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TRABAJO FIN DE GRADO EN
PROGRAMA INTERNACIONAL DEL DOBLE GRADO EN
ADMINISTRACIÓN Y DIRECCIÓN DE EMPRESAS Y EN ECONOMÍA

A DYNAMIC MACROECONOMIC MODEL TO ANALYZE THE EFFECTS OF A MONETARY POLICY TIGHTENING OF THE ECB FOR THE SPANISH ECONOMY

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Análisis Económico

ABSTRACT

The end of the zero-interest policy rate that began during the Spanish economic crisis is a pressing matter. This study seeks to construct a dynamic macroeconomic model to study the effects of an increase of the interest rates for the Spanish economy. The first macroeconomic analysis will be focused on explaining some empirical evidence on variables that are relevant to our model. Next, we will develop a dynamic general equilibrium model that mimics a New Keynesian model with price rigidities. After calibrating the model parameters for the Spanish economy, we will write a code in Dynare (run by MatLab) to simulate and solve the model. Finally, we describe the short-run fluctuations in all the endogenous variables resulting from a net export, government spending and interest rate shock. We will work in different scenarios to explain the effects of a higher interest rate for the Spanish's GDP, consumption, investment, the risk premium and the size of public debt.

Key words. Monetary policy, impulse-response functions, dynamic macroeconomic model.

RESUMEN

El final de la política de la política de tipos de interés nominales iguales a cero que tuvo lugar durante la crisis económica española es un asunto apremiante. Este estudio busca construir un modelo de equilibrio general dinámico para estudiar los efectos del incremento de los tipos de interés para la economía española. El primer análisis que realizaremos está basado en la evidencia empírica acerca de las variables relevantes para nuestro modelo. Luego, desarrollaremos un modelo de equilibrio dinámico que simula el comportamiento de un modelo neo keynesiano con rigidez de precios. Después de calibrar los parámetros del modelo para la economía española haremos uso del software Dynare (ejecutado mediante MatLab) para simular y resolver el modelo. Finalmente, explicaremos posibles fluctuaciones a corto plazo en las variables exógenas resultantes de un shock de exportaciones netas, gasto público y tipo de interés. Vamos a trabajar en diferentes escenarios para explicar los efectos de una subida de tipos de interés para la economía española sobre el PIB, consumo, inversión, prima de riesgo y deuda pública sobre PIB.

Palabras clave: política monetaria, funciones impulso-respuesta, modelo de equilibrio dinámico.

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1. INTRODUCTION

The recent economic crisis hit the Spanish economy in 2008, following a long period of economic boom. Although the economic crisis did not have its origin in a deficient macroeconomic policy, a collection of internal imbalances accumulated in the pre-crisis period made the crisis have a deep impact in the Spanish economy (González-Páramo, 2011).

Economic recession is a significant decline in the economic activity spread across the country, lasting more than a few months, visible in industrial production, employment, real income and sales (NBERs Recession Dating Procedure, 2017). The economic recession was mainly caused in Spain by the real estate bubble, the lack of flexibility in the labor market and a high level of indebtedness both in the public and private sectors (Rahman, Galván, Martínez, 2017). Also, all together with the price rises of raw material and the influence of the financial crisis led to the Spanish economy to one of the worst financial crises since the Great Depression of the 30's.

In order to alleviate the consequences of the economic crisis, the European Central Bank (ECB), who is charge of the monetary policy, decided to launch in July 2009, the first Asset Purchase Program. The objectives of this initiative were related to the reduction in the interest rates, the alleviation of the financing conditions of credit entities and companies, the support of credit institutions to expand the granting of credit to households and businesses and improvement in market liquidity. This policy has been an adaptable and effective instrument to ease monetary and financial conditions, foster economic recovery and sustain price stability (Hammermann, Leonard, Nardelli and Landesberger, 2019). It has contributed to pump vast amounts of cash through financial institutions and on the real economy to cushion the impact of the global economic crisis and avoid a credit crunch (Graupner, 2018). This policy boosts the economy in the short term, but it could have deep consequences in the long term.

Currently, the interest rates are an important signal on the level of risk, and they are an indicator of the perception of health of an economy. For all these reasons it is important that the price of money gives the proper signal to the economic agents. Therefore, the development of a proper economic policy is essential. It is high time that the monetary stimulus policy reaches an end (Lacalle, 2017).

The European Central Bank has recently removed this key pillar of its monetary policy and it announced the end of the Asset Purchase Program in December 2018. For the Spanish case, this means that the ECB will maintain around 211.000 millions euros in its public balance in Spanish public debt (Sánchez, 2018). The bank will not buy more Spanish debt, but as securities expire, the ECB will reinvest that amount in the purchase of new Spanish bonds in order to avoid a sudden reaction in the price of Treasury securities.

The next policy to be taken by the ECB is the increase in the interest rates. However, for the moment, even though it was supposed a first hike in the interest rates in the summer of 2019, the ECB is not expecting an increase of policy rates until the third quarter of 2020. In an attempt to study the effects of an increase in the interest rates for the Spanish economy, we will develop a dynamic general equilibrium model that explains the behavior of the most important macroeconomic variables.

We start the paper by analyzing some empirical evidence on variables that are important to analyze the behavior of our model from the year 2008 to 2018. Section 3 introduces the dynamic equilibrium model. In Section 4, we will calibrate the model parameters according to the economic framework of the Spanish economy. In Section 5, we describe the short-run fluctuations in all the endogenous variables resulting from a net export, government spending and interest rate shock. We will focus on a policy mix approach to the hike in the policy rates. Final conclusions and implications are provided in Section 6.

2. EMPIRICAL EVIDENCE.

Gross Domestic Product

Gross Domestic Product (GDP) is the market value of the final goods and services produced in the economy during a given period (Krugman, 2018). In the following figure it is seen the growth of the real (constant prices) GDP for the Spanish economy in the period from 2008 to 2018, with the purpose of studying its evolution during the economic crisis and in the following years.

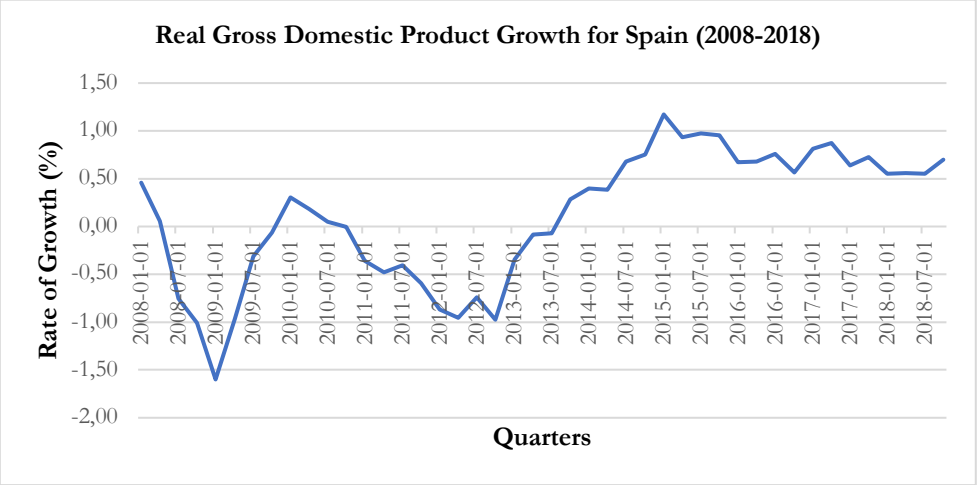

Figure 1. Rate of growth of quarterly real GDP in Spain (2008-2018). Source: Federal Reserve Economic Data. Own elaboration.

In this case, for the Spanish economy, the real Gross Domestic Product shows two slowdowns during the analyzed period. Firstly, the GDP started to decrease in the second quarter of the year 2008 as a result of the outset of the global economic financial crisis. From that moment on it is seen a downward trend in the real GDP as a result of the macroeconomic and financial imbalances accumulated in the period of higher growth. Examples of these imbalances are the real estate boom, the excess of indebtedness or the loss of competitiveness (Ortega and Peñalosa, 2011). Between 2007 and 2013 real per capita GDP fell by 9%, reaching its lowest point in the second quarter of 2013 (256.172 million of euros). [1] The real GDP for the Spanish economy seems to be recovering from that quarter on in part due to the outwards migration since 2013 (Martí and Pérez, 2016) and it has reached levels from before the economic crisis from the second quarter of 2017 on.

Consumption and investment

[1] Ortega and Peñalosa (2013) point out that these downturns present common characteristics as the persistent reduction of domestic demand, net positive contribution of the external sector, job destruction and a downward trend in house prices.

