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FISCAL CONSTRAINTS ON MONETARY POLICY: THE CASE OF MEXICO

TESINA

QUE PARA OBTENER EL TÍTULO DE

LICENCIADO EN ECONOMÍA

PRESENTA

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A mis padres,
Alba y Gonzalo

Nothing so weakens a government as inflation.
– J. K. Galbraith

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Abstract

This study examines the impact of public debt on inflation expectations in Mexico, where inflation has persistently exceeded the 3% target despite adequate management of monetary policy. By using public debt surprises as an instrumental variable, we identify exogenous shocks and estimate their effects on short and medium-to-long term inflation expectations through local projections. Our findings indicate that public debt shocks de-anchor inflation expectations, with a more immediate impact on longer-term expectations and a stronger impact on shorter-term expectations. The study highlights the need for sustainable fiscal policies and their crucial role in supporting the inflation-targeting efforts of the central bank.

Contents

List of Figures

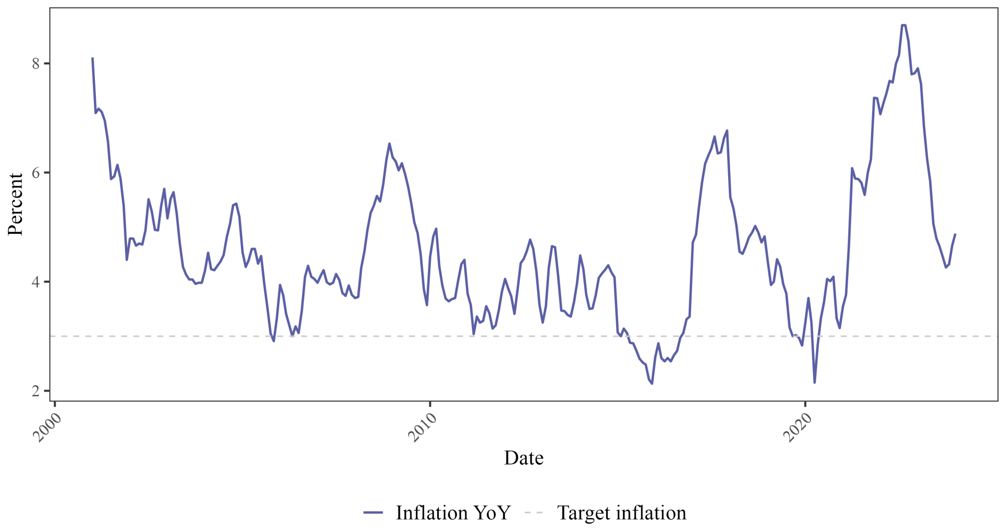
List of Tables

1 Introduction

Throughout its economic history, Mexico has had significant struggles in maintaining price stability. The last two decades of the 20^{th} century were characterized by economic recessions, defaults, exchange rate instability, and explosive growth in prices. These tumultuous times motivated a shift in the conduction of economic policy. In particular, on the fiscal side, public debt was put under much more scrutiny, and many of the government's capacities were transferred to the private sector. Meanwhile, monetary policy also experienced significant changes, marked by the granting of autonomy to the central bank in 1994 and the later adoption of the inflation-targeting framework for conducting monetary policy in 2003.

Under this novel regime, economic indicators began to show much more stable behavior. In particular, as shown by Chiquiar et al. (2010), consumer price inflation has behaved as a stationary process since 2001. This characteristic has been of paramount importance for conducting forecasts and reducing volatility, which in turn makes the country an attractive option for foreign investment, among other impacts. It is undeniable that monetary policy committed to its goal of price stability was crucial in obtaining this status. However, despite these achievements and despite the central bank's autonomy, targeting policies, and state-of-the-art conduction of monetary policy, inflation has consistently remained above the 3% target for most of the 21^{st} century, as displayed in figure 1.1 below.

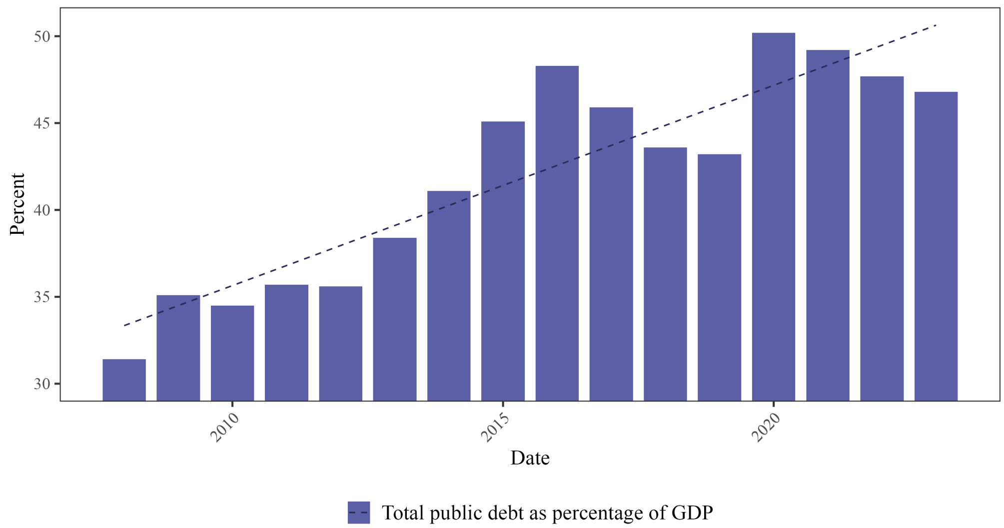
Figure 1.1: Consumer price inflation and inflation target.



Notes: Own elaboration with data from Banco de México.

This phenomenon implies the existence of other mechanisms that are constraining the effectiveness of monetary policy to maintain price stability. In this study, we argue that an important driver is public debt. Looking at the data, it stands out that there has also been a consistent rise in total public debt as a percentage of GDP. Figure 1.2 displays the evolution of the Historical Balance of the Financial Requirements of the Public Sector from 2008 to 2023, which is the period our empirical analysis covers. In the plot, it is clear that there have been positive shocks through the years. In this study, we show that these shocks have a positive response in inflation expectations both in the short term and the medium-to-long term.

Figure 1.2: Total public debt in Mexico.



Notes: Own elaboration with data from SHCP.

Specifically, we claim that concerns regarding the government's intertemporal budget constraint put upward pressures on the price level. To support this idea, we rely on three theoretical mechanisms from the literature: Fiscal Dominance, the Fiscal Theory of the Price Level, and the effects of high levels of public debt on the natural interest rate. In section 2.1 we delve into each mechanism, and in section 6 we show how empirical patterns suggest that they are at play.

Our econometric analysis rests on the identification of exogenous public debt shocks using public debt surprises as an instrumental variable. We define this surprise as the difference between the debt forecast made by the Mexican Ministry of Finance and Public Credit (SHCP) in October of the prior year and the realized debt. With this technique, we are able to obtain true surprises that allow us to estimate impulse response functions with local projections (LP), introduced by Jordà (2005). With the use of LP we can easily incorporate the instrument by using two-stage least squares.

