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**Working Paper**

## Stimulus vs. austerity vs. default

Working Papers, No. 2014-10

**Provided in Cooperation with:**

Bank of Mexico, Mexico City

*Suggested Citation:* Cuadra, Gabriel; Ramos-Francia, Manuel (2014) : Stimulus vs. austerity vs. default, Working Papers, No. 2014-10, Banco de México, Ciudad de México

This Version is available at:

<https://hdl.handle.net/10419/100120>

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**Banco de México**  
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**Banco de México**  
**Working Papers**

**N° 2014-10**

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June 2014

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## Stimulus vs. Austerity vs. Default\*

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### Abstract

There is an ongoing debate about austerity and stimulus in the Euro zone. Moreover, given the fiscal and financial problems in the region, a default has appeared likely at times. In this context, this paper develops a dynamic stochastic quantitative model of sovereign default with fiscal policy, which captures the most salient features of the recent fiscal and debt situation in the Euro zone. In this setting, this highlights the economic nature of the decision to default, the key role of official aid in avoiding such event and, thus, improving the overall economic outlook.

**Keywords:** Sovereign Default, Fiscal Policy.

**JEL Classification:** E62, F34.

### Resumen

Hay un debate en curso acerca de las medidas de austeridad y de estímulo en la zona del Euro. Asimismo, debido a los problemas fiscales y financieros en la región, un evento de default se ha llegado a percibir como probable en diferentes ocasiones. En este contexto, en el presente trabajo se desarrolla un modelo cuantitativo dinámico y estocástico de default soberano con política fiscal, el cual captura las características más sobresalientes de la reciente situación fiscal y de deuda soberana en la zona del Euro. En este entorno, lo anterior pone de manifiesto la naturaleza económica de la decisión de default, el papel clave de la ayuda oficial para evitar dicho evento y, por lo tanto, para mejorar las perspectivas económicas.

**Palabras Clave:** Default Soberano, Política Fiscal.

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\*The opinions expressed in this paper are exclusively the responsibility of the authors and do not necessarily reflect the point of view of the Banco de México. A version of this paper was presented at the International Monetary Seminar, Banque de France, July, 2013. We are indebted to Santiago Gacía-Verdú for his invaluable comments and suggestions.

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# 1 Introduction

The debate on economic adjustment and high levels of indebtedness in advanced economies has focused on the austerity versus stimulus dichotomy (Rogoff 2012). At the risk of oversimplifying, there are those who favor fiscal consolidation in highly indebted countries. The gist of their argument is that austerity would restore confidence and market accessibility and, thus, reduce borrowing costs. At the other end, there are those who argue that fiscal adjustments have had an adverse effect on economic activity and that measures to stimulate growth are needed (Krugman 2012), e.g., implementing fiscal stimulus. (Both sides emphasize the need for structural reforms.) Yet, neither course seems to be a viable solution to the sovereign debt crisis in the Euro zone. On the one hand, draconian fiscal adjustments have had a negative impact on economic growth, preventing the correction of fiscal imbalances and the reduction of debt to GDP ratios to sustainable levels. On the other hand, given the imbalances and debt levels' magnitudes, it would be very difficult to obtain financing for fiscal stimulus packages which would also possibly further erode market participants' confidence. Furthermore, it will take a relatively long time for structural reforms to be enacted, implemented and, finally, to have an effect on the economy. We believe that much of this debate does not make much sense. As part of the recent global crisis' aftermath and consumption patterns previous to the crisis, a plethora of countries have endured an abrupt adjustment in their government expenditure paths, given the lack of further market financing. Accordingly, their aggregate demands have had to consolidate, and as a matter of simple absorption arithmetic their economic growth rates have already corrected negatively. Indeed, some of these adjustments, brought about by the global financial crisis, were nonetheless going to eventually take place. The pre-crisis consumption paths in such countries were not sustainable to begin with, as their productivities had been maintained at subpar levels for several years.<sup>1</sup>

In this context, given the substantial burden of fiscal and debt problems, a default has seemed imminent at times.<sup>2</sup> Crucially, the choice to default does not hinge on an ecumenical debate, but rather it is the dire consequence of an economic cost-benefit analysis which depends on the macroeconomic conditions and parameters faced by each individual country: its debt levels, fiscal situation, economic growth prospects, among others. In this setting, it may be argued that the financial support provided by multilateral institutions (official aid) to some countries of the Euro zone's periphery may

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<sup>1</sup>For example, see Evans, Kotlikoff and Phillips (2012).

<sup>2</sup>The timely official aid implemented by the corresponding multilateral institutions has proved essential to avoid this scenario.

have contributed to prevent a default episode. In order to explain the macroeconomic dynamics of a representative economy of the Euro zone’s periphery during the recent fiscal and sovereign debt crisis, this paper posits a dynamic stochastic quantitative model of a small open economy with endogenous fiscal policy and optimal sovereign default.<sup>3</sup>This model illustrates the main trade-offs that a government faces when deciding between paying its outstanding debt obligation or defaulting on it.

Our paper builds on the recent literature of quantitative models of sovereign debt. Aguiar and Gopinath (2006) and Arellano (2008) were the first papers to develop quantitative models to analyze the business cycles in emerging market economies. They based their models on the theoretical contribution of Eaton and Gersovitz (1981). The one presented in this paper is similar to that of Cuadra et al. (2010), who develop a model of sovereign debt and fiscal policy to explain the pro-cyclical nature of fiscal policy in emerging market economies.<sup>4</sup>

Our model captures the most salient features of the macroeconomic dynamics from the development of economic imbalances to the adjustment process, under the absence of official aid. Although our model does not account directly for official aid, we can think of its presence in terms of an increase in the economy’s endowment. This, in effect, improves a country’s economic outlook which reduces its default probability and, consequently, lowers its borrowing costs. Accordingly, this underscores the relevance of aid by multilateral institutions. The paper proceeds as follows: the sovereign debt model with fiscal policy is developed in section 2. A numerical exercise that illustrates the quantitative implications of the model is analyzed in section 3. Some conclusions are presented in section 4.

## 2 Model Economy

Our model includes fiscal policy in a standard sovereign default setup.<sup>5</sup>There are three agents: households, government, and foreign lenders. The representative household has preferences given by the expected value of the stream of utility in each period:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{(C_t^\alpha G_t^{1-\alpha})^{1-\sigma}}{(1-\sigma)}.$$

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<sup>3</sup>In this paper, by the Euro zone’s periphery we mean the following countries: Greece, Ireland, Italy, Portugal and Spain. That is, the so-called GIIPS.

<sup>4</sup>To the extent that both emerging economies from Latin America and Asia, and the so-called GIIPS are small open economies, these models are appropriate to explain the dynamics of the Euro zone’s periphery.

<sup>5</sup>Our model without fiscal policy is similar to Arellano’s (2008).

