Social Security and Public Debt: Empirical evidence for the Brazilian economy

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Abstract

This paper presents a contribution to the empirical literature concerning the relationship between social security and public debt in emerging economies. In particular, several economic and social shocks, as income inequality, were considered in the analysis. Based on Brazilian data from 2004 to 2010, and taking into account the effects of shocks on variables which are essential to the public debt and the social security deficit, two sets of GMM models were considered. Furthermore, with the objective of testing the results, a GMM system model was built. The findings confirmed that the social security deficit significantly contributes to an increase in the public debt. Regarding the effects on social security, it was observed that an increase in the level of formality in the economy reduces the deficit. In contrast, a reduction in income inequality, real increase in the minimum wage, and increase in health benefits imply an increase in the social security deficit. Therefore, these variables play a crucial role in the search for an efficient social security management system and cannot be overlooked in ensuring fiscal sustainability.

Key words: public debt; social security; economic and social variables; Brazilian economy.

JEL classification: E62, H55, H63.

Resumo

Este trabalho apresenta uma contribuição para a literatura empírica relativa à relação entre a previdência social e a dívida pública nas economias emergentes. Em particular, vários choques econômicos e sociais, como a desigualdade de renda, foram considerados na análise. Com base em dados do Brasil para o período de 2004-2010, e levando em conta os efeitos dos choques sobre as variáveis que são essenciais para a dívida pública e o déficit da previdência social, dois conjuntos de modelos GMM foram considerados. Além disso, com o objetivo de testar os resultados, um modelo de sistema GMM foi construído. Os resultados confirmaram que o déficit da previdência social contribui de forma significativa para o aumento da dívida pública. Com relação aos efeitos sobre a previdência social, observou-se que um aumento no nível de formalidade da economia reduz o déficit. Em contraste, uma redução na desigualdade de renda, um aumento real do salário mínimo e um aumento na concessão de auxílios-doença implica um aumento do déficit da previdência social. Portanto, estas variáveis desempenham um papel crucial na busca por um sistema de gerenciamento eficiente da previdência social e não pode ser negligenciado para garantir a sustentabilidade fiscal.

Palavras chaves: dívida pública; previdência social; variáveis econômicas e sociais; Economia Brasileira.

Classificação JEL: E62, H55, H63.

Área 5: Economia do Setor Público

1. Introduction

Since 1999, Brazilian economic policy has been based on the tripod of inflation targeting, primary surplus and flexible exchange rates. In particular, the introduction of primary surplus targets has guided fiscal policy and worked as a safeguard for the inflation targeting system. In other words, the patterns of primary surplus are essential to explain the evolution of fiscal and monetary policies. Therefore, it is crucial to identify and analyze which factors can erode this framework sustained by the primary surplus.

Given the importance of the difference between revenues and expenditures of the General Social Security for the primary result of the federal government, the long-term financial viability of the social security system has been one of the main topics of fiscal policy discussed in Brazil in recent decades. The Brazilian pension system runs at a deficit and may become fiscally unsustainable in the future. As a result, the need for funding of the social security system represents a source of fiscal imbalance that could set public debt onto an unsustainable path.

In recent years, the federal government has adopted a series of social measures to increase the average standard of living of the population. Those measures include, for example: encouraging the formalization of the Brazilian labor market, promoting a real increase in the minimum wage and reducing income inequality in the labor market. The implementation of this social policy has had a direct impact on the labor market and, consequently, has implications for the financing of the social security system.

This paper seeks to make a contribution to the literature on public debt and social security by considering a variety of economic and social shocks. It is important to highlight that this study presents, in an innovative way, issues that have been neglected by the literature, but which are fundamental for the management of economic policy. As examples of this, we can cite the analysis of the effects of income inequality on the social security deficit and the impact of the social security deficit on the evolution of the Brazilian public debt.

In short, the main objective of this paper is to present empirical evidence of the relation between social security and public debt, and of the effects of social policies, adopted by the federal government, on the social security deficit. To this end, several models were estimated using the generalized method of moments (GMM). In addition to estimates of individual models, an estimation of systems of simultaneous equations was also performed.

The remainder of this paper is organized as follows. The next section provides a brief summary of the literature on public debt management. Section 3 presents a short review of the literature on social security. Section 4 shows empirical evidence, through an econometric analysis, of the relationship between the social security system and public debt and of the relationship between the social policies of the federal government and the social security system. The last section presents the conclusions.

2. Public debt: main features in the literature

It is possible to identify three perspectives regarding public debt management in the literature. The first, examines the problem of dynamic inconsistency of fiscal policies, and is represented by the models of Giavazzi and Pagano (1990) and Calvo and Guidotti (1990). The second, which considers the model of Barro (2003), seeks to determine the optimal structure for public debt, considering a smoothing out of tax revenues in an environment in which public spending is exogenous. The last view, represented by the models of Missale, Giavazzi and Benigno (2002) and Giavazzi and Missale (2004), seeks stabilization of the public debt/GDP ratio. In general, all these models conclude that an increase in the average maturity and the partial indexation of public debt are optimal strategies for public debt management.

The Giavazzi and Pagano model (1990) focuses on the analysis of the roll-over of public debt. Consequently, the amount, average maturity and amortization structure of public debt are important elements in this study. The model evaluates whether the choice of a particular maturity structure can mitigate the risks of a crisis of confidence. Four basic assumptions are adopted: (i) an open economy with a fixed exchange rate regime, (ii) free capital mobility, (iii) imperfect public information about the preferences of the government or the central bank's ability to maintain the fixed exchange rate, and (iv) a high stock of public debt needing to be rolled over in all periods. The conclusion is that the central bank's ability to withstand a crisis of confidence depends on its success in managing the public debt. The concentration of debt maturities in a few periods is detrimental, because in times of crisis of confidence

the government is obliged to pay higher risk premiums. Therefore, a good strategy would be to increase the average maturity of government securities, as well as to distribute their maturity dates evenly over time.

Calvo and Guidotti's model (1990) considers several environments for optimal indexing structure and maturity of public debt. Additionally, the restriction corresponds to a social loss function which includes taxation and inflation rate. The four basic assumptions of the model are: (i) the stock of debt is a predetermined variable, (ii) government spending is the source of uncertainty in the model, (iii) strict purchasing power parity is considered, and (iv) the current government can curb the next government with respect to the use of instruments of economic policy. The result suggests that the indexation of public debt is desirable in order to avoid the use of an inflation tax. However, full indexation is not recommended because it can generate an increase in taxation as a source of financing for the public sector. Therefore, the optimal strategy would be public debt with long-term maturity, which is partially indexed.