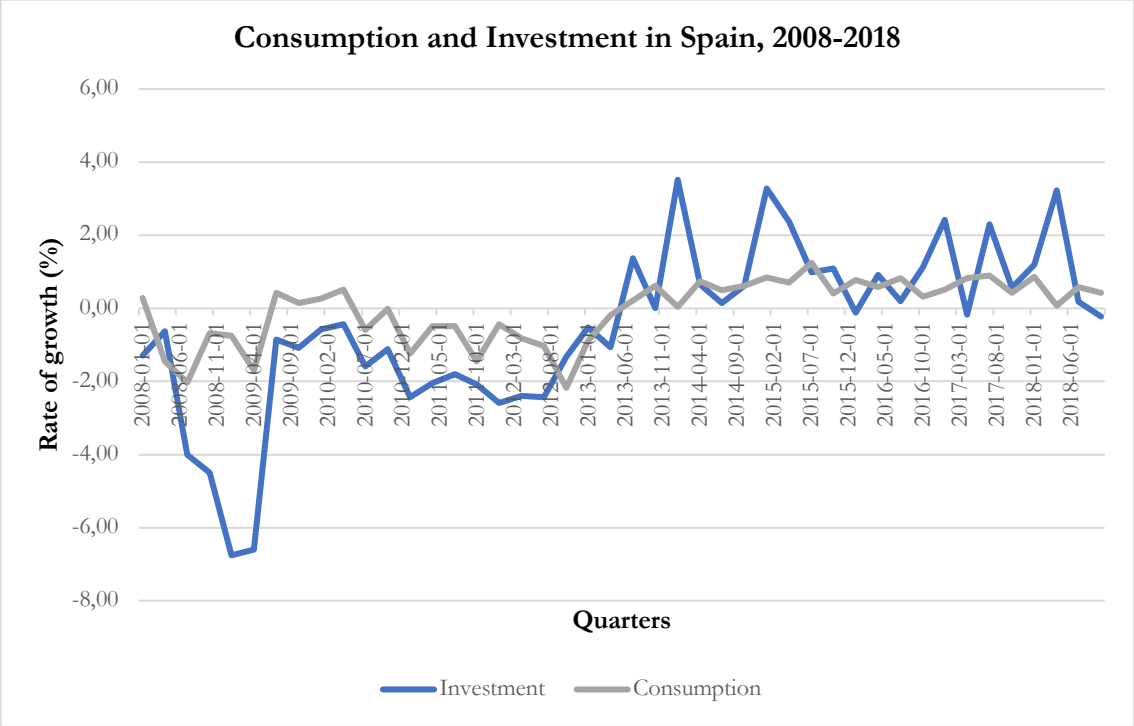

Figure 2. Real Private Final Consumption and Investment Expenditure. Source: Federal Reserve Economic Data. Own elaboration.

Consumption measures the use of goods and services used by households (Britannica, 2019). It follows a similar pattern as the Gross Domestic Product. It shows a first slowdown in the first quarter of the year 2009 and a second one in the last quarter of the year 2010. The consumption expenditure reaches its lowest value (149058 billion of euros) in the first quarter of the year 2013 (FRED, 2019).

Investment measures the spending on capital accumulation that businesses intend to undertake during a given period. According to the accelerator principle, a higher growth rate of GDP leads to a higher planner investment spending, and a lower growth rate of real GDP leads to a lower planned investment spending (Krugman & Wells, 2013). Therefore, investment spending in the Spanish economic faced a downward trend at the beginning of the financial crisis. The economy was characterized by having a huge investment in the period pre-crisis due to the high investment in housing. Later, policy actions such as the reduced interest rates tried to enhance the investment did not have the expected results, as investment was held very volatile during the economic crisis.

Private and public sector debt

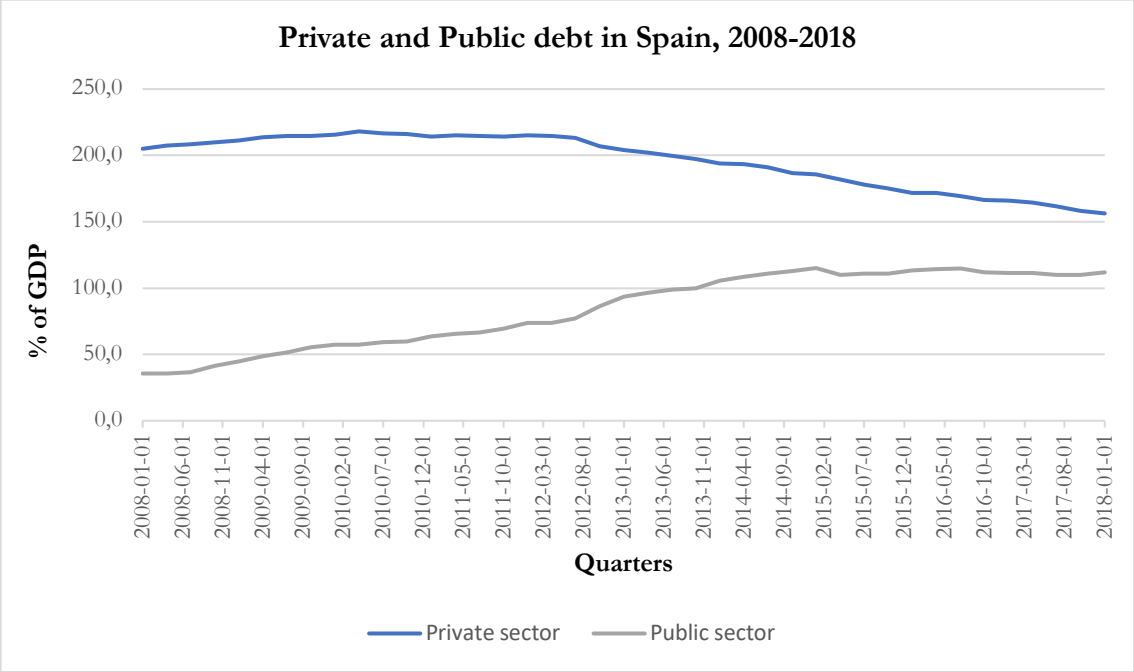

Figure 3: Total private and public debt as a % of GDP. Source: Federal Reserve Economic Data. Own elaboration.

In the Spanish economy the public sector debt increases more rapidly than the private sector debt. In order to analyze this graph, it is important to mention the high level of indebtedness of the private sector as a consequence of the expenditure in the real estate sector. For that reason, the private debt follows a constant trend since the beginning of the analyzed period, reaching its highest point in the first quarter of 2012. After the Great Recession, the private sector decreases the level of growth of its debt (Soriano, 2016). From that moment on, it is seen a decrease in the private debt as a result of the bad projections from the Spanish economy after the outbreak of the financial crisis. In this moment, the debt of the private sector follows a decreasing pattern, although its value exceeds the 150% of GDP.

However, the credit to the public sector follows an increasing pattern in the studied period. From the second half of the year 2012 to the year 2014, the debt in the public sector increases due to the increase in government spending and the reduction of the public income. This is due to the economic rescue package that was given to the Spanish economy and the constant reduction in the GDP levels. The Spanish public debt has gone from 35% of its GDP in the year 2007 to 100, 1% of its GDP in the year 2016, which equals 700.000 million of euros (International Monetary Fund, 2019). In this moment, Spanish net debt is one of the highest among the European Union countries and its reduction is mainly explained due to the

economic expansion and not for an improvement in the annual accounts (Calvo and Puerto, 2019).

Interest rates

The long-term interest rates refer to central government bond yields in ten years on the secondary market and they are used as a convergence criterion for the long-term interest rates by the Economic and Monetary Union (Eurostat, 2019).

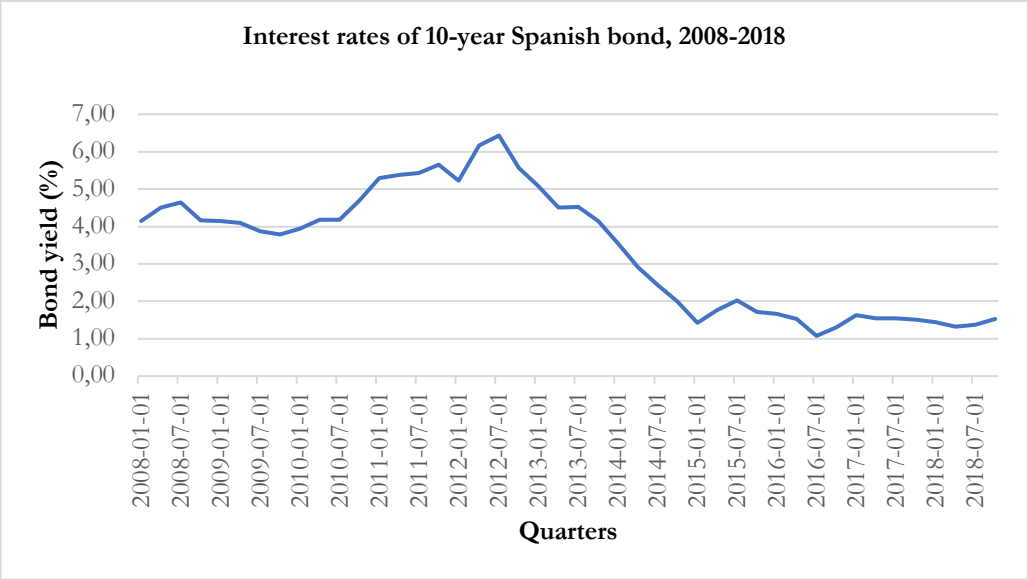

Figure 4. Interest rates of 10-year Spanish bond. Source: Federal Reserve Economic Data. Own elaboration.

Although the graph follows an irregular pattern, two distinctive parts can be seen. On the one hand, from the beginning of the crisis till the year 2012 the long-term government bond yield increases as a result of the high-risk present in the Spanish economy. In such a recessionary period, the debt repayments were really difficult. On the other hand, there is a rapid decrease in the interest rates from that year on. This comes as a result of a program launched by the European Central Bank in order to address severe distortions in the pricing of sovereign debt. These were known as Outright Monetary Transactions or OMTs (Fuest and Heinemann, 2015). Their main aim was to provide economic support to countries in the European Union and to provide them with credit lines (ECB Annual Report, 2012). Also, the European Central Bank was in charge of buying government bonds [2]so as to provide low interest rates and high liquidity to all countries that belong the European Union.

[2] This will be mentioned afterwards for as the Asset Purchase Programm done by the ECB.