The discount factor is  $\beta \in (0, 1)$  and  $\sigma$  is the coefficient of risk aversion. Households derive utility from private consumption  $C_t$  and public expenditures  $G_t$ . We consider a Cobb-Douglas aggregator, where  $\alpha$  is the private consumption weight. Households' income  $y_t$  follows a Markov process, with conditional density function  $Q(y_{t+1}|y_t)$ . Output is divided between private and public consumption. Income is taxed by the government. Households take public expenditures and taxation as given. Thus, they consume according to:

$$C_t = (1 - T_t)y_t.$$

The government maximizes households' utility. It does so by issuing one-period bonds, taxing households' income, and financing public expenditures. Conditional on being in good credit standing, it chooses between paying the outstanding debt or defaulting on it. The government compares the cost of repayment given by the disutility of reducing current consumption to repay the non-contingent loan, against the cost of temporarily being excluded from international markets given by the foregone benefits of consumption smoothing and an output loss in autarky. If default is not optimal, the government decides how much to borrow, the public expenditure and, at the same time, the tax rate. If default is optimal, it only decides its public expenditure and, in tandem, its tax rate.

This problem can be expressed in dynamic programming form. The state variables are output  $y$ , and foreign assets  $B$  (debt corresponds to negative values of  $B$ ). The government decides between honoring its debt or defaulting on it by comparing the value function associated with not defaulting  $V^c(B, y)$ , with the value function corresponding to default  $V^d(y)$ :<sup>6</sup>

$$V_0(B, y) = \max \{V^c(B, y), V^d(y)\}.$$

The government maximizes the representative household's utility subject to her budget constraint, and its own budget constraint. The problem, when the government has access to credit markets, is:

$$V^c(B, y) = \max_{T, G, B'} \left\{ (C^\alpha G^{(1-\alpha)})^{(1-\sigma)} / (1 - \sigma) + \beta \sum_{y'} V_0(B', y') Q(y' | y) \right\}$$

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<sup>6</sup>As explained below, the country's debt is set to zero if it decides to default. Hence, the value function corresponding to default is not a function of  $B$ .

s.t.

$$G = Ty + B - q(B', y)B',$$

$$C = (1 - T)y$$

where  $q(B', y)$  is the price of the bond.<sup>7</sup> If the government defaults, the country is temporarily excluded from financial markets and suffers an output loss. Accordingly, the tax on income is the only instrument to finance public expenditures. The output in autarky is represented by  $h(y)$ . In this case, the problem is:

$$V^d(y) = \max_{T_d, G_d} \left\{ (C_d^\alpha G_d^{(1-\alpha)})^{(1-\sigma)} / (1-\sigma) + \beta \sum_{y'} [\mu V_0(0, y') + (1-\mu)V^d(y')] Q(y' | y) \right\}$$

s.t.

$$G_d = T_d h(y)$$

$$C_d = (1 - T_d)h(y).$$

Once excluded from credit markets, in the next period it regains access to them with exogenous probability  $\mu$  and it would do so with no debt,  $B = 0$ .<sup>8</sup> Finally, foreign creditors are risk-neutral and have access to an international risk-free bond with interest rate  $r_f$ . Perfect competition among creditors implies a zero profit condition. The equilibrium bond price is then:

$$q = ((1 - \lambda(B', y)))/(1 + r_f).$$

### 3 Numerical Exercise

We perform a numerical exercise to obtain some insights on the economy's dynamics during a period in which macroeconomic imbalances are built up and, therefore, when

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<sup>7</sup>The timing convention is as follows. The government starts period  $t$  with debt  $B$ , observes output  $y$ , and decides debt  $B'$ . It does not observe output  $y'$  until the next period.

<sup>8</sup>Admittedly, this is a strong assumption as countries typically negotiate their debt when they default.

the economy has to adjust to less access to external borrowing.<sup>9,10</sup> To this end, we first discuss the values of the parameters used in the exercise. Second, we analyze how changes in the parameters' values affect the incentives (not) to pay in the model. Finally, we choose a sequence of output shocks that coincide with the evolution of the GDP in the Euro zone's periphery in recent years and analyze the model economy's dynamics. Below, we describe the precise way in which this is performed. It is worth mentioning that we have used a yearly frequency.

### 3.1 Calibration

The parameter values used in the model's solution are comparable to those utilized in the literature of sovereign default quantitative models (e.g., see Aguiar and Gopinath (2006), Arellano (2008), Cuadra et al. (2010)). Others are chosen to emulate the most salient empirical features of the economies from the Euro zone's periphery. Table 1 presents the parameters' values used. The parameter,  $\sigma$ , the coefficient of relative risk aversion, is set equal to 2, a standard value in the literature (e.g., see Aguiar and Gopinath (2006)). The discount factor  $\beta$  is set to 0.95.<sup>11</sup> The private consumption weight  $\alpha$  is fixed at 0.76, so that the private consumption to public consumption ratio is approximately that of the Euro zone's periphery, which is close to 3.<sup>12</sup>

The parameter  $\mu$  corresponds to the exogenous probability of re-entering international financial markets after a default episode and is set equal to 0.1. This value implies that a country will return to financial markets, on average, 10 years after defaulting.<sup>13</sup>

There is output loss in autarky.<sup>14</sup> This is captured in the model by the output in autarky  $h(y)$ , as in Arellano (2008). Thus, it is assumed that a default episode entails

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<sup>9</sup>It is worth mentioning that up to now quantitative models of sovereign default have not been able to generate debt levels and interest rate spreads similar to those observed in the data.

<sup>10</sup>The model abstracts from some factors affecting the dynamics of sovereign debt, such as the role of banks. As mentioned, there is only one asset: a one period non-contingent bond. Thus, the total amount of debt and debt service (amortization plus interest payments) are equal in this setup.

<sup>11</sup>A standard value for the discount factor for annual data is 0.96. However, one disadvantage of sovereign default quantitative models is that they require a high level of impatience to generate default in equilibrium. Thus, a value of 0.95 was chosen, a standard assumption in the literature.

<sup>12</sup>In order to calculate the private consumption to public consumption ratio in the euro zone's periphery, the following countries are considered: Greece, Ireland, Italy, Spain, and Portugal. To calculate the average ratio, the data of each country was weighted taking into account the size of its population. Since 2000, the private consumption to public consumption ratio, in the model  $\alpha/(1-\alpha)$ , is around 3. In addition, we also use real GDP as weight, and the aforementioned ratio is still close to 3.

<sup>13</sup>According to Benjamin and Wright (2008) a process of sovereign debt restructuring takes eight years on average.

