Pedro Henrique da Rocha Duque

Debt Salience: Evidence and Theory

Brasília - DF, Brasil

Agosto de 2020

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Dissertação apresentada ao Curso de Mestrado Acadêmico em Economia, Universidade de Brasília, como requisito parcial para obtenção de título de Mestre em Economia.

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Resumo

O papel da política fiscal sobre a atenção não tem sido devidamente documentado recentemente. Ainda assim, suas implicações são consideravelmente fortes. Nesse trabalho, nós investigamos a relação entre atenção e a dívida pública, usando as técnicas de identificação em alta frequência de Nakamura & Steinsson (2018), considerando os dados do Google Trends como uma *proxy* para a miopia e analisando-os nos dias de anúncio da relação dívida-PIB. Além disso, nós utilizamos essa evidência para construir um modelo de racionalidade limitada baseado em Gabaix (2020) e obtemos resultados inéditos, como uma *Zero Lower Bound* custosa, um multiplicador fiscal “auto-destrutivo” e um *Forward Guidance Puzzle* “condicional”.

Palavras-chave: Racionalidade Limitada; Política Fiscal; Macroeconomia Comportamental; Identificação em Alta Frequência.

Abstract

The role of fiscal policy on attention has not been well assessed recently. Still, its implications are quite strong. In this paper, we exploit the relationship between attention and public debt, using the techniques of high-frequency identification presented in Nakamura & Steinsson (2018), considering Google Trends data as a proxy for myopia and analyzing it on the days of Debt-to-GDP's announcements. Also, we build on this evidence to construct a model of bounded rationality based on Gabaix (2020) and obtain unique features, such as a costly Zero Lower Bound, a "self-destructive" fiscal multiplier and a "conditional" Forward Guidance Puzzle.

Keywords: Bounded Rationaliy; Fiscal Policy; Behavioral Macroeconomics; High-Frequency Identification.

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Sumário

1 Introduction

Myopia has been turned into a central piece to explain human behavior in the economic cycle. Myopia, which is defined as a distortion factor over the expected value of a variable, turns possible to explain why Ricardian equivalence does not hold in reality, as pointed by the empirical evidence[1]. Therefore, myopia can explain why a fiscal multiplier exists since agents would not fully consider that an increase in the debt due to a fiscal stimulus would be paid in the near future. Also, myopia can explain why “helicopter drops of money” are efficient to avoid the zero lower bound (ZLB) of the interest rates, and several puzzles (Gabaix (2020)) usually unsolvable in a standard model with homogeneous agents.

However, less attention has been paid to what may explain the dynamics of myopia. If people’s attention depends on economic dynamics, it is possible that some results obtained by the myopia literature become limited. Especially, if we consider that attention tends to increase with the public debt, the existence of Ricardian equivalence, and consequently of a fiscal multiplier, becomes dependent on the level of the debt. This latter assumption might be very realistic as there are several pieces of evidence of a positive relationship between debt and Gross Domestic Product (GDP) volatility. Since Gabaix (2014) points out that myopia is mainly explained by volatility, there may be a relation between debt and myopia. This relation will be developed later.

This feature not only has theoretical implications but also implications for the optimal policy. According to Gabaix (2020), the ZLB is not too costly because people’s bounded rationality turns monetary and fiscal stimulus efficient to increase the output gap. However, this ZLB could be attained due to, for example, a high level of public debt which demanded a high level of taxes to pay it, and, therefore, a considerable interest rate cut to stabilize the output gap. In this case of a debt-driven ZLB, considering that a higher level of debt increases the level of attention, those stimuli proposed by Gabaix (2020) might not be as efficient as in the case with fixed myopia.

This paper will assess whether attention increases with fluctuations in economic variables, especially GDP and debt. Firstly, we go after empirical evidence using the volume of searches of economic terms in Google Trends as a proxy of people’s attention, and use high-frequency identification on the date of the GDP release, based on Nakamura & Steinsson (2018). Also, we construct a model where a high level of debt brings fiscal consolidation pressures, as in Alesina, Favero, and Giavazzi (2015). In this setup, the expected reduction of the debt increases the expected volatility of the economy and

[1] For a detailed discussion on this evidence, see Galí, López-Salido, and Vallés (2007) and Kaplan, Moll and Violante (2018).

increases the attention as well. Our results point that, when debt is very high, the fiscal multiplier decreases and that to avoid the ZLB, it may be necessary to solve the debt's level even if it is only possible by "helicopter drops of money." Also, some interactions between fiscal and monetary policy surge, especially a relation between the Taylor rule's efficiency and the level of the public debt.

1.1 Related Literature

In a particular aspect, this paper bridge the gap between two kinds of literature: the bounded rationality works on macroeconomics (Reis (2006), Cavallo, Cruces and Perez-Truglia (2017), Angeletos & Huo (2019), Gabaix (2020), Farhi and Gabaix (2020), among numerous others) and the smaller literature regarding the effects of debt on the fiscal multiplier and monetary policy shocks (Huidrom et al. (2019), Ilzetzki, Mendoza and Vegh (2013), Neri & Notarpietro (2014), Mian, Straub, and Sufi (2020)).

Usually, the works in the bounded rationality literature highlight a distortion factor in the agent's decision-making process. This distortion factor can be "salience", such as in Bordalo, Genaiolli, and Shleifer (2013) and Chetty, Looney, and Kroft (2009). Salience is defined as the capacity of an attribute of a good to draw attention, such as quality or price. Therefore, when a particular aspect of a good is noticeable, we say this attribute is salient. Salience happens because it is costly for an agent to analyze all the attributes of a good when making his decision, and therefore he entails the attributes he values the most to make his decision, such as the quality/price ratio. Under salience, choices become context-dependent, as the alternative options alter the optimal decision.

In the pivotal work of Bordalo, Genaiolli, and Shleifer (2013), salience was introduced in the context of an agent choosing his consumption bundle among multiple items. However, this term was broadened to encompass other situations where an attribute can draw (or withdraw) attention. Especially, Chetty, Looney, and Kroft (2009) consider salience in the context of hidden taxes on products. Their setup turns possible even to endogenize salience directly by maximizing the utility gain from paying this attention. More recently, Rees-Jones and Taubinsky (2017) showed that the consumer's attention to not-fully-salient taxes increases with the tax's size, and therefore the efficiency cost of the tax may increase as well.

Another branch of bounded rationality focuses on myopia, a reduction factor over the expected output gap for the next years, such as in Reis (2006) and Gabaix (2020). Myopia usually plays a significant role in explaining business cycles, as it implies that people evaluate more the present than the future when taking their actions, similar to hyperbolic discounting (as pointed by Gabaix and Laibson (2017) and Angeletos & Huo (2019)). This factor can explain why it is possible to have a positive fiscal multiplier.

Consequently, the ZLB is much less costly, as it is possible to avoid it by increasing government spending and "helicopter drops of money". Moreover, myopia also helps solve the "forward guidance puzzle" regarding why future hikes on interest rates do not affect the present. This solution occurs because this distortion factor leads agents to partially ignore the effects of a future hike on the interest rate. Several other puzzles can be explained by myopia[2]. Some attempts were made to turn myopia endogenous. Notably, Gabaix (2014) endogenized myopia considering an infinitely-living household maximizing the utility gain of attention. As a result, it shows that volatility is the critical factor in determining myopia's size, as there is a more significant loss of utility due to inattention in a more unstable economy.

However, this model of Gabaix (2014) considered a fixed level of volatility, and consequently, a fixed level of myopia. If we depart from this assumption and consider that volatility may vary across time, myopia would vary across time as well, as the cost of inattention would change, and therefore the optimal level of attention will be adapted. In this sense, the critical factor in analyzing attention would be the key factors in analyzing the agents' expected volatility. Nonetheless, the results of this literature would potentially be revisited, as this endogenizing process could change one of the key variables to explain economic dynamics.

Interestingly, another growing literature regards the effect of the debt on the magnitude and direction of the fiscal multiplier and of the monetary policy efficiency. On the fiscal side, Huidrom et al. (2019) and Ilzetzki, Mendoza, and Vegh (2013) show that the bigger the debt, or similarly, the worst the country's fiscal position, the smaller the fiscal multiplier be. Moreover, Pescatori, Sandri, and Simon (2014) and Cecchetti (2011) point out that debt explains even better volatility than growth itself. This relationship between debt and volatility can happen due to the effects of fiscal consolidation, as a high level of debt would increase the pressure to do contractionary fiscal policy to reduce the debt, and therefore increase the volatility of the GDP for the next periods if we consider that Ricardian equivalence does not hold. On the monetary side, Neri & Notarpietro (2014) shows that when the economy is on the ZLB due to a sizable debt (debt-deflation), even cost-push shocks that usually would reduce inflation and stimulate output have the contrary effect.

More recently, Mian, Straub, and Sufi (2020) showed that when debt is sufficiently high, the economy goes through a debt-driven liquidity trap (debt trap), and less standard policies may be necessary to solve this situation. The possibility of a debt trap is outstanding because it highlights, even more, the importance of the debt in the ZLB. Considering a debt trap possible and that debt reduces the fiscal multiplier, not only the debt would turn the ZLB more costly, as it would bring the economy to the ZLB by itself.

[2] For a broader discussion, see Gabaix (2020).

In the seminal model of Gabaix (2020), the myopia parameter is the critical factor in determining the existence of the fiscal multiplier, the forward guidance puzzle, among numerous other consequences. However, the estimation of this parameter is quite arduous, as pointed by Andrade, Cordeiro, and Lambais (2020), and there is a wide range of estimated values for myopia, as shown by Farhi and Gabaix (2020). This ambiguity regarding the myopia estimation can be possibly due to treating a variable as a parameter, as the attention can be potentially affected by the economic dynamics, especially by the debt and the output growth, and this kind of relationship would also have consequences on attention's role on the economic cycle and the optimal economic policy.

If the debt has a relationship with attention, probably, some of the findings in the literature regarding debt and policy shocks are due to the variation in attention since they would have similar results. Moreover, it is possible that some results consolidated in bounded rationality could be wrong due to the lack of dependence of debt on the effects of fiscal and monetary shocks. A clear example refers to the cost of ZLB. Gabaix (2020) states that, due to bounded rationality, Ricardian equivalence does not hold, and a fiscal multiplier exists, and therefore a ZLB would be easily solved by fiscal stimulus. However, if a country has high debt, and it arises a high level of attention, the fiscal multiplier would plummet, and therefore the cost of the ZLB would not be cheap. Similarly, a high level of attention would make people anticipate the future more, and therefore the existence of "Forward Guidance" can be enhanced when debt is high. As happens with the efficiency of fiscal and monetary policy under the ZLB, other findings of the bounded rationality literature may change as the relationship between debt and attention arises and therefore are worthy of being evaluated.

2 Empirical Evidence

This section goes after evidence of the relationship between attention and public debt using high-frequency identification.

2.1 Identification Method

There are potential identification problems when addressing whether a variable has a causal effect over myopia. Firstly, attention might also affect the variable. Therefore there may be reverse causality, For example, considering the relationship between attention and the GDP, if people start paying more attention to the future, the product can fall due to a reduction in consumption to increase savings, and the regression of attention on GDP can potentially be biased. Also, there are potential confounding factors that may generate a bias on this kind of analysis. For example, during a pandemic with serious adverse effects on economics, debt-to-GDP would rise, and attention to economics would rise as well, but not necessarily this attention variation occurred due to the increase in debt.

Therefore, we may need a method that can overpass this problem. Due to data restrictions, we looked after evidence using high-frequency identification, based on Nakamura & Steinsson (2018). The main goal of this method is to consider a moment where a disproportional quantity of information arrived, such as the effect of the release of FED's Fund Rate on 1-year yields in a 30-minute window, and therefore the variation on the explained variable would occur solely due to the variation in the released variable. Moreover, considering a narrow time window, the possibility of reverse causality plummets, as there would not be enough time to raise a reverse effect.