We find evidence consistent with the view that (sufficiently) forward-looking agents react to public debt shocks by raising (and thus, de-anchoring) their short and medium-to-long term inflation expectations. While the former takes some time to respond, the latter shows an immediate effect, adding evidence to the findings in Brandao-Marques et al. (2023) that longer-term inflation expectations are the channel through which fiscal policy constrains its monetary counterpart.

The rest of the article is structured as follows. In section 2 we present the literature on which our ideas are based, and in section 3 we describe the theoretical framework that we rely on. We continue by describing the econometric methodology in section 4 followed by the data we use for our estimations in section 5. We then present our results in section 6 and conduct robustness exercises in section 7. Finally, in section 8 we discuss policy implications and conclude.

2 Literature review

2.1 Theoretical mechanisms

The literature has proposed many theoretical frameworks that establish a connection between public debt and inflation. Since monetary authorities in Mexico have no say in fiscal policy, we interpret this relationship as constraints on the central bank's effectiveness in maintaining price stability. Here, we focus on three ideas that point towards inflation pressures generated by public debt.

First, we present fiscal dominance. The idea behind it is that in response to an inflationary shock under high levels of public debt, central banks are unable to tighten monetary conditions as much as they would under stable fiscal conditions. In this framework, agents anticipate the constraint and respond by raising their inflation expectations. These arguments are present in Sargent and Wallace (1981) and further developed in forward-looking models of inflation in Aiyagari and Gertler (1985) and Calvo (1988), among others. An important aspect of this literature is that even if tight monetary policy is effective in reducing inflation in the short run, it surely delivers higher inflation in the future when fiscal policy dominates its monetary counterpart. This happens because it affects the inflation expectations of agents who internalize the need for insufficiently tight policy later on.

The second theoretical mechanism that we focus on is the fiscal theory of the price level or FTPL (Leeper, 1991; Sims, 1994; Woodford, 1994; Cochrane, 2001). The argument of the FTPL is that the price level adjusts so that the nominal value of debt equals the real present value of primary surpluses (taxes minus spending) (Cochrane, 2023). The main difference between FTPL and fiscal dominance is that in this model, an increase in trend inflation driven by fiscal policy is not necessarily due to credibility issues regarding the central bank. Instead, it arises from a misalignment between the central bank's goals and the fiscal authority's anticipated actions to credibly manage its debt.

Finally, an alternative and more recent theoretical mechanism is developed by Campos et al. (2024), which proposes the natural interest rate as the conductor in the relationship between public debt and inflation. In this model, the natural rate, defined as the real interest rate in the deterministic steady state of the economy, evolves in response to changes in public debt levels. The authors argue that the stock of public debt influences this natural rate, showing that an increase in public debt raises the natural rate. This increase in the natural rate is unobserved and determines how tight the monetary stance is, thereby creating inflationary pressures if the central bank fails to adapt its policy appropriately.

Although there are substantial theoretical differences, all three frameworks discussed share the similarity that they raise the price level via the de-anchoring of inflation expectations. This common characteristic would result in empirical patterns simultaneously consistent with all of them. Because of this, we focus on studying this channel. Therefore, this literature leads us to quantify the response in inflation expectations to a shock in public debt.

2.2 Empirical literature

The literature that estimates the response of inflation to shocks on public debt is limited. However, a recent study was done by Brandao-Marques et al. (2023) in which the authors study the response in inflation expectations to debt surprises. The authors use a theoretical framework similar to ours but differ in their objective, which is to look at country characteristics that determine the magnitude of the response. They have two main findings, the first one is that debt surprises raise long-term inflation expectations in emerging market economies in a persistent way, but not in advanced economies. And, the second one is that high initial levels of debt, inflation, and debt dollarization add to the strength of the effects, while inflation targeting regimes mitigate the effects.

With these results in mind, the case of Mexico is of particular interest. Mexico is an emerging market economy, listed as such in Brandao-Marques et al. (2023), which categorizes the country in the group with a persistent response on inflation expectations to debt shocks. However, Mexico implemented an inflation targeting regime since the beginning of the 21st century and, furthermore, among these emerging market economies, Mexico does not qualify for neither high initial levels of public debt, inflation or debt dollarization. In this context, it is necessary to study the country in isolation in order to determine its adequate categorization.

3 Theoretical framework

The theoretical framework draws upon the FTPL, particularly the Fiscal Theory with Long-Term Debt presented in Cochrane (2001). This model describes a frictionless economy with no cash held overnight, thus ignoring monetary frictions for simplicity without altering first-order predictions. The model is constructed as follows. Let $B_t(j)$ denote the face value of zero-coupon nominal bonds outstanding at the end of period t that come due in period j, and $Q_t(j)$ denote the nominal price at time t of a bond that matures at time j. Let p_t denote the price level, and s_t denote the real primary surpluses defined as tax collections less government purchases.

The analysis flows from two equivalent equilibrium conditions, derived in Appendix 8. The *flow condition* states that the real primary surplus s_t must equal bond redemptions plus net repurchases,

$$\frac{B_{t-1}(t)}{p_t} - \sum_{j=1}^{\infty} \beta^j E_t \left(\frac{1}{p_{t+j}} \right) [B_t(t+j) - B_{t-1}(t+j)] = s_t, \tag{3.1}$$

and the *present value condition* states that the real value of outstanding debt equals the present value of real surpluses,

$$\frac{B_{t-1}(t)}{p_t} + \sum_{j=1}^{\infty} \beta^j E_t \left(\frac{1}{p_{t+j}} \right) B_{t-1}(t+j) = E_t \sum_{j=0}^{\infty} \beta^j s_{t+j}. \tag{3.2}$$

An *equilibrium* is thus defined as a sequence of prices $\{p_t\}$, of surpluses $\{s_t\}$, and of debt of all maturities $\{B_t(t+j), j = 1, 2, \ldots, \infty\}$ such that equation (3.1) or (3.2) holds at each date and state. Since we are interested in finding the price level as a dependent variable from debt and surplus policies, a *solution* is the equilibrium price sequence for given debt and surplus sequences.

These solutions are not trivial to find and the algebra is beyond the scope of this study.

Therefore, we skip to the exact solution,

$$p_t = \frac{B_{t-1}(t)}{E_t\left[\sum_{j=0}^{\infty} \beta^j W_{t,j} s_{t+j}\right]}, \tag{3.3}$$

where the weights W are defined recursively by

$$\begin{aligned}
W_{t,0} &= 1, \\
W_{t,1} &= A_t(t+1), \\
W_{t,2} &= A_{t+1}(t+2)W_{t,1} + A_t(t+2), \\
W_{t,3} &= A_{t+2}(t+3)W_{t,2} + A_{t+1}(t+3)W_{t,1} + A_t(t+3), \\
W_{t,j} &= \sum_{k=0}^{j-1} A_{t+k}(t+j)W_{t,k},
\end{aligned} \tag{3.4}$$

and $A_t(t+j)$ denotes the fraction of maturity j debt issued at time t,

$$A_t(t+j) \equiv \frac{B_t(t+j) - B_{t-1}(t+j)}{B_{t+j-1}(t+j)}; \quad j = 1, 2, \ldots \ . \tag{3.5}$$

This complex characterization of the effects of debt policy on the price level shows us that the maturity structure of the debt is a major determinant of this process. Additionally, it pinpoints the importance of debt prospects in the determination of the current and future price level, thus providing a channel for debt policy to impact inflation expectations. And, furthermore, we argue that this channel has played a role in the de-anchoring of inflation expectations observed in Mexico throughout the better part of the century.