<sup>14</sup>Rose (2005) provides a rationale for the loss of output when countries face debt crises.



an output cost of the following form:<sup>15</sup>

$$\begin{aligned} h(y) &= (1 - \theta)E(y) & \text{if } y > (1 - \theta)E(y) \\ h(y) &= y & \text{if } y \leq (1 - \theta)E(y) \end{aligned}$$

The default cost parameter  $\theta$  is set equal to 0.02, which is similar to the values used in Arellano (2008) and Cuadra et al. (2010).<sup>16</sup>

Output is assumed to follow an AR(1) process:

$$\ln(y_t) = \rho_y \ln(y_{t-1}) + \sigma_y z_t$$

where  $z_t$  is iid  $N(0, 1)$ .

The parameters of the stochastic process for output,  $\rho_y$ ,  $\sigma_y$ , are set to match the autocorrelation and standard deviation of the Euro zone periphery countries' (log) aggregate GDP.<sup>17</sup> To be able to solve the dynamic programming problem, the output process is approximated by a discrete Markov chain. The model is solved numerically using a value function iteration algorithm.<sup>18</sup>

### 3.2 Effects of Parameters' Values on the Incentives to Default

Prior to presenting our results, it is worth discussing how different values of the parameters affect the incentives to default in the model. Several comments are in order.

With respect to the coefficient of relative risk aversion, a higher  $\sigma$  means a more risk-averse agent. The higher its value, the more she wishes to have smoother consumption across states of the world. In effect, she cares more about consumption smoothing and, consequently, she is less willing to default as this would entail more variability in her consumption across states.

Regarding the discount factor, a lower value of  $\beta$  means a more impatient agent.<sup>19</sup>

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<sup>15</sup>As explained in Arellano (2008), this specification extends the range of debt values that carry positive default premia, which, all else equal, allows the model to generate higher interest rate spreads.

<sup>16</sup>Cuadra et al. (2010) use a value of 0.01 for this parameter, while Arellano (2008) uses a value of 0.03.

<sup>17</sup>In order to calculate the aggregate GDP in the periphery of the Euro zone, the following countries are considered: Greece, Ireland, Italy, Spain, and Portugal. The GDP of each country is weighted taking into account the size of its population. For robustness, we also considered real GDP as weight. The result does not change significantly.

<sup>18</sup>The value function algorithm is based on a discrete space method with a grid of 25 values for the output shock and a grid of 200 values for debt levels. The size of the grids was chosen so that the numerical results were robust. In other words, they do not change when the size of the grids increases.

<sup>19</sup>Alternatively,  $\beta$  can be expressed as  $1/(1+\rho)$ , with  $\rho$  being the discount factor. In this case the interpretation goes the other way around. That is, a higher discount factor would imply a higher

This implies that she is more likely to get into debt, incurring in a higher cost of borrowing, which reflects a higher default probability in case of an adverse scenario. The decision to default prevents a decrease in consumption in the current period, the main benefit to do so. Since the exclusion from financial markets and the fall in output in the following periods correspond to the main costs, a lower value of  $\mu$  implies that the agent cares less about this, which reduces the cost of defaulting and, thus, increases the incentives to do so.

With respect to the probability of regaining access to financial markets after a default episode,  $\mu$ , a greater value implies a higher expected utility when the economy is in autarky. This implies that the cost of defaulting is lower. Thus, a rise in this parameter increases the incentives to default. Regarding the output loss in autarky,  $\theta$ , a higher value of this parameter makes a default episode more costly and, consequently, provides fewer incentives to do so.

Finally, as for the endowment process parameters,  $\rho_y$ ,  $\sigma_y$ , both have similar effects. In particular, they have two effects in opposite directions. To see this, first note that a higher  $\rho_y$ , entails a more persistent and variable process (unconditionally).<sup>20</sup> Also, a higher  $\sigma_y$  implies a more variable process (unconditionally and conditionally).<sup>21</sup> On the one hand, higher values of any of these two parameters make default more attractive. To see this, think of default as an exit option, whereby higher variability makes such an option more valuable and, thus, more probable. On the other hand, once the agent is in autarky, the endowment variability would make it less bearable. Therefore, the agent will be less willing to default. The relative strength of each effect depends on the values of these and other parameters.

### 3.3 Results

Having solved the model, a sequence of the model's output shocks is chosen such that its path is as close as possible to the GDP's observed path in the Euro zone's periphery from 2005 to 2012.<sup>22</sup> Figure 1a shows the GDP's paths in the data and in the model economy, while Figure 1b shows the GDP's paths for a number of Euro zone's countries.

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degree of impatience.

<sup>20</sup>To see this, consider the MA representation of the endowment process. As  $\rho_y$  tends to 0, the unconditional volatility tends to  $\sigma_y$ , whereas, as  $\rho_y$  tends to 1, the unconditional volatility tends to infinity.

<sup>21</sup>To see the unconditional case, consider the MA representation of the endowment process. As  $\sigma_y$  increases,  $var(y_t)$  increases.

<sup>22</sup>The output shocks were chosen directly from the values of the Markov chain of the output process, in order to minimize the sum of the squared deviations between the observed GDP and the endowment in the model.

Given this exogenous output path, we consider the policy functions to solve for the model economy's dynamics.<sup>23</sup> At the beginning, the economy faces a sequence of positive shocks, and its output shows a positive trend. The favorable economic performance implies an interest rate spread equal to zero. The economy starts to experience a sequence of negative output shocks and, thus, the expansion eventually comes to an end. Hence, foreign lenders demand a risk premium in order to keep on lending to the government, and the interest rate spread increases. Figure 2 depicts both the output level and the interest rate spread in the model economy.

The government initially takes advantage of the low interest rate spreads and, accordingly, borrows from abroad to finance a relatively high level of public spending. It mostly relies on external borrowing to finance public expenditures rather than on taxes, which allows households to consume more. In this scenario, domestic absorption, which in this model corresponds to public plus private consumption, increases with respect to output.<sup>24</sup> Figure 3 shows the excess of domestic absorption over output during the economic expansion. Simultaneously, the government runs a fiscal deficit (Figure 4). The fiscal imbalance leads to the accumulation of debt and, consequently, to increments in the debt service (Figure 5). It can be argued that the model's dynamics qualitatively resemble the macroeconomic variables' behavior of some countries in the Euro zone's periphery, such as Greece, in the years prior to the global financial crisis.

Once the expansion ends and interest rate spreads increase, the economy goes through an adjustment process. In the model, the output contraction that triggers the need to adjust the domestic economy to an adverse external environment corresponds to the global downturn associated with the recent global financial crisis. A more restricted access to international financial markets diminishes the government's capacity to refinance its contracted debt in the model. Accordingly, the government reduces public spending, and increases the tax rate to improve its fiscal accounts to be in a position to honor its debt obligations. Thus, it runs a fiscal surplus (Figure 4). Simultaneously, the economy as a whole has to contract domestic absorption below its output to be able to repay its outstanding debt (Figure 3). The fiscal measures implemented by the government induce this adjustment. On the one hand, the government

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<sup>23</sup>It is assumed that in the period before the simulation starts the government has no debt and its fiscal balance is equal to zero.