Barro (2003) found that smoothing taxation stimulates the government to issue government bonds, the payments of which are contingent on government spending and taxation. Hence, when public expenditure is equal in all periods, public debt should be structured as indexed perpetuities (consoles). One advantage of adopting this structure is the ability to isolate the budget constraints from unexpected changes in the securities of different maturities indexed to the price index.

Missale, Giavazzi and Benigno (2002) made an empirical analysis that considered the maturity of government securities suitable for fiscal stabilization. It was assumed that the stabilization of public debt would be achieved through the attainment of fiscal surplus targets. The analysis included 72 cases of fiscal stabilization, between 1975 and 1998, in the Organization for Economic Cooperation and Development (OECD) countries. The authors concluded that the optimal strategy is to increase the average maturity of public debt.

Based on the analysis of the stabilization of the Brazilian public debt/GDP ratio, Giavazzi and Missale (2004) recommended that the government find sources of financing that offer low costs and low volatility of returns. Thus, the choice of public debt instruments involves a trade-off between risk and expected cost of debt servicing. Under this view, the risk is minimized when an instrument has low return and when it is also capable of offering protection against fluctuations in the primary surplus and in the public debt/GDP ratio. The findings denoted that the use of pre-fixed government bonds and price-indexed securities was the best strategy for public debt management.

2.1. Change in the Brazilian public debt management

As a result of a payment balance crisis trigged by successive speculative currency attacks on several emerging economies in the second half of the 1990s, the Brazilian government adopted a flexible exchange rate system in January of 1999. Due to the exchange rate overshooting and the fact that approximately 25% of the public debt had been indexed to the exchange rate at that time, the Brazilian National Treasury adopted a new strategy for managing the country's public debt. The main objectives were the improvement of the composition of public debt and the lengthening of the maturities of government securities. One important change introduced was the establishment of primary surplus targets. As a result, the economic policy was changed and the cornerstone of the Brazilian economy became the tripod of inflation targeting, primary surplus, and floating exchange rates.

Despite the changes introduced in the political economy, which were briefly successful, the beginning of the 2000s was marked by successive shocks to the Brazilian economy that led to the failure to meet the inflation targets (see figure 1).[1] This environment created a macroeconomic instability that implied a reduction in the maturities of government securities. This scenario changed only after 2005 due to the success in achieving the targets for primary surplus and the consequent fall in the public debt/GDP ratio.

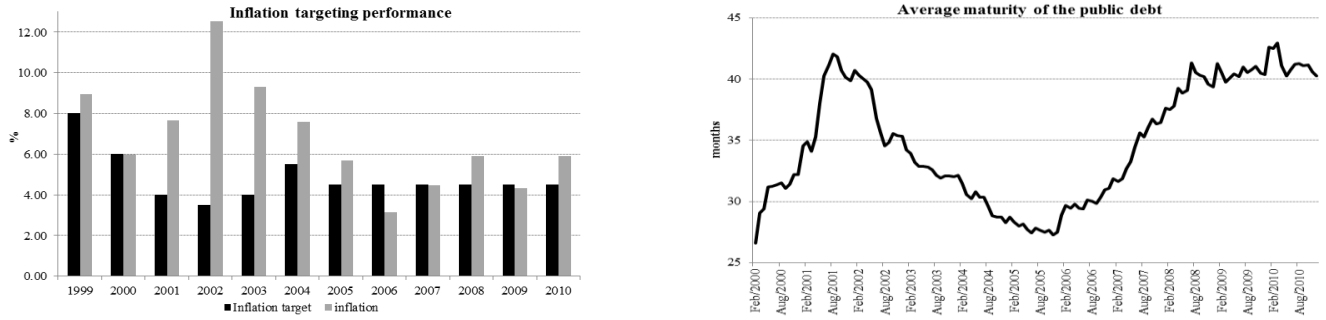
After 2002 the National Treasury adopted an assets and liabilities management strategy that strengthened the substitution of interest rate indexed securities (Selic-indexed bonds) and exchange

[1] As examples of shocks on the Brazilian economy: instability in the American economy (2001), crisis in Argentina (2001), and political shock caused by first Lula's government.

indexed securities by fixed rate securities and inflation indexed securities.[2]The result of this strategy was a considerable increase in the proportion of fixed rate and inflation-indexed government securities (see figure 2). Moreover, the proportion of exchange indexed securities became negligible. Nevertheless, although the proportion of Selic-indexed bonds was decreased, it remains very high (approximately 35%).

Figure 1

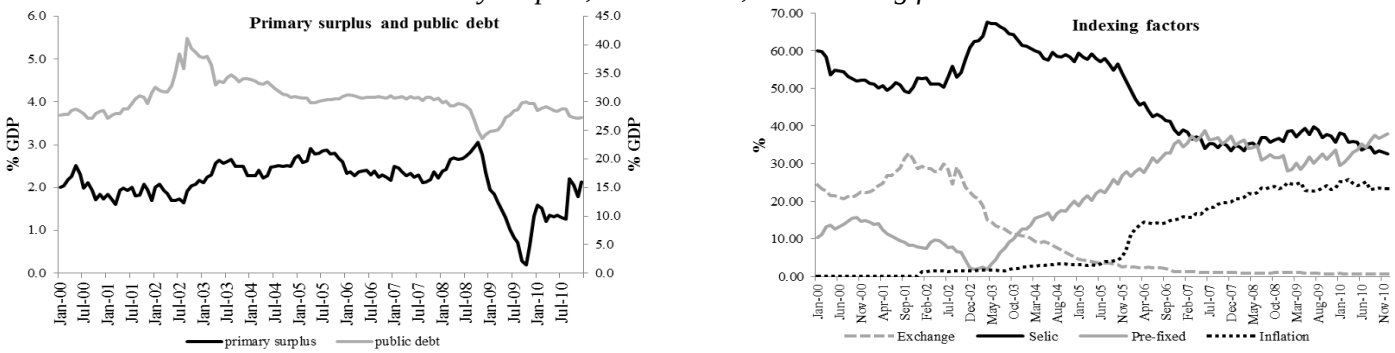
Inflation targeting[a] and public debt maturity



Note: Source of data – Central Bank of Brazil and Brazilian National Treasury.[a] Tolerance intervals for the inflation target is ±2.5% from 2003 to 2005, and ±2% after this period.

Figure 2

Primary surplus, Public Debt, and Indexing factors



Source of data: Central Bank of Brazil.