The Euro Interbank Offered Rate is the rate at which euro interbank term deposits are being offered by one prime bank to another within the European Monetary Union zone (European Money Markets Institute, 2019). Therefore, they are considered to be the most important references rates.

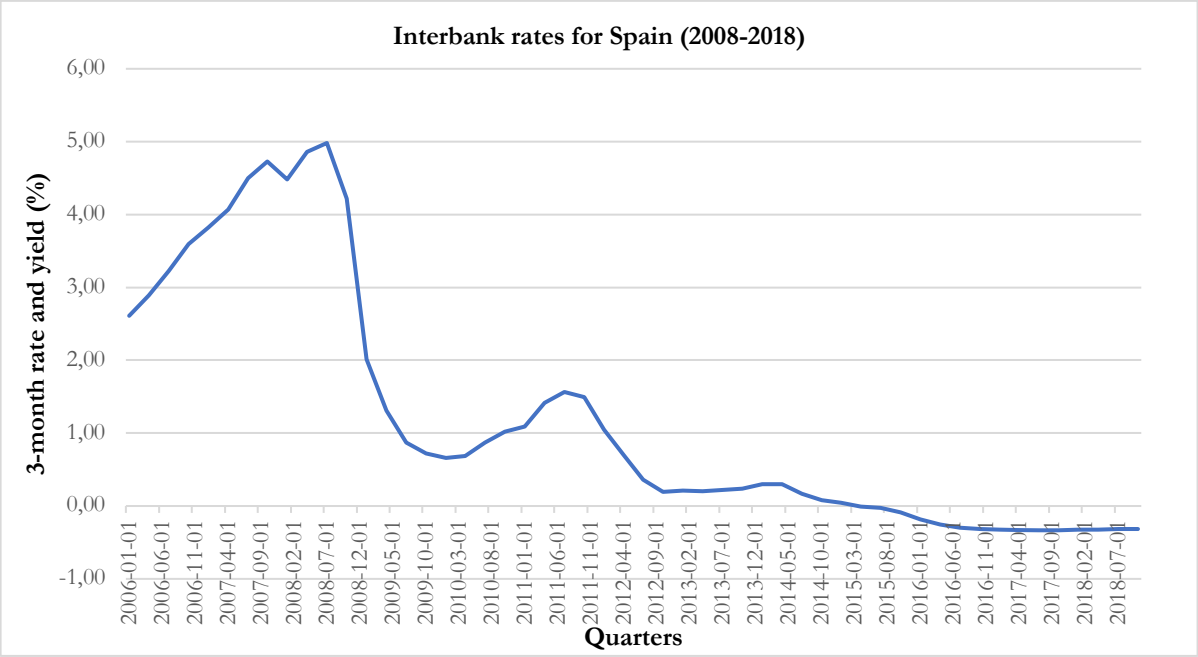

Figure 5: interbank rates for Spain. Source: Federal Reserve Economic Data. Own elaboration.

For the Spanish economy, the evolution of the interbank rates is marked by the several policies launched by the European Central Bank in an attempt to get out of the financial crisis. In the last quarter of 2009 the Asset Purchase Program took place. This includes covered bonds, public sector, asset-backed securities and corporate sector purchase programs (BBVA, 2017). All these have the objective of keeping the euro growing and facilitating the granting of credits.

Taking a look at the graph, it can be seen that the first time the interbank rates were approaching zero is in the third quarter of 2009. This means that banks are lending money with a high default risk and low profitability. Seeing the evolution of the graph, the rates are negative since the second quarter of 2015, reaching its lowest point in the second quarter of 2017.

Risk premium

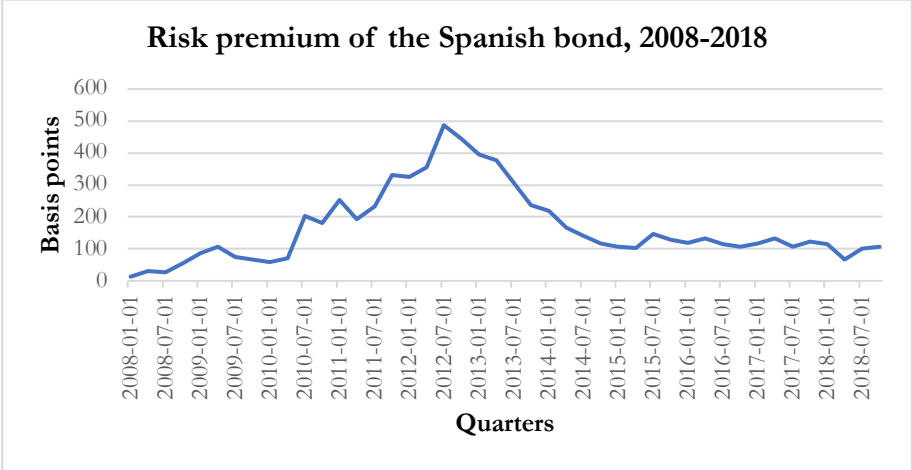

Figure 6. Risk premium of the Spanish bond. Source: Federal Reserve Economic Data. Own elaboration.

The risk premium is defined as the additional interest paid between two different countries. In the European countries, the risk premium is calculated subtracting from the 10-year bond interest rate of each country from the German one, which acts as a benchmark (BBVA, 2019). For the Spanish economy, the financial instability, unemployment rate and ratio of public debt over GDP are the key elements that explain the high-risk premium in the economy (Calvo and Puerto, 2019). The Spanish economy needs to deal with the management of the public debt.

The risk premium has suffered different downturns along the Spanish crisis. It started in low values at the beginning of the crisis and it quickly reached its historical maximum of 640 basis points in July 2012, a month after the Government confirmed they were asking for a rescue plan up to 100,000 million euro. This increase was due to the rescue of Bankia, an increase in amount of taxes and the new government (Maqueda, 2017). From that moment on, the risk premium decreases, although the volume of public debt over GDP is constantly increasing. This decrease in the risk premium is due to the intervention of the European Central Bank that is constantly taking place. In the moment, the country risk of Spain is stable and touching 100 basis points.

3. A DYNAMIC GENERAL EQUILIBRIUM MODEL

This section provides a dynamic macroeconomic model for analyzing the increase in the interest rates. Currently, interest rates are among the most closely watched variables in the economy (Mishkin, 2019).

Macroeconomic models are an analytic tool designed in order to describe the functioning of a given economy. Spanish monetary policy has been designing monetary policy rules in order to achieve its targets, defined in terms of macro stabilization (Constancio,2017). Macroeconomic models can be very useful when they are used in order to adjust the policy instruments in response to the actual state of the economy.

Many macroeconomic models represent a simplification and, in some cases, unrealistic approach of the behavior of an economy. However, they are a really useful tool for understanding the potential effects of policies, assessing and quantifying different mechanisms that might be at play and to consider interactions that might go beyond the direct or intended effects of the policy (Tenreyro, 2018).

The dynamic general equilibrium model (DGE) has become a major paradigm in macroeconomics (Gong and Semmler, 2006). Our macroeconomic model is a general equilibrium model that mimics a new Keynesian model. New Keynesian theories of business cycles postulates that fluctuations in nominal variables influence fluctuations in real variables (Schmidt and Wieland, 2013). For our model this fact is important as nominal and real interest rates fluctuate proportionally.

An assumption in our model is that agents have rational expectations and producers have market power over prices that facilitates the introduction of short-run nominal price rigidities (Smets and Wouters, 2003). This assigns an explicit stabilization role to the monetary policy. In our model, real shocks can generate macro fluctuations. For that reason, we will see how a defined shock[3] can alter the natural equilibrium of the variables defined in the model and how long does it take to go back to the general equilibrium.

The development of a dynamic model could be done by taking into account the optimization behavior of agents in an economy (Marín and Rubio, 2011). A representative household

[3] In our model the shocks will be the following: NX_t, as a net exports shock, GG_t as a government spending shock and RR_t as an interest rate shock.

looks for maximizing their intertemporal utility in an infinite time horizon (Torres, 2018). Their utility is derived, on the one hand, as consumers by buying consumption goods from the production sector and as owners of labor and capital goods by obtaining wages derived from their labor hours and obtaining a rent derived from their capital goods. Their income is spent on consumption goods, capital accumulation and on government bonds (Casares, 2019). However, it would be very costly and due to the time-constraint, we will take simple relations that approximate the rational behavior of agents in an economy.

In this dynamic general equilibrium, we will simulate the business cycle dynamics of relevant macro variables such as GDP, consumption, investment, interest rates, risk premium and public deficit. All of them with the aim of analyzing the increase in the interest rates in the Spanish economy. After determining the appropriateness of the model, it will be solved by using Dynare that is run by Matlab. Then it will be calculated the importance of the shocks introduced in the model and the constant values on the dynamics of the endogenous variables, through the calculation of impulse-response functions.[4]

Model description

The model represents the existing interrelations between GDP, consumption, investment, interest rates, risk premium and public deficit together with three different exogenous shocks. In this section we will explain the model, the definition of the variables and how their relationships have been developed through the several model equations.

The first equation to be considered in this model describes the aggregate demand. Gross Domestic Product is the market value of the final goods and services produced in the economy during a given period (Krugman, 2018). Taking a simplified version of this equation would be as follows:

$$Y_t = C_t + I_t + G_t + NX_t \quad (1),$$

where Y stands for real GDP, C for consumption, G for government spending and NX_t is a net exports shock. In our model variations in net exports are assumed to be exogenous. Through this equation we also take into account the market clearing condition by which in an economic market the aggregate demand equals the aggregate supply, so that there is no leftover supply and demand in the market.

[4] We will suppose that the shocks will be produced only one period, but they will have impact over time.