4 Econometric approach

4.1 Endogeneity concerns and instrumental variable

When estimating how public debt constrains monetary policy, a few endogeneity concerns arise. First, fiscal policy measures can also directly shape inflation expectations via aggregate demand effects, which we aim to exclude. Second, the relationship between debt levels and inflation could be spurious and driven by an omitted variable. This can take many forms; one example is reductions in capital flows due to changes in global risk aversion that are often accompanied by exchange rate depreciation, thus raising inflation expectations and the level of public debt.[1] Third, we could observe inverse causality at times when, for example, fiscal authorities tighten their policy in response to a rise in inflation expectations.

To address these concerns, we follow Brandao-Marques et al. (2023) in instrumenting debt shocks with forecast errors of public debt to identify unanticipated exogenous shocks that mitigate endogeneity. We differ from them by using the forecasts published by the Mexican Ministry of Finance and Public Credit (SHCP) rather than the IMF's, hence taking advantage of our single country context. This instrument is effective in excluding short-term inflationary demand effects from fiscal expansions because debt surprises are less likely to be driven by changes in government expenditures (Singh et al., 2005).

The debt surprises are defined as the difference between the realized level of public debt to GDP ratio minus the corresponding SHCP forecast published in September of the prior year. Since debt forecast are expected to contain all available information at the time they are made, our instrument constitutes a true surprise and is most likely to reflect unanticipated policy changes, natural disasters or debt revaluations (Blanchard and Perotti, 2002; Abiad et al., 2016; Furceri and Li, 2017), i.e., non-aggregate demand effects.

[1] The level of public debt can increase via a negative response from GDP, thus raising the debt-to-GDP ratio, or because debt in foreign currency is now worth more in local currency.

4.2 Impulse response function estimation

We use the local projections (LP) method of Jordà (2005) to estimate our results. This methodology is better suited for our study because it provides ease of estimation by ordinary least squares while being equivalent to a VAR in terms of impulse response analysis, as shown in recent literature (Montiel Olea and Plagborg-Møller, 2021; Plagborg-Møller and Wolf, 2021; Li et al., 2022). In addition to this advantage, it is also simple to obtain LP estimates robust to heteroskedasticity and autocorrelation via a semi-parametric estimation of the error variance matrix, such as the Newey and West (1987) estimator, and by incorporating lags of the response variable (Montiel Olea and Plagborg-Møller, 2021; Jordà, 2023).

In this study, we estimate the accumulated response of inflation expectations in Mexico h periods ahead, $\pi(H)^e_{t+h}$, to an exogenous public debt shock in period t, $debt_t$. Furthermore, we control for a set of macroeconomic factors that follow an open market version of Taylor's rule, x_t, which also includes lags of our dependent variable. With this notation, the LP are obtained through the ordinary least squares estimation of the following model:

$$\pi(H)^e_{t+h} = \boldsymbol{\alpha}_h + \mathbf{debt}_t\boldsymbol{\beta}_h + \mathbf{x}'_t\boldsymbol{\Gamma}_h + \boldsymbol{\nu}_{t+h}, \quad h = 1, \ \ldots, \ H, \tag{4.1}$$

where $\pi(H)^e_{t+h}$ denotes the measure of inflation expectations for horizon H at time $t+h$, $\boldsymbol{\nu}_{t+h}$ denotes a scalar moving average process of order h, as shown by Jordà (2005), $\boldsymbol{\alpha}_h$ and $\boldsymbol{\Gamma}_h$ are parameters, and $\boldsymbol{\beta}_h$ are the estimates of the LP. However, given the endogenous nature of public debt, we modify our model using debt surprises to instrument public debt shocks as detailed in section 4.1.

We thus adopt a two-stage least squares (TSLS) methodology, in which the identification of our exogenous public debt shocks is the fitted values from the first-stage regression:

$$\mathbf{debt}_t = \boldsymbol{\delta}_0 + \mathbf{debt}^{shock}_t\boldsymbol{\eta} + \mathbf{x}'_t\boldsymbol{\delta} + \mathbf{u}_t, \tag{4.2}$$

and proceed with the second stage, analogous to model (4.1) using the fitted values, $\widehat{\mathbf{debt}}_t$, from (4.2):

$$\pi(H)^e_{t+h} = \boldsymbol{\alpha}_h + \widehat{\mathbf{debt}}_t\boldsymbol{\beta}_h + \mathbf{x}'_t\boldsymbol{\Gamma}_h + \boldsymbol{\nu}_{t+h}, \quad h = 1, \ \ldots, \ H. \tag{4.3}$$

Then, following notation from Jordà (2023) ad setting $H = 24$, the LP are given by:

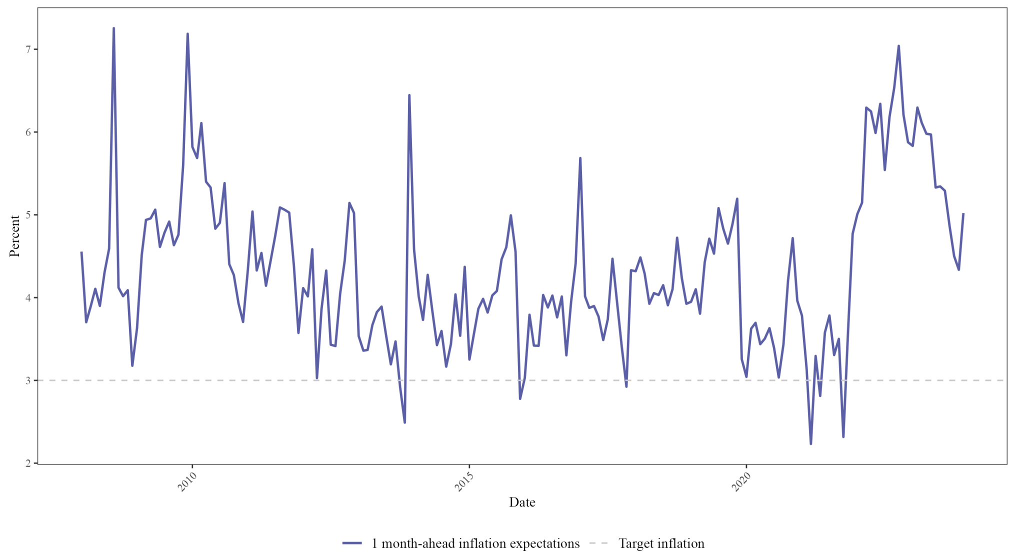
$$\mathcal{R}(h) = \hat{\beta}_h \quad h = 1, \ldots, 24. \tag{4.4}$$