An important implication of the Brazilian public debt framework is that the impact caused by an increase in the interest rate (Selic) to reduce inflationary pressure implies pressure to increase the public debt/GDP ratio. It is important to highlight that the combination of inflation targeting, a large portion of the public debt being indexed to the interest rate, and the short average maturity of the public debt, creates interdependence between fiscal and monetary policies. In particular, the generation of primary surplus has an important role in this system because it contributes to fiscal balance which, in turn, is one of the preconditions to the success of inflation targeting.[3]

The generation of primary surplus depends on the successful implementation of fiscal policy to achieve its goals. A successful fiscal policy is one which is able to rationalize public expenditure to produce primary surpluses. A significant source of government expenditures is the social security system expenses. An imbalanced social security system, as is the case in Brazil, represents a permanent drain of public resources. Therefore, the primary result of the social security system is an important variable for analysis of the management of Brazilian public debt.

3. Social security literature: main features

In the middle of the last century, the change in the demographic profile of the developed countries stimulated the literature on social security. The increase in life expectancy and the reduction in the birth rates implied an increase in the elderly/young ratio (United Nations, 2007). Furthermore, since in most countries the social security system in effect is the pay-as-you-go kind, the consequences on long-term financial viability are an increase in the payment of social security benefits and a decreased funding base for the system.[4]

[2] Regarding this strategy, see Back and Musgrave (1941), Lucas and Stokey (1983), Bohn (1988), and Calvo (1988).
[3] Fiscal balance eliminates the possibility of the "unpleasant monetarist arithmetic" taking place (see Sargent and Wallace, 1981).
[4] For an analysis of social security systems, see Mulligan and Sala-i-Martin (2004a).

Samuelson (1958) was one of the first authors to study the problem of social security in a general equilibrium context and he demonstrated that the social security pay-as-you-go system corrects the fundamental market incompleteness (for example, the impossibility of writing contracts with the unborn). Moreover, in the overlapping generation model of Samuelson (1958), the market results were not efficient, so that the transfer of resources from the young generation to the elderly generation, through a social security pay-as-you-go system, could increase the welfare of a society.

Mulligan and Sala-i-Martin (2004b), based on Browning's model (1975), considered three generations of the same size: young people, adults, and old people. These three groups were required to choose whether or not to adopt the social security pay-as-you-go system. The proposal was as follows: in each period, young people and adults would pay a contribution of *T*, and the old people would receive a pension of *2T*. The conclusion was that adults and old people support this system because their net gain is *T* and *2T*, respectively. In turn, young people are indifferent, because their net gain is zero.

Diamond (1977) argues that the choice of a pay-as-you-go system is required due to the shortsighted action of individuals when they are young. Most individuals are not forward-looking enough in their youth and, therefore, do not save enough to maintain the same standard of living in old age. According to Diamond (1977), this may be because young people lack the necessary information to judge their needs in old age, or are unable to make effective decisions about long-term issues, or, simply, fail to place sufficient importance on their future necessities.

Cooley and Soares (1999) argue that a pay-as-you-go system can also be chosen and maintained in a sustainable way in societies where economic agents are rational, forward-looking, and self-interested. Under this view, pay-as-you-go systems cause dynamic inconsistency and therefore rational agents do not believe in their sustainability. As a way to avoid this problem, mechanisms of reputation and credibility among the generations should be used. The social security system can be thought as a dynamic game that involves repeated iterations between the generations. If generation *t* expects that its act to stop the financing of pensions of generation *t-1* will be followed by the future generation *t+1*, a reputational trade-off is introduced in generation *t*. Generation *t* finds that the cost of stopping the financing of the system can be very high because, for its own generation, the system may collapse at *t+1* (when generation *t* would benefit from the pension system). Therefore, to ensure the system at *t+1*, generation *t* disclaims possible short-term benefits that it would earn with the discontinuation of financing of the system for generation *t-1*.

As identified by Feldstein (1974), the pay-as-you-go systems can stimulate workers to take early retirement. In addition, Feldstein (1974, 1996), Kotlikoff (1979), and Seidman (1986), show empirical evidence that the choice of pay-as-you-go systems reduces significantly the long-term pattern of capital-intensive accumulation and standard of living in those countries.

In contrast to the above results, recent empirical studies have shown that social policies play a positive influence on economic growth. Zhang and Zhang (2004), through an empirical analysis of cross-section data for 64 countries during the period 1960 to 2000, concluded that pay-as-you-go systems tend to stimulate per capita economic growth by reducing birth rate and increasing investment in human capital without affecting the saving rate.

These beneficial results of the action of social policies were also found by Justino (2007) through an analysis of panel data for 14 Indian states over the period 1973 to 1999. The findings indicate that the strengthening of social security contributes to reducing poverty and increasing economic growth. In a similar vein, Alan, Sultana and Butt (2010) studied the long-term relationship between social spending and economic growth in 10 developing Asian countries. The main conclusion was that spending on social policies results in faster economic growth.

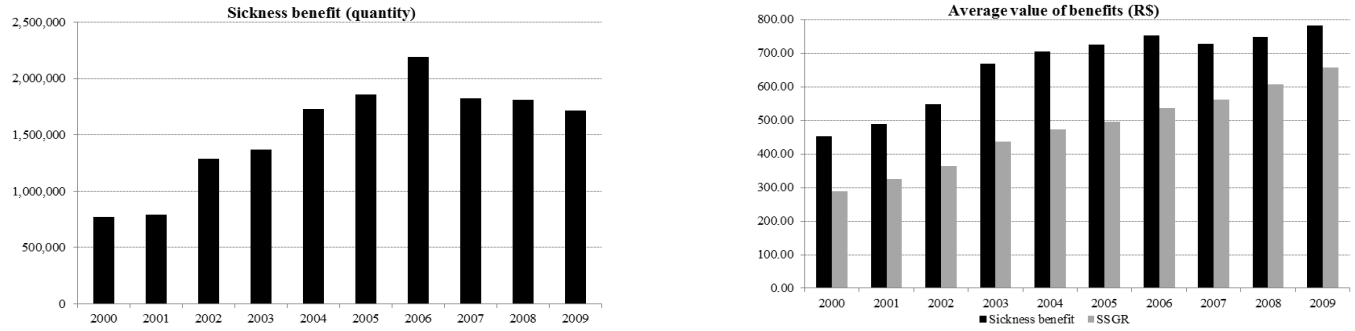
3.1. Social security in Brazil: main variables

Based on the literature on social security, this section identifies the key variables for the analysis of the Brazilian case. The first variable to consider is the sickness benefit. Figure 3 shows that there was a significant increase in the granting of sickness benefits to social security beneficiaries over the past decade. In addition, it was observed that the average value of the sickness benefit under the Social Security General Regime (SSGR) was always greater than the average of all other benefits paid by the

SSGR. This can be explained by the deferral of retirements due to the application of a social security factor and stricter criteria for granting retirements. Other factors that contributed to the increase in the sickness benefits were: adverse economic conditions at the beginning of the decade, which raised the unemployment rate and, thus, sickness benefits were seen as a complement to household income; and the facility to get this benefit.