To identify a pure debt shock, we consider the change in our myopia index in a 1-day window around debt-to-GDP releases. The idea is that the information about the current debt-to-GDP dominates the change in the index during this 1-day window. However, there is not a day where a disproportional amount of information about the debt solely arrives, since there is daily-frequency data of debt on Treasury Direct. Still, as the metric debt-to-GDP is widely more popular than debt in its nominal value and reflects a country fiscal position more consistently, we considered the day of GDP release[1] as a day where a disproportional amount of information about the debt-to-GDP ratio arrives. However, for comparative purposes, as the information of GDP itself arrives on the same date, we also regressed with the variation of GDP as the independent variable using high-frequency identification.

[1] We considered only the day of consolidated releases of GDP (excluding preliminary results).

Specifically, we want to identify the impact of the variation in debt-to-GDP[2] on people's attention. To cope with the identification method of Nakamura & Steinsson (2018), we consider that the agents' attention would be affected by unexpected variations on the debt-to-GDP release. Therefore, we estimate:

$$\Delta M_t = \gamma \Delta (D_t - \bar{D}_t) + \bar{v} + \epsilon_t \tag{2.1}$$

$$\Delta \bar{D} = \frac{\bar{D}_t - \bar{D}_{t-1}}{\bar{D}_{t-1}} \tag{2.2}$$

$$\Delta M_t = \gamma \Delta D_t - \gamma \Delta \bar{D} + \bar{v} + \epsilon_t \tag{2.3}$$

$$\Delta M_t = \gamma \Delta D_t + \alpha + \epsilon_t \tag{2.4}$$

Where $\Delta M_t$is the change in the myopia index in the 1-day time window after the release, ΔD_t is the variation in the released debt-to-GDP, $\Delta \bar{D}$ is the linear trend of the steady-state debt-to-GDP $\bar{D}_t$[3], ϵ_t is an error term, and α and γ are parameters. The parameter of interest is γ, which measures the effect of the debt variation over people's attention. Considering that changes in the debt-to-GDP dominate the change in myopia on the release window, we can simply estimate equation (2.4) above by OLS.

Regarding the potential identification problems in this setup, one may think that a share of the population may keep keen on the debt-to-GDP variation and check the results regardless of the change, biasing our results. Still, this pattern will be captured by the constant of the model $\bar{v}$. Also, due to the narrow time window, it is not expected to have a correlation between the independent variable and the error of the model. Another concern is whether we should use the unexpected variation on debt-to-GDP instead of the full variation.

Until now, we are considering an agent expecting that the debt-to-GDP grows on a constant rate. However, we can also consider individuals that believe that the economy will grow at the same rate of the last period. In this case, we would have:

$$\Delta M_t = \gamma_2 (\Delta D_t - \Delta D_{t-1}) + \bar{v} \tag{2.5}$$

If we consider both expectation formation processes, we would have:

$$\Delta M_t = \gamma_1 (\Delta D_t - \Delta \bar{D}) + \gamma_2 (\Delta D_t - \Delta D_{t-1}) + \bar{v} \tag{2.6}$$

$$\Delta M_t = (\gamma_1 + \gamma_2) \Delta D_t - \gamma_2 \Delta D_{t-1} - \gamma_1 \Delta \bar{D} + \bar{v} \tag{2.7}$$

[2] When we are regressing for GDP instead of debt-to-GDP, we follow the same approach, merely replacing the explanatory variable.

[3] We added the term $\Delta \bar{D}$ because there can be a historical growth trend in the debt-to-GDP ratio, as pointed by Yared (2019).

To cope with the possibility of agents expecting the last released value to happen, we did a comparative equation, including the lagged variation ΔD_{t-1}. These expectation formation processes corresponds to the processes present in De Grauwe (2012)[4].

2.2 Data

To measure attention in high frequency, we build a Google's Search Volume Ratio Index (SVRI) based on Yin & Narita (2018)[5]. The SVRI is an index ranging from 0 to 100, showing the searching volume (SV) of a term i in terms of the maximum searching volume of a term i in the period requested T, such that:

$$SVR_{t,i}(T) = \frac{SV_{t,i}(T)}{\Sigma_T SVt,i(T)} \tag{2.8}$$

The index is normalized such that the maximum value of the series equals 100, creating an index as follows:

$$SVRI_{t,i}(T) = \frac{SVR_{t,i}(T)}{maxSVR_{t,i}(T)} * 100 \tag{2.9}$$

It is noteworthy that, as pointed by Varian and Stephen-Davidowitz (2015), Google Trends data may vary depending on the time of request due to Google's constant re-scaling. However, as also pointed out by Varian and Stephen-Davidowitz (2015), these changes are marginal, and the analytical results of the data requested might not change. It is also noteworthy that Google Trends does not supply daily data of $SVRI$ for periods bigger than 90 days. Instead, we obtained daily data $SVRI_{d,i}(M)$ for each day in each monthly period, and obtained the monthly data $SVRI_{m,i}(T)$[6] for the whole period of analysis, ranging from 2008 to 2019. We weighted the monthly volume by the daily volume to create a more extended daily set, such as below:

$$SVR_{d,i}(T) = \frac{SVRI_{d,i}(M)}{\Sigma_M SVRI_{d,i}(M)} * SVRI_{m,i}(T) \tag{2.10}$$

After it, we again normalize the index so that the maximum value of the series takes 100, such that:

$$SVRI_{d,i}(T) = \frac{SVR_{d,i}(T)}{maxSVR_{d,i}(T)} * 100 \tag{2.11}$$

[4] In the baseline model of De Grauwe (2012), there are two types of agents in the economy. The first type, the fundamentalist agent, expects that the output gap will always be on its steady-state level, that is, zero. The other type, the extrapolative agent, has the last released value of the output gap as the expected output gap for the next period. The fraction of the agents in each group varies according to the perceived prediction error of these systems, but we consider it fixed to simplify our analysis.

[5] We only departed from Yin & Narita (2018) regarding term's time trend. Yin & Narita (2018) took off the time trend of Google Searches because they were studying the context of low-income and emerging countries, where digital inclusion was in an increasing trend. The economy we are analyzing is of the United States, a developed country, and these growing trends were not present in the majority of our data.

[6] We took of the seasonal trend of the monthly data using an additive method before proceeding with these metrics. We did this because, depending on the month, and people might be paying more attention to the economics, e.g., planning summer trips in April and May, etc.

Still, the attention of people to economics may not be wholly captured by a single term. Also, as in Shiller (2017), some terms may gain popularity as narratives about the economics surges. Therefore, it is wise to construct an index compiling different terms about economics. In this sense, it is handy that Google Trends allows to compare terms $i = 1, ...I$ by supplying comparative $SVRI^C_{t,i}$ such that:

$$SVR^C_{t,i}(T) = \frac{SV_{t,i}(T)}{maxSV_{t,i=1,...,I}(T)} * 100 \tag{2.12}$$

Therefore, $SVR^C_{t,i}(T)$ represents the search volume in terms of the maximum search volume of all the terms i in the period T. Also, Google Trends offers the comparative Average Searching Volume Ratio $ASVR$ of a term i such that:

$$ASVR_i(T) = \frac{\Sigma_T SVR^C_{t,i}(T)}{maxSVRI_{t,i=1,...,I}(T)} * 100 \tag{2.13}$$

Therefore, these averages represents the ratio between the average volumes of searches of term i and the maximum searching volume among all the terms $i = 1, ..., I$. Using the $ASVR$, it is possible to generate weights of search for a index such that:

$$w_i(T) = \frac{ASVR_i(T)}{\Sigma_I ASVR_i(T)} \tag{2.14}$$

Constructing the weights as above allows us to give more importance for more popular terms, creating a more parsimonious index. Our resulting preliminary index is such that:

$$SVRI^P_{t,I}(T) = \Sigma_I w_i(T) SVRI_{t,i} \tag{2.15}$$

Again, this index is further normalized such that its maximum value takes 100 as follows:

$$SVRI_{d,I}(T) = \frac{SVRI^P_{t,I}(T)}{maxSVRI^P_{t,I}(T)} * 100 \tag{2.16}$$

Therefore, the index $SVRI_{d,I}(T)$ encompass information about people's attention by merging the search volume of different terms in one index ranging from 0 to 100. The selected terms to regard economic attention were: "US Economy", "US GDP", "US Growth", "US Debt", "US Unemployment", and "US Crisis". We regressed both the terms individually and aggregated as above. Our period extends from 2008 to 2019 due to the availability of GDP releases.

We use the SVRI as a proxy for myopia due to the information gathering process[7]. If someone is willing to pay more attention to economics, this person will spend more gathering information about economic dynamics. Therefore, even not being the same as myopia, the SVRI of economic terms will be positively correlated with attention.

[7] For a broader discussion about information gathering, see Veldkamp (2011).

The construction of the debt-to-GDP is more tricky yet more straight. Regardless of the high-frequency data of the public debt available daily on Treasury Direct, previous quarter GDP results are released monthly, either in preliminary or consolidated results. However, only the consolidated data of the last quarter (also available quarterly) is used to calculate the debt-to-GDP. Therefore, as the debt-to-GDP reflects the country's fiscal position more consistently than the nominal debt itself, we used the variation in the debt-to-GDP in the day of the consolidated GDP release. We used GDP data from the U.S. Bureau of Economic Analysis, and data of debt-to-GDP compiled by the Federal Reserve Bank of St. Louis. For the GDP release dates and the expected GDP variation, we obtained data from the site *Investing.com*. Due to this site's data restrictions, our data range from the GDP release of the first quarter of 2008 to the last quarter of 2019.

2.3 Results

Table 1 shows the results in high-frequency of the relation between GDP variation and the weighted-average SVR index. Similarly, table 2 shows the same equation with debt-to-GDP variation as the regressor.

Tabela 1 – GDP and Attention: High-Frequency Identification

	Dependent variable: SVR Variation	
	(1)	(2)
GDP Variation	-2.348^{*}	-3.013^{**}
	(1.314)	(1.468)
Lagged GDP Variation	-	1.538
	-	(1.462)
Constant	5.394	3.833
	(3.799)	(4.193)
Observations	48	47
R^2	0.065	0.088
Adjusted R^2	0.045	0.047
Residual Std. Error	19.971 (df = 46)	20.163 (df = 44)
F Statistic	3.194^{*} (df = 1; 46)	2.130 (df = 2; 44)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Both equations have the expected signal: an increase in GDP reduces attention, while an increase in debt increases attention. The positive signal in the intercept of the first equation may indicate that people expect an increase in GDP naturally, as not any degree of GDP growth would raise myopia. Nonetheless, the negative intercept in column

1 of table 2 may indicate that people expect some continuous degree of growth in the Debt-to-GDP ratio. However, both intercepts are insignificant at 90%.

Another curious finding is that, besides that our high-frequency identification is occurring on the day of GDP release, the Debt-to-GDP equation has higher R-squared than the GDP equation itself. The debt-to-GDP equation has a parameter of interest significant at 99%, while the GDP parameter of interest is significant only at 90%. This fact may show that the attention is more driven by Debt-to-GDP than by GDP itself, what is expected since the size of the debt may contain more information about the future than the GDP itself, especially if considering that a considerable part of this debt should be paid on a near future, as in fiscal consolidation.

We also tested for the variation of debt[8] solely, regardless of GDP, under high-frequency identification. Besides the absence of disproportional information about the debt on the day of the GDP release, we considered that people might analyze both information simultaneously, as usually the GDP and the debt are compiled in one metric, the debt-to-GDP. The results were in line with expected, with a parameter of interest positive and significant at 99%. More interestingly, without using lagged variables, the R-Squared of this regression is 0.13, smaller than the Debt-to-GDP regression but bigger than the regression of GDP itself. This is another evidence that people consider more the debt than the GDP when considering how much attention to pay at future economic dynamics. It is especially exuberant when we consider that the announcement window used for identification is of the GDP release.