5 Data

5.1 Dependent variables

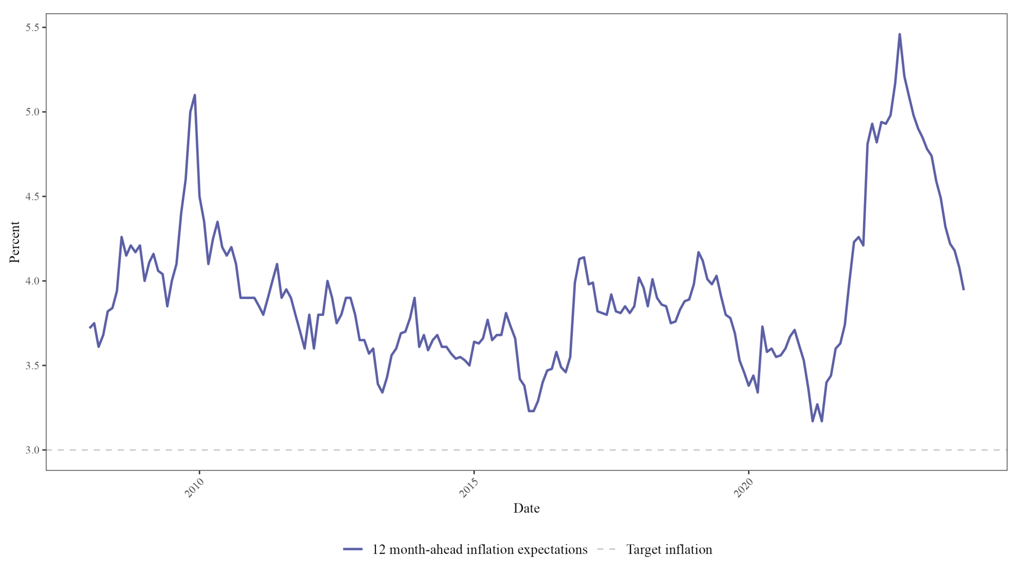
Due to data availability, we include observations from 2008 to 2022 to conduct our estimations. Since this study focuses on the response of 1-month, 12-month, and 4-year ahead inflation expectations to a shock in public debt, those are the three dependent variables that we examine. For this, we use data from the Survey on the Expectations of Private Sector Economic Specialists (Encuesta sobre las Expectativas de los Especialistas en Economía del Sector Privado), which is published on a monthly frequency by Mexico's central bank, Banco de México. The 12-month and 4-year inflation expectations are already in annual growth rate, while month-ahead inflation expectations are transformed into annualized rates and seasonally adjusted. Figures 5.1 through 5.3 below show all three of them along with the central bank's goal of 3% inflation (plus/minus 1%). Here, it is straightforward to observe the de-anchoring of inflation expectations during the better part of the current century.

Figure 5.1: 1-month ahead inflation expectations (seasonally adjusted).



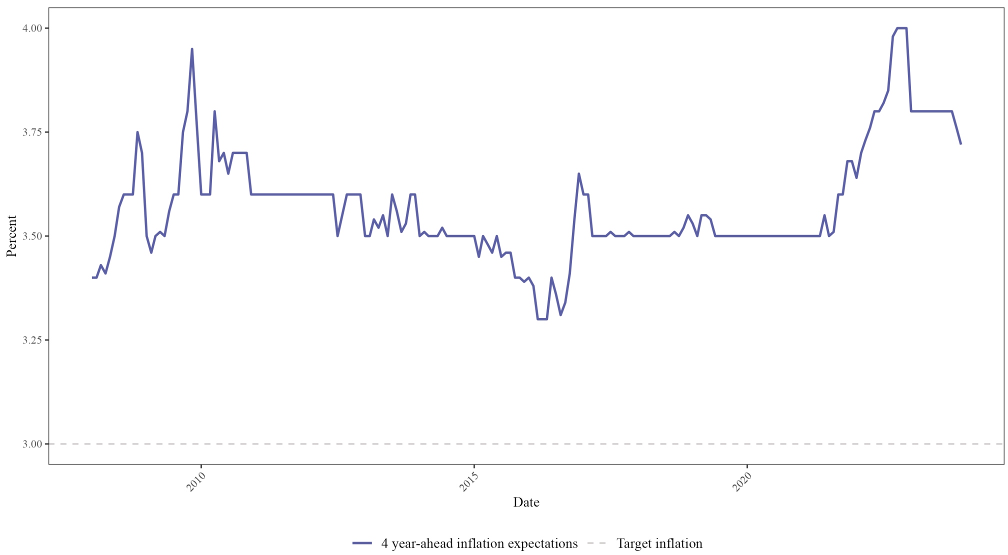
Notes: Own elaboration with data from Banco de México.

Figure 5.2: 12-month ahead inflation expectations.



Notes: Own elaboration with data from Banco de México.

Figure 5.3: 4-year ahead inflation expectations.



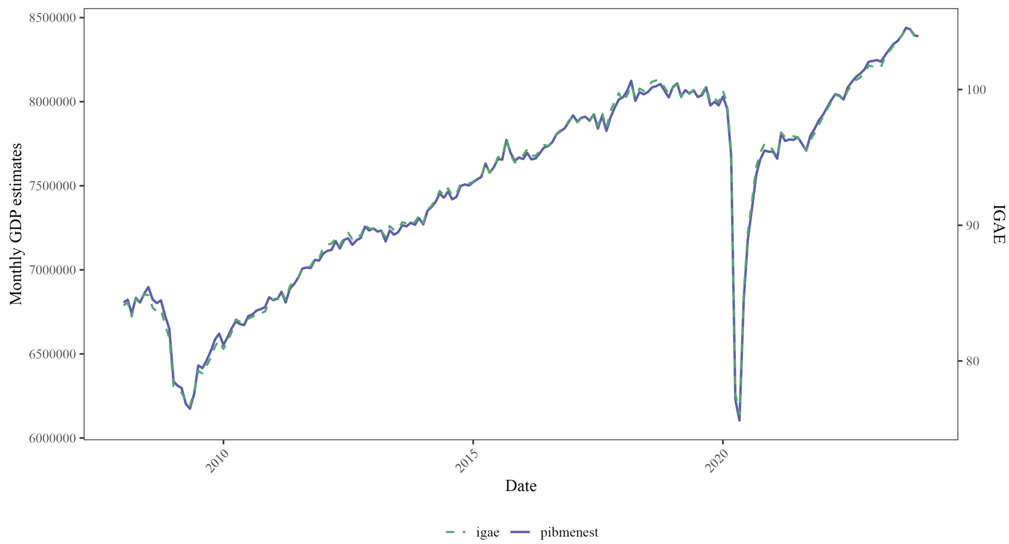
Notes: Own elaboration with data from Banco de México.

5.2 Explanatory variables

As explained before, the specification of our model follows an open economy version of Taylor's rule. With this in mind, we are interested in monthly observations of the output gap, inflation, interest rate, and exchange rate net depreciation. The latter three do not present any complications since they are published at least with monthly frequency. However, the output gap comes from GDP which is only available on a quarterly basis. To solve this issue, we use the trend from the General Economic Activity Index (IGAE) to interpolate GDP data from quarter to monthly frequency. Figure 5.4 below shows both IGAE and the resulting GDP estimates.[2] Following this procedure, we obtain the output gap by applying the Hodrick-Prescott filter to the series.