Figure 3

Sickness benefits and other SSGR benefits

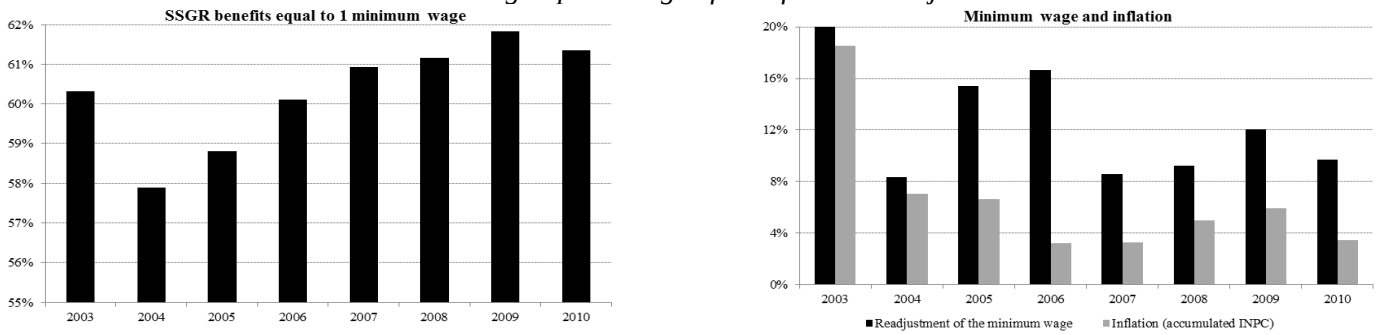


Source of data: National Social Security Institute.

Another variable that is important in analyzing the behavior of the Brazilian social security system is the minimum wage. Figure 4 demonstrates that approximately 60% of SSGR benefits are equal to one minimum wage. This percentage shows the importance that the minimum wage policy has on the social security budget. Furthermore, one cannot neglect the systematic readjustment of the minimum wage, at rates higher than the inflation rate.

Figure 4

Minimum wage - percentage of benefits and readjustments

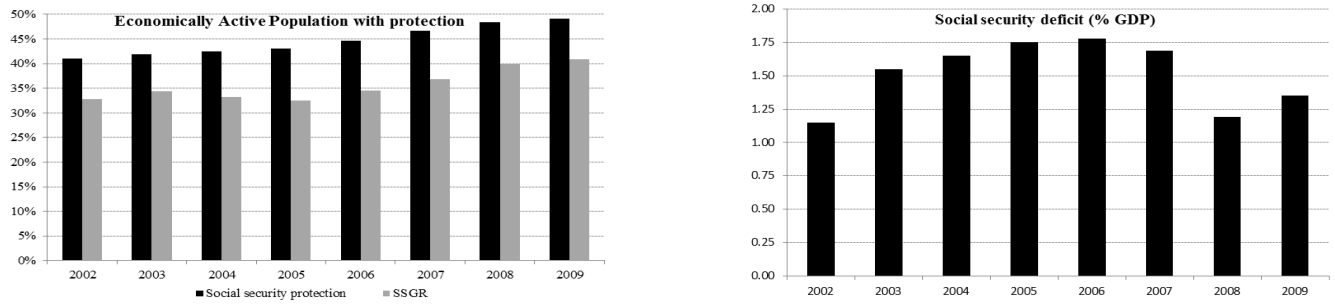


Note: Source of data - National Social Security Institute and Central Bank of Brazil. INPC is the National Consumer Price Index.

One aspect that should be considered in the study of social security in Brazil is the formality of the labor market, which directly affects the social security budget. The social security contribution on payrolls is one of the SSGR's main sources of revenue. The higher the level of formality in the economy, the greater is the number of working-age workers who are contributing to the social security system. Consequently, there is an increase in the social security revenues. Figure 5 shows that social security protection has been increasing in recent years and that the social security deficit has begun to decrease, due to an increase in the number of contributors to the SSGR.

Figure 5

Social Security – protection and deficit

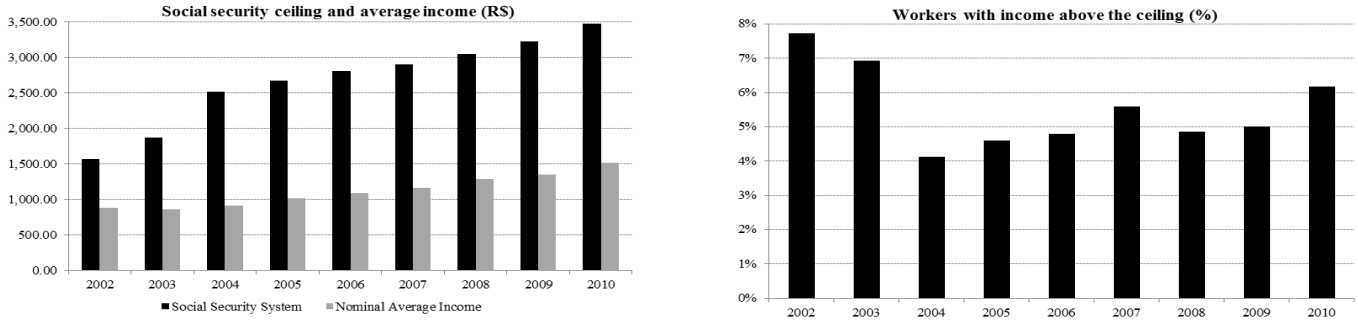


Source of data - National Social Security Institute, Central Bank of Brazil, and Brazilian Institute of Geography and Statistics.

It is important to highlight that the implications of income inequality for the Brazilian social security deficit should not be overlooked. Income inequality is particularly relevant because contributions from workers' wages are main sources of revenue for the social security system. In general, it is expected that a decrease in income inequality would imply an increase in the poorest households' income, which would foster conditions for admission into the social security system. Figure 6 shows that average nominal income is lower than the social security ceiling. Moreover, the percentage of workers with income above the ceiling corresponds to, on average, only 5% of the population. This observation is important because it shows that, although undesirable, an increase in income inequality could reduce the social security deficit. As a small portion of the population have income above the ceiling, an increase in the inequality may imply an increase in the social security revenue.

Figure 6

Income and social security ceiling



Source of data - Brazilian Institute of Geography and Statistics.

4. Empirical analysis

This section shows empirical evidence of the relation between the social security deficit and federal public debt in the Brazilian economy. Moreover, it demonstrates how the federal government's social policies impact the social security deficit.