Regarding columns 2 of tables 1 and 2, we can see that the lagged independent variable improved the model, showing that some people might move their attention based on the difference between the released value and the last release. Notably, this lagged variable increased the R^2 for the Debt-to-GDP regression from 0.17 to 0.27, enhancing the model fitting. To a lesser extent, a similar movement occurred on the GDP regression.

In tables 3 and 4, we have the equations of columns 1 of tables 1 and 2, respectively, but now measured in quarterly frequency. We considered the quarterly variation of the mean of attention and the quarterly variation present on the last GDP release (GDP release has one-quarter lag).

Interestingly, the signal of the GDP equation stays negative but is insignificant at 95% at a quarterly frequency. Meanwhile, the signal of the Debt-to-GDP equation turns negative, yet insignificant. The absence of significance may be related to identification problems, since the period is now more extended than under daily frequency, and potential confounding factors are undergoing.

We also tested the quarterly frequency equations regressing Debt-to-GDP variation

[8] We considered a linear approximation such that $\Delta Debt_t = \Delta Debt - to - GDP_t - \Delta GDP_T$.

Tabela 2 – Debt-to-GDP and Attention: High-Frequency Identification

	Dependent variable: SVR Variation	
	(1)	(2)
Debt-to-GDP Variation	5.519***	7.593***
	(1.790)	(1.922)
Lagged Debt-to-GDP Variation	-	−4.800**
	-	(1.936)
Constant	−4.028	−1.779
	(3.161)	(3.216)
Observations	48	47
R^2	0.171	0.271
Adjusted R^2	0.153	0.238
Residual Std. Error	18.800 (df = 46)	18.029 (df = 44)
F Statistic	9.510*** (df = 1; 46)	8.180*** (df = 2; 44)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Tabela 3 – GDP and Attention: Quarterly Frequency

	Dependent variable:
	SVR Variation
GDP Variation	0.901
	(0.817)
Constant	−1.941
	(2.386)
Observations	47
R^2	0.026
Adjusted R^2	0.005
Residual Std. Error	12.372 (df = 45)
F Statistic	1.215 (df = 1; 45)
Note:	*p<0.1; **p<0.05; ***p<0.01

on the variation of the SVR in the same quarter that the information was regarding, that is, one-quarter before the release. Still, the results are insignificant at 95%.

Table 5 shows the results of the high-frequency identification of the GDP variation regressed on the terms apart. Only three of the terms ("US Economy", "US GDP", and "US Unemployment") are significant, and still at 90%. Similarly, in table 6, we have the

Tabela 4 – Debt-to-GDP and Attention: Quarterly Frequency

	Dependent variable:
	SVR Variation
Debt-to-GDP Variation	−1.216
	(1.181)
Constant	0.894
	(2.107)
Observations	47
R^2	0.023
Adjusted R^2	0.001
Residual Std. Error	12.393 (df = 45)
F Statistic	1.060 (df = 1; 45)
Note:	*p<0.1; **p<0.05; ***p<0.01

results of the high-frequency identification of the Debt-to-GDP variation regressed on the terms apart. Only one of the terms ("US Unemployment") was significant at 95% for the debt-to-GDP variation. This fact can generate doubts about our SVR index, as it can be driven by a few terms, with other being potentially unrelated to economic attention.

However, curiously, all the significant coefficients of interest by term had magnitude smaller than the magnitude of the coefficient of interest in the aggregate index. Due to this doubt, we conducted the high-frequency identification of debt relationship constructing the index without the term "US Unemployment", and obtained similar results as Table 2, both in significance and in magnitude. Therefore, we believe that there is the potential substitution of the terms during the time (for example, during the debt crisis, the most popular term becomes "US Debt", while "US Unemployment" turns more popular during an unemployment crisis) instead of the index being driven by a few terms alone. This substitution may be related to the "boom-and-bust" of narratives in economics, as in Shiller (2017), since each narrative has its entailed aspects of economics, and so its preferred terms. Therefore, the popularity of a term may depend on the focus the current narrative gives to it.

Tabela 5 – GDP Parameter per Term

	γ
"US Economy"	-1.6872^{*}
	(0.6787)
"US GDP"	-0.8011^{*}
	(0.3333)
"US Growth"	-0.02931
	(0.52576)
"US Debt"	0.07813
	(0.22840)
"US Unemployment"	-1.4448^{*}
	(0.6871)
"US Crisis"	0.08341
	(0.49920)
Observations	48
Note:	*p<0.1; **p<0.05; ***p<0.01

Tabela 6 – Debt Parameter per Term

	γ
"US Economy"	1.375
	(1.026)
"US GDP"	0.3614
	(0.5089)
"US Growth"	-0.1953
	(0.7602)
"US Debt"	-0.3166
	(0.3276)
"US Unemployment"	2.9094^{**}
	(0.9483)
"US Crisis"	-0.2018
	(0.7219)
Observations	48
Note:	*p<0.1; **p<0.05; ***p<0.01

3 Bounded Rationality Model

In this section, we attempt to microfound the relationship between debt and myopia. Also, we build a Bounded rationality model and analyze its results.

3.1 Microfounding the Debt-Myopia Link

First, consider the behavioral new-Keynesian model of Gabaix (2020), but extended with a debt law-of-motion:

$$d_t = (1 + i_{t-1} - \pi_t - x_t)d_{t-1} + b_{t-1} \tag{3.1}$$

and a debt-target fiscal rule such that:

$$b_t = (\pi_{t+1} - i_t)d_t - \psi(d_t - \bar{d}) + \eta_t^f \tag{3.2}$$

In this model, Ricardian equivalence does not hold, and the impulse η_t^f results in non-null responses of the output, as in Figure 1.

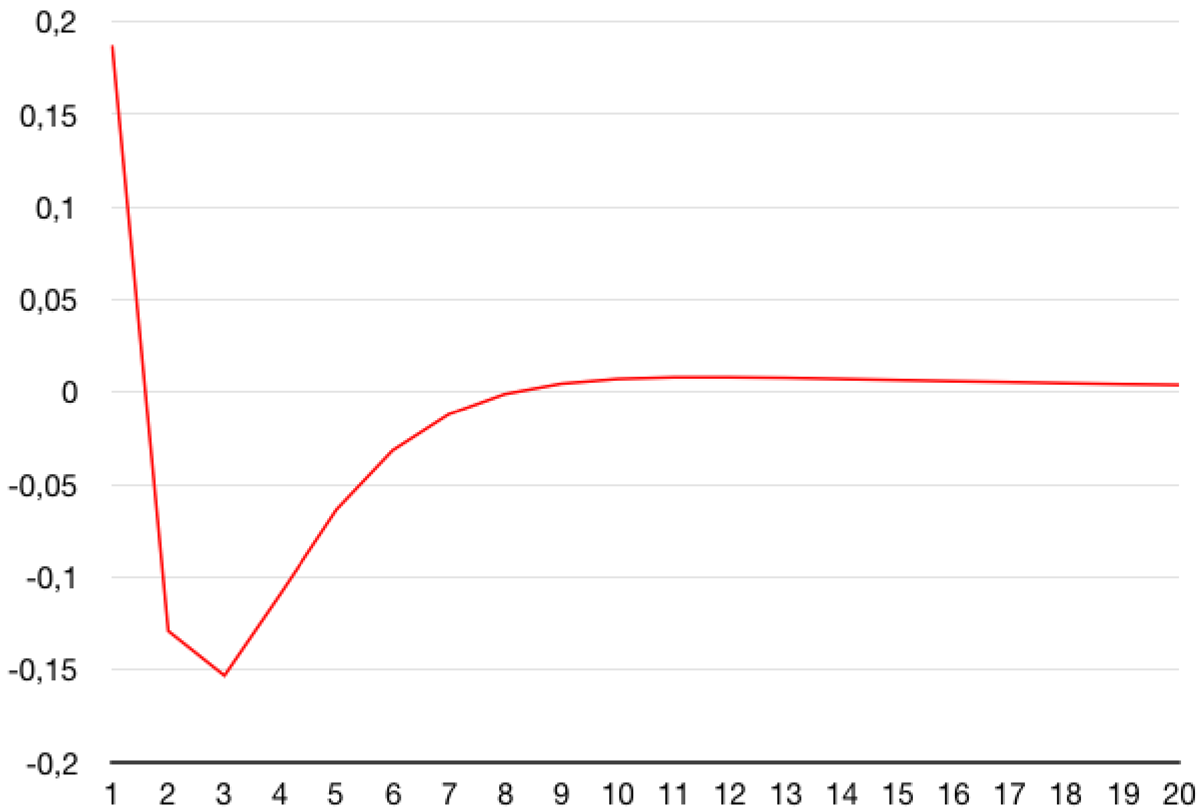

Figura 1 – Impulse-Response of Output to a Fiscal Stimulus

Therefore, considering a steady-state economy with GDP volatility σ_S only due to a technology shock with normal distribution, the increase in the forward GDP volatility due to this shock will be:

$$\Delta\sigma_N = (\frac{\Sigma_{i=0}^{N}(Q_t^{t+i}\eta_f)^2}{N})^{\frac{1}{2}} \tag{3.3}$$

Where Q_{t+i} is the fiscal multiplier of the outcome in time $t+i$ due to a spending shock in t, and N is the size of the horizon. Note that the negative responses occur due to the debt burden generated by this discretionary spending during the first moments. Also, if N tends to infinite, $\Delta\sigma_N$ tends to 0, as Q_t^{t+i} tends to zero. Otherwise, $\Delta\sigma_N$ will be a positive number. This IRF, together with the equation above, shows that the deficit affects volatility and, more interestingly, that debt affects volatility, as a good size of this volatility occurs to bring debt back to its steady-state level.

Now, consider the problem of endogenizing myopia, proposed in Gabaix (2014). In this problem, the agent has a subjective value function $V(S, m)$, where m is the attention parameter and S_t is the state vector such that $S_t = (k_t, X_t)$ (k_t is the agent's personal wealth and X_t a vector of macroeconomic variables[1]). The agent wants to maximize:

$$v(a_t, \mathbf{S}_t, m) = u(a) + V(\mathbf{G}^S(\mathbf{S}_t, a_t, m, \epsilon_{t+1}), m) \tag{3.4}$$

Where $a_t = (C_t, N_t)$ (consumption and labor supply). He takes the action:

$$a(m, S_t) = argmax_a v(a, S_t, m) \tag{3.5}$$

In theory, the agent would like to maximize his true utility, given by:

$$max_m v(a(m, \mathbf{S}_t), \mathbf{S}_t, 1) - \kappa_g(m - m^d) \tag{3.6}$$

Where m_d is the default (costless) myopia, and κ is a parameter of the cost of attention. This problem represents that the agent wants to maximize his utility by increasing his attention to approaching the utility of the true model (indexed by $m = 1$) and wants to avoid the thinking cost of increasing attention. However, this problem is typically intractable, and an alternative formulation is necessary to solve it. Gabaix (2014) proposes a sparse max model where the agent solves a linear-quadratic approximation of this problem using Taylor's expansion of the utility losses of inattention but keeping the true nonlinear utility when taking action. The problem is therefore replaced by:

$$max_m - \frac{1}{2}\Lambda(1 - m^2) - \kappa_g(m - m^d) \tag{3.7}$$

With $\Lambda = \lambda\sigma_S^2$, where σ_S is the volatility of the GDP and λ is a structural parameter. This problem results in equilibrium such that:

$$m = max(1 - \frac{\kappa}{\lambda\sigma_S^2}, m_d) \tag{3.8}$$

[1] The value at the default state is normalized so that $\mathbf{S}^d = 0$

In this model of Gabaix (2014), the individual has full information about the economy's future GDP volatility and maximizes his utility concerning that. However, as the rationality is bounded, the individual may not observe future volatility thoroughly. A more parsimonious approach with bounded rationality would encompass the way agents perceive GDP volatility, either forward-looking or backward-looking. For our model, we will consider that the agent considers the forward-looking GDP volatility, but for a limited period.