[2] We do this by assigning weights to each month of the quarter following $w_i = \frac{igae_i}{\sum_{i=1}^{3} igae_i}$.

Figure 5.4: IGAE and monthly GDP estimates.



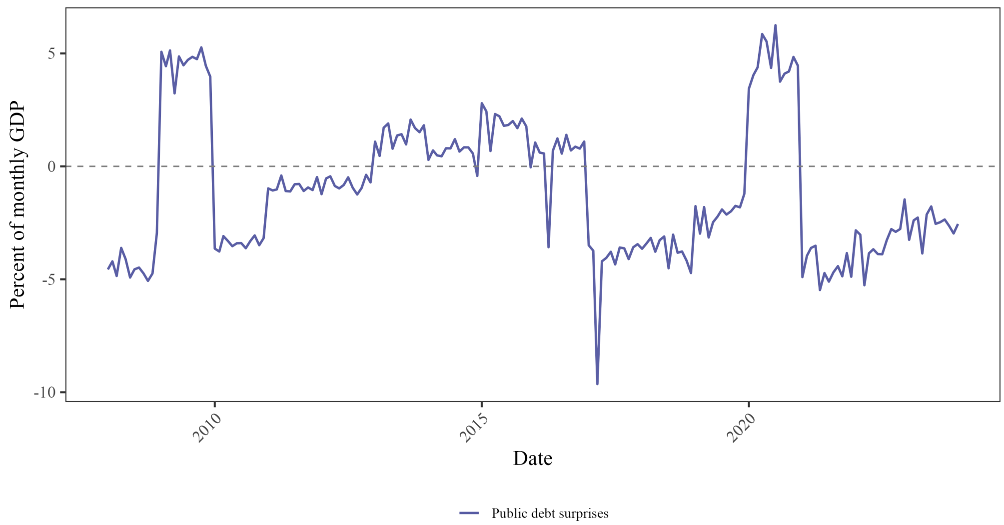
Notes: Own elaboration with data from INEGI.

5.3 Shock variable

As mentioned in section 4.1, we identify exogenous public debt shocks by instrumenting public debt with debt surprises. In this framework, we again face a problem with data frequency. SHCP publishes their public debt forecast for the whole year, and as a result, we can only get the precise surprise on a yearly basis. However, SHCP does publish monthly levels of public debt acquired and because of this, we can interpolate the yearly surprise to monthly frequency. We use the Financial Requirements of the Public Sector (RFSP) as our monthly trend variable and assume that the debt surprise is distributed throughout the year in accordance with RFSP (seasonally adjusted). Then, we rely on Chow and Lin (1971) temporal disaggregation methodology to obtain monthly public debt surprises. The resulting series is displayed in Figure 5.5.[3]

[3] For the debt surprise we use the Historical Balance of the Financial Requirements of the Public Sector (SHRFSP) because it contains more information regarding debt structure than RFSP, in particular regarding maturity. Why this is relevant for our purposes is explained in section 3.

Figure 5.5: Public debt surprises on a monthly frequency.



Notes: Own elaboration with data from SHCP.

Here, it stands out that the series mostly takes negative values. However, there are two stylized facts that matter. First, the surprises are the biggest in the two global economic recessions: the 2008 Global Financial Crisis and the 2020 global pandemic. Second, there is a period from 2013 to 2016 that shows consistent positive surprises, and during this period, Mexico also experienced a rise in inflation largely driven by factors such as oil prices and exchange rate depreciation due to the Trump election.

5.4 Contemporaneous variables

Lastly, our model's specification allows for exogenous variables to have contemporaneous effects on the estimates. In this case, we opted to include three controls. First, we add the United States' Industrial Production Index. This variable serves as both an important macroeconomic characteristic of Mexico's biggest commercial partner and a proxy for international industrial production. In a similar manner, our second control is the Wu and Xia (2016) Shadow Federal Funds Rate, which we introduce because of the importance it carries in Mexico's monetary relative stance and also as a representative of advanced economies' monetary policy. Finally, we include the WTI crude oil price because of the undeniable relevance of oil prices in the Mexican economy.

6 Results

With the specification described above, we are able to compute the LP IRF estimated as in (4.4). Table 6.1 and figures 6.1 and 6.2 show the main results of this study, which are the accumulated responses of 1-month, 12-month, and 4-year consumer inflation expectations to an exogenous shock in public debt. We consistently find that the response is of positive sign and statistically different from zero from 5 months after the shock, reaches its peak between periods 12 to 15, and the effect dissipates towards the two-year mark. This tendency of the effect to revert to zero is no real concern to our hypothesis because shocks occur repeatedly over 24 month periods. This is supported by the manner in which the overall level of public debt has grown during the period that our study covers.[4]

Table 6.1: Accumulated responses on inflation expectations h periods ahead oh the shock.

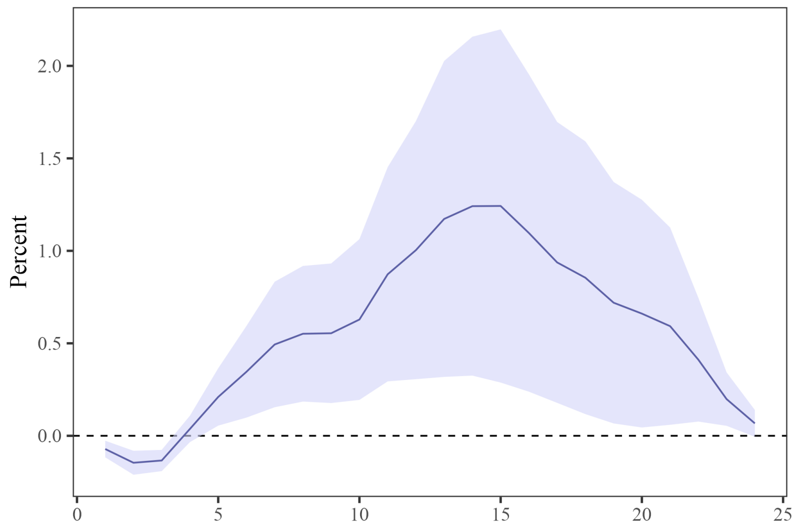
h	**1-month ahead**	**12-month ahead**	**4-year ahead**
6	0.30^{***}	0.35^{***}	0.06^{**}
12	1.87^{***}	1.01^{***}	0.24^{***}
18	1.36^{**}	0.86^{**}	0.19^{**}
24	-0.15	0.07^{*}	-0.03^{**}

Notes: The significance levels are indicated by *** ($p<0.05$), ** ($p<0.01$), and * ($p<0.32$). Responses represent percentage points. Own ellaboration.

An additional interesting result that comes from comparing the responses across the different horizons is that, while 1-month and 12-month ahead inflation expectations first respond with a negative sign and take some time to cross into the positive sign, longer-term expectations respond positively from the beginning. This supports the idea presented by Brandao-Marques et al. (2023) that longer-term expectations are more appropriate to measure the impact of public debt on prices.