Regarding the federal public debt, in addition to the effect of the social security deficit, we also considered shocks transmitted by relevant variables to explain the behavior of the public debt (e.g., average maturity, the primary surplus, interest rates, and exchange rates). Since social programs may have an important role in the analysis concerning the social security deficit, the following variables were considered in this study: the amount of sickness benefits paid by the National Social Security Institute (INSS), the financial impact of minimum wage on the social security costs, the level of formality in the Brazilian economy, and inequality indexes.

One difficulty in estimating the effects of economic shocks on the social security system and public debt is the endogeneity problem, or identification problem. It is hard to distinguish, for example, if, after an economic shock, an increase in the social security deficit is due to a decrease in the level of formality in the economy (due to, for example, the slowdown in economic activity) or due to an increase in the amount of benefits (for example, as a result of times of economic crisis). Likewise, it is hard to identify whether an increase in the public debt, caused by an economic shock, is a consequence of: reduction in the primary surplus, reduction in the average maturity of public debt, an increase in public debt service, or an increase in the social security deficit.

One way to avoid the endogeneity and identification problems in the estimations is to use the generalized method of moments - GMM (Hall, 2005). One advantage of the GMM in relation to, for example, the ordinary least squares (OLS) is that it presents robust estimators even in the presence of serial autocorrelation, heteroskedasticity or non-linearity, which is typical in macroeconomic time series models (Hansen, 1982).

In order to assess the relevance of the management of the social security system for the federal public debt, and the influence of federal social policies on the social security management system, thus bypassing potential endogeneity problems, two sets of GMM models were estimated: (i) the first set examines the effects of changes in the social security deficit on the federal public debt, and (ii) the second set examines the effects of changes in the social variables on the social security deficit.

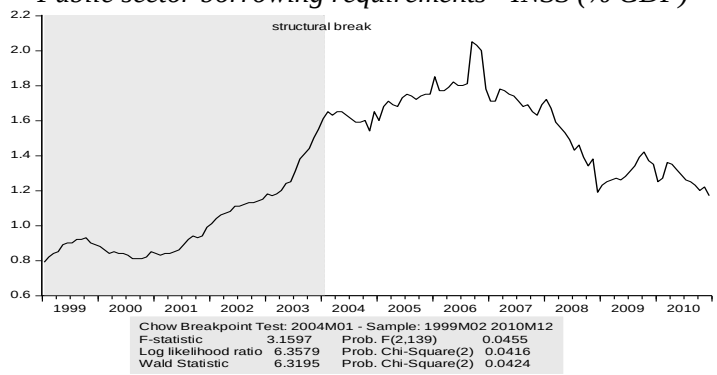
It is important to note that the choice of the independent variables in the models was based on the literature about the subject, and the use of lags followed the general to the specific method in a search for the most parsimonious model. In addition, to provide robustness to the analysis and to observe the validity of the models, a GMM system model was built.

4.1. Data

A key variable for this study is the social security deficit. The evolution of this variable allows one to conjecture how social security management can contribute to the sustainability of the public debt. As shown by Figure 7, the trajectory for the public sector borrowing requirement - INSS (series extracted from the Central Bank of Brazil (CBB) site) presents a structural break at January 2004. Hence, as a way of eliminating possible problems in the estimations due to the instability of parameters (the "Lucas critique"), the period considered in the empirical analysis extends from January 2004 to December 2010.

Figure 7

Public sector borrowing requirements - INSS (% GDP)



All data are in logs with monthly frequency (84 observations). The data is divided into two groups:

(i) variables with effect on the federal public debt

- *DEBT* – net public debt (% GDP) - total - federal government and CBB (available from CBB). In the period analyzed in this paper, there is a decreasing trend in the public debt/GDP ratio. An explanation for this observation is a consequence of the change in the management of public debt that was introduced in 1999.
- *INSS* - public sector borrowing requirement - INSS - primary result - %GDP - flows accumulated in 12 months (available from CBB). In general, it is expected that an increase in the INSS would cause an increase in the public debt and thus, a positive relation between these variables exists.
- *MTDEBT*– public debt average maturity – in months (available from Brazilian National Treasury – CODIV). The public debt average maturity increased approximately 40% between January 2006 (29 months) and December 2010 (40 months). As an increase in the average maturity can reduce the public debt service costs (see, Giavazzi and Pagano, 1990), it is expected that there exists a negative relation between this variable and the public debt.
- *SURPLUS* - public sector borrowing requirement - primary result - %GDP - flows accumulated in 12 months (available from CBB).[5] In general, with exception of the period after the subprime crisis, the primary surplus has shown a relative stability (between 2.4% and 2.8%). It is important to highlight that the systematic generation of primary surplus reduces the public debt default risk which, in turn, decreases the cost of the public debt. Therefore, it was expected that the empirical evidence would reveal a negative relation between primary surplus and public debt.

Based on the composition of the federal public debt, the main indexing factors over the period were also considered in this analysis:[6]

- *SELIC* - interest rate - Selic accumulated in the month in annual terms (available from CBB). Selic is the main indexing factor of the federal public debt and the main instrument of monetary policy. Due to the high relevance of this variable on the public debt composition, a positive relation between these variables

[5] Positive values correspond to the primary surplus in the series.

[6] It is important to note that although in the recent period the price-indexed securities have grown considerably, they are not considered in this study due to their lack of significance for the public debt.

is expected.
- *EXCH* - exchange rate - free - United States dollar (purchase) - period average (available from CBB). Even though the proportion of exchange rate indexed bonds has been decreasing substantially, it was one of the main indexing factors over the period. It is expected that currency valuations (decreases in *EXCH*) contribute to a decrease in the public debt.
(ii) variables with effect on the *INSS*
- *AUX* – sickness benefit paid by National Social Security Institute. It is a result of the ratio between concessions of sickness benefit and all benefits paid by the SSGR (both series available from Social Statistical Bulletin - flows accumulated in 12 months). The trajectory of this variable reveals a significant increase until the first quarter of 2007 (representing almost 56% of all benefits). From the second quarter of 2007, there was a decreasing trend, but the relevance is still very significant, being approximately 45% of the total. In short, it is expected that there exists a positive relation of this variable with the *INSS*.
- *WMIN* - financial impact of minimum wage on social security expenditures (% GDP). This series is the result of the ratio between the total of benefits equal to one minimum wage paid by the SSGR (available from Social Statistical Bulletin - flows accumulated in 12 months) and the Gross Domestic Product (GDP – flows accumulated in 12 months – available from CBB). It is important to highlight that the real increase in the minimum wage has a significant impact on the social security budget and thus it is expected that an increase in this variable implies an increase in the *INSS*.