Considering that the series are random and independent, suppose that the perceived GDP volatility, $sigma_p$, is such that:

$$\sigma_S^2 = \sigma_p^2 = \sigma_x^2 + \sigma_N^2 \tag{3.9}$$

Where N is the agent's planning-horizon, similar to Woodford (2018). The variation in the perceived GDP volatility will be positive due to an increase in the debt if N is finite, as in figure 1, as equation (3.3) is increasing in η_f. Also, attention would increase with the distance between d_t and its steady value. This increase would occur because a high level of debt would generate pressure for fiscal consolidation, as in the negative coefficients of figure 1 and Cecchinatti (2011). This fiscal consolidation would increase the GDP volatility while it takes place, increasing, therefore, the agent's attention. Due to this link, the agent may consider more debt-to-GDP than GDP itself when gathering information about future GDP volatility, as debt-to-GDP explains better the future GDP volatility generated by the fiscal policy.

Sadly, as Q^t depends on attention, our problem is virtually intractable, and an approximation is necessary. Indeed, as Q^t is decreasing in attention but greater in the module than zero, we know that m_t will be increasing in d_t. Due to this, for simplification, we consider a linear effect of debt on volatility, as if people do not consider the counter effects of myopia on fiscal multipliers when reoptimizing for myopia. In this setup, we yield:

$$\sigma_N = \xi|d - \bar{d}| \tag{3.10}$$

And therefore,we use:

$$m_t = 1 - \frac{\alpha}{\omega + (d_t - \bar{d})} \tag{3.11}$$

with $\alpha = \frac{\kappa}{\lambda\xi^2}$ and $\omega = \frac{\sigma_s^2}{\xi^2}$. This equation is our "debt salience" equation, entailing that a higher debt will increase volatility ,and, consequently, attention. We call this a salience equation because, despite of not considering the debt burden directly as a not-fully-salient cost, it shows how the attention to the future would change with debt, and therefore debt can turn the future more salient. Strictly, we would rather consider:

$$m_t = 1 - \frac{\alpha}{\omega + (d_t - \bar{d})^2} \tag{3.12}$$

This equation reflects that the farther the debt is from its target, the higher the fiscal adjustment will be, so volatility rises, and attention rises. However, as the fiscal rules usually occur in situations of weak fiscal positions, as in Alesina, Favero, and Giavazzi (2015), there is probably an asymmetry on the equation. Nonetheless, unsustainable debt situations are much more reported by the literature, as more problems arise in this kind of situation, such as fiscal dominance and the ZLB, and a high level of debt generates pressure for fiscal consolidation that a low debt does not generate. Moreover, as in Tversky and Kahnemann (1974), loss aversion is another potential source of asymmetry as people react differently on fiscal retractions and fiscal stimulus. Therefore, as the center of our analysis focus on highly indebted economies, we can simplify using the linear equation.

In steady-state, considering $d = \bar{d}$, m won't be affected by the level of debt. However, if we consider a "debt bias" $\tilde{d}$, similar to the deficit bias present in Alesina & Tabellini (1990) and the "tragedy of the commons" regarding the debt present in Yared (2019), we can have a fiscal rule such that:

$$b_t = (\pi_{t+1} - i_t)d_t - \psi(d_t - (\bar{d} + \tilde{d})) + \eta_t^f \tag{3.13}$$

We can also interpret $\bar{d}$ as the steady-state public debt expected by the population, and $\bar{d} + \tilde{d}$ as the public debt aimed by the fiscal planner. Considering a fiscal rule such as above, it is possible to have a steady-state level of attention depending on the debt level, especially on the level of the debt bias.

3.2 Model

Our model is entirely based on Gabaix (2020), except for the equations for fiscal rule, debt law-of-motion and debt salience. Our model entails the following equations:

$$x_t = m_t x_{t+1} - \sigma(i_t - \pi_{t+1} - r_n) + b_t^d(-\psi(d_t - (\bar{d} + \tilde{d})) + \eta_t^f) + \eta_t^d \tag{3.14}$$

$$\pi_t = \beta m_t(\theta_p + \frac{1 - \beta\theta_p}{1 - \beta\theta_p m_t}(1 - \theta_p))\pi_{t+1} + (\frac{1}{\theta_p} - 1)(1 - \beta\theta_p)(\phi_\pi + \gamma_\pi)x_t + \eta_t^s \tag{3.15}$$

$$i_t = \rho_i i_{t-1} + (1 - \rho_i)(\phi_\pi \pi_t + \phi_x x_t + r_n + (\frac{b_t^d}{\sigma}(-\psi(d_t - (\bar{d} + \tilde{d})) + \eta_t^f) + \eta_t^m \tag{3.16}$$

$$m_t = 1 - \frac{\alpha}{\omega + (d_t - \bar{d})} \tag{3.17}$$

$$b_t^d = \frac{\phi_\pi r_n(1 + r_n)(1 - m_t)}{(\phi_\pi + \gamma_\pi)((1 + r_n) - m_t)} \tag{3.18}$$

$$d_t = (1 + i_{t-1} - \pi_t - x_t)d_{t-1} + b_{t-1} \tag{3.19}$$

$$b_t = (\pi_{t+1} - i_t)d_t - \psi(d_t - (\bar{d} + \tilde{d})) + \eta_t^f \tag{3.20}$$

$$\eta_t^d = \rho_d \eta_{t-1}^d + \epsilon_d \tag{3.21}$$

$$\eta_t^s = \rho_s \eta_{t-1}^s + \epsilon_s; \tag{3.22}$$

$$\eta_t^m = \rho_m \eta_{t-1}^m + \epsilon_m \tag{3.23}$$

$$\eta_t^f = \rho_f \eta_{t-1}^f + \epsilon_f \tag{3.24}$$

Also, for comparative purposes, we constructed a model where there is not debt salience, as in Gabaix (2020), and therefore equations (3.17) and (3.18) are replaced by constants.

3.3 Parameters

Table 7 shows the parameters we used for estimation. To keep a standard, we use the parameters as in Gabaix (2020). Also, we set the persistence parameters ρ to 0.5[2]. However, for our new parameters $(\tilde{d}, \bar{d}, \alpha, \omega)$, we used different approaches. We set α and ω such that they match both the degree of myopia in Rees-Jones and Taubinsky (2019), which is $m = 0.6$, and our empirical evidence for debt salience response in column 1 of Table 2, which is that an 1% increase in the debt-to-GDP ration increases attention in 5% [3]. For $\tilde{d}$ and $\bar{d}$, we report the IRFs under different values, to analyze how the reaction changes under different parameters. We considered $\bar{d} = 0.6$ with $\tilde{d} = 0$ as a low debt situation, and $\bar{d} = 0.6$ with $\tilde{d} = 0.5$ as a high debt situation. For the fiscal stimulus, we considered an increase in government spending equivalent to 10% of GDP. For the monetary shock, we considered a 10% increase in the interest rate.

[2] The only persistence parameter we did not set to 0.5 was ψ, which we set to 0.1

[3] We set α and ω by solving the system $\alpha/(\omega + 0.01) = \alpha/\omega - 0.05$ and $\alpha/\omega = 0.4$.

Tabela 7 – Parameters for Estimation

	Parameter
β	0.99
r_n	1.0101
γ_π	1
σ	0.2
θ_p	0.7
ϕ_x	0.5
ϕ_π	1.5
ψ	0.1
α	0.028
ω	0.07

4 Model Results

4.1 Results of Fiscal Stimulus

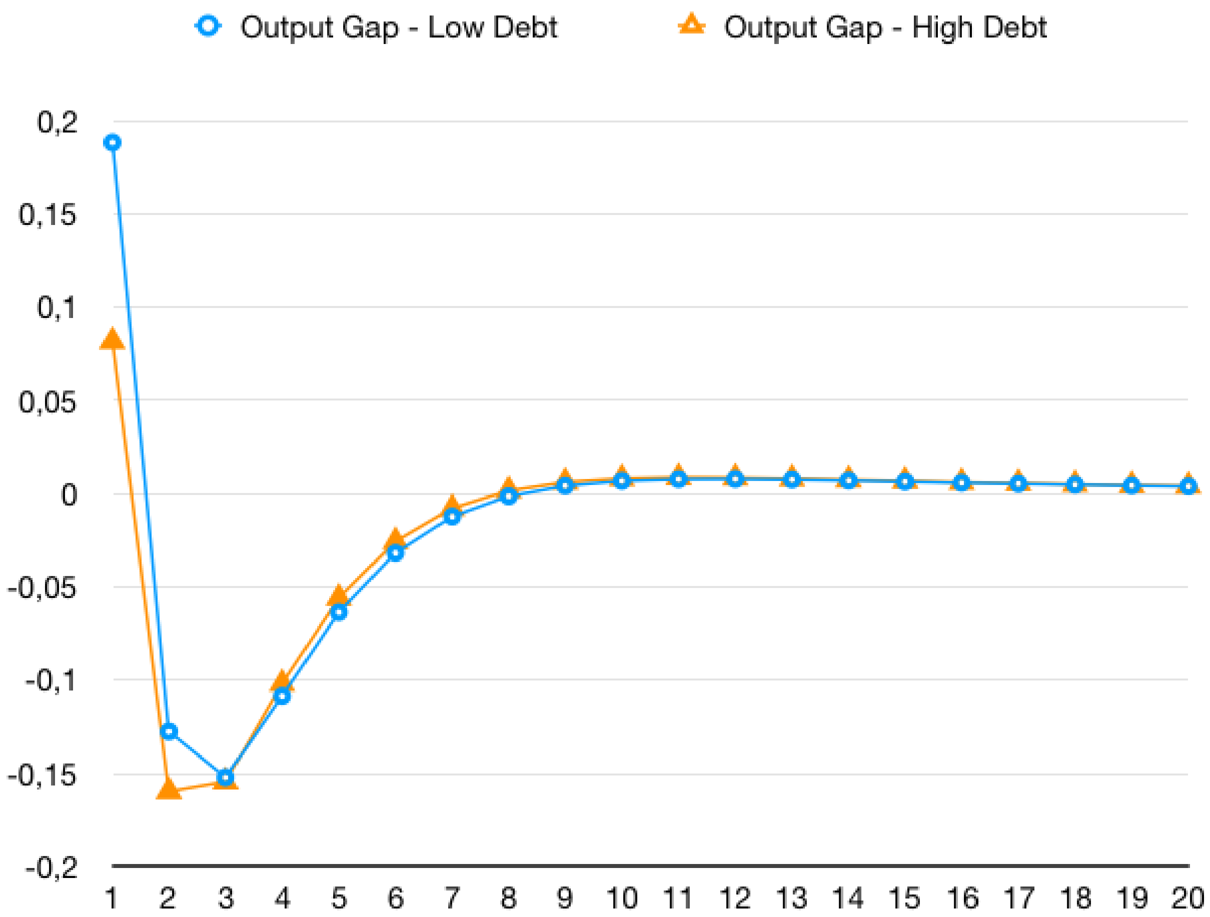

Figura 2 – Impulse-response of Output Gap for a Fiscal Stimulus under Debt Salience (in thousandth units)

