990s, followed by analysis of the results of the calculated output gaps.

3.1 – Evolution of output gap analysis in Brazil

With Brazil's economic slowdown after 1980, accompanied by the unbridled increase in inflation and large-scale economic instability, seven different stabilization plans were adopted in less than ten years. These plans proved less and less effective in the reduction of inflation, which returned with renewed strength in the period following each plan, as can be seen in Graph 7, below. As such, long-term studies, including output gap analysis, lost importance to Brazilian economists, who had previously had to focus on finding solutions to the great short-term problems of the country.

Graph 7 - Monthly variation in inflation in Brazil measured by IGP-DI



Source: FGV IBRE. Own elaboration (2019)

Long-term questions associated with economic growth returned to the fore and were once again placed on the agenda of debates after the adoption of the Real Plan (Plano Real), in 1994. With the stabilization of inflation from 1995, as can be seen in Graph 7, and with the alteration of economic policy in 1999 to the so called “tripé econômico” or "economic tripod", the commitment to price levels became a central issue. This new economic policy established Central Bank's commitment to three main aspects: inflation targeting, floating exchange rate and fiscal targeting. As a result, preoccupation regarding future price levels and long-term issues, together with the debate on potential GDP, became priority for economic policymakers. This commitment to price levels was shown by Bogdanski, Tombini and Werlang (2000):

> “[...] IT involves several elements that must be properly addressed: a well-defined quantitative target for the inflation rate in the medium term; an institutional commitment to this target as the overriding

> objective of monetary policy; increased transparency of the monetary policy strategy through communication with the public and the markets about the plans of monetary authorities; and increased central bank's accountability for achieving its inflation target. " (BOGDANSKI, TOMBINI, WERLANG, 2000, p. 27)

According to Bogdanski, Tombini and Werlang (2000), the Inflation Targeting System requires monetary authorities to adopt a forward-looking attitude[3] and anticipate its movements, given the difference between a policy decision being taken and its reflex in the economy. Rather than reacting to present events, monetary policymakers should make decisions based on future inflation rates, conditioned to possible interest rate alternatives and based on the best estimate of the current state of the economy. Thus, the necessity arises to formulate models that enable the most precise exercise possible of such a judgment.

One of the ways in which Central Bank controls inflation is through the interest rate via aggregate demand, which affects the productive capacity of the economy, that is, potential output. Therefore, through estimation of the output gap, economists can identify inflationary pressures, as an elevation in this variable would indicate excess inflation. The importance of the output gap for the conducting of fiscal policy lies in the long-term evaluation of public debt, as it is important to know the capacity for growth of the economy and assess its sustainability.

3.2 – Evolution of output gap analysis during Brazilian recessions

It was found that Brazil passed through one of the worst recessions in history between the 2nd quarter of 2014 and the 4th quarter of 2016, leaving the country in a position further from its potential output, with an extremely negative output gap. This cyclical movement is natural in capitalist economies, with periods of expansion and recession. However, the last Brazilian recession stands out, not only for its duration and intensity, but also for the slow rate of economic recovery in the following periods (quarters), as per Graph 8.