An equation that introduces the behavior of consumption is introduced in the model:

$$C_t = C_0 + C_1 C_{t-1} + (1-C_1) E_t C_{t+1} - C_2 R_t - C_3 Tax_t, \quad (2)$$

$$\text{with } C_0, C_2, C_3 > 0 \text{ and } 0 < C_1 < 1.$$

Equation (2) represents the behavior of consumption taking into account the fact that individuals can be either backward looking by deciding to consume the goods in the present time or forward looking by consuming the goods in the next year. We include the rational expectations operator (E_t) as individuals will decide their level of future consumption upon the information available to them. Also, if households observe an increase in the interest rates, they would prefer to save income as its profitability is high, they will decrease the current level of consumption and they would prefer to invest in future consumption. Finally, the level of taxes negatively affects consumption, because of lower disposable income.

Equation (3) represents the pattern of investment. Clearly two facts can be derived: when the expected profit [5] increases, so does investment. Secondly, when the interest rate increases, the financing is more costly and investment decreases.

$$I_t = i_0 + i_1 Y_t - i_2 R_t, \quad (3)$$

Equation (4) provides the exogenous pattern of government spending. It depends on a constant government spending modified by a fiscal shock that contains elements such as the existence of an economic expansion that is translated into more public spending.

$$G_t = g_0 + GG_t \quad (4)$$

The following equation represents the behavior of taxes. It is based on the assumption that when aggregate income increases, the government increases the amount of revenues from taxes, due to the fact that taxes are proportional to the level of income.

$$Tax_t = t_0 + t_1 Y_t, \quad (5)$$

$$\text{with } t>_0 0 \text{ and } 0 < t_1 < 1$$

[5] Note that Y_t is a proxy for expected investment.

This equation represents the behavior of taxes. It is based on the assumption that when aggregate income increases, the government increases the amount of revenues from taxes, due to the fact that taxes are proportional to the level of income.

Monetary policy actions are initially designed by the central bank following this rule:

$$R_t = r_0 + r_1 (Y_t - Y) + r_2 (\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}) + RR_t,$$

where r_o is the benchmark interest rate in the steady-state, r_1 represents the response of real interest rate to the business cycle, r_2 represents the risk premium effect and RR_t represent an interest rate shock.[6] Other elements in the equation are Y_t, that represents output in the steady state equilibrium, B_t that represents the amount of public debt and $(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}})$ that represents the public deficit.

Moreover, the Central Bank proceeds with a gradual adjustment of the policy rate, as usually occurs in the real world. Thus, the monetary policy rule will be taking a linear combination between the policy action defined above and the previous interest rate:

$$R_t = r_3 R_{t-1} + (1 - r_3) [r_0 + r_1 (Y_t - Y) + r_2 (\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}) + RR_t], (6)$$

where $0 \leq r_3 < 1$,[7] is the coefficient that measures the smoothing for the interest rates.

This equation combines the interest rate of the previous period together with the previously mentioned monetary policy actions. In this equation, the risk premium effect is represented by $r_2 (\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}})$, that measures the response of the interest rates to the public deficit. An increase in the public deficit represents an increase in the risk to debt sustainability and creditors will require a higher compensation for a country's debt. Therefore, when the public debt increases, the risk of default increases and so does the interest rate.

The business cycle effects on monetary policy are captured in the equation by $r_1 (Y_t - Y)$. This represents the response of the interest rates to the difference between the actual output

[6] An interest rate shock occurs when interest rates suddenly change. Interest rate shocks move the entire curve. It covers any factor that alters the interest rate as the political instability or financial distress, among many others.

[7] A value of 0 represents that no smoothing is applied to the model.

of an economy and its potential output. [8] When this difference is positive, output is above its potential level and the economy is going through a growth period so that the government would typically do a contractionary policy implying an expected increase in the interest rates. Potential output will be constant at the steady state (long-run) value of output in the model solution. On the contrary, when it is negative, it represents that the economy is going through a recessionary period and the interest rates are expected to decrease.

Equation 8 represents how the interest rate responds to the public deficit. This is known as the risk premium or the additional interest paid between two different countries.

$$RP_t = (1 - r_3)\, r_2 \left(\frac{B_t}{Y_t} - \frac{B_{t-1}}{Y_{t-1}}\right) (7)$$

In the equation we see the effect of the adjustment of the interest rates to the public deficit in the current period.

For further developing the model, it would be presented the relation between public debt over GDP. First of all, we define the output rate of growth from one period to another.

$$\frac{Y_t}{Y_{t-1}} - 1 = g_{y_t} \quad (8)$$

We will proceed with the public debt described as follows:

$$B_t = B_{t-1} + G_t - Tax_t + R_t B_{t-1};$$

where public debt depends positively on its lagged value, government spending and on the previous interest repayments, and positively on the amount of government spending.

$$B_t = B_{t-1} + R_t B_{t-1} + (G_t - Tax_t)\ ^{9},$$

dividing it by Y_t and reorganizing the items equation (8) is obtained representing the public debt over GDP.

$$\frac{B_t}{Y_t} = \frac{B_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t} + R_t \left(\frac{B_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t}\right) + \frac{1}{Y_t} (G_t - Tax_t)$$

[8] The potential output is the maximum amount of goods and services an economy can produce when it is more efficient or at full capacity.

[9] This is the same result as obtained before, but after having reorganized the items.

$$\frac{B_t}{Y_t} = \frac{B_{t-1}}{Y_{t-1}} (1 + g_{y_t})^{-1} + R_t \frac{B_{t+y}}{Y_{t+y}} (1 + g_{y_t})^{-1} + \frac{1}{Y_t} (G_t - Tax_t)$$

$$\frac{B_t}{Y_t} = \frac{1+Rt}{1+g_{y_t}} by_{t-1} + \frac{1}{Y_t} (G_t - Tax_t) \quad (9)$$

This equation is very representative for our model as it contains three different factors that will play an important role in the model:

1. $\frac{G_t - Tax_t}{Y_t}$, represents the primary [10] public deficit over GDP. If the primary public deficit increases, the effect over public debt over GDP is positive.
2. $(1+R_t) \frac{B_{t-1}}{Y_{t-1}}$, represents the interest payment from ongoing debt. Its effect over public debt is positive, meaning an increase in the public debt over GDP when the interest repayments increase.
3. $(1 + g_{y_t})$ represents the growth. If growth exists, the level of public debt over GDP decreases.

Therefore, our macroeconomic model consists of nine equations from (1) to (9), that provide solution paths for our set of nine endogenous variables. The only source of variability in our model is provided by the three shocks that will produce short-run fluctuations in all the endogenous variables. The endogenous variables show the relationship between output (GDP), consumption, investment, taxes, interest rates, risk premium, public debt over GDP and GDP growth.

Summarizing, the model contains:

- Set of endogenous variables: Y_t, C_t, I_t, G_t, Tax_t, R_t, RP_t, g_{y_t}, $\frac{bt}{yt}$.
- Set of exogenous variables: NX_t, as a net exports shock, GG_t as a government spending shock and RR_t as an interest rate shock.
- Model parameters: c_o, c_1, c_2, c_3, i_0, i_1, i_2, g_0, t_0, t_1, r_0, r_1, r_2, r_3

The exogenous components are generated by an AR (1) that introduces variability in the model meaning that the shocks will be permanent in our economy. The shocks are generated

[10] The primary public deficit over GDP represent the public deficit without interest payments. Therefore, the sum of (1) and (2) is the overall public deficit.

by a white-noise innovation following a normal distribution with zero mean and a constant variance. The AR (1) is defined as follows:

- $NX_t = \rho_{nx} nx_{t-1} + \varepsilon_t^{nx}$, where ε_t^{nx} is a white-noise innovation ~ N (0, $\sigma_{\varepsilon^{nx}}$)
- $GG_t = \rho_{gg} gg_{t-1} + \varepsilon_t^{gg}$, where ε_t^{gg} ~ N (0, $\sigma_{\varepsilon^{gg}}$)
- $RR_t = \rho_{rr} rr_{t-1} + \varepsilon_t^{r}$, where ε_t^{r} ~ N (0, $\sigma_{\varepsilon^{rr}}$)

4. CALIBRATION OF THE MODEL PARAMETERS FOR THE SPANISH ECONOMY.

The final step of the model is the calibration of the parameters that compound it. We are doing this by estimating the presented values of the model parameters that explain the relationship between the different variables.

For the purpose of performing simulations of the model, we will use the software Dynare, that is run by MatLab. The first step is to define some random values for the parameters and write the correspondent expressions for the model. Therefore, the program will define values for all the variables in the model both in the steady-state equilibrium and in response to the shocks.

In order to obtain realistic results that reflected the potential increase in the interest rates, we have made several trials. The final values defined when the calibration process was completed are the following ones:

Model parameters	Calibration criteria
$c_0 = 6.5$	The constant term of the Consumption function (2) has been assigned value of 6.5 in order to obtain a realistic steady-state share of consumption over GDP. This ratio equals 55% to obtain a long-run value of output of 100.
$c_1 = 0.5$	It represents the proportion of consumption that individuals decide to consume in the present year. It has been given a value of 0.5, to obtain an equal smoothing between present and future consumption.
$c_2 = 50$	It represents the effect of interest rates in consumption. It justifies than an increase in the interest rates would have a negative effect on consumption. We define this value in 50, meaning that a 1% rise on interest rates will have a correspondent decrease of 0.5% on the level of consumption from its steady state value.