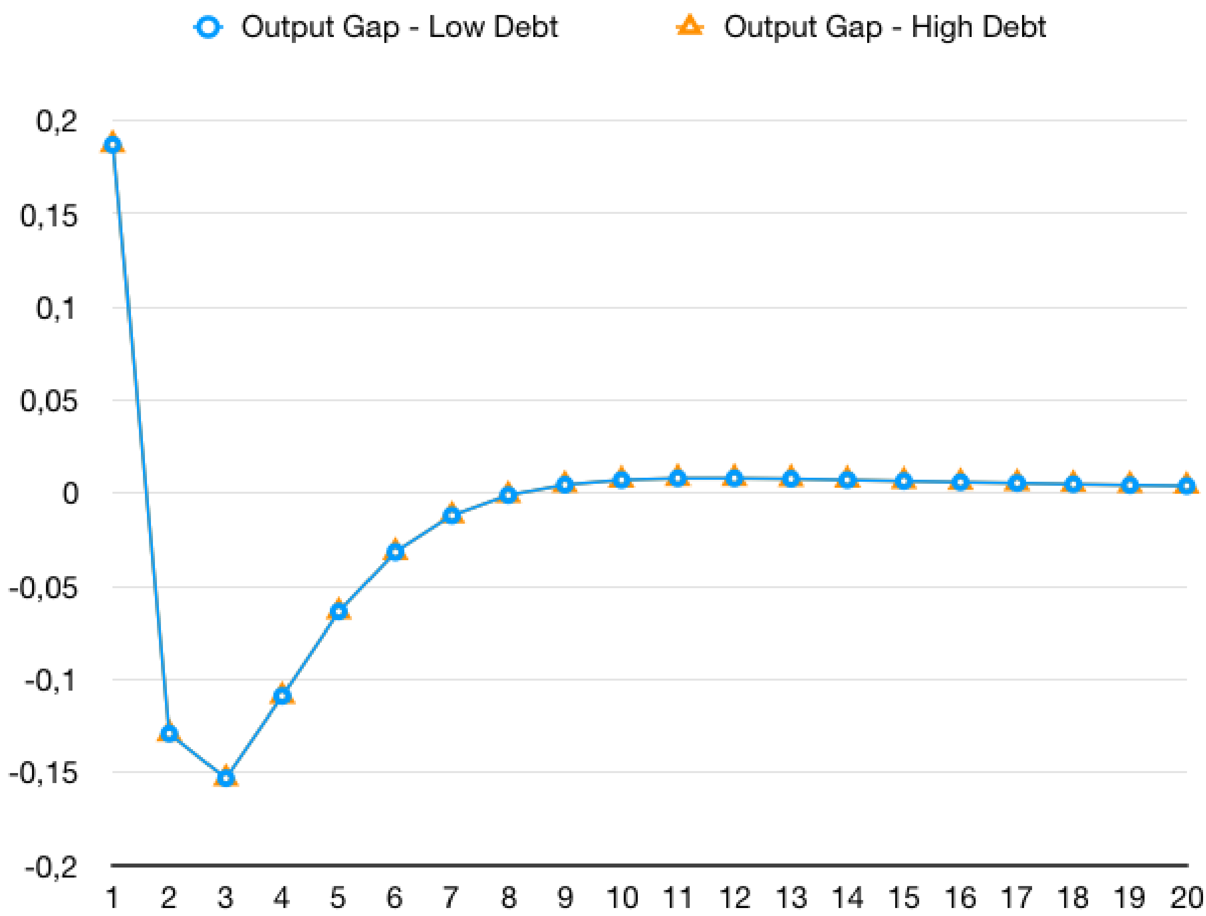

Figura 3 – Impulse-response of Output Gap for a Fiscal Stimulus without Debt Salience(in thousandth units)

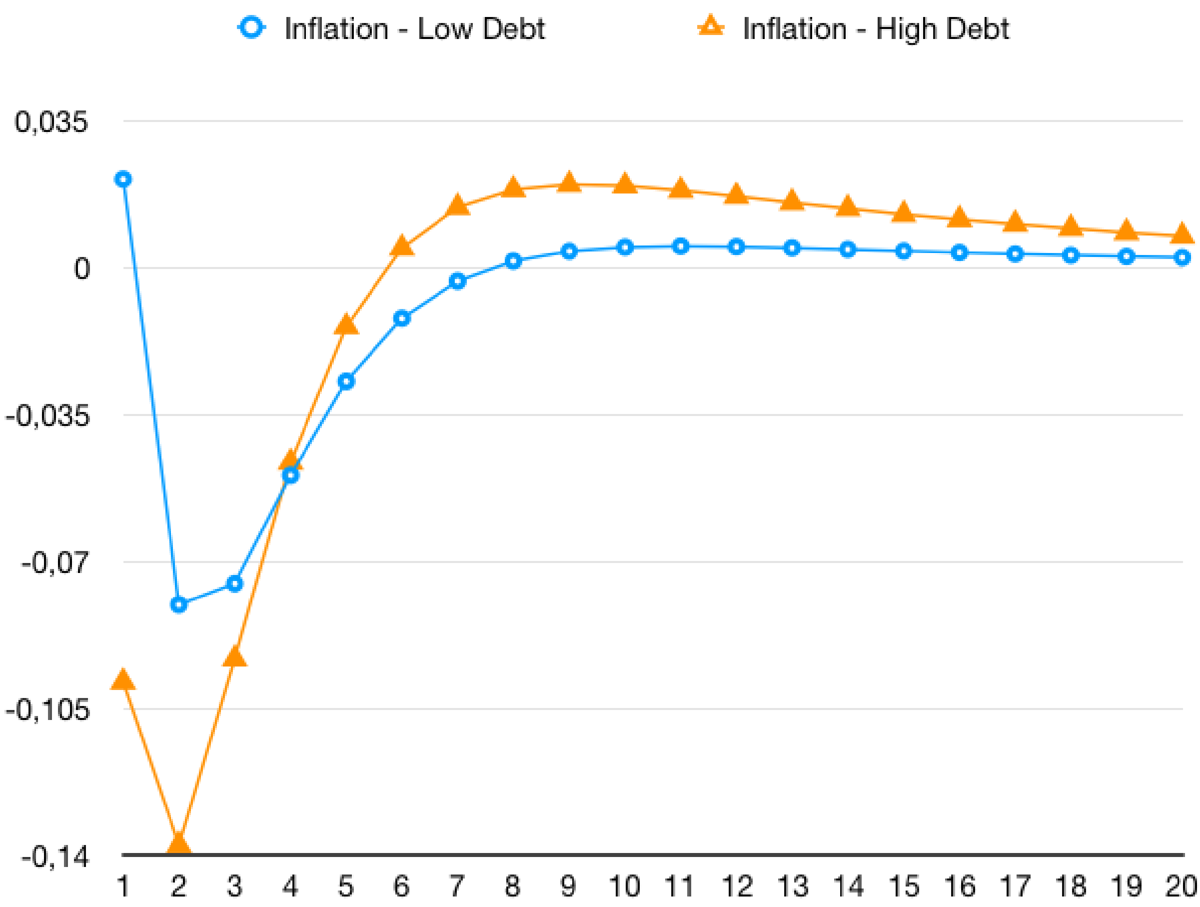

Figura 4 – Impulse-response of Inflation for a Fiscal Stimulus under Debt Salience(in thousandth units)

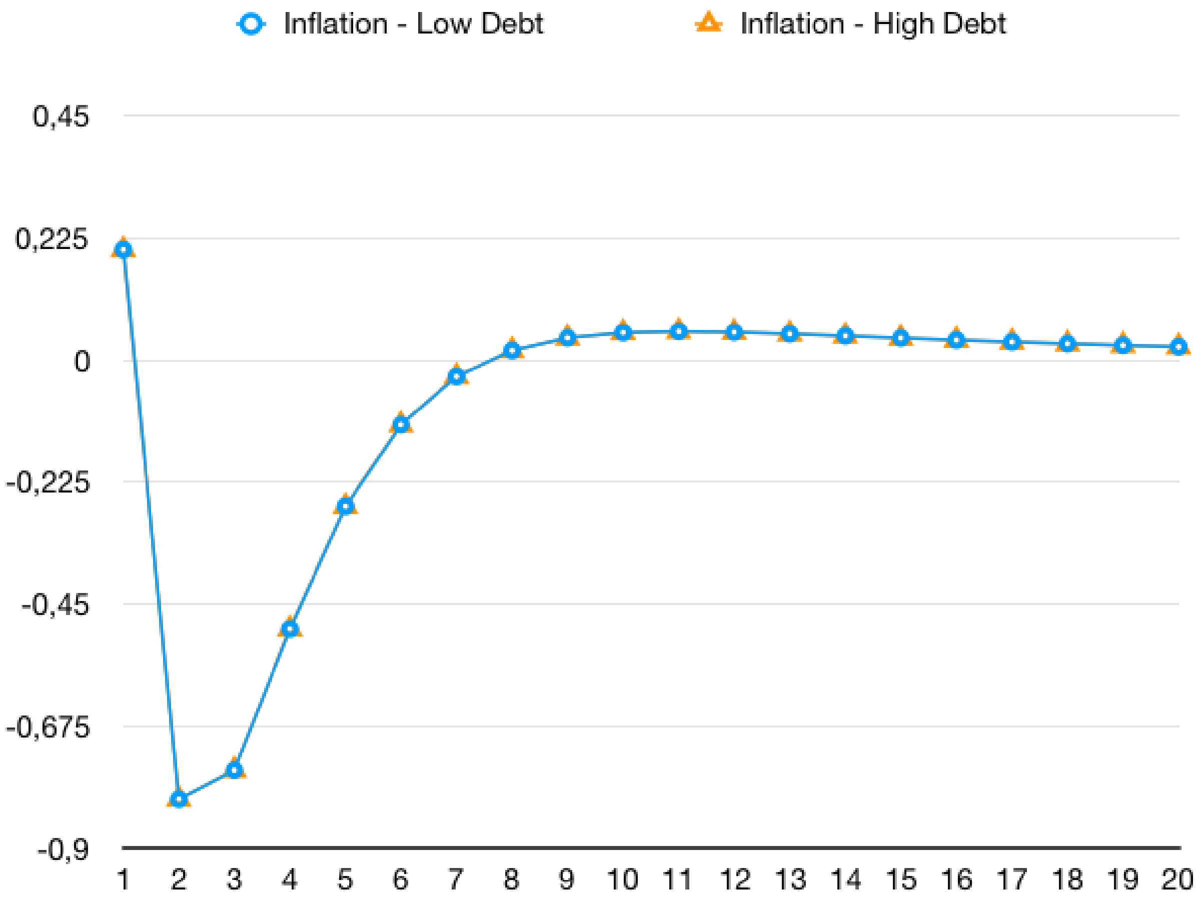

Figura 5 – Impulse-response of Inflation for a Fiscal Stimulus without Debt Salience(in thousandth units)