<sup>24</sup>Macroeconomic imbalances are created by having an excess of expenditure over income. In practice, an excess of expenditures and, thus, indebtedness, could be due to the public or the private sector. Nonetheless, in a crisis, it is the government that typically assumes the debts of the private sector. Thus, the model abstracts from private debt and assumes that all debt is generated by the government. Yet, households end up paying the debt through taxes. In the model, this is captured by setting a tax on the households' endowment.

directly reduces public expenditures. On the other hand, private consumption declines due to higher taxes. In this scenario, debt service begins to drop. In spite of this, the output contraction makes the debt obligations' repayment relatively more costly. As a result, the probability of default increases and the interest rate spreads rise even more (Figure 2).

Figure 6 depicts a fall in output that would have hypothetically caused a default episode based on the model. If in the last period (corresponding to 2012) output had fallen by 6.5 percent then -based on the model- the decision to default would have been optimal (output actually dropped 2.8 percent in the Euro zone's periphery during 2012). In short, such a scenario was plausible.

Furthermore, it can be argued that the provision of official aid to highly indebted countries in the Euro zone may have prevented the aforementioned scenario. That is, in the absence of such aid, the output drop in the last years could have been larger, hence, making a default episode much more likely. Thus, official aid, by changing the relative prices of the decision to default, reduces the incentives to do so. A crucial question is whether the changes in relative prices have been sufficient to avoid such an episode indefinitely.

Within the model, official aid can be interpreted as an increase in the economy's endowment. Given the non-contingent debt's sheer size, official aid reduces the cost of its service in terms of the foregone consumption in the absence of such aid. Under these conditions, the benefit of defaulting (preventing a fall in current consumption) decreases relative to the cost of doing so (going to autarky). This reduces the incentives to default. In turn, a lower probability of default leads to lower interest rate spreads and, consequently, borrowing costs fall. The greater resources available to the economy and the lower interest rate spreads it faces, due to official aid programs, allow it to maintain higher aggregate spending and debt levels. Thus, financial aid may delay the adjustment process in highly indebted countries.<sup>25</sup>

In this setting, the effects of official aid programs are similar to those obtained with a higher value of  $\theta$  (output loss in autarky) or a lower value of  $\mu$  (probability of regaining access to markets after a default episode). As it was discussed in the previous section, all else equal, such changes in the value of these parameters increase the cost of going to autarky. As a result, the benefits of defaulting would fall with respect to the cost of doing so, which reduces the probability of default. In the same way, since staying in autarky in future periods corresponds to the cost of defaulting, a lower degree of

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<sup>25</sup>With respect to this point it should be noted that Mario Draghi, President of the European Central Bank, stated in 2012 that "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro".

impatience means that agents care more about this, which also increases the relative cost of defaulting. Likewise, this generates similar effects to those corresponding to the implementation of official aid programs.

In general, countries that find themselves in financial distress might reach a point where it is in their own interest to cease their debt payments. Their decisions would account for the reputational costs and the lost access to international markets. More formally, if a country reaches a point in which the level of utility it obtains under default is higher than the level of utility it gets from paying its debt's service, it will then be a rational economic decision to default. It is important to note, however, that given the recent fragile conditions worldwide, if a sovereign default does take place, a significant contagion effect might ensue, which would surely "endogenously" exacerbate any countries' costs associated with default. Although a contagion effect is not modeled here, it is something worth bearing in mind.

After analyzing the model's dynamics, we compare its results with the developments of the Euro zone periphery's economies during recent years. Figure 7a and 7b exhibit the interest rate spreads of the Euro zone's periphery and those generated by the model, while Figure 8a and 8b show the CDS for the same countries.<sup>26</sup> As these figures indicate, in the early years of the period in all the economies considered, the spreads and CDSs pointed to very low risk. This could be associated with the economic expansion observed until 2007 (Figure 1). As economic activity began to contract, interest rates and CDS spreads started to rise. This dynamic is also seen in the model. However, it should be noted that the spreads in the model are somewhat smaller than those observed in the data.<sup>27</sup>

Figure 9a and 9b show the domestic absorption paths in the model and of the countries in the Euro zone's periphery from 2005 to 2012. As depicted in this figure, in the early years (i.e., from 2005 to 2007), domestic absorption shows an upward trend in all countries considered. This reflects the increase in domestic spending, financed by borrowing in these economies during those years. What is more, these economies borrowed paying very low risk premiums in those years, so they resorted considerably to foreign borrowing to increase their spending (Figures 7b and 8b). It should be noted that the domestic absorption values in the model are similar to those observed for

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<sup>26</sup>A CDS is essentially an insurance against the risk of a sovereign bond default, and its price is positively and highly correlated with the interest rate spreads.

<sup>27</sup>This may be related to the linear relationship between the default probabilities and spreads in the model, due to the assumption of risk neutral lenders. In the literature on quantitative models of sovereign debt, interest rate spreads are exclusively due to the probability of default. In practice there are other factors, such as market risk, that influence spreads. Thus, this might be one of the reasons why these models are not able to replicate the magnitude of interest rate spreads observed in the data.

the aggregate absorption in the Euro zone's periphery (Figure 9a and 9b). In 2007, the absorption path shows a turning point in most of the countries considered in the sample (except for the case of Portugal, in which the adjustment process began in 2008). From that year on, it exhibits a downward trend associated with the need to adjust to a recessionary environment and higher borrowing costs. Similarly, the absorption also shows a negative trend in the model, associated similarly with the fall in economic activity and higher risk premiums.

Regarding the fiscal accounts, Figure 10a and 10b show the primary balance in the Euro zone's periphery and in the model. As can be seen, there are differences between the primary balance in the data and the one generated by the model. In the early years, most of the countries considered exhibited a moderate surplus. One possibility is that the macroeconomic imbalances in these countries were mainly attributed to the private sector. Recall that in the model, the government is the only agent with access to external financing. Therefore, the imbalances are reflected in a fiscal deficit.

Subsequently, in accordance with the data, the economic recession was associated with the deterioration in the primary balances in the Euro area, particularly in the periphery. This was mainly due to the implementation of expansionary fiscal policies in an attempt to support economic activity, and due to the adoption of rescue program packages for financial institutions (in particular, Ireland). It was only from 2010 onwards, that most of these countries began to adjust their primary balances. As for the primary balance's dynamics in the model, the fiscal consolidation process begins with the recession. This is because in the model, as explained, the GDP is exogenous. Consequently, the fiscal policy does not affect the product. Under these circumstances, there is essentially no room for expansionary fiscal policies to support economic activity in the model. Therefore, the economy begins to inexorably adjust its primary balance at the time the recession starts.