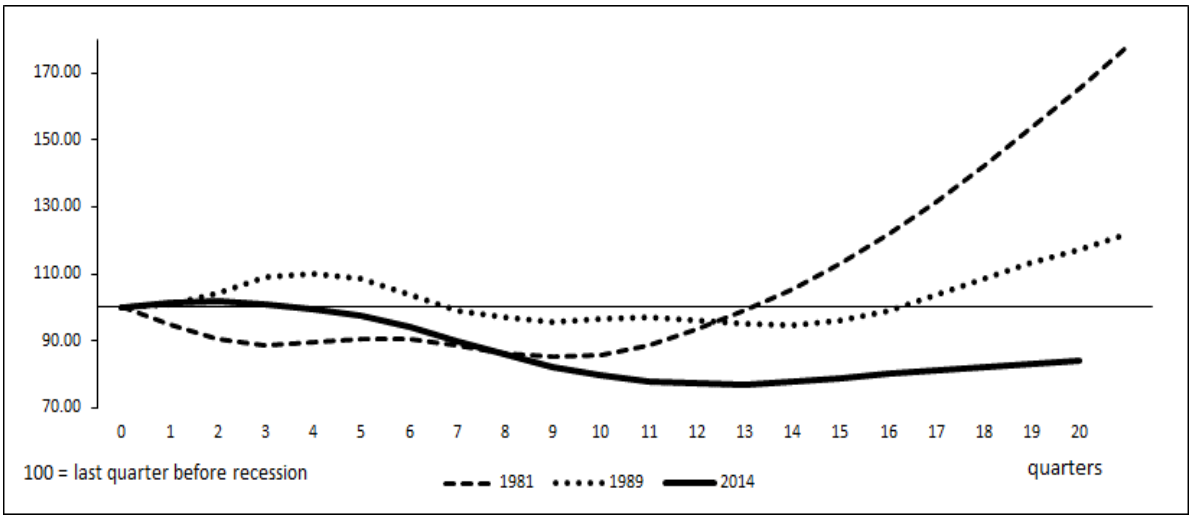
Since 1980, CODACE - The Brazilian Committee for Economic Cycle Dating (Comitê de Datação de Ciclos Econômicos brasileiro), has dated nine recessive periods in the country, with three being considered the most severe in terms of accumulated loss of GDP. The recessions began in the 1st quarter of 1981, in the 3rd quarter of 1989 and in the 2nd quarter of 2014. The latest recession is level in terms of duration with that of 1989, which lasted for eleven quarters; but, despite having the

[3] "(...) The challenge of monetary policy is to interpret data on the economy and financial markets with an eye to anticipating future inflationary forces and to countering them by taking action in advance." (GREENSPAN, Humphrey-Hawkins Testimony, 1994)

same duration, the most recent crisis presents greater slowness in recovery of the productive capacity it possessed prior to entering the recession.

Graph 8 illustrates that in the crises of 1981 and 1989, the economy could recover the pre-crisis level of GDP in 13 and 16 quarters, respectively, from the starting point. However, the recession that started in 2014, has already reached the first quarter of 2019, the last official information available, 19 quarters after its start, with the projected output for the 20th quarter still far from recovering the productive capacity it possessed prior to the recession. It is possible to state that this is the largest recession to have been faced by the Brazilian economy, since economic cycles began being more closely monitored in the 1980s.

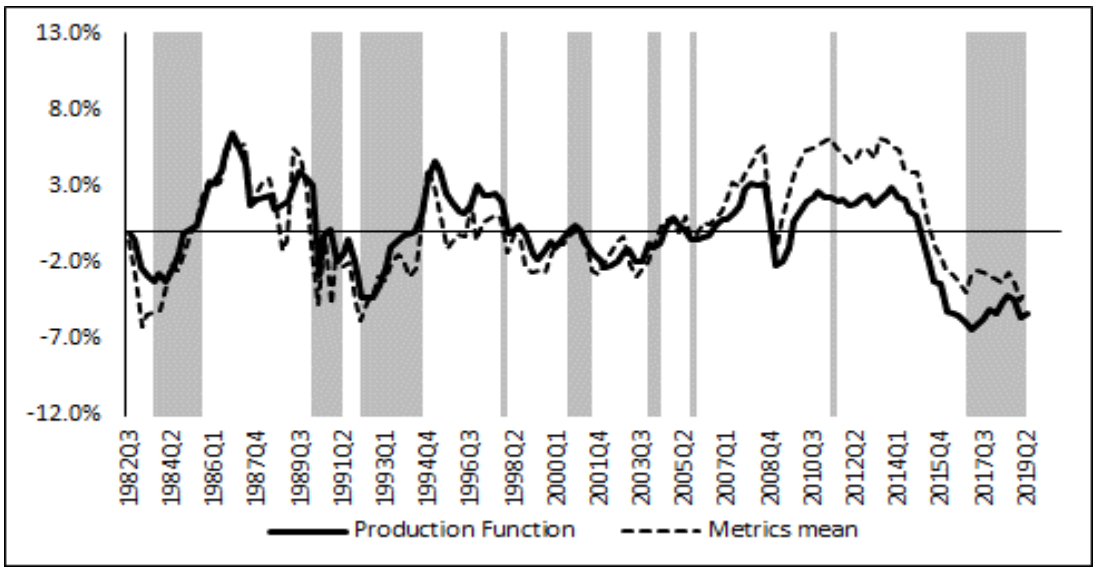
Graph 8 – Comparison of the current recession with previous recessions