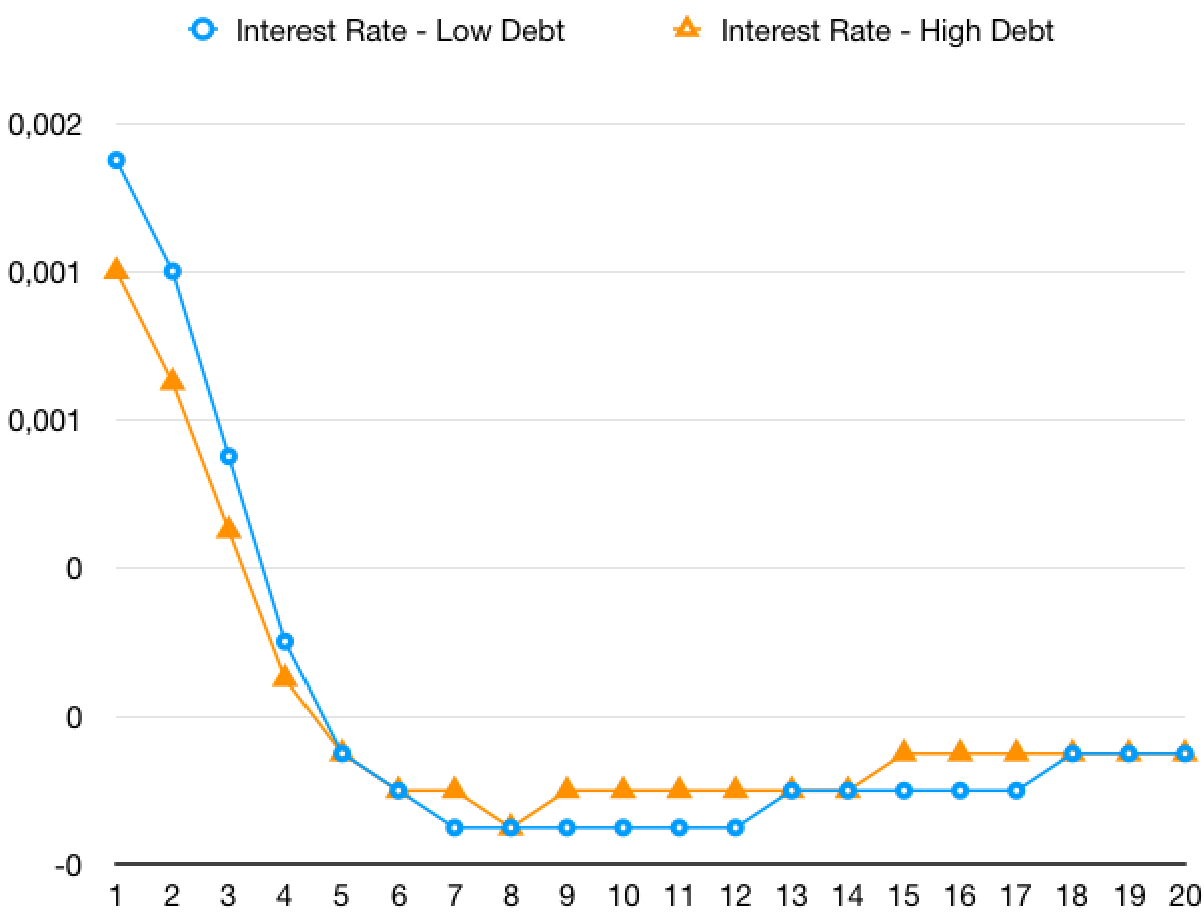

Figura 6 – Impulse-response of Interest Rate for a Fiscal Stimulus under Debt Salience

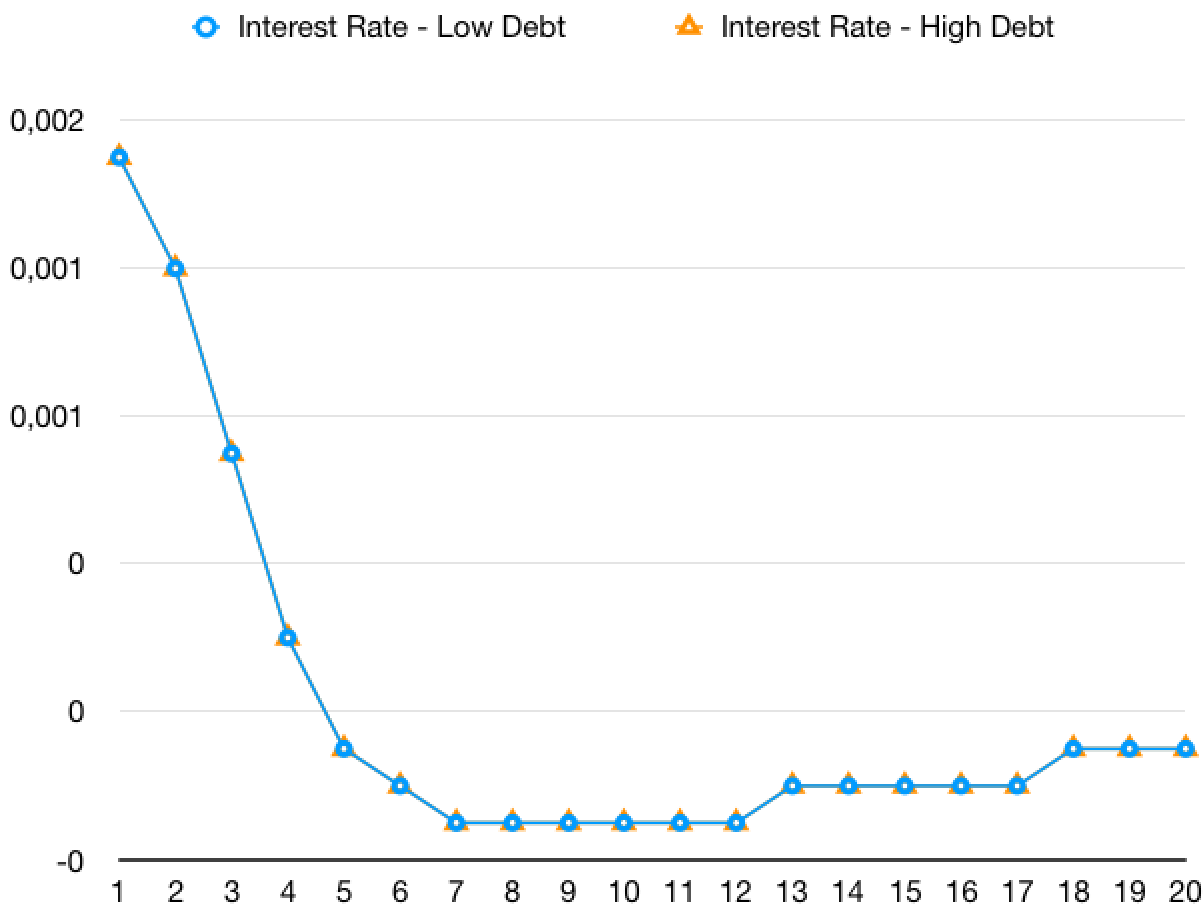

Figura 7 – Impulse-response of Interest Rate for a Fiscal Stimulus without Debt Salience

Figura 8 – Impulse-response of Attention for a Fiscal Stimulus under High Debt

As we can see in figures 2 and 3, there is a “boom-bust” response of the output gap to a fiscal stimulus[1]. This pattern occurs because, in the first periods, output rises due to the fiscal multiplier effect, but then it plummets due to the increase in the debt burden and in the interest rate. However, since there is a friction in the response of the monetary policy, as the interest rate goes down due to the increase in the debt burden, the real interest rate needs to go even lower, bringing a second, more modest, boom, and after it, the economy goes back to the steady-state.

Also, in figure 2, considering debt salience, the first periods’ fiscal multiplier seems higher when debt is lower. This result suggests that an increase in the deficit aiming to expand the output gap would result in bigger debt, and therefore a smaller multiplier for the next fiscal stimulus, similar to a ”self-destructive” trend in the fiscal multiplier. Moreover, this result goes in line with the notion of a higher debt reducing the fiscal multiplier as present in Huidrom et al. (2019) and Ilzetzki, Mendoza, and Vegh (2013). However, without considering debt salience, as in figure 3, there is no effect of the debt over the IRFs[2]. This absence of effect happens because the myopia variation drives the variation in the fiscal multiplier, and myopia does not change without debt salience, as shown in figure 8.

A curious aspect of figure 4 refers to its first period: when debt is low, fiscal stimulus positively affects the first period, while the effect is negative when debt is high. It probably happens because, when debt is high, people anticipate future inflation more, bringing a negative effect since there will be a negative output gap when the government starts to pay off his debt. Also, in both cases, after a fall in the second period, inflation starts to rise, until it goes beyond its steady-state level, and then returns to normal. These movements seem associated with the movements over the output gap, but the first-period movement still quite cloudy. The initial downturn can happen due to the negative output gap on the next periods, and also due to the increase in attention itself, as it makes the agent anticipates the future better. Also, similarly to the effects of a fiscal stimulus, the distortion is higher when the debt is higher, and there is no difference in the impulse response functions if we do not consider debt salience, as shown in figure 5.

Due to this pattern over the output gap, we see that the monetary policy’s response to a fiscal stimulus is bigger when debt is lower since a broader increase in the output gap will happen. However, due to the friction in monetary policy, the interest rate, which starts with a positive effect, goes to a negative one after some periods, as the fiscal policy turns contractionary due to the new debt burden, and after this, it goes back to 0. Due to

[1] Notably, our multipliers are considerably lower than the multipliers of Galí, López-Salido, and Vallés (2007) and Kaplan, Moll, and Violante (2018). This limited scale of the multiplier under bounded rationality happens because our representative agent deviates from Ricardian equivalence, but still preferring to smooth his consumption over time, differently of a hand-to-mouth agent in a heterogeneous agents model.

[2] The green line may not be seen as it is hidden behind the blue line since both series are equal.

the rounding in numbers, the graphs of figures 6 and 7 may sound confusing. However, we can see that when debt is high, the monetary policy comes to the steady-state fastly, as the distortion of the fiscal policy is smaller than when debt is low.

4.2 Results of Monetary Stimulus

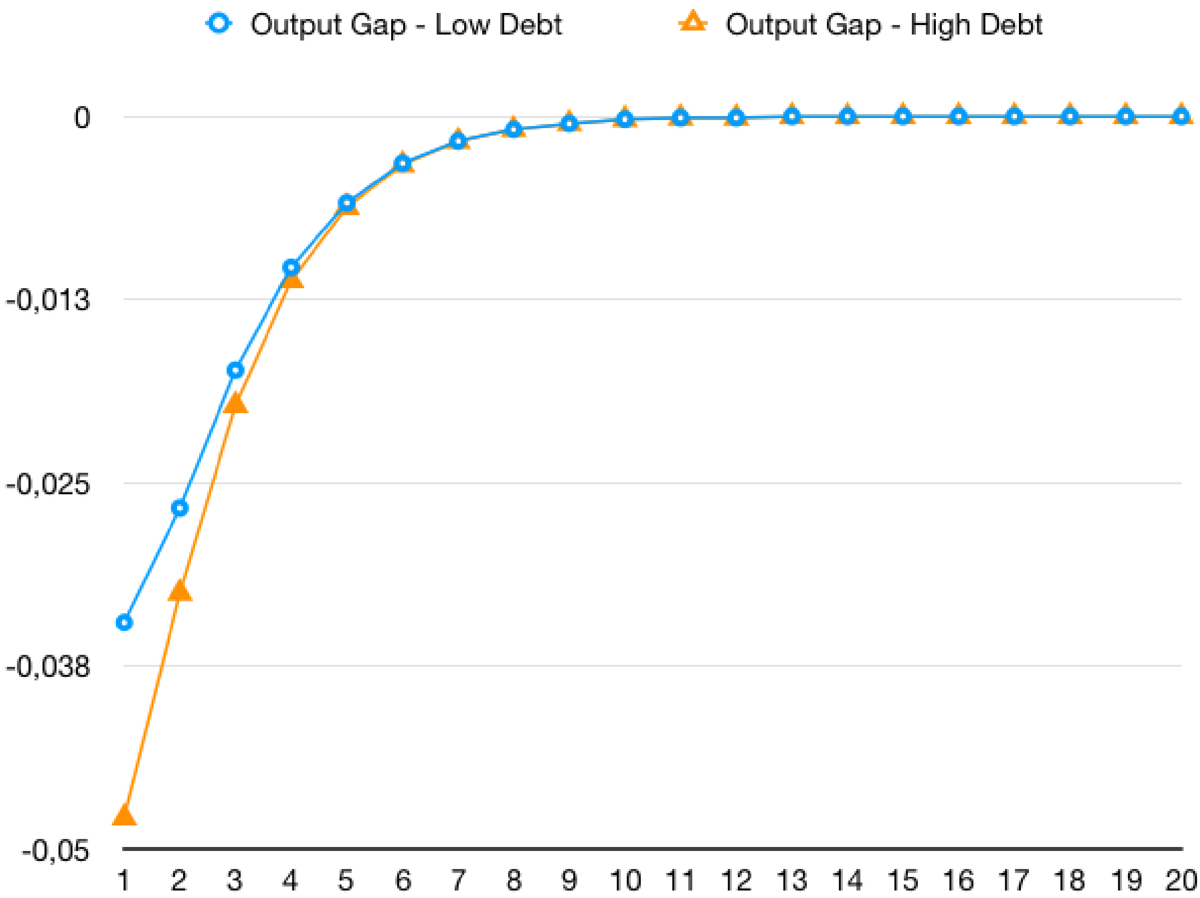

Figura 9 – Impulse-response of Output Gap for an Interest Rate Shock under Debt Salience