Finally, Figure 11a and 11b exhibit an approximate measurement of the debt service in the Euro zone's periphery and the corresponding variable in the model. Based on the model, its level is similar to the one observed in the data. However, the dynamics are somewhat different. In the early years, the debt service increases both in the data and in the model. However, the increase is more pronounced in the latter. Subsequently, the debt service begins to decrease in the model, which is associated with the adjustment process of the economy. At the same time, in the data there is a clear increment in the debt service which is related to the marked rise in risk premiums and, therefore, in the interest rates.<sup>28</sup> On this point, the fact that the model generates low interest rate

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<sup>28</sup>In the model, this is the case as the risk-free interest rate is constant.

spreads prevents it from replicating their dynamics more closely, in particular, in terms of the data magnitude. It may be argued that the implicit or explicit guarantee for the debt of monetary union' members may explain, in part, why interest rate spreads are higher in the data than in the model. In particular, since the model does not consider such a guarantee, the model economy has to inevitably endure an adjustment. This tends to be reflected in lower interest rate spreads.

## 4 Conclusion

With the purpose of rationalizing the dynamic of some macroeconomic variables in the Euro zone's periphery during the recent crisis, we have developed a dynamic stochastic quantitative model of sovereign debt with endogenous fiscal policy. In this model the government has the option to default on its debt obligations, thereby generating endogenous interest rate spreads. Our exercise illustrates the dynamics of an economy, from the formation of macroeconomic imbalances, to the adjustment process which qualitatively resembles the recent fiscal and debt situation for some countries in the Euro zone's periphery. It also illustrates the adjustment in domestic absorption that these countries have had to implement in order to deal with the global economic recession. In addition, the model shows the rise in risk premia that was observed in these economies' government bonds during the period considered.

One of our main exercises highlights what might have taken place -a sovereign default episode- had it not been for the response in terms of the official aid by the international community. However, this puts forward the question of whether the official aid has been up to this point sufficient to definitively discard a default episode.

All in all, we believe that the austerity vs. stimulus is a senseless debate mainly for three reasons. First, the peripheral economies reached unsustainably high levels of debt after presenting consumption patterns that were not sustainable. This has to be inexorably corrected and all talk about stimulus without proper financial markets functioning and the access to market finance seems out of place. Second, it does not entail what we believe is the elephant in the room, concretely whether an economy in the Euro zone's periphery might default and, accordingly, the role of the official aid. Third, such a debate is typically based on analyses which are perhaps not sufficiently rigorous. As Fergusson (2013, p. 41) has argued in the context of institutional economics: "Often these debts get discussed as if they themselves are the problem, and the result is a rather sterile argument between the proponents of 'austerity' and 'stimulus.'" Thus, we believe our paper sheds light on, first, an unequivocally pressing and plausible economic issue,

the adjustment process of highly indebted countries, and second, on the fundamental economic elements that determine if a country might have the incentives to default or not.

## **Acknowledgements**

We are indebted to Santiago García-Verdú for his invaluable comments and suggestions. The opinions in this paper correspond to the authors and do not necessarily reflect those of the Banco de México.



## A. Tables and Figures

		Value	Source
<b>Risk Aversion</b>	$\sigma$	2.00	Standard in the literature
<b>Discount Factor</b>	$\beta$	0.95	Standard in the literature, annual frequency
<b>Consumption Weight</b>	$\alpha$	0.76	Euro zone's periphery data
<b>Re-entry Probability</b>	$\mu$	0.10	Cuadra et. al. (2010)
<b>Output Loss in Autarky</b>	$\theta$	0.02	Cuadra at. al. (2010) and Arellano (2008)
<b>Endowment Process's Parameters</b>	$\rho_y$	0.89	Euro zone's periphery data
	$\sigma_y$	0.02	

Table 1: PARAMETER VALUES

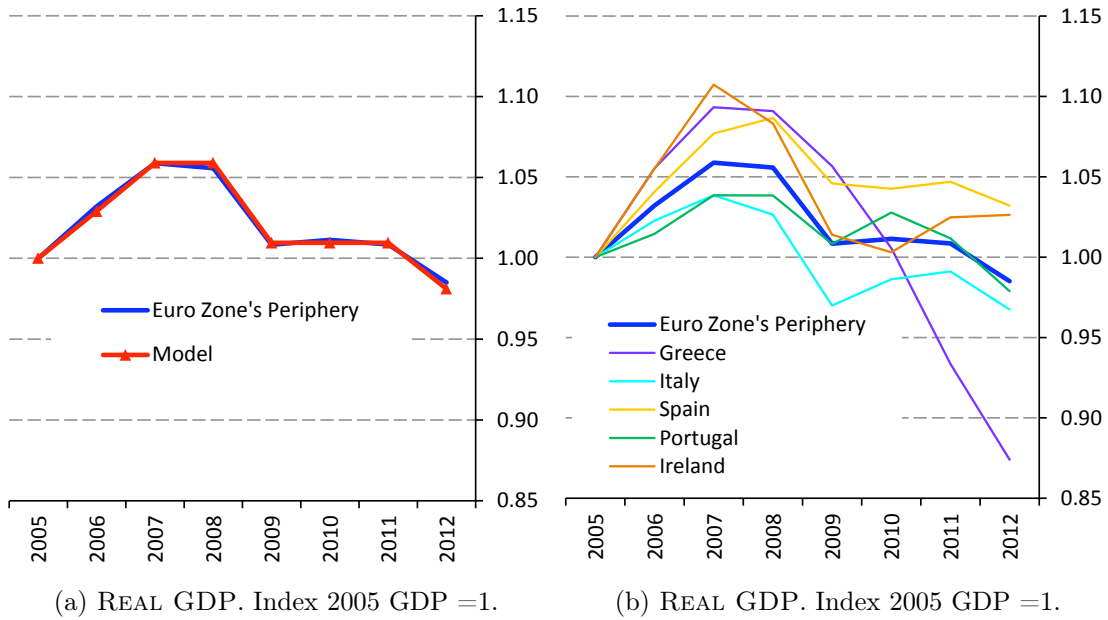


Figure 1: REAL GDP. Source: Haver Analytics.