In addition to the aforementioned variables, the consequence of the level of formality in the Brazilian economy on the *INSS* was also considered. It is expected that a greater level of formality reduces the *INSS* due to the increase in the government's tax revenue. Hence, the following variables are considered in this study:
- *EMPF* – formal employment – seasonally adjusted index (available from CBB). In the period analyzed in this paper, there is a strong increasing trend over the period. A possible justification for this observation is the favorable macroeconomic environment and the policies adopted by the federal government for increasing the level of formality.
- *CT_PO* – Brazilian labor Market – formality rate. It is a result of the ratio between the employed people (registered) and occupied people (total) – both series are available from CBB. In this period, the trajectory shows a strong increasing trend.

As in the case of a greater level of formality, a lower income inequality may also be able to reduce the *INSS*. Hence, the following indices are considered:
- *GINI* – Gini coefficient – measures the inequality of a distribution, a value of 0 expressing total equality and a value of 1 maximal inequality. This coefficient is the result of information available from Monthly Employment Survey - Brazilian Institute of Geography and Statistics (IBGE). In this period, this variable shows a decreasing trend over the period. This observation matters because a major source of revenue for social security is the levy on the workers' remuneration. Therefore, a decrease in inequality can indicate an increase in workers' remuneration, which, in turn, could cause an increase in the social security revenues.
- *THEIL* – Theil index is a statistic used to measure economic inequality. This index is calculated based on information available from Monthly Employment Survey – IBGE. As the Gini coefficient, a value of 0 expresses total equality and a value of 1 maximal inequality.

4.2. Empirical evidence

To preliminarily evaluate the relation between the aforementioned variables with *DEBT* and *INSS*, figure 8 shows scatter plot diagrams with correlations. With the exception of the correlation between *DEBT* and *SURPLUS*, all correlations are in accordance with the theoretical view for the analysis regarding public debt.[7] In a similar manner, except for *WMIN*, the correlations for *INSS* are also in agreement with the theoretical perspective.[8]

[7] A possible reason for the positive correlation between *DEBT* and *SURPLUS* is that an increase in the primary surplus does not have an immediate effect on the public debt.
[8] It is true that while the financial impact of the minimum wage on the social security expenditures had a strong growth over the period, the *INSS* had a decreasing trend. However, the decrease in *INSS* is a result of other economic and social factors that offset the positive effects on the *INSS* of an increase in the WMIN.

4.2.1. Economic shocks on public debt

With the objective of estimating the effect of economic shocks, especially from the *INSS*, on public debt, two specifications (GMM models) were considered:

(1) $DEBT_t = \gamma_0 + \gamma_1 DEBT_{t-1} + \gamma_2 INSS_{t-1} + \gamma_3 MTDEBT_{t-6} + \gamma_4 SURPLUS_{t-1} + \gamma_5 SELIC_{t-6} + \mu_t^1$; e

(2) $DEBT_t = \gamma_6 + \gamma_7 DEBT_{t-1} + \gamma_8 INSS_{t-1} + \gamma_9 MTDEBT_{t-6} + \gamma_{10} SURPLUS_{t-1} + \gamma_{11} EXCH_{t-2} + \mu_t^2$,

where, $\mu_t \sim N(0,\sigma^2)$.

A first step in time series analysis is to check the presence of unit root. Hence, the augmented Dickey-Fuller test (ADF) and the Phillips-Perron (PP) test were performed (see table A.1 - appendix). The results indicate that the use of the series in first difference in the estimation of equations (1) and (2) would be adequate, however it is possible that a linear combination of series is stationary even in the case of non-stationary series.[9] Hence, cointegration tests were performed on both specifications. The selection of lags for the tests was made based on Akaike and Hannan-Quinn criteria in a vector-autoregressive model. For both specifications, the number of lags is 2 (see table A.2 – appendix). Furthermore, the inclusion of intercept and trend is based on the Pantula principle (see Harris, 1995). The cointegration tests proposed by Johansen (1991, LR test statistic), based on the significance of the estimated eigenvalues, indicate that there is a relation of long-term equilibrium among the series for both specifications and thus the equations can be estimated with the series in levels without the problem of spuriousness in the result[10].

The GMM method minimizes a function that represents the moment conditions being carefully weighed. If the moment conditions are correct, their average is zero. In addition, it is necessary that the instruments used in GMM are lagged one or more periods, as a prerequisite to predict the contemporary variables that were not available at time *t*. As pointed out by Wooldridge (2001, p. 95), "to obtain a more efficient estimator than two-stage least squares (or ordinary least squares), one must have overriding restrictions." In order to test the validity of moment conditions and test over-identifying restrictions in each estimated model, a standard J-test was performed (see Hansen, 1982; and Cragg, 1983). As a way to help predict the contemporary variables which are not available at time *t*, we used instrumental variables uncorrelated with the regression residuals.

Table 1 presents the GMM estimation results for equations (1) and (2). In order to consider the effect of the subprime crisis on public debt, a dummy variable was included in the estimation of both models. Both estimates showed an adjusted R^2 greater than 0.90 and J-statistics that validate the instruments used.

The estimated results reveal that the *INSS* has significant influence on public debt. Both models indicate that an increase in the *INSS* causes an increase in the public debt/GDP ratio (INSS coefficient is positive coefficient and significant). This result is important because it shows that a social security management system, capable of reducing the *INSS*, would contribute to public debt sustainability.

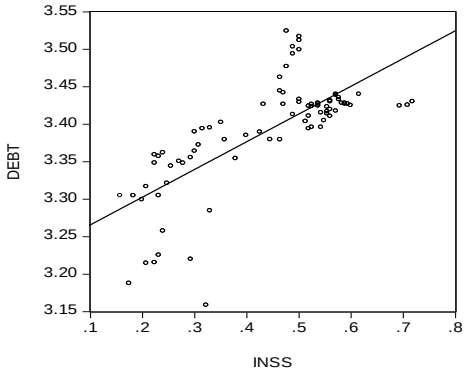
The coefficients regarding lagged federal debt are positive and have statistical significance. This result indicates that economic shocks on public debt are persistent. Furthermore, the estimates show that the coefficients of other variables have statistical significance and signs according to the theoretical arguments. In other words, increases in the SELIC and EXCH lead to increases in public debt. On the other hand, an increase in primary surplus contributes to a decrease in public debt. The only result that was different from what would be expected, according to the theoretical perspective, is the coefficient of the *MTDEBT* (positive sign). However, this observation is consistent with the idea that in economies where credibility is not sufficiently developed the strategy to extend the public debt may imply an increase in *SELIC* and thus in public debt service. Regarding the coefficients of the dummies, it shows that they are negative and statistically significant. A possible explanation for this result is due to the sharp fall in the *SELIC* to neutralize the recessive effects of the crisis which, in turn, reduced the public debt service cost.