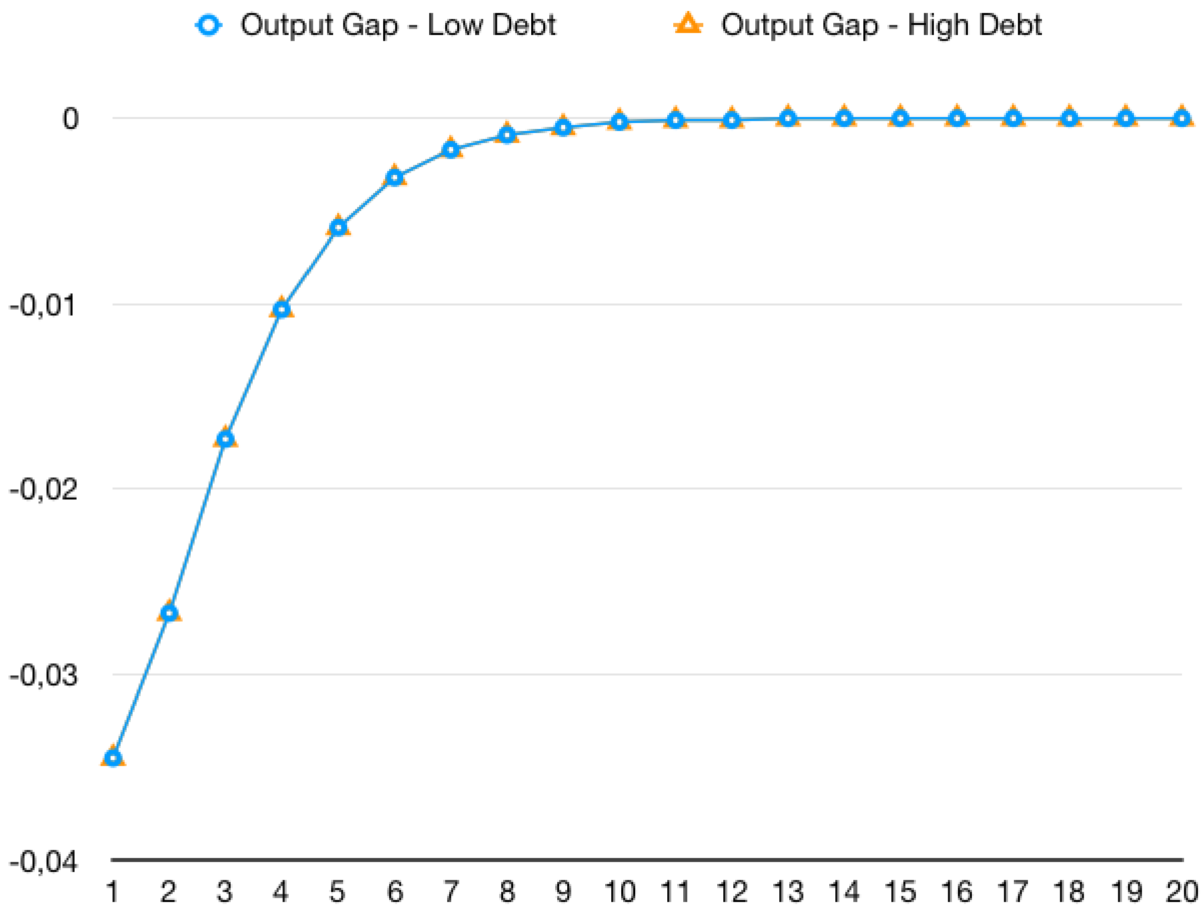

Figura 10 – Impulse-response of Output Gap for an Interest Rate Shock without Debt Salience

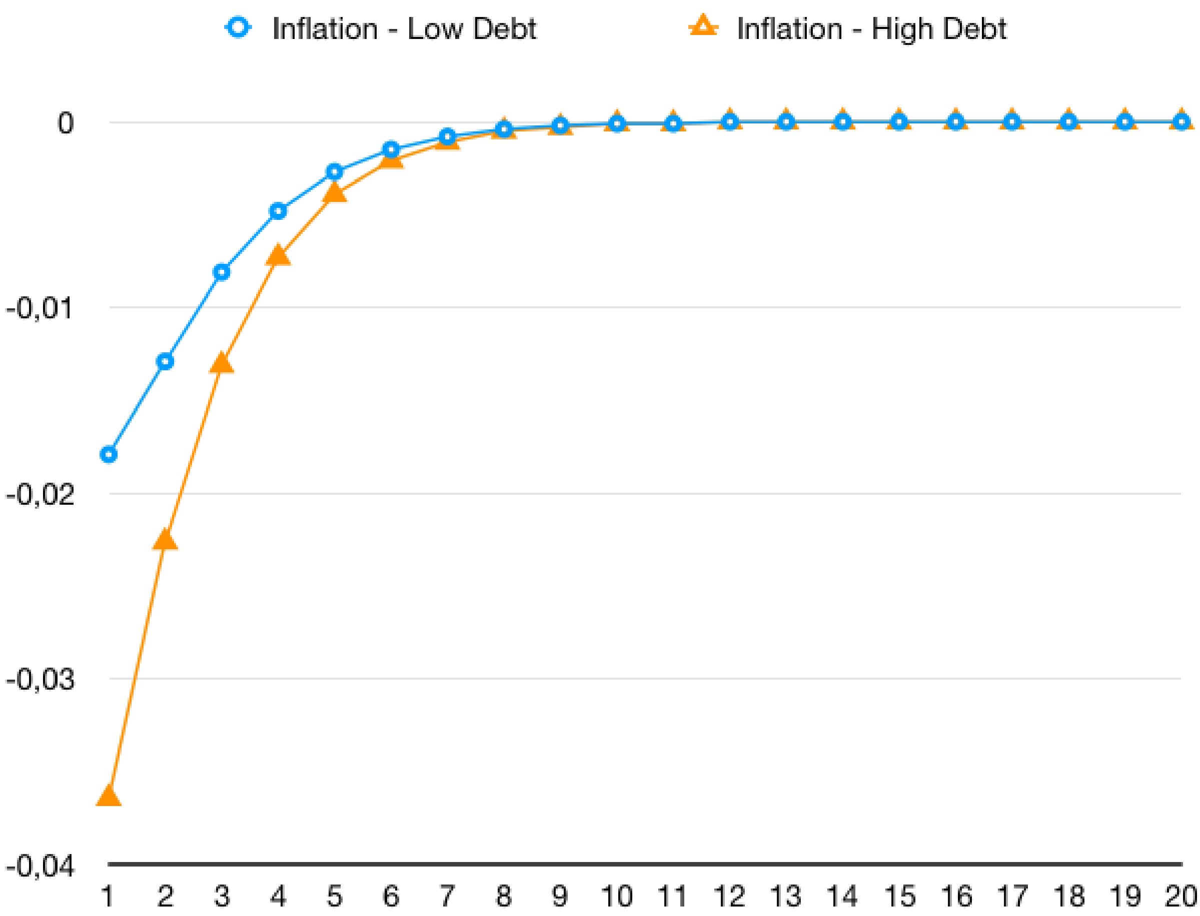

Figura 11 – Impulse-response of Inflation for an Interest Rate Shock under Debt Salience

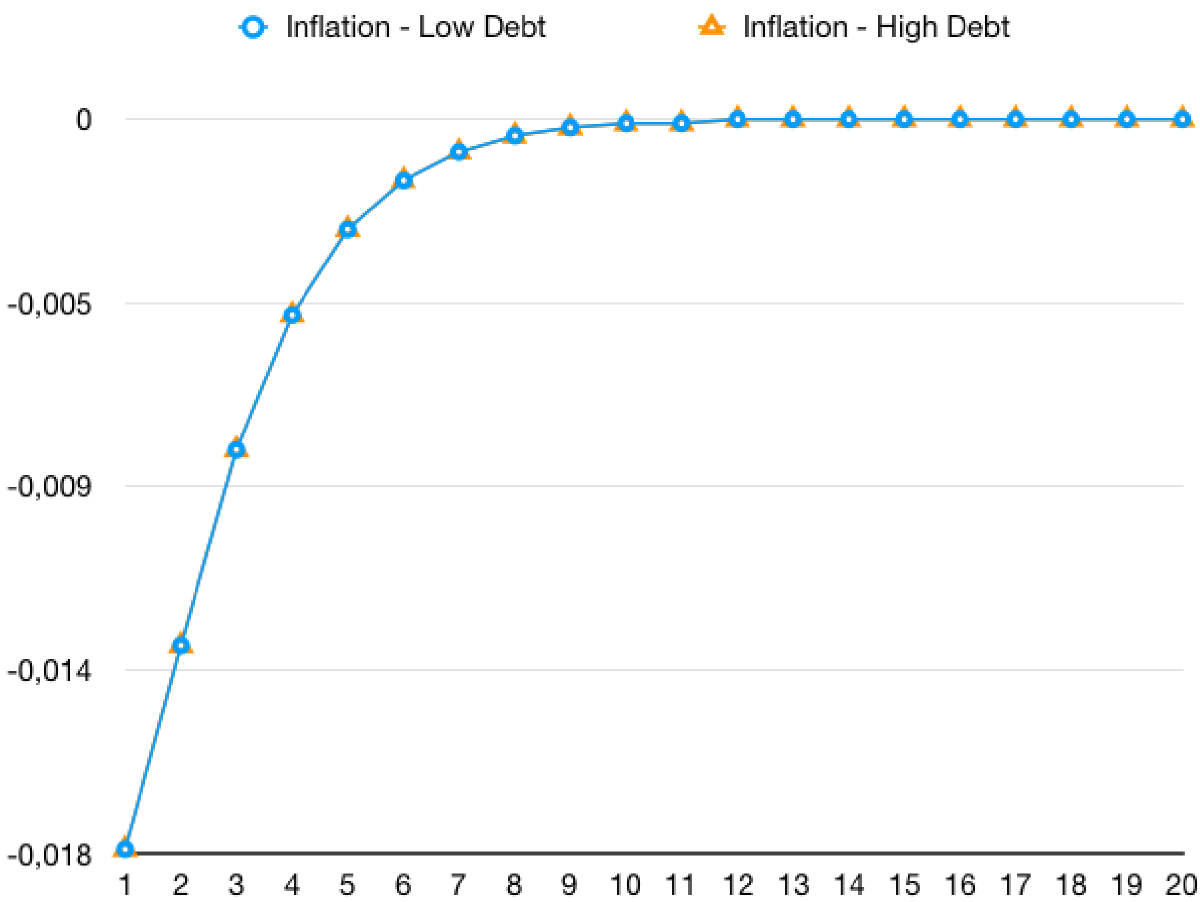

Figura 12 – Impulse-response of Inflation for an Interest Rate Shock without Debt Salience