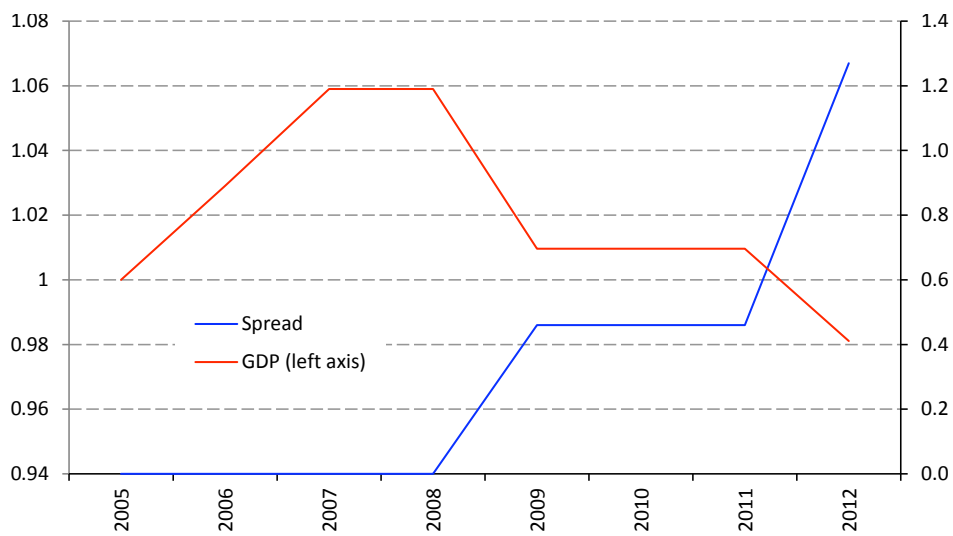


Figure 2: GDP vs. SPREAD. Index 2005 GDP =1 and %.

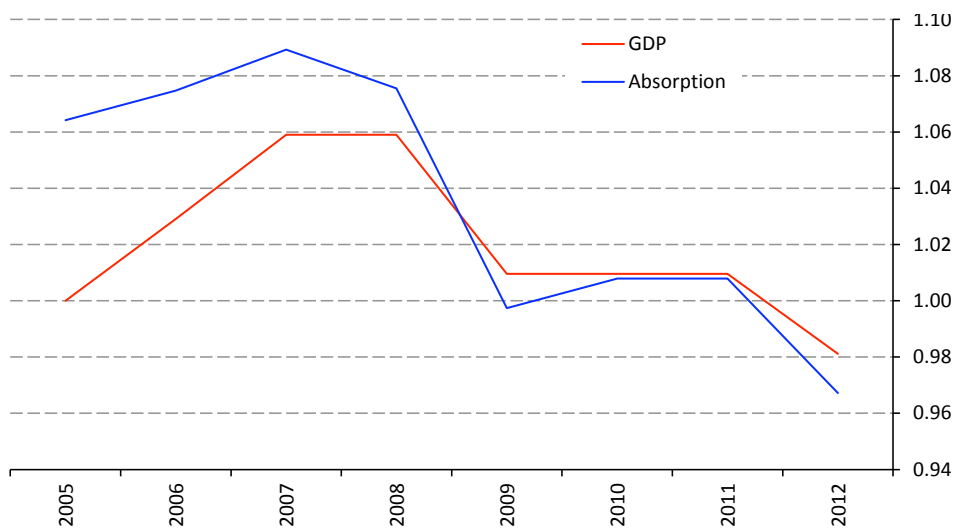


Figure 3: GDP vs. ABSORPTION (Index 2005 GDP = 1).

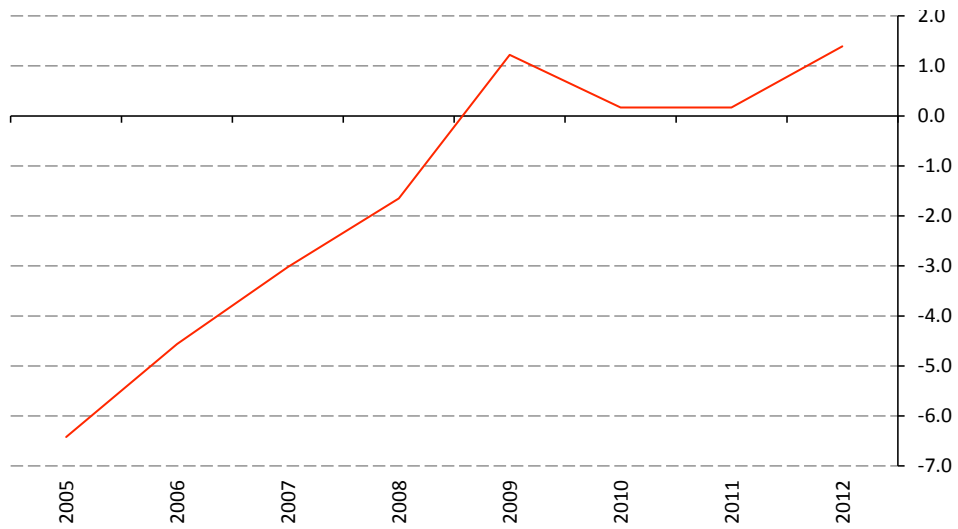


Figure 4: FISCAL BALANCE (% of GDP).

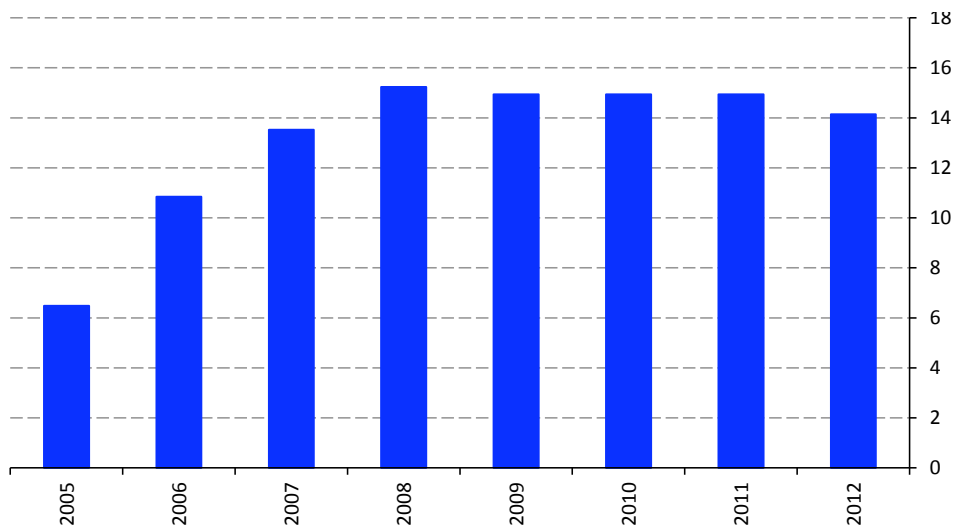


Figure 5: DEBT SERVICE TO GDP RATIO (% of GDP).