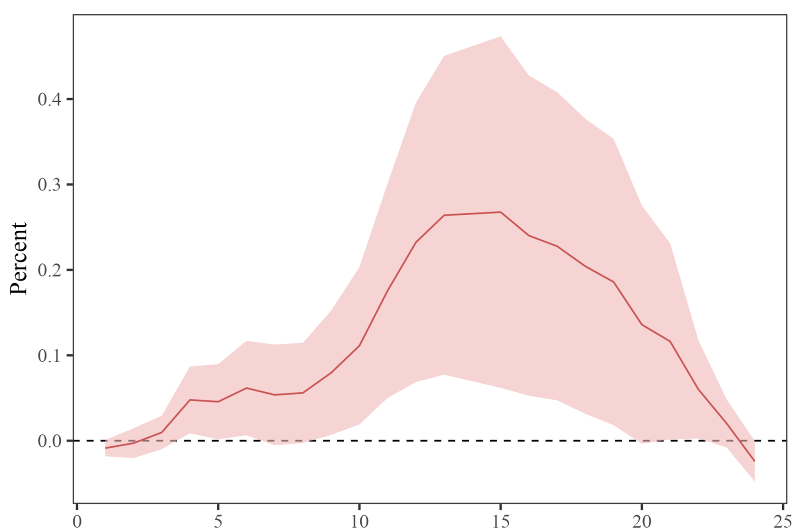
[4] The IRF of 1-month ahead inflation expectations is displayed in Appendix 8 figure A1. It is displayed in the annex because we follow the literature focusing on longer term inflation expectations.

Figure 6.1: Accumulated response of the 12-month consumer inflation expectations to a shock in public debt (90% confidence intervals).



Notes: Own elaboration.

Figure 6.2: Accumulated response of the 4-year consumer inflation expectations to a shock in public debt (90% confidence intervals).



Notes: Own elaboration.

Furthermore, we can observe that as the horizon of the inflation expectations increases, the size of the effect decreases. We believe this is mainly because of short-term aggregate demand effects, which we are not interested in showing. However, in Figure 6.2, we also observe a positive response, which implies that the theoretical mechanisms described in section 2.1 are at work. Hence, focusing on medium- to long-term inflation expectations is preferable to obtain the result we are looking for. In our study, the response of the 4-year ahead inflation expectations reaches its peak 15 months after the shock takes place and accounts for an accumulated increase of 27 basis points.

7 Robustness exercises

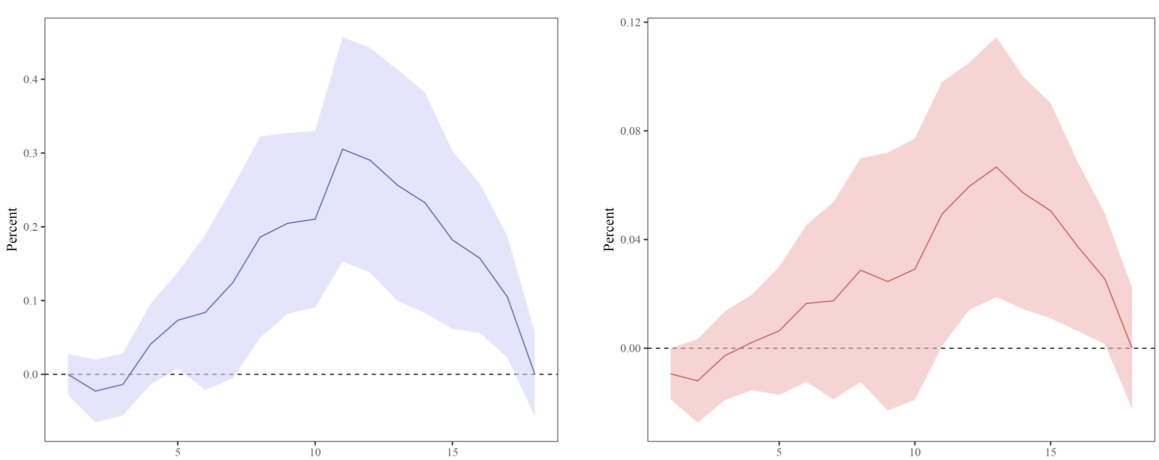
We undertook various robustness exercises concerning our instrument and our model specification. First, with regard to our instrument we explored how our results change when we construct it using a different debt measure. For our main analysis, we rely on historical public debt as percentage of GDP. This measure is superior to the alternatives because it contains more information about outstanding debt and its maturity structure, which impacts the price level, as we show in section 3. However, one can argue that the flow measure of public debt is also adequate to conduct this analysis.

Figure 7.1 displays the results from this alternate approach. There are two aspects that are essential to highlight. The first one is that these IRFs are qualitatively similar to our baseline estimation, in figures 6.1 and 6.2. Second, despite the statistical similarity, the estimated mean is smaller in both cases, and the dissipation of the effect occurs more quickly, in 18 months rather than 24. This is consistent with the view that the historical balance of the public debt contains information relevant to the relationship between public debt and the price level, as explained above.

Figure 7.1: Accumulated response of the 12-month and 4-year ahead inflation expectations to a public debt shock (RFSP)

(a) 12-month ahead

(b) 4-year ahead



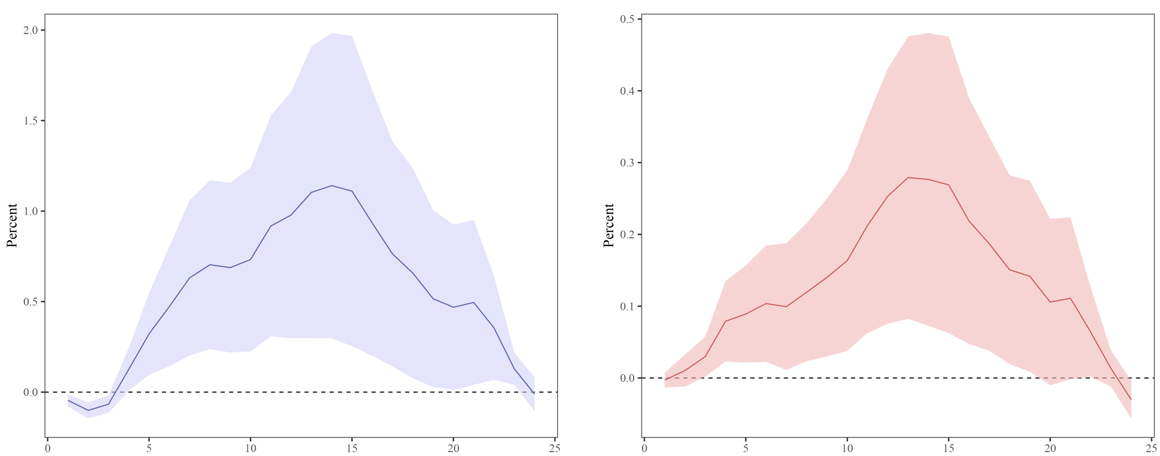
Notes: Own elaboration.

Concerning our control variables, we estimated model (4.3) with different exogenous variables. In particular, we substituted the US Industrial Production Index with its G7 counterpart. This allows us to capture more international information at the expense of losing some information on Mexico's most important commercial partner. Additionally, we considered changes in the smoothing parameter, λ, in the Hodrick-Prescott filter we used for our measure of the output gap. Finally, we contemplated several changes in lags for our set of endogenous variables. In all cases, our results (Figure 7.2) were qualitatively similar to the baseline case.