$c_3 = 0.2$	This parameter represents the negative effect of taxes on consumption. It has been given the value of 0.2, meaning that a tax increase of 1% will decrease the consumption expenditure in 0.2%
$i_0 = 0.3$	It defines the constant term in the equation of investment. It takes a value that brings a steady state share of investment over GDP of 19%.
$i_1 = 0.2$	It represents the marginal propensity to invest, meaning that a 1% increase in the profit of a firm, will increase investment by 0.2%.
$i_2 = 100$	It represents the response of investment to changes in R. A 1% rise on interest rates, will decrease investment by 1% from its long-run value. Investment also responds to changes in interest rates double of consumption.
$g_0 = 30$	The constant term of the government expenditure function is defined as 25 to obtain a realistic steady state share of government spending over GDP of 26% and to obtain an equal proportion between government spending and taxes in the steady state solution.
$t_0 = 1.25$	It is the constant term of the tax collection function and it is defined as 1.25 to obtain a ratio of taxes over GDP equals to 26%, so there exists a balanced budget in steady state.
$t_1 = 0.25$	It denotes the income tax rate of 25%, that for the Spanish economy is the average IRPF rate. Therefore, a 1% increase in the level of output, will increase the total amount of taxes collected by 0.25%.
$r_0 = 0.01$	It denotes the benchmark interest rate for the European markets. In this case it has been quarterly fixed as 0.01, meaning that the annual interest rate would be 4%, which seems to be reasonable for our economy.
$r_1 = \frac{0.5}{4}$	It represents the Taylor prescription (1993), meaning that for each one-percent increase in the output gap, the central bank tends to increase nominal interest rates by 0.5% annually. As we will deal with quarterly data, we will give a value of 0.125, meaning that interest rates will increase by 0.0125 when the output increases 1% from its steady state value.
$r_2 = 5$	It represents the risk premium effect on interest rates. As this parameter is very important for our model, it will be changed in the analysis of section 4.
$r_3 = 0.8$	It represents the moderate smoothing of the interest rates. The value is realistic with the Spanish data.

Regarding the components of exogenous components of the model, we can say that:

- Both the ρ_{nx}, ρ_{gg} and ρ_{rr} represent the permanent effect of the shock over time. They have been given a value of 0.8, meaning that a 1 unit shock will have an 0,8% permanency in the next quarter.

- The standard deviations of shock innovations are the following:

1. $\sigma_{\varepsilon^{nx}} = 0.3$. It represents the standard deviation of the net exports shock. Its value has been fixed at 0.3 to obtain an initial increase on aggregate demand by 0.3%.

2. $\sigma_{\varepsilon gg} = 0.3$. It represents the standard deviation of the government spending shock. Its value has been fixed at 0.3 to obtain an initial increase on aggregate demand by 0.3%.
3. $\sigma_{\varepsilon rr} = 0.1935$. It represents the standard deviation of the interest rate shock. Its value has been fixed at 0.1935 to obtain a baseline increase of 25 basis points on the interest rates.

To conclude, the calibration of this model has been a complex process where we have made estimations based on reasonable assumptions on the behavior of our economy. Also, this calibration process has been conditioned to obtain realistic results in order to reflect the oncoming increase in the interest rates in the Spanish economy. It leads us to realistic steady-state values of GDP, consumption, investment, government spending, tax level, interest rate and public deficit. The steady state solution of the model takes place when the exogenous variables are constant at their zero expected values. Given the calibration given to the model, the solution to the main variables of our proposed model is the following[11]:

- $Y_t = 115 - 28{,}615\ R_{t-1} + 0.0038 \frac{B_t}{Y_t}_{t-1} + 0.1260\ NX_{t-1} - 0.1342\ GG_{t-1} - 5.9859\ RR_{t-1}$
$+0.1340\ C_{t-1} + 0.1575\ NX_t - 0.1678\ GG_t - 7.4824\ RR_t$
- $R_t = 0.01 + 0.146813\ R_{t-1} - 0.000013 \frac{B_t}{Y_t}_{t-1} + 0.002876\ NX_{t-1} + 0.003892\ GG_{t-1} +$
$0.023365\ RR_{t-1} + 0.003059\ C_{t-1} + 0.003595\ NX_t + 0.004865\ GG_t + 0.029206\ RR_t$
- $B_t = 0.062207\ R_{t-1} + 0.9998 \frac{B_t}{Y_t}_{t-1} - 0.000274\ NX_{t-1} + 0.007248\ GG_{t-1} + 0.013013$
$RR_{t-1} - 0.000291\ C_{t-1} - 0.000342\ NX_t + 0.009060\ GG_t + 0.016266\ RR_t$
- $RP_t = 0.062207\ R_{t-1} - 0.000108 \frac{B_t}{Y_t}_{t-1} - 0.000274\ NX_{t-1} + 0.007248\ GG_{t-1} + 0.013013$
$RR_{t-1} - 0.000291\ C_{t-1} - 0.000342\ NX_t + 0.009060\ GG_t + 0.016266\ RR_t$

5. THE EFFECTS OF MONETARY POLICY TIGHTENING AT THE EUROPEAN CENTRAL BANK

After having designed, calibrated and solved the model, we will focus on the main macroeconomic variables for the Spanish economy when the interest rates suddenly increase or when we implement fiscal policies to control the deficit.

[11] The solution for the endogenous variables of the model is called policy function.

During this section we will make use of impulse-response functions which describe the evolution of endogenous variables along a specified time framework after a one-time shock. Therefore, we will make use of them to analyze the dynamic behavior of the endogenous variables depending on the shocks. These shocks are going to be introduced as innovations that last only one period but have immediate and lasting effects over the endogenous variables through the AR (1) process.

These simulations help us to observe the effects of each of the different shocks and see how long takes for the endogenous variables to recover back to the initial steady-state equilibrium situation of the economy.

For the purpose of this paper, we are going to focus our study in the realization of three different shocks. First of all, we give the results on a shock on net exports. Afterwards we focus on studying the effects of a fiscal expansionary policy and consequently an increase in public deficit. Finally, we show the effects of an increase in the interest rates in different scenarios. However, for the purpose of this study we are going to focus most of our attention on the last two.

5.1 Net Exports Shock

The first simulation that we are going to mention shows how the Spanish economy will be affected by a net exports shock. This scenario is not particularly important to our model, but we are going to show the immediate effects of this shock, in order to illustrate the transmission mechanism of our model.

To examine its effects, we propose a scenario in which a foreign economy decides to buy our products and increase by 1% their demand, while the other two existing shocks remain constant at a value 0. For example, the german households could have an increase in disponsable income that leads to raise imports of Spanish consumption goods. This shock is produced in period one but it remains over time until it goes back to its steady state value. We will analyze the effects of a temporal rise in the volume of domestic exports on the evolution of other macroeconomic variables.

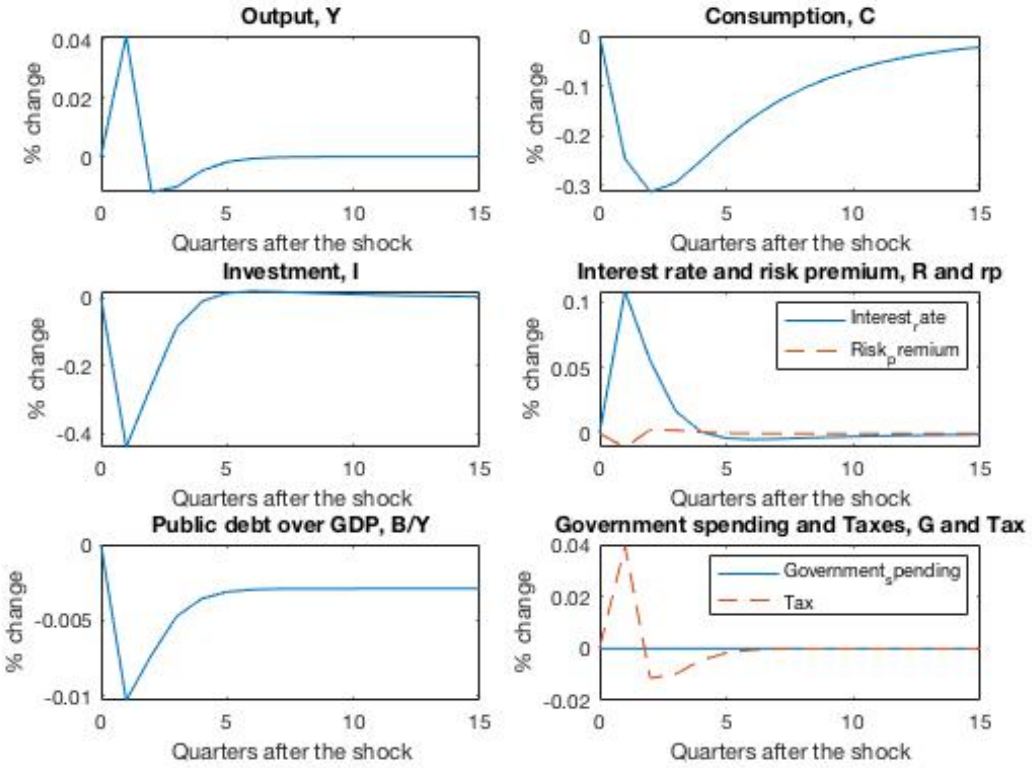

Figure 7. Effects of a net exports shock for the Spanish economy. Source: MatLab.

When the shock is produced and foreigners increase their demand for our products by 1%, the domestic level of output increases by 0.04% due to a higher demand. As income is above its natural level of output, according to the Taylor prescription, interest rates will go up. The shock drives interest rates up that increase by 0.055% in quarter one, reaching its highest value in quarter three of 0.17%.