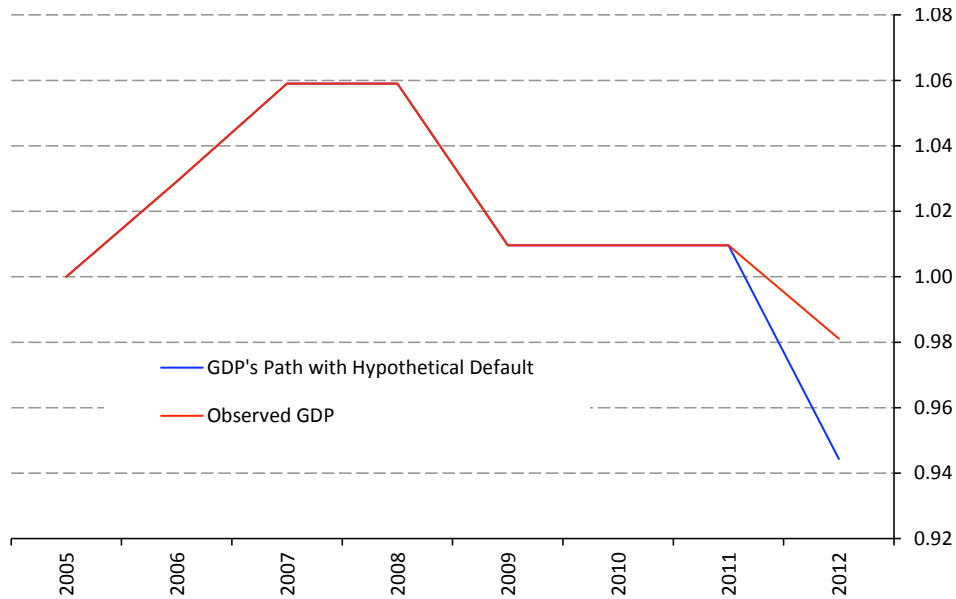
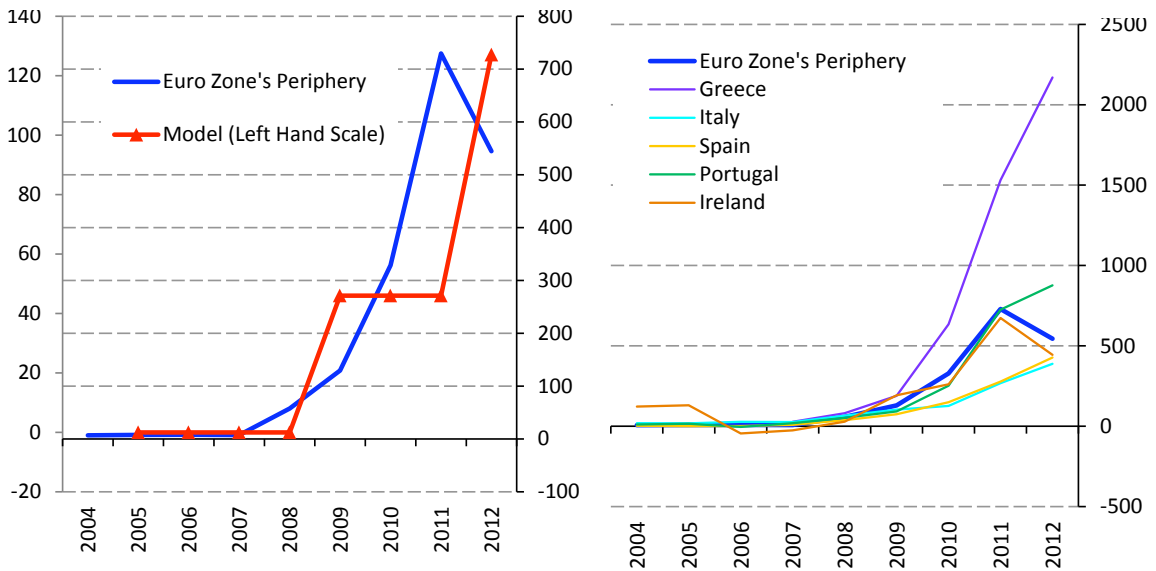


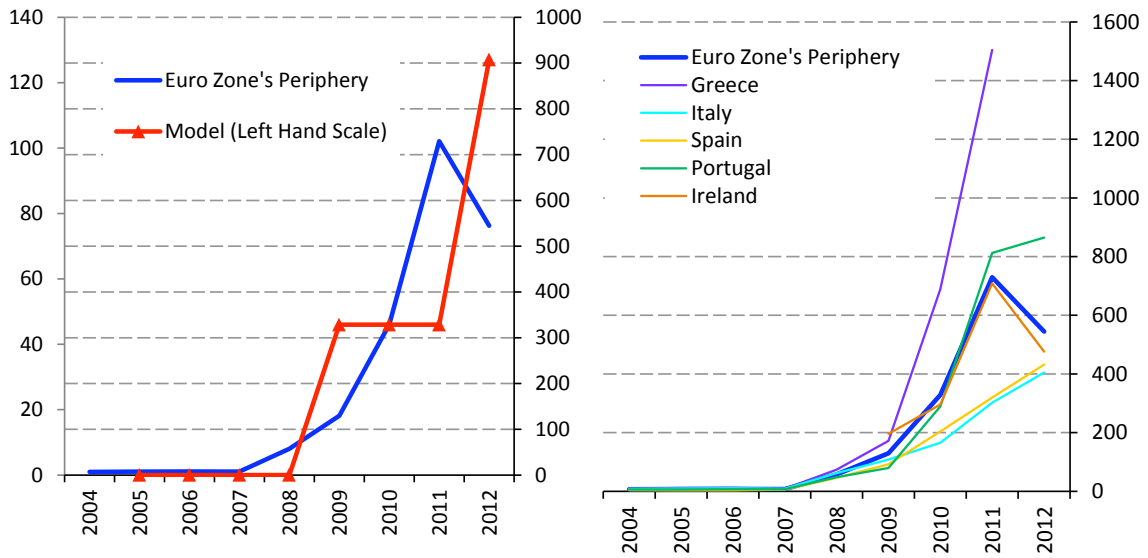
Figure 6: REAL GDP (Index 2005 GDP=1).



(a) INTEREST RATE SPREADS (Basis Points).