[9] Tests ADF and PP are in disagreement regarding the presence of unit root in *SELIC*. As a consequence, the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test was performed and the result is that *SELIC* is I(1) – see table A.1 - appendix.

[10] The test for Number of Cointegrating Relations by Model and Johansen's Cointegration Test are available from the authors on request.

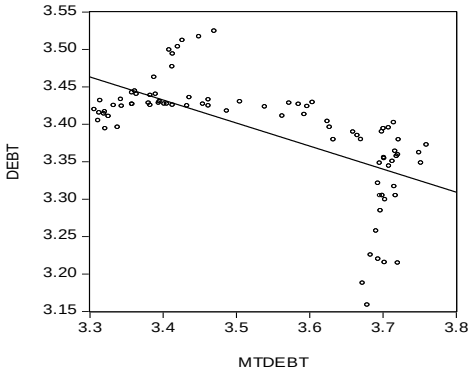
Figure 8: *Scatter plots diagrams*

DEBT vs. INSS



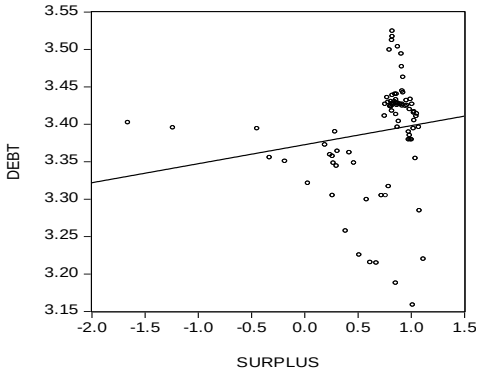
Correl.: 0.7288

DEBT vs. MTDEBT



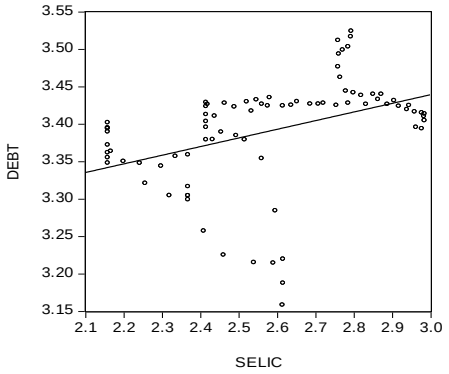
Correl.: -0.6555

DEBT vs. SURPLUS



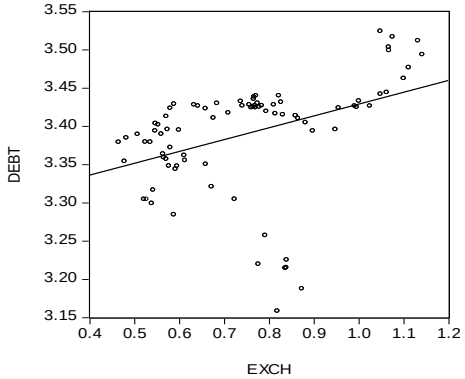
Correl.: 0.1612

DEBT vs. SELIC



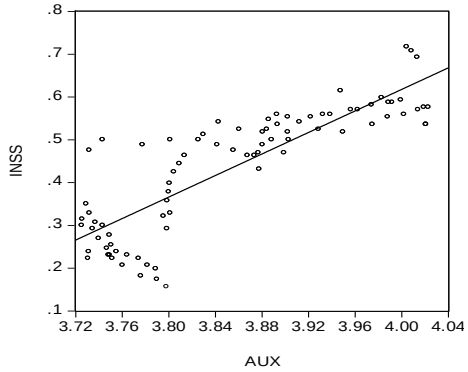
Correl.: 0.3976

DEBT vs. EXCH



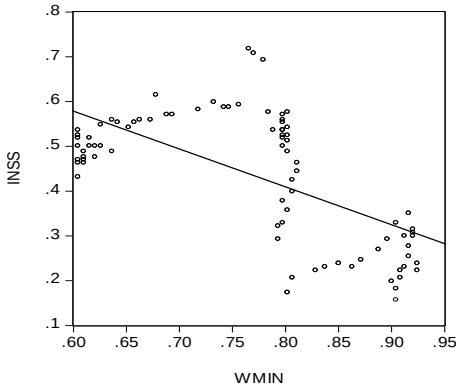
Correl.: 0.3896

INSS vs. AUX



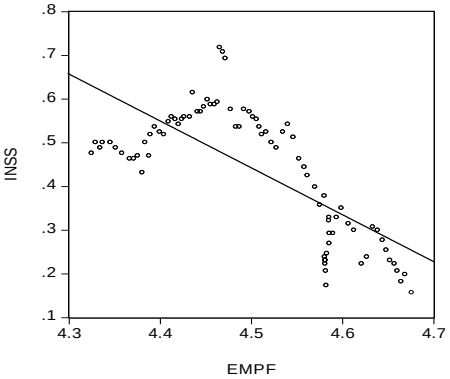
Correl.: 0.8389

INSS vs. WMIN



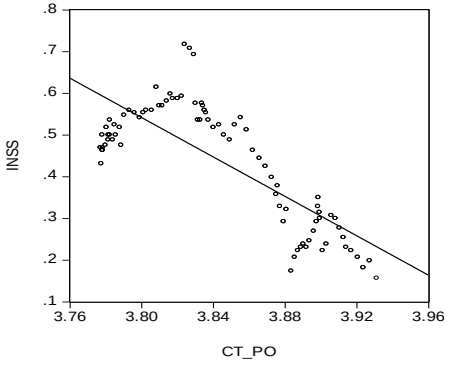
Correl.: -0.6338

INSS vs. EMPF



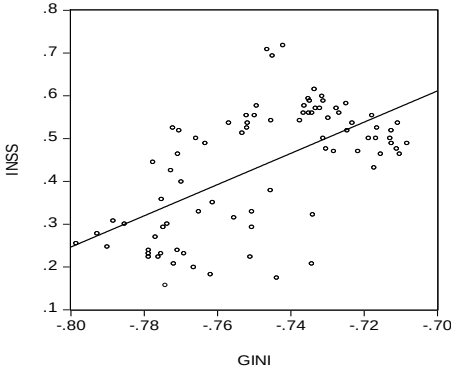
Correl.: -0.7276

INSS vs. CT_PO



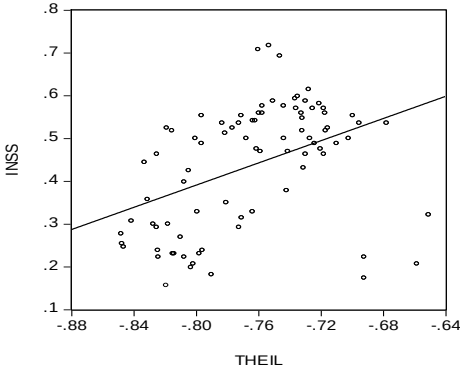
Correl.: -0.7855

INSS vs. GINI



Correl.: 0.6012

INSS vs. THEIL



Correl.: 0.4192

Table 1

GMM estimation – DEBT

Explanatory variables	Specification Eq(1)	Specification Eq(2)
Constant	-0.058	1.494***
	(0.384)	(0.401)
	[-0.151]	[3.725]
$DEBT_{t-1}$	0.670***	0.526***
	(0.095)	(0.102)
	[7.030]	[5.138]
$INSS_{t-1}$	0.115***	0.154***
	(0.039)	(0.050)
	[2.938]	[3.091]
$MTDEBT_{t-6}$	0.226**	0.010
	(0.091)	(0.046)
	[2.481]	[0.211]
$SURPLUS_{t-1}$	-0.025**	-0.037***
	(0.012)	(0.013)
	[-2.154]	[-2.882]
$SELIC_{t-6}$	0.136**	
	(0.045)	
	[3.021]	
$EXCH_{t-2}$		0.053***
		(0.016)
		[3.359]
Dummy	-0.059**	-0.043**
	(0.026)	(0.019)
	[-2.253]	[-2.289]
R^2	0.913	0.905
Adj. R^2	0.906	0.897
J-statistic	4.313	6.100
	p= 0.634	p = 0.412

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, (*) denotes 0.1. Standard errors in parentheses and t-statistics in brackets.

From estimated coefficients in equations (1) and (2) (see table 1) the effects on federal public debt at period *t* are calculated. The shocks of one standard deviation in the explanatory variables at period *t-1* are shown in table 2.[11] The shock of one standard deviation on $INSS_{t-1}$ causes a positive change on the federal public debt at period *t* which corresponds to 2.23 basis points (b.p.).

Table 2

Economic shocks on DEBT

Variable	Stand. dev.	Coefficient	Eq(N.)	Effect	Confid. interv.
INSS	0.144	0.154	2	2.23 b.p.	1.05 — 3.41
MTDEBT	0.156	0.226	1	3.53 b.p.	1.21 — 5.97
SURPLUS	0.464	-0.037	2	-1.74 b.p.	-2.72 — -0.74
SELIC	0.252	0.136	1	3.44 b.p.	1.54 — 5.32
EXCH	0.184	0.054	2	0.99 b.p.	0.50 — 1.46

Note: Confidence interval is calculated by Monte Carlo simulation with 10.000 repetitions.