The initial increase in current output leads public debt over GDP to decrease by 0.01% from its steady state value. The decrease in public deficit leads to foreign markets to have a higher degree of confidence in our economy. Therefore, the risk premium is reduced by 0.01%. In this case, risk premium follows the opposite pattern of interest rates. However, from the second quarter on, public deficit is affected by the higher interest rates and slightly increases after the shock is produced, leading to a lower decrease of 0.005% in the second quarter. This affects to the risk premium that returns to its initial value in quarter 2 as a result of the increase in the interest rate debt payments. As we can see in Figure 7 the shock has some

impact in the long run and then from quarter three on public deficit decrease permanently by 0.003%.

This increase in interest rates leads output to decrease and get its lower value in quarter 3 (0.1%), as high interest rates encourage savings and discourage both consumption and investment. Aditionally, when output decreases, interest rates begin to decrease again, leading both consumption and investment to increase. So there is a crowding out effect of endogenous components of aggregate demand. Although the shock is produced in period one, its effects in output last until quarter six, when this effect is close to zero and both consumption and investment go back to its natural steady-state equilibrium

Even the shock is produced in period 1, as all the variables are interrelated in our model, this creates a self-reinforcing cycle that make this shock to have a deeper impact over time. As we have shown before, the decrease in domestic income produced in quarter 3 together with the decrease in the level of taxes that are procyclical to the level of output, increases public deficit, which threats the risk premium effect of the model. Higher interest rates increase interest payments from ongoing debt, increasing further the deficit. Therefore, even the primary effect of the shock was positive leading to an overall increase in the output of the economy, we see that the shock does not have a permanent effect on the aggregate demand.

5.2 Government Spending Shock

The second scenario we will present is a fiscal consolidation policy taken by the Spanish government in an attempt to increase the output of our economy and recover from the economic crisis. During 2008 the government launched the *Spanish Economy and Employment Stimulation Plan* (Plan E) with support measures for businesses and families, employment and several financial measures (Gobierno de España, 2009). Additionally, they proposed an increase in pensions and social benefits, public salaries, education and health.

Due to the behavior of equation (4) in the model, we see that government spending shock is an exogenous component of it. The following situation represents the reaction of our economy to an increase of 1% in the public expenditure level. In order to realize this simulation, we fix the parameter r_2 in the model in a value of 0.05, meaning that our country is not sensible to the public deficit and the Spanish economy is supported by the European Central Bank and its Asset Purchase Program.

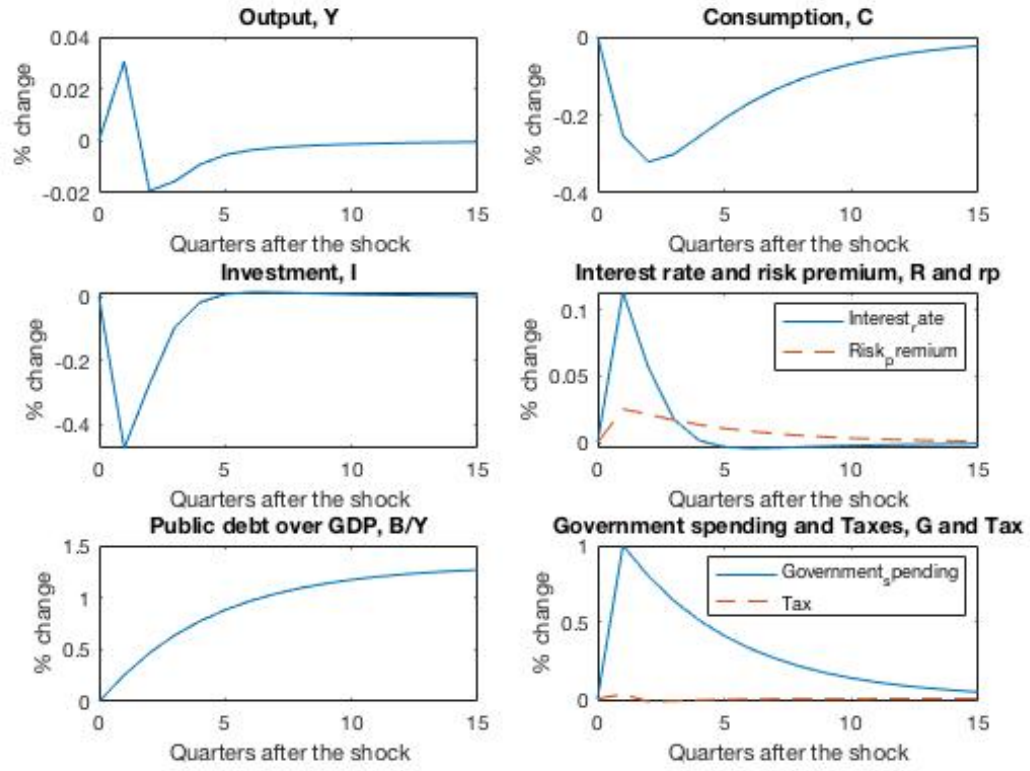

Figure 8. Effects of a governement spending shock for the Spanish economy under an alternative scenario. Source: MatLab.

An increase in government spending by 1%, will first of all increase the level of output of the economy by 0.02% and affect public deficit through the equation (9) of the model. As public spending is a component of the public deficit, an increase in the level of public spending immediately increases the amount of borrowing debt making sovereign debt bigger. However, the low risk premium effect in Spanish market leads interest rates to increase by 0.11%. This is because the risk premium effect is almost withdrawn from the equation, increasing only by 0.025% as we can see in Figure 8.

The level of output increases until quarter two when it reaches its maximum increase of 0.035%. This is due to the change in the composition of aggregate demand as a result of the increase in public expenditure by 0.3%, which is slightly higher than the decrease in consumption (-0.15%) and investment (-0.10%) resulting higher interest rates. Afterwards, the level of output diminishes due to the increase in interest rates, reaching its lowest value in quarter 3 until it reaches its natural state equilibrium in period 5.

We observe that the transmission mechanism enlarges the effect of the shock on the endogenous variables. This is because when the public deficit increases, first due to the increase in government spending together with higher interest debt payments, and then due to the reduction in the collection of output together with even higher interest payments, leads to an exponential increase of public deficit. However, as the risk premium does not increase in this case, this limits the multiplication of the effects of the perturbation on the rest of the variables and the economy remains stable in period 6, when output and interest rates go back to their natural equilibrium levels. Although this policy has enhanced the level of growth in the short-run, the policy itself has involved a greater growth of public debt that will last permanently.

The second case that we are going to present in the analysis is the real situation of the Spanish economy, when we do not have the support of the ECB and interest rates are sensitive to the public deficit. For this reason, we fix the risk premium effect on interest rates in 5 (value r_2).

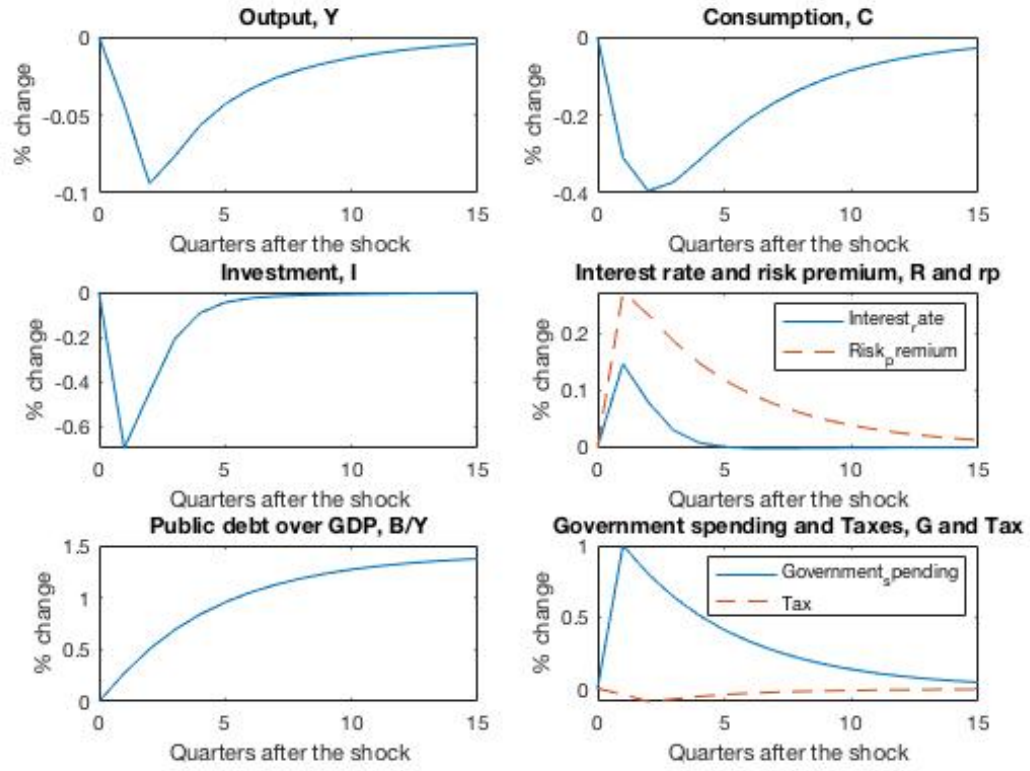

Figure 9. Effects of a governement spending shock for the Spanish economy. Source: MatLab.