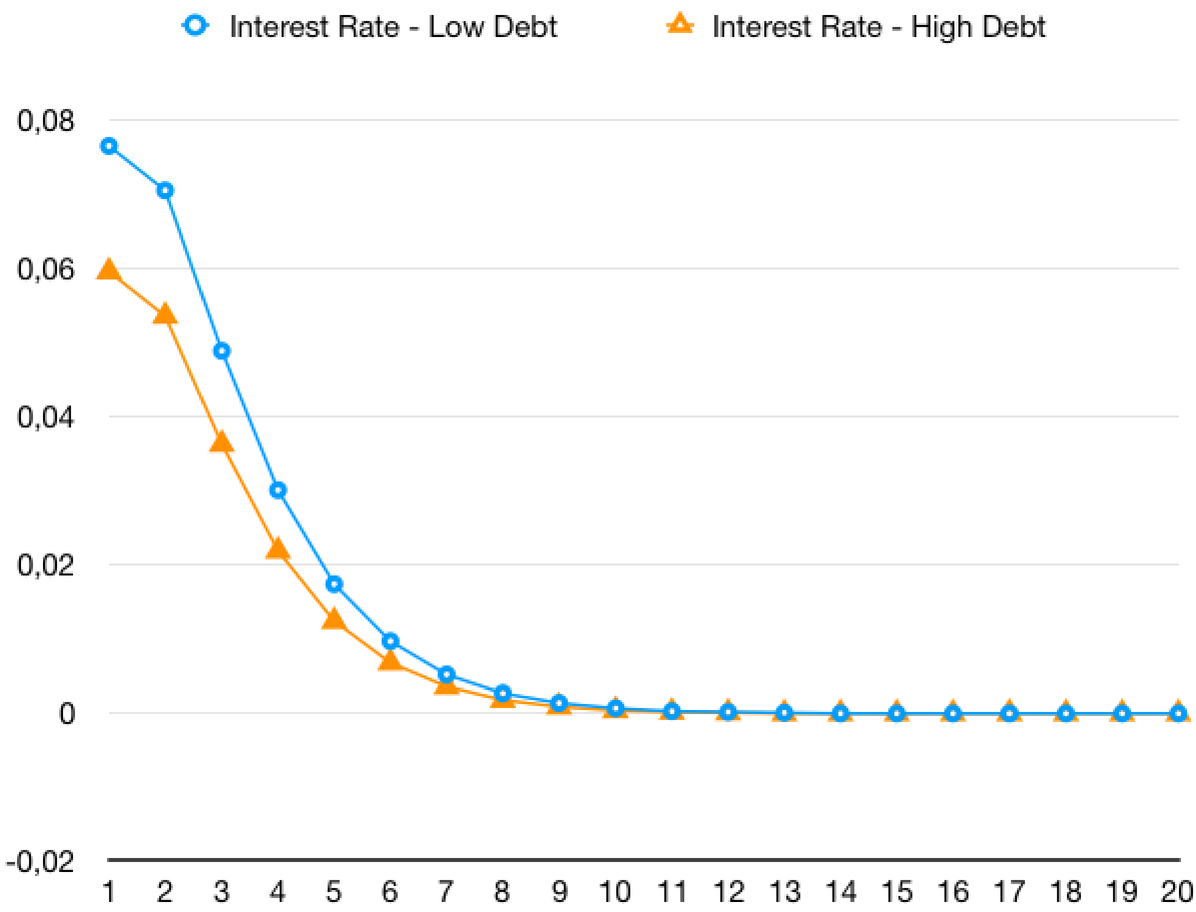

Figura 13 – Impulse-response of Output Gap for an Interest Rate Shock under Debt Salience

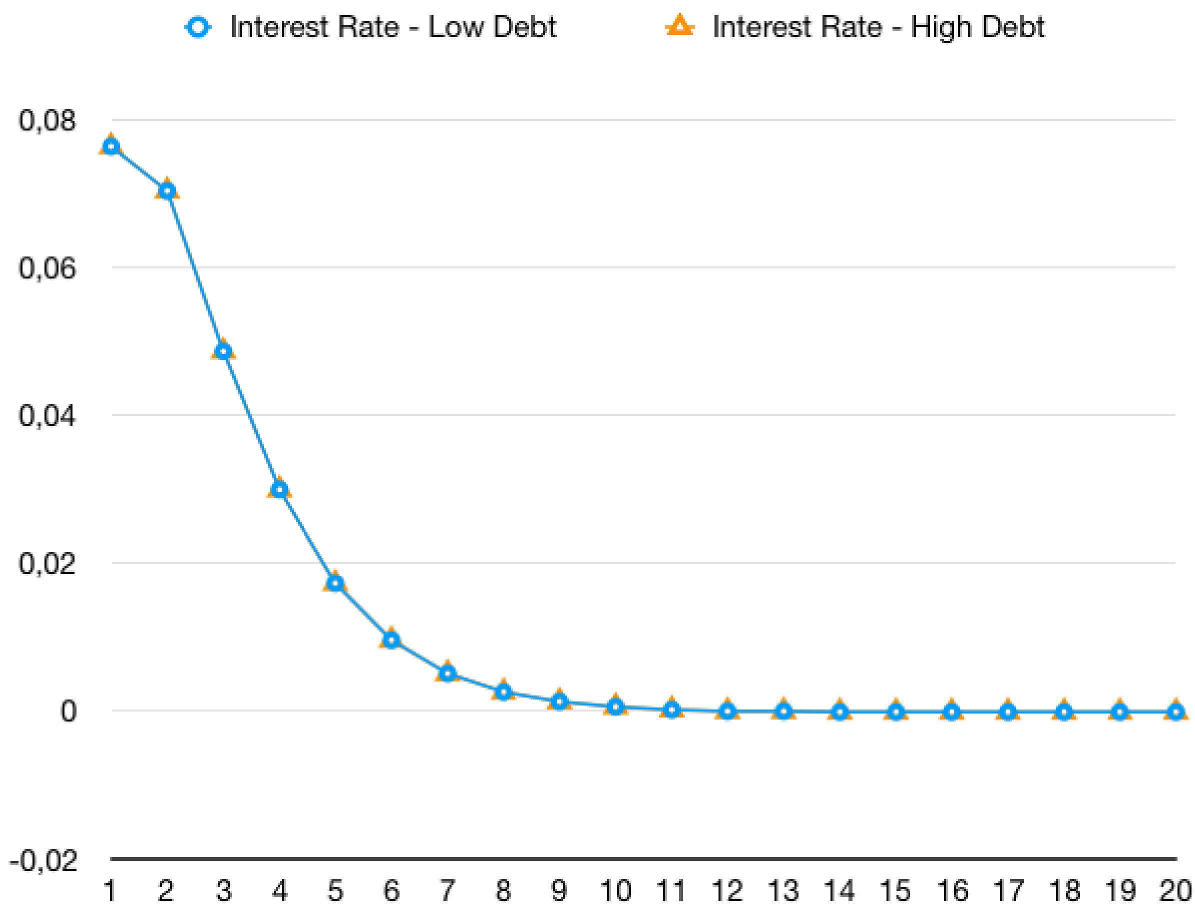

Figura 14 – Impulse-response of Output Gap for an Interest Rate Shock without Debt Salience

Regarding the stimulus over the monetary policy, present in figures 9 to 14, it is noteworthy that, under debt salience, the interest rate hike's effect is more robust with higher debt. This relationship between monetary policy response and the debt does not occur when we do not have debt salience, and It probably occurs because the agents now pay more attention to the future, and therefore the effects of an interest rate hike on the GDP are anticipated.

Similarly, the forward guidance channel becomes clearer when myopia is low (that is, m_t is nearer one), increasing monetary policy strength. In fact, a situation where $m_t = 1$ would be similar to a situation where there is common knowledge in the model of Angeletos & Lian (2018), or when there are complete markets in the model of McKay, Nakamura & Steinsson (2016). In these situations, the leading solution for the forward guidance puzzle is gone, and therefore a future increase in the interest rates would affect the present. According to our model, a high debt-to-GDP relation may alleviate the "forward guidance puzzle", as the forward guidance channel is more influential when attention is sizable. Therefore, the existence of a forward guidance puzzle may be conditional on the extent of attention and, consequently, the size of the debt.

However, as monetary policy strengthens, the breaking-even debt point that would bring a "debt-driven ZLB", or "debt-trap", present in Mian, Straub, and Sufi (2020), is higher, as the response of output to the interest rate is now higher. Also, the fiscal multiplier reduction due to higher debt points to a higher debt level to generate a debt-trap. Still, this point is perfectly achievable as this multiplier effect can increase proportionally less than the debt, and the interest rate still limited to zero.

5 Concluding Remarks

Relying on the fact that myopia tends to change with volatility and, consequently, with the public debt, the consistency of some results in the bounded rationality literature, especially the absence of Ricardian equivalence, is questionable. At least, the consideration of a fixed response of the output to a fiscal or monetary stimulus might be reinterpreted, and this is even more important as more economies are going on debt-traps, which simple quantitative easings are not solving. Therefore, some considerations about the ZLB being much less costly in a bounded rationality model, such as in Gabaix (2020) is questionable.

Instead, this debt salience model suggests that, under a debt-driven trap, it is probably best to do “helicopter drops of money” to alleviate public debt than to stimulate the demand. At least, it may be better to do both jointly, as the multiplier effects will be higher with smaller debt. However, this notion of a “fiscal easing” needs to be better assessed, as there would be other counter-effects happening if a government print money to pay off debt, such as smaller credibility and weakened business confidence. However, it is noteworthy that Rogoff & Reinhart (2015) pointed out that the most prosperous countries in solving the debt overhang used heterodox policies. Still, considering debt salience, even some of these heterodox politics should be questioned as efficient.

Other results present in the bounded rationality literature are questionable under this kind of debt salience. Notably, the forward-guidance can still be valid under a high-debt. However, most of these results regarding monetary policy changes more in magnitude than in direction. Only some of the results regarding the fiscal policy changes in direction, and still, depending on the fiscal rule. Moreover, a better calibration of the parameters might be required to analyze these results’ validity, and it is not odd to do even with a fixed parameter, as shown in Andrade, Cordeiro, and Lambais (2018).

In some sense, this paper bridges the gap between the literature regarding the importance of fiscal positions on fiscal multipliers and the literature regarding the importance of bounded rationality in macroeconomics. Differently from Alesina, Favero, and Giavazzi (2015) and Huidrom et al. (2019), our model’s microfoundings are based on the effect that high debt has on volatility, and so on the fiscal multiplier, instead of being based solely on the anticipation of fiscal consolidation.

There are other possible forms of achieving debt salience on a new-Keynesian model. Firstly, it is possible to consider that the future debt burden is costly to watch and calculate, and therefore, the salience parameter would be introduced directly in the debt burden. This formulation would be similar to Chetty, Looney and Kroft (2009) and Rees-Jones and Taubinsky (2017), except that we would be considering future taxations.

However, a parameter such as this one, denoting a dynamic inconsistency, can also be virtually intractable. Another way to prove the existence of a positive relationship between debt and attention would be based on Tversky and Kahnemann (1974), as people would pay more attention under the eminence of losses than of gains, explaining why attention would move more when debt is higher than the expected steady-state level than when it is below this threshold.

Another possible research line is to question if, beyond some debt point, agents stop being myopic and start being hyperopic, arising another set of implications that can be consistent with the “90% threshold” of Reinhart and Rogoff (2010) and the fiscal dominance vision of Cochrane (2011). Still, as an upcoming theory, more works are necessary to validate the assumptions needed for debt salience, but more works become possible due to these assumptions.

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