Source: IBGE, Cunha (2017) and CODACE-FGV. Own elaboration (2019)

It is interesting to note that the highest positive levels of the output gap were reached in periods preceding the country's entrance into recession, and that, consequently, the lowest output gap levels are identified in the post-recession periods. After these recessive periods the economy tends to grow, and the gap tends towards zero. Both a very positive and a very negative output gap show economic imbalances, as can be observed in Graph 9, in which recessive periods dated by CODACE are marked in grey.

Graph 9 – Output gap through PF, mean metrics and recessions



Primary source: IBGE, Cunha (2017), CODACE-FGV. Own elaboration (2019)

However, there are some exceptions to this rule of a very positive gap preceding a recession. In the Brazilian reality, very positive gaps precede recessive periods, but there are also recessions that were not preceded by such high gaps. These periods are those of the recessions that started in 2001 and 2003. The former can be explained mainly by the energy crisis, the high interest rates and the strong external economic slowdown (the pre-recession era gap was 0.2% through Production Function and -0.3% through metrics mean). The 2003 recession can be explained by the reluctance of investors to invest in Brazil after the election of Lula at the end of 2002 and the possibility that economic policy might be significantly altered (-1.3% through Production Function and -0.3% by mean metrics). Both recessions were motivated by specific issues and not by more structural issues, as with most other recessions experienced in Brazil.

Similarly, there were cases of leaving the recession with positive output gaps, but even so, they were always lower than the output gaps that preceded the recession. Table 1 identifies the behaviour of the output gap before and after each of the nine Brazilian recessions.

Table 1 – Comparison of the output gap through PF and mean metrics prior to and following recession periods

Period immediately prior to recession		Period immediately following recession	
Production Function	**Metrics mean**	**Production Function**	**Metrics mean**
-	4.30%	-2.80%	-5.50%
4.50%	5.80%	2.00%	-0.50%
3.20%	5.50%	-4.30%	-4.70%
4.60%	3.20%	1.90%	-0.70%
2.10%	0.90%	-1.80%	-2.50%
0.20%	-0.30%	-2.40%	-1.80%
-1.30%	-0.30%	-2.00%	-2.60%
3.20%	5.60%	-2.00%	0.60%
2.30%	5.40%	-6.40%	-2.90%

Primary source: IBGE, Cunha (2017), CODACE-FGV. Own elaboration (2019)

4 – OUTPUT GAP FOR ECONOMIC ACTIVITIES

It is not usual to estimate the output gap of economic activity. Moreover, as capital stock data cannot be relied upon in this disaggregation, it is not possible to estimate an output gap using the Production Function method, which appears to be the most adequate for such estimates.