Figure 7.2: Accumulated response of the 12-month and 4-year ahead inflation expectations to a public debt shock with variations in control variables and H-P filter smothing parameter

(a) 12-month ahead

(b) 4-year ahead



Notes: Own elaboration.

8 Policy implications and concluding remarks

The results portrayed here shed light on the constraints that the central bank has faced in Mexico over the last 20-plus years. Our findings show that consistent fiscal shocks have played a pivotal role in the de-anchoring of inflation expectations, which partly explains the inflation dynamics we have seen in the current century (described in section 1).

Furthermore, our analysis suggests that the interaction between monetary and fiscal authorities should be studied more closely. We find that fiscal policy constrains monetary policy, which implies that, in order to maintain price stability, joint efforts are required. However, the specific characteristics of these efforts are yet to be proposed.

To rationalize what policy interventions on the monetary side should be proposed, the theoretical mechanisms described in section 2.1 each have their own view. However, all three rest on the idea that fiscal policy should prioritize debt sustainability. Although more research is needed to answer these questions with precision, these results offer a solid starting point.

Finally, our results also imply the existence of forward-looking agents who internalize the government's intertemporal budget constraint and thus are able to predict fiscally driven increases in the price level. This finding is of great importance because it shows that the Mexican economy behaves consistently with standard economic theory. Consequently, this study adds evidence to the idea that the Mexican economy can be effectively studied using these types of economic models, supporting a vast number of theory-based approaches.

While our study provides valuable insights, it also highlights certain limitations that warrant further investigation, as discussed above. Future research could delve deeper into the nuances of the fiscal-monetary policy interaction in Mexico and other similar economies. By addressing these complexities, questions regarding specific interventions can be answered and policy can be improved.

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Appendix

A Additional tables and graphs

Table A1: Model variables and sources.

Variable	Source
US	
Shadow Federal Funds Rate	Federal Reserve Bank of Atlanta
Industrial Production Index YoY	Federal Reserve
Mexico	
Historical balance of public debt (SHRFSP)	SHCP
Public debt (RFSP)	SHCP
Consumer Price Index (*INPC*) SA	INEGI
Economic Activity Index (*IGAE*) SA	INEGI
GDP (*PIB*) SA	INEGI
28-day interbank interest rate (*TIIE28*)	Banco de México
1-month ahead inflation expectations SA	Banco de México
12-month ahead inflation expectations	Banco de México
4-year ahead inflation expectations	Banco de México
Peso-US Dollar Nominal Exchange Rate	Banco de México
Global variables	
WTI Crude Oil Prices	IMF

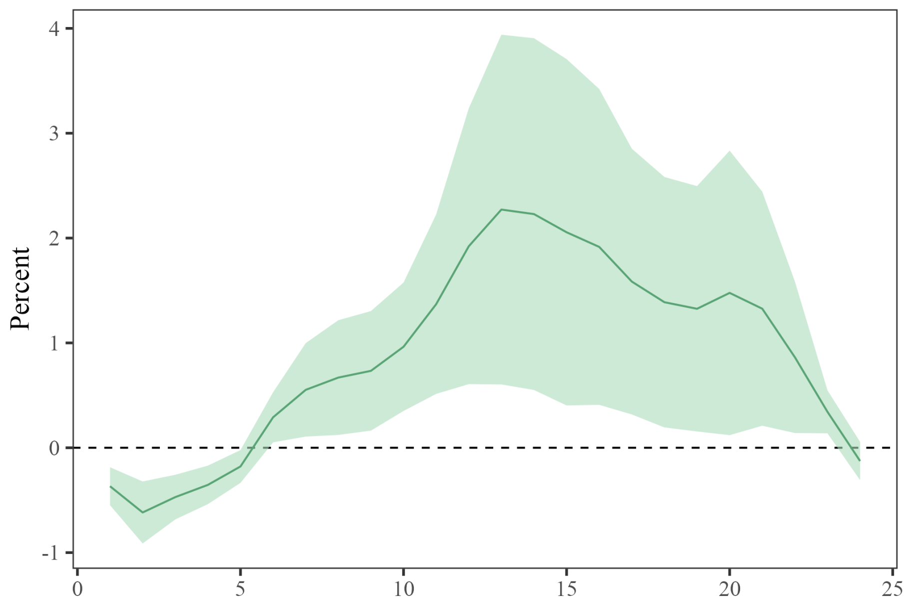
Notes: All expectations refer to consumer price inflation expectations. YoY stands for year on year growth rate. SA stands for seasonally-adjusted. Own elaboration.

Table A2: Impulse Response Function values from the LP of section 6.

	1-month ahead			**12-month ahead**			**4-year ahead**		
h	**mean**	**low**	**up**	**mean**	**low**	**up**	**mean**	**low**	**up**
1	-0.34	-0.45	-0.24	-0.07	-0.12	-0.03	-0.01	-0.02	0.00
2	-0.60	-0.78	-0.43	-0.15	-0.21	-0.08	-0.00	-0.02	0.02
3	-0.46	-0.59	-0.33	-0.13	-0.19	-0.08	0.01	-0.01	0.03
4	-0.45	-0.58	-0.32	0.04	-0.03	0.11	0.05	0.01	0.09
5	-0.16	-0.26	-0.07	0.21	0.05	0.36	0.05	0.00	0.10
6	0.30	0.16	0.45	0.35	0.10	0.59	0.06	0.00	0.11
7	0.57	0.29	0.84	0.49	0.15	0.83	0.05	-0.01	0.11
8	0.71	0.36	1.06	0.55	0.18	0.92	0.06	-0.00	0.12
9	0.76	0.40	1.11	0.55	0.18	0.93	0.08	0.01	0.16
10	0.97	0.60	1.35	0.63	0.19	1.07	0.11	0.02	0.21
11	1.34	0.83	1.85	0.87	0.29	1.46	0.18	0.05	0.30
12	1.87	1.10	2.65	1.01	0.30	1.71	0.24	0.07	0.40
13	2.21	1.23	3.19	1.17	0.31	2.03	0.27	0.08	0.45
14	2.18	1.19	3.17	1.24	0.32	2.17	0.27	0.07	0.47
15	2.01	1.03	2.98	1.24	0.28	2.20	0.27	0.06	0.48
16	1.86	0.98	2.75	1.10	0.24	1.96	0.23	0.05	0.42
17	1.55	0.80	2.30	0.94	0.18	1.70	0.22	0.04	0.39
18	1.36	0.65	2.08	0.86	0.12	1.60	0.19	0.03	0.34
19	1.28	0.59	1.96	0.73	0.07	1.39	0.17	0.01	0.33
20	1.39	0.61	2.16	0.67	0.05	1.30	0.13	-0.00	0.27
21	1.29	0.63	1.94	0.61	0.07	1.15	0.11	0.00	0.23
22	0.83	0.41	1.25	0.42	0.08	0.76	0.06	0.00	0.12
23	0.30	0.19	0.40	0.20	0.06	0.35	0.01	-0.01	0.04
24	-0.15	-0.27	-0.03	0.07	-0.00	0.14	-0.03	-0.06	-0.00

Notes: All three dependent variables are consumer inflation expectations for the time ahead that the table specifies. Low and up values are from 90% confidence intervals. Own elaboration.