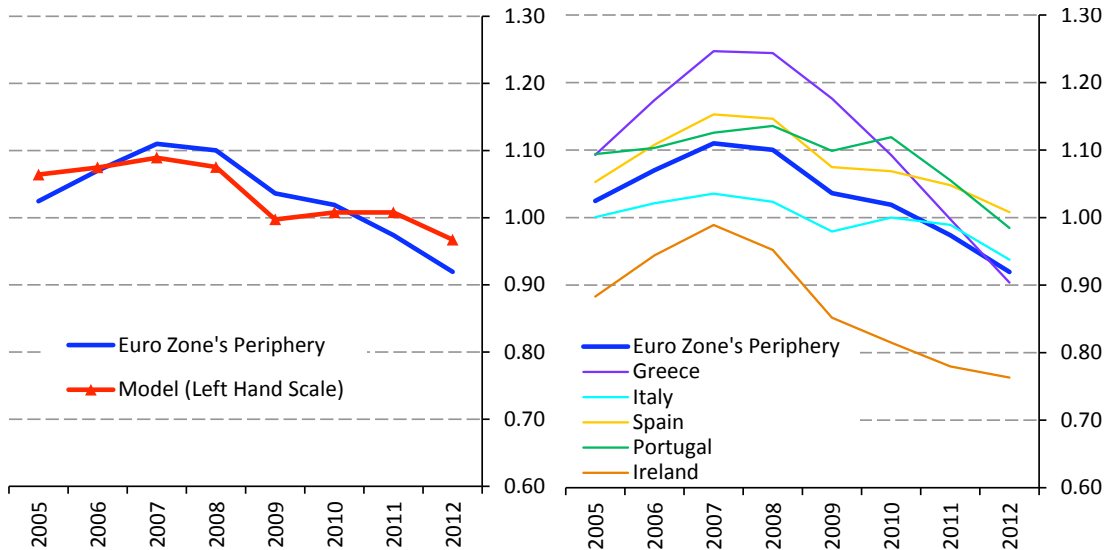
(b) INTEREST RATE SPREADS (Basis Points).

Figure 7: INTEREST RATE SPREADS IN THE EURO ZONE AND THE MODEL. Spreads are calculated as the difference between the interest rate of the 10-year bond of each country and the interest rate corresponding to the 10-year bond of Germany.



(a) CDS IN THE EURO ZONE AND SPREADS IN THE MODEL (Basis Points). (b) CDS IN THE EURO ZONE (Basis Points).

Figure 8: CDS. Source: Bloomberg.



(a) ABSORPTION (Fraction of 2005 GDP).

(b) ABSORPTION (Fraction of 2005 GDP).

Figure 9: ABSORPTION. Absorption is estimated as GDP - net exports. Source: Eurostat.

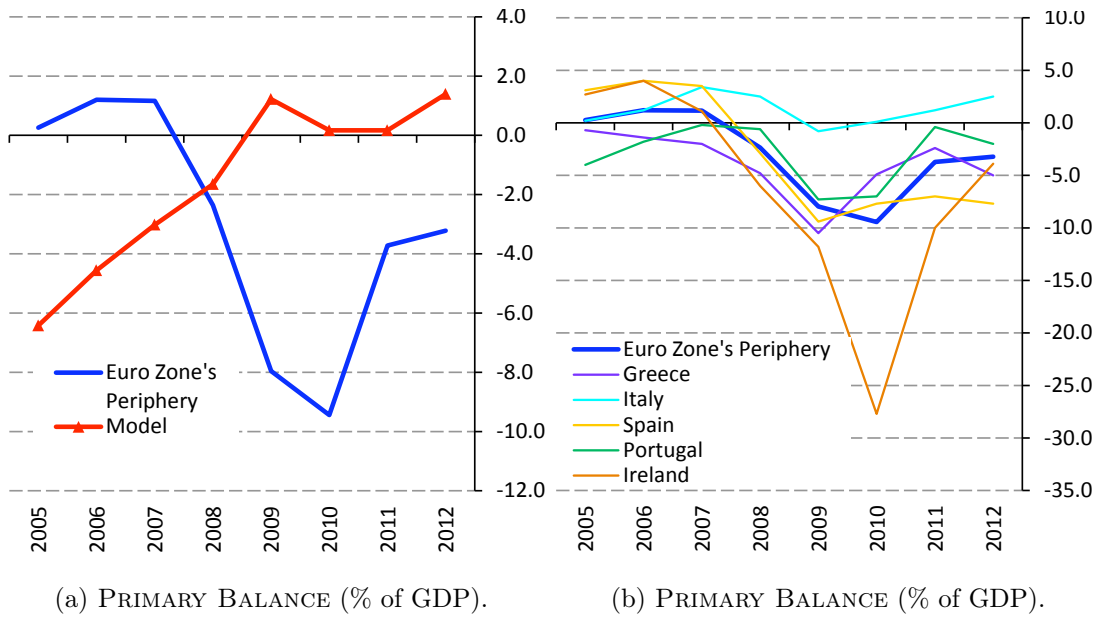


Figure 10: PRIMARY BALANCES. Source: Eurostat.

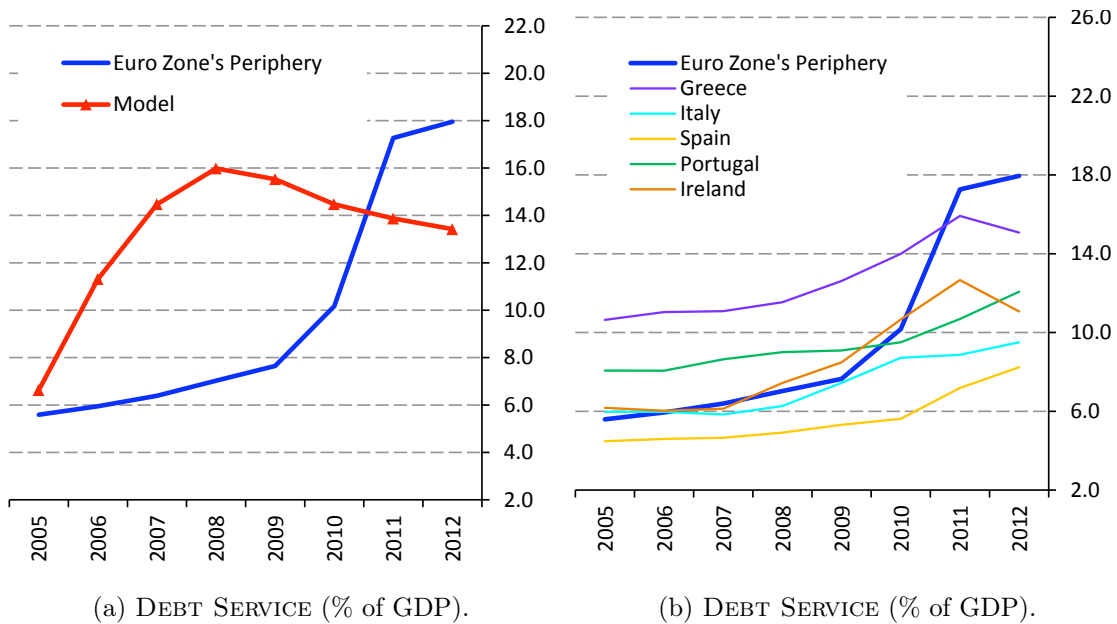


Figure 11: DEBT SERVICE. Debt service is equal to amortizations plus interest rate payments. Amortizations are approximated by multiplying Central Government Gross Debt times the 10 year bond interest rate of each country. Source: Eurostat.

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