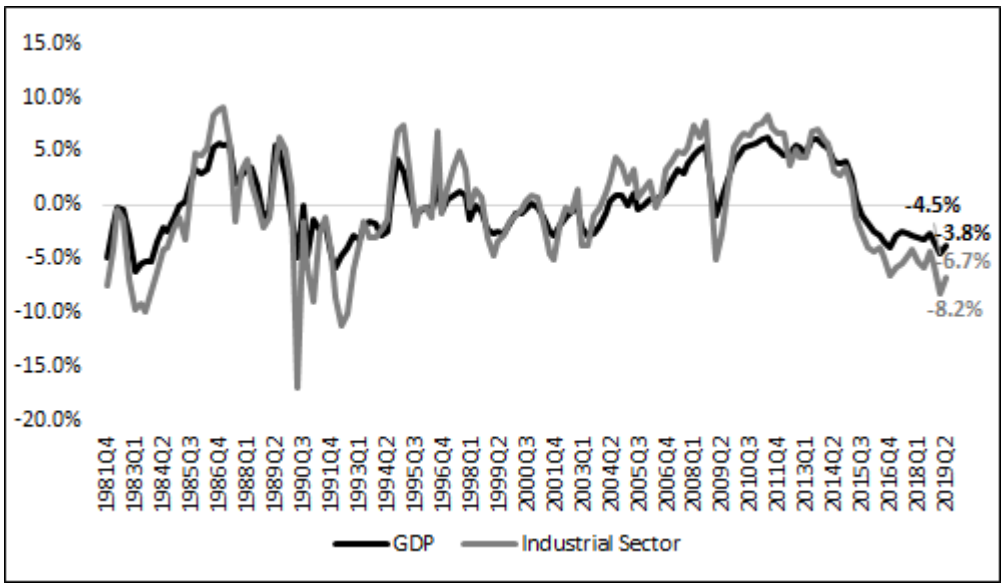
It does not make sense to make an ad hoc choice of one of the metrics of each activity to represent output gap. An alternative was to use the mean of various statistical metrics to substitute the Production Function. In the previous section, the comparison of mean metrics of the total output gap with the estimate through the Production Function was presented. Good adherence could be verified between both methods, which makes this a viable alternative to be used here. Presented below are the results of output gap calculation for the principal economic activities.

The industrial sector, which consists of: (i) extractive industries, (ii) manufacturing industries, (iii) electricity and gas, water, sewage and waste management activities; and (iv) construction, is considered one of the engines of Brazilian economic growth given its characteristic of driving other sectors of activity.[4] As such, it presents very similar behaviour to the total output gap, as presented in Graph 10. Since the second quarter of 2015, it has been operating below its potential, reaching, in the

[4] For more details see CUNHA (2017). Available at: https://bibliotecadigital.fgv.br/dspace/bitstream/handle/10438/17997/Disserta%C3%A7%C3%A3o%20-%20Juliana%20Carvalho%20da%20Cunha%20-%20vers%C3%A3o%20final.pdf

most recent result (2019.I), the most negative output gap of the series (-8.2%) since 1992, albeit with a projected trajectory of closing 2019.II at -6.7%.

Graph 10 – Output gap – Mean metrics: Industrial Sector and GDP



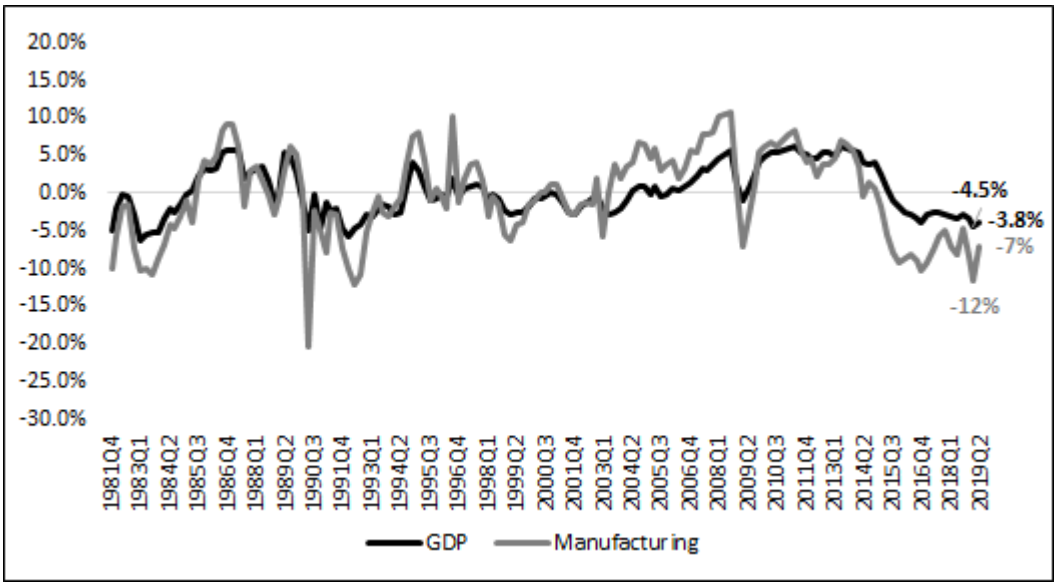
Primary source: IBGE, Cunha (2017). Own elaboration (2019)