The reaction of our economy to an increase of 1% in the public expenditure level would lead to a simultaneous increase in public debt of 0.03%. Investors will see uncertainty in the future of the Spanish economy and there is a higher risk of default [12] so that markets will require higher compensation for the Spanish debt. In this context the central bank should increase the interest rate to bear this risk premium effect. The interest rates increase by 0.15% in the first quarter as a result of the shock. However, as the interest rates diminishes both consumption and investment, the interest rates continue a decreasing patter that lasts till period five, when the interest rates achieve a permanent decrease of 0.002%. This risk premium effect is also seen in equation (7), as risk premium is severally affected by the increase in public deficit increasing by 0.27%. The risk premium effect lasts till quarter 15, longer than the interest rate increase since investors create expectations for further increases in future public deficits. This has a reinforcing effect in the level of public debt over GDP that increases over time and becomes stable in quarter 11 reaching a permanent increase of 1.3%.

Consumption and investment take disadvantage of the increase in the interest rates and this leads to a decrease in the level of output in the economy by 0.05%. The changes that take place in the composition of aggregate demand are a decrease in consumption (-0.19%) that together with the decrease in investment (-0.156%) are higher than the increase in government spending (0.3%), so overall the effect of the shock is negative, contrary to the previous case. [13]

We see that the fiscal expansionary shock causes an increasingly permanent deficit enlargement. The effect is permanent as higher interest rates lead to an increasing cost of debt that together with the lower government income, involve a growing domestic public deficit. We see in Figure 8, several self-reinforcing effects that enforce the duration of the shock over time. However, when the government spending shock start to go back to its natural level, the effects of the shock start to smooth, and the level of output goes back to its natural level from the fourth year on.

In this case the expansionary fiscal policy that has taken place in order to reactivate the economy has not been positive due to the dependence of the public deficit in interest rates.

[12] It is seen in Equation (6) through the parameter r_2, that represents the risk Premium effect.

[13] We need to bear in mind that the results of the models are given according to the model parameters that we established before. The model is sensible to the model parameters and the calibration of the model.

In the first analysis of the model, we have set the parameter in a low value ($r_2 = 0.5$), meaning that financial markets have a high confidence on the Spanish economy. We see that setting this parameter at a lower value limits the multiplication of the effects of the perturbation produced in the first quarter and the economy goes back to its natural equilibrium level by quarter 6 in contrast to quarter 16, as we see in the second case.

This situation is conclusive to understand the role that the European Central Bank determines in the Spanish economy. This section has clearly justified that in our dynamic model changing one single parameter has completely altered the results obtained in the model. We can conclude, that when a country decides to apply a specific policy, the government needs to take into account other variables, as we have done in this case by adjusting the level of trust of the European Central Bank to our economy.

5.3 Interest Rate Shock

Finally, the last shock introduced in the model is going to determine the effects of an increase in the interest rates. In last December (ECB, 2019) the ECB announced the end of the Quantitative Easing Program and it is now in the process of increasing interest rates. The last time that the ECB increased interest rates was on July of 2011[14]. Over the last 8 years, interest rates have been very close to 0%. Now, monetary policy is about to change, and official interest rates may be raised by the ECB as it has already occurred at the Federal Reserve System (FED) and the Bank of England (BoE). In order to see the increase in the interest rates we propose different scenarios, depending on the intervention or not of the ECB in the bond market, modulated by the value set to the parameter r_2. Figure 10 displays the responses to the interest rate shock with the no intervention of the ECB (Case 1 and parameter $r_2=5$) and with it (Case 2 and parameter $r_2=0.5$).

[14] This was the highest level reached since March 2009. The official rate was raised from 1.25% to 1.5% (Doncel, 2019)

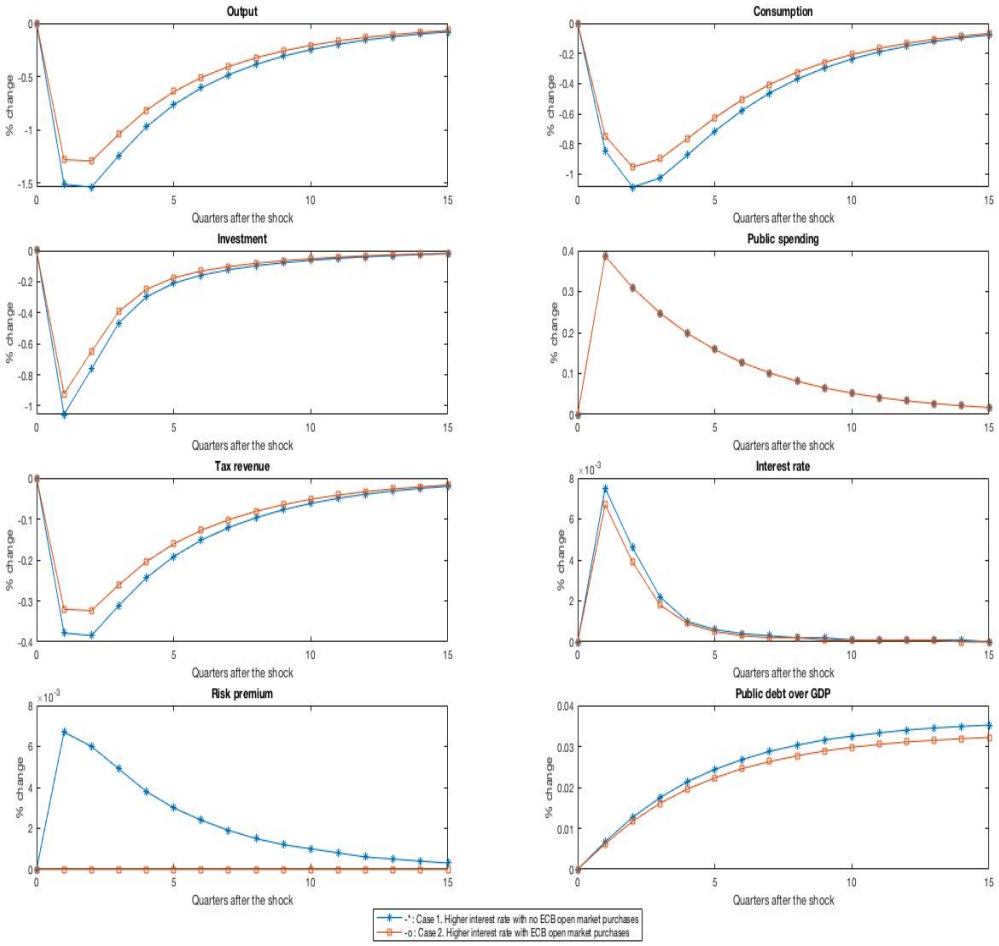

Figure 10 : effects of a interest rate shock in two alternative scenarios. Source: MatLab.

In both cases, the immediate reaction to an increase in the interest rates is seen in a decrease in the economic activity. An increase in the interest rates would lead households and firms to save more income, lowering their spending on consumption and investment goods. For the first quarter, the effect on investment (-1.05% when the ECB does not intervene and -0.9% when it does) is much higher than the effect on consumption (-0.85% when it does not and -0.7% when ECB intervenes). As we can imagine, these responses have an immediate effect on the level of output that is lowered by almost 1.5% at the quarter of the shock and in 1.3% in the other case. In both cases, the economy goes back to its initial equilibrium level 4 years after the shock, although in the second case the impact of the initial shock is smaller.

As taxes are procyclical (proportional to current income), this situation leads the government to reduce their tax collection, that decrease by 0.4% in the first case and by 0.3% in the second case in the quarter the shock is produced. The reduction in the collection of taxes, together with the increase in the quantity of interest paid increases the level of public deficit.

This has a reinforcing effect, that continuously increases the public debt over GDP. In the first case, due to the risk premium effect, public deficit increases at a higher path.

The increase in the public deficit has immediate effects on interest rates and risk premium through the interest rate equation of the model. When the central bank does not intervene in our economy (case 1), investors lose confidence on our country and risk premium increases by 7% that together with the monetary behavior of the central bank lead to an overall increase of 8% in the interest rates in just one quarter. However, if the ECB buys our public debt, the risk premium effect is minimized, and interest rates increases only by 7%. In case 1, the loss of confidence has deeper and unpredictable impact in our economy.

Moreover, there is an even higher increase in the public debt as the amount of interest paid for current debt is higher. Public debt over GDP increases by 0.01% when the ECB does not intervene in the economy (r_2= 5) slightly more than when ECB intervenes (r_2= 0.5) due to a higher cost of government interest payments As it is seen in Figure 10, public debt increases exponentially till it becomes stable in the quarter 15 after the shock with an increase close to 0.04% in public debt over GDP. However, when the ECB intervenes in the economy, the public debt over GDP increases by 0.03% due to the risk premium effect in the economy.

Putting together both the increase in public debt and the decrease in the collection of sources of income for the Spanish government leads to an even more important decrease in the level of output in the second quarter (decreases by 1.6% in the first case and 1.4% in the second). Interest rates hike will affect both consumer and business confidence. It will discourage investment because of the increase in the cost of borrowing and the policy will make firms and households less willing to take risky investments or purchases. Therefore, this policy ends up in a recessionary period where the economic activity is diminished and the price to be paid for the debt increases.

Overall, we can see that the interrelation between the variables presented in our model, multiply the effects of the initial shock. Although interest rates go back to its steady-state value by quarter 6, the effects on other variables lasts more, mainly till period 15, as we can see in consumption, tax collection and output. We see a decrease in both investment and consumption that will drive output down and will lead the public deficit to continuously

increase. Even, the intensity of these effects will decrease quarter by quarter, until the economy reaches the state equity equilibrium after 16 quarters (4 years).

5.4 A policy mix approach to the hike in the interest rates

Monetary policy in Spain depends upon the decisions of the European Central Bank (ECB). Central banks seek to influence the interest rates on short-term financial transactions and, through them, on longer-term financial interest rates. Also, the ECB is in charge of performing less conventional interventions to influence the interest rates, such as the ECB open market purchases. The Spanish economy has been taking advantage of this program since 2009, but the ECB decided to finish this intervention at the end of 2018.