Figure A1: Accumulated response of the 1-month consumer inflation expectations to a shock in public debt (90% confidence intervals).



Notes: Own elaboration.

Table A3: Impulse Response Function values from the LP of Figure 7.1.

	1-month ahead			**12-month ahead**			**4-year ahead**		
h	**mean**	**low**	**up**	**mean**	**low**	**up**	**mean**	**low**	**up**
1	0.03	-0.09	0.16	-0.00	-0.03	0.03	-0.01	-0.02	-0.00
2	0.01	-0.16	0.19	-0.02	-0.07	0.02	-0.01	-0.03	0.00
3	0.04	-0.16	0.24	-0.01	-0.06	0.03	-0.00	-0.02	0.01
4	0.06	-0.15	0.26	0.04	-0.01	0.10	0.00	-0.02	0.02
5	0.22	0.01	0.43	0.07	0.01	0.14	0.01	-0.02	0.03
6	0.30	0.08	0.53	0.08	-0.02	0.19	0.02	-0.01	0.05
7	0.24	-0.05	0.53	0.12	-0.01	0.25	0.02	-0.02	0.05
8	0.24	-0.14	0.61	0.19	0.05	0.32	0.03	-0.01	0.07
9	0.45	0.00	0.90	0.20	0.08	0.33	0.02	-0.02	0.07
10	0.56	0.15	0.96	0.21	0.09	0.33	0.03	-0.02	0.08
11	0.71	0.25	1.16	0.31	0.15	0.46	0.05	0.00	0.10
12	0.82	0.32	1.31	0.29	0.14	0.44	0.06	0.01	0.11
13	0.62	0.16	1.07	0.26	0.10	0.41	0.07	0.02	0.11
14	0.55	0.10	0.99	0.23	0.08	0.38	0.06	0.01	0.10
15	0.34	-0.06	0.75	0.18	0.06	0.30	0.05	0.01	0.09
16	0.38	0.03	0.73	0.16	0.06	0.26	0.04	0.01	0.07
17	0.31	0.04	0.59	0.11	0.02	0.19	0.03	0.00	0.05
18	0.05	-0.15	0.26	0.00	-0.06	0.06	-0.00	-0.02	0.02

Notes: All three dependent variables are consumer inflation expectations for the time ahead that the table specifies. Low and up values are from 90% confidence intervals. Own elaboration.

Table A4: Impulse Response Function values from the LP of Figure 7.2.

	1-month ahead			**12-month ahead**			**4-year ahead**		
h	**mean**	**low**	**up**	**mean**	**low**	**up**	**mean**	**low**	**up**
1	-0.32	-0.48	-0.16	-0.05	-0.08	-0.01	-0.00	-0.01	0.01
2	-0.57	-0.84	-0.31	-0.10	-0.15	-0.06	0.01	-0.01	0.03
3	-0.41	-0.60	-0.21	-0.07	-0.12	-0.02	0.03	0.00	0.06
4	-0.28	-0.46	-0.09	0.13	0.01	0.24	0.08	0.02	0.13
5	0.10	-0.16	0.37	0.32	0.10	0.55	0.09	0.02	0.16
6	0.59	0.17	1.00	0.47	0.14	0.80	0.10	0.02	0.18
7	0.90	0.25	1.56	0.63	0.20	1.06	0.10	0.01	0.19
8	1.09	0.30	1.88	0.70	0.24	1.17	0.12	0.02	0.22
9	1.03	0.29	1.78	0.69	0.22	1.16	0.14	0.03	0.25
10	1.17	0.44	1.90	0.73	0.22	1.24	0.16	0.04	0.29
11	1.50	0.57	2.44	0.92	0.31	1.53	0.21	0.06	0.36
12	1.91	0.61	3.20	0.98	0.30	1.66	0.25	0.08	0.43
13	2.15	0.58	3.73	1.10	0.30	1.91	0.28	0.08	0.48
14	1.99	0.49	3.50	1.14	0.30	1.98	0.28	0.07	0.48
15	1.79	0.34	3.24	1.11	0.25	1.97	0.27	0.06	0.48
16	1.63	0.34	2.91	0.93	0.20	1.67	0.22	0.05	0.39
17	1.26	0.24	2.28	0.76	0.14	1.38	0.19	0.04	0.34
18	0.99	0.10	1.88	0.66	0.08	1.24	0.15	0.02	0.28
19	0.88	0.05	1.71	0.52	0.03	1.00	0.14	0.01	0.27
20	0.99	0.01	1.97	0.47	0.01	0.93	0.11	-0.01	0.22
21	1.02	0.13	1.91	0.50	0.04	0.95	0.11	-0.00	0.22
22	0.60	0.08	1.12	0.35	0.07	0.64	0.06	0.00	0.13
23	0.08	-0.04	0.21	0.13	0.04	0.22	0.01	-0.01	0.04
24	-0.30	-0.59	-0.01	-0.01	-0.10	0.08	-0.03	-0.06	-0.00

Notes: All three dependent variables are consumer inflation expectations for the time ahead that the table specifies. Low and up values are from 90% confidence intervals. Own elaboration.

B Derivation of equilibrium conditions

In order the derive equations (3.1) and (3.2) we start with the accounting identity which states that the primary surplus equal bond purchases less sales,

$$B_{t-1}(t) - \sum_{j=1}^{\infty} Q_t(t+j)\left[B_t(t+j) - B_{t-1}(t+j)\right] = p_t s_t. \tag{B1}$$

Additionally, we express bond prices in terms of future price levels by denoting equilibrium marginal utility by $\rho^t u'(c_t)$, and conditional expectation by E_t^*,

$$Q_t(t+j) = E_t^*\left(\rho^j \frac{u'(c_{t+j})}{u'(c_t)} \frac{p_t}{p_{t+j}}\right) = \beta^j E_t\left(\frac{p_t}{p_{t+j}}\right). \tag{B2}$$

We are able to get to the right-hand equality by assuming a constant real discount factor $\beta = E_t[\rho u'(c_{t+1})/u'(c_t)]$ and by using risk-neutral expectation E_t. Since we are dealing with a frictionless model, changes in the price level sequence do not alter equilibrium consumption or the real interest rate.

Now, by substituting (B2) in (B1) and dividing by p_t, we obtain the *flow condition* (3.1). In order to derive the *present value condition* we first note that (3.1) can be rewritten as

$$E_t(1 - \beta L^{-1})v_t = s_t,$$

where

$$v_t \equiv \sum_{j=0}^{\infty} \beta^j \left(\frac{1}{p_{t+j}}\right) B_{t-1}(t+j).$$

Here, we can either iterate forward on v_t, or apply $E_t(1 - \beta L^{-1})^{-1}$ to both sides, together with the equilibrium condition $\lim_{T\to\infty} E_t \beta^T v_T = 0$ to we obtain (3.2).