In this sector, manufacturing and construction industries stand out. Manufacturing recorded its lowest level output gap in the 2nd quarter of 1990, at a time of extreme economic fragility in Brazil, with inflation reaching its peak in April 1990 in the 12-month accumulated rate measured by IPCA[5] (6,821%). Despite having opened up trade with the objective of increasing competition and reducing internal prices, the ruling government of President Fernando Collor was heavily marked by the confiscation of bank deposits and savings and subsequently by the impeachment of the president, which emphasizes the uncertainty experienced in the country at the time.

After this period, as showed in Graph 11, the manufacturing industry operated below its potential during the period from 1998 to 2003 and then above its potential for 12 years (2003-2014), except during a short interval as a result of the 2008 crisis. Nevertheless, for the last 5 years (middle of 2014 to 2019) it has operated well below its potential.

[5] Índice Nacional de Preços ao Consumidor Amplo - Extended National Consumer Price Index

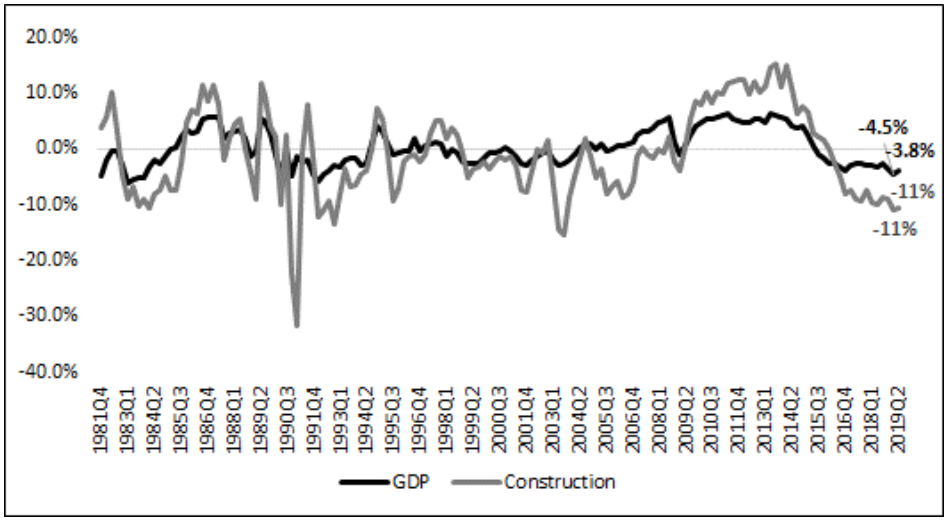
Graph 11 – Output gap – Mean metrics: Manufacturing Sector and GDP



Primary source: IBGE, Cunha (2017). Own elaboration (2019)

Construction, in Graph 12, also registered the lowest output gap of its series at the beginning of the 1990s (in the first quarter of 1991), which reflected the economic fragility that also affected manufacturing. However, during the entire period of the global crisis (2010-2015) construction operated well above its potential (reaching +20%, in the third quarter of 2013), which characterized the Brazilian property bubble. Nevertheless, from the first quarter of 2016 onwards, construction has been characterized by the stagnation the country has been experiencing, operating more than 10% below its potential.