In order to minimize the adverse consequences of the increase in the interest rates, a fiscal policy can promote macroeconomic stability by sustaining aggregate demand and private sector incomes during an economic downturn (Issing, 2005). We propose a possible path to the increase in interest rates, without leading to a drastic and lasting decrease in output by introducing a fiscal expansion implemented by the Spanish government. Since June 2018, socialist party holds the government in Spain, and it has recently passed bills to create new public sector jobs and improve public provision of health, education and pensions for retired people.

Hence, we display in the following Figure 11, the impact of three different policies. We start with a fiscal expansion together with no ECB open-market purchases (blue lines displayed in Figure 11), fiscal expansion together with ECB open market purchases (orange lines, showed in Figure 11) and the last case we introduce in this section (yellow lines in Figure 11) brings neither ECB open-market nor a fiscal plan developed by the Spanish government. The effects in the figure are measured as a percentage of steady state.

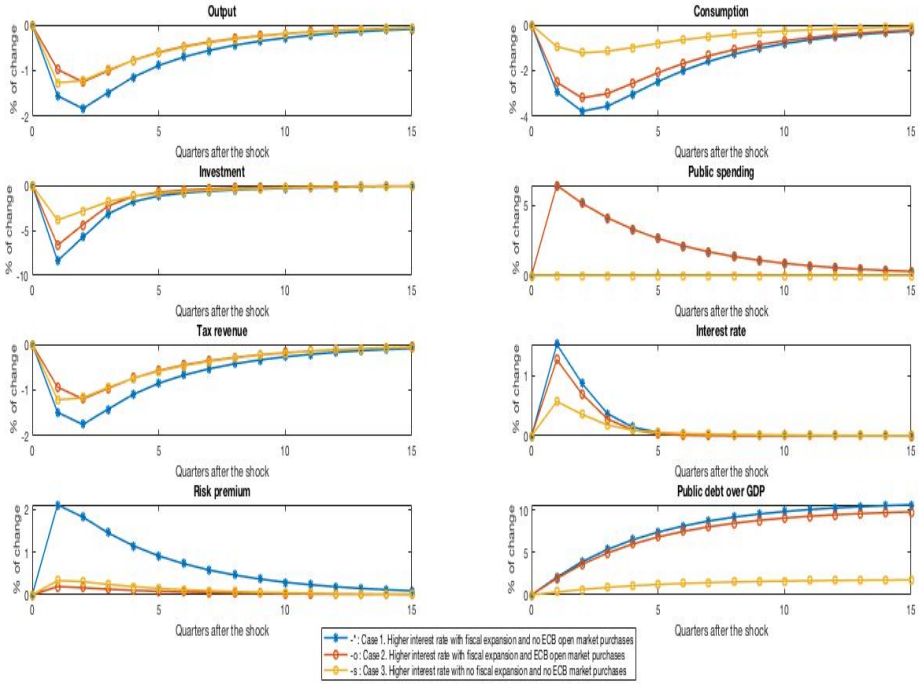

Figure 11 : effects of a interest rate shock under alternative scenarios for the Spanish economy. Source: MatLab.

In the first case (fiscal expansion and no ECB open market purchases) we see that the effect on interest rates (increase by 1.5%) is high due to the rise of the risk premium, that increases by 2.1% in comparison with the steady-state scenario. The increase in interest rates makes businesses and households to prefer saving money than invest and they decrease both their level of investment (-8.4%) and consumption (-3%). Therefore there is a clear decrease in the level of output for the Spanish economy decreasing output by 1.55% the first quarter the shock is produced. This reduction in output leads the government to decrease their collection of taxes by -1.5% in the first quarter. Consequently, both the less amount of taxes collected and the increase in the interest payments for Spanish debt leads to an increase in in the cost of public debt over GDP of 2.1% in the first quarter. This increase in public debt over GDP will have drastic effects in the financial market's confidence in the Spanish economy. This is the result of the drastic effect in the level of consumption (-3.8%), investment (-5.7%) and the amount of government spending that decreases in comparison to the previous quarter and clearly pushes output down by 1.83% in the second quarter. Tax revenue is subsequently decreased by 1.8% which poses a threat to the amount of public debt over GDP that exponentially increases. Overall, this policy leads the Spanish economy to have a high

decrease in output of 1.83%, together with a public deficit close to 11% and high risk premium effects as expected.

The second scenario shows the fiscal expansion together with the continuation of the open market operations of the ECB. In this scenario, we see a lower increase in the interest rate (1.3%) due to the null risk premium effect (increases 2% less than in the previous case). This is because in this scenario the ECB supports economic growth by buying Spanish bonds or other financial assets. We see a smaller decrease in both consumption (-2.5%) and investment (-6.7%), that together lead to a smaller decrease in output (-1%) than in the previosly mentioned case. As taxes are proportional to current income, the amount of taxes collected decreases by almost 1%. Therefore public deficit increases by 1.9%, slightly less than in the previous case. High interest rates will push output down by 1.24% less than in the previous case because the lower risk premium effect makes consumption (-3.2%) and investment (-4.4%) decrease by a lower amount. However, as the government spending is kept increasing and debt payments are higher, public deficit exponentially increases till 10%. Overall, this policy leads the Spanish economy to get a moderately bad outcome, where the risk premium effects are medium, output falls by 1.24%, consumption and investment fall sharply, while government spending rises and public deficit increases exponentially.

The third scenario is represented by the end of the liquidity-providing operations of the ECB together with the lack of a fiscal expansion. In this context, government spending is kept at constant levels. Therefore, the effect in the risk premium is barely noticeable and we see a weak increase in the interest rates (0.6%). Consumption and investment decrease by 0.94% and 3.9% respectively, as a result of the higher returns of savings. In this case, the composition in aggregate demand changes as public spending remains constant while consumption and investment fall. This leads to a decrease of 1.3% in output that would lead to a reduction in the amount of taxes collected of 1.2%. We will see an increase in the amount of public deficit by 0.3%. This amount is less than in the previous cases due to higher interest debt payments and the decrease in tax collection together with the lack of public spending that highly reduces public deficit in comparison to the previously mentioned cases. Overall, we see a smaller decrease in consumption and investment due to the constant value in public spending that leads to a similar decrease in output than the previously mentioned case. The effect in public deficit is little , increasing by less than 2%, due to the lack of government spending and the low risk premium effects.

6. CONCLUSIONS

The European Central Bank ended the Asset Purchase Program in December 2018 and it is nowadays in the process of increasing interest rates. For the moment, even though it was supposed a first hike in the interest rates in the summer of 2019 (Sánchez, 2018), the ECB is not expecting an increase of policy rates until the third quarter of 2020 (Jimenez, 2019). We have studied the effects of a higher interest rate that may take place soon in the Spanish economy.

In order to address the possible effects of an increase of the interest rates for the Spanish economy, we have designed a dynamic macroeconomic model. The model follows a New-Keynesian framework with price rigidities, where nominal and real interest rates fluctuate proportionally. Our model represents the interrelations between real GDP, consumption, investment, interest rates, risk premium and public deficit together with different exogenous shocks. The sources of variability in our model are three shocks that will produce short-run fluctuations in all the endogenous variables. These shocks are related to an unexpected increase in foreign demand for national products, an unexpected government's expansionary policy and a sudden increase in interest rates.

The calibration of the model has been a detailed process. We have worked on the proper calibration of the values of the model parameters in order to obtain results that reflected the real economic framework of the Spanish economy. In order to calibrate the model, we have made use of the real share of both consumption and investment over GDP, the Spanish average income rate or the Taylor prescription, among others.

The net exports shock has helped us to illustrate the transmission mechanism of the model. The other two have evidenced that the effects of fiscal and monetary policy presented in our model differ greatly depending on the paramenter calibration set on it and on the real conditions of the economy. We see how in the case of an expansionary fiscal policy, the effects of an increase in the public expenditure level differs depending on the degree of confidence that the financial markets have in our economy (parameter r_2 of the interest rate equation of the model). The low value in this parameter is justified by a complete level of trust of the ECB in our economy buying our soverign debt to address the risks of the country and hence, makes the risk premium on the interest rates be less sensitive to the public deficit.

On the contrary, a high value means that investors will reduce their confidence in the sustainability of the Spanish sovereign debt and it would push the risk premium upwards.

In the last section of our study we focus on an interest rate shock by studying three different scenarios. In the first case in Figure 11, we have shown that interest rates may be raised by the ECB combined with a fiscal expansion together with the end of the ECB open-market purchases. This represents the worst scenario as output falls by 1.83%, public deficit increases exponentially close to 11% and the risk premium effects are high. In the second scenario, there is a fiscal expansion together with purchases of Spanish debt by ECB. The outcome is moderately bad as output falls by 1.24%, consumption and investment fall sharply while government spending keep rising. The risk premium effects are medium due to the increase in government spending that increases public deficit by 10%. The last scenario presented in our study focus on the lack of fiscal expansion together with the end of liquitidy-providing operations of the ECB. The outcome is moderately bad as output falls by 1.26% but consumption and investment do not fall as much as in the previous case. The constant government spending leads to little public deficit and low risk premium effects.

Given these circumstances, the governement and the ECB are in charge to apply either one policy or the other. For that they should take into account the real conditions of the economy. As the ECB has recently finished the Asset Purchase Program, we strictly recommend the last scenario where the ECB does not intervine in the economy together with the lack of fiscal expansion. This policy means more favourable results for both consumption and investment, a less severe risk premium effect and favourable results for public deficit.

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