Graph 12 – Output gap – Mean metrics: Construction Sector and GDP

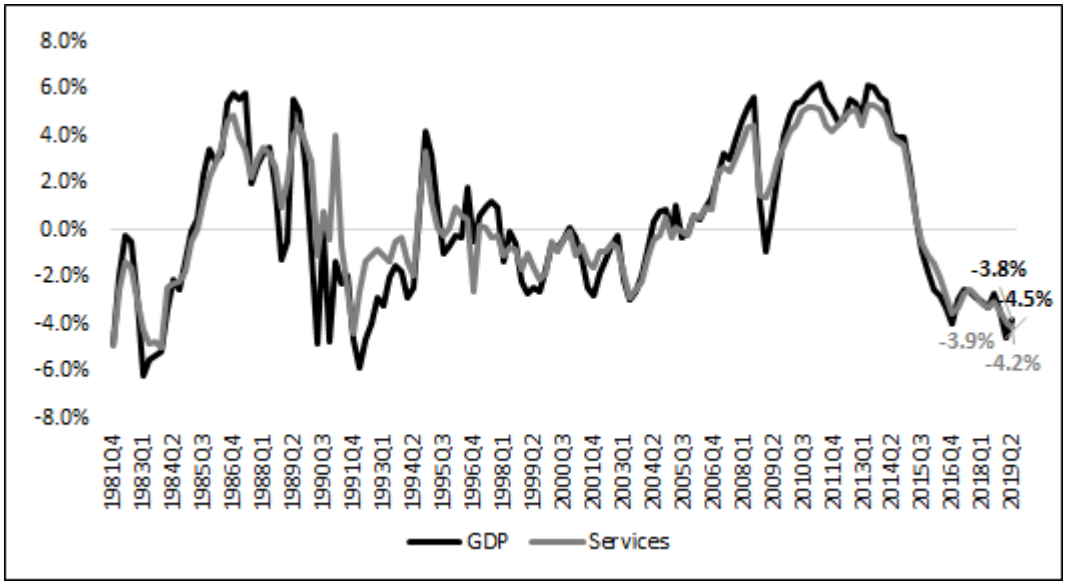


Primary source: IBGE, Cunha (2017). Own elaboration (2019)

The service sector is composed of: (i) commerce, (ii) transport, storage and freight, (iii) information and communication, (iv) financial activities, insurance and related services, (v) rental services activities, (vi) other activities and services, and (vii) administration, defence, public healthcare and education and social security. In 2018 services represented 63% of national GDP. Due to its great representativity, the behaviour of the output gap in the service sector is highly correlated (0.92) with total output gap. For the last four years, like the total economy, this activity has operated well below its potential, as showed in Graph 13. Except for financial activities, insurance and related services, which operate close to their productive potential, all the other service activities operate well below their potential outputs.

The service sector as a whole presented an output gap of -3.9% in the first quarter of 2019, and a gap of -4.2% in the projected output gap for the second quarter of 2019.

Graph 13 – Output gap – Mean metrics: Service Sector and GDP



Primary source: IBGE, Cunha (2017). Own elaboration (2019)

5 – CONCLUSION

The output gap is an important variable for economic analysis, despite its measurement possibly presenting very different results, depending on the methodology adopted. In this paper, potential output estimates have been presented for various approaches in order to eliminate biases characteristic of each individual metric.

All the methodologies present disadvantages, but the Production Function approach manages to most efficiently incorporate possible changes occurring in the economy into its structure. As a difficult

variable to estimate precisely, it is important to stress that the choice of the Production Function is not without criticism, and as such, it is important that studies on the subject continue to be constantly improved.

Analysis of the output gap results demonstrated that its evolution impacts on business cycles in Brazil. Currently, and in real time, this analysis is providing additional information for the examination of the Brazilian case in which the economy remains stifled. The country is passing through a fiscal crisis, with a gross debt/GDP of approximately 80% and an output gap that remains particularly wide (-5.6% in the first quarter of 2019 and -5.4% in that projected on real time for the second quarter), and a 13% of unemployment rate, even after more than two years since the end of the last recession.

Analysis of the output gap in activities also provides relevant data to assist in the understanding of movement in the output gap of the economy, as it enables the disaggregated analysis of the economy, whereby it is possible to evaluate which activity has the largest output gap.

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