The immediate impacts transmitted by the *MTDEBT* and *SELIC* are relatively close (about 3.5 b.p.). The impact of lower magnitude is the *EXCH* (less than 1 b.p.). Although the shock transmitted by the *SURPLUS* is greater (in absolute terms) only to the *EXCH*, it contributes to a negative growth of public debt of approximately 1.74 b.p. Moreover, confidence intervals are calculated for the estimates (see table 2). If the weighting matrix used in GMM estimations is efficient, the estimators are asymptotically normal. Given the normality of the coefficients and their estimated standard errors, it is possible to calculate the probability of what the effects of economic shocks on the federal public debt would be in a given confidence interval.

4.2.2. Economic shocks on the *INSS*

Using the same methodology adopted in the previous section and the variables listed in section 4.1, this section shows empirical evidence of economic shocks, in particular those caused by social policies, on the *INSS*. Hence, two specifications were considered:

(3) $INSS_t = \alpha_0 + \alpha_1 INSS_{t-1} + \alpha_2 AUX_{t-1} + \alpha_3 WMIN_{t-1} + \alpha_4 EMPF_{t-1} + \vartheta_t^1$, and

[11] The coefficients consider the highest statistical significance among the two models estimated.

(4) $INSS_t = \alpha_5 + \alpha_6 INSS_{t-1} + \alpha_7 AUX_{t-1} + \alpha_8 WMIN_{t-1} + \alpha_9 CT\_PO_{t-1} + \vartheta_t^2$,

where, $\vartheta_t \sim N(0,\sigma^2)$.

The unit root tests (ADF and PP) indicate that the series in both models are I(1) (see table A.1 – appendix). As a consequence, there exists the possibility of a long-term relationship among the series when they are cointegrated and thus the models may use the series in levels. The tests denote that the series in both models are cointegrated[12].

Besides the aforementioned variables in the models, two social variables (*GINI* and *THEIL*) were included for observing the impact on the *INSS*. A justification for the inclusion of these variables is that an important source of revenue for the National Social Security Institute is the contribution on workers' wages. Therefore, a change in the distribution of wealth can have significant effects on the social security deficit. Furthermore, to take into account the effect of the subprime crisis, a dummy variable with a value of "1" for the period between August 2008 and September 2009 and value of "0" for the other periods was introduced in the models. Therefore, the models to be estimated are:

(5) $INSS_t = \beta_0 + \beta_1 INSS_{t-1} + \beta_2 AUX_{t-1} + \beta_3 WMIN_{t-1} + \beta_4 EMPF_{t-1} + \beta_5 GINI_{t-1} + \omega_t^1$,

(6) $INSS_t = \beta_6 + \beta_7 INSS_{t-1} + \beta_8 AUX_{t-1} + \beta_9 WMIN_{t-1} + \beta_{10} CT\_PO_{t-1} + \beta_{11} GINI_{t-1} + \omega_t^2$,

(7) $INSS_t = \beta_{12} + \beta_{13} INSS_{t-1} + \beta_{14} AUX_{t-1} + \beta_{15} WMIN_{t-1} + \beta_{16} EMPF_{t-1} + \beta_{17} THEIL_{t-1} + \omega_t^3$,

(8) $INSS_t = \beta_{18} + \beta_{19} INSS_{t-1} + \beta_{20} AUX_{t-1} + \beta_{21} WMIN_{t-1} + \beta_{22} CT\_PO_{t-1} + \beta_{23} THEIL_{t-1} + \omega_t^4$,

where, $\omega \sim N(0,\sigma^2)$.

Table 3 presents GMM estimations based on equations (5) to (8). In general, the coefficients are in line with the theoretical arguments. All specifications show that the coefficient of the lagged *INSS* has statistical significance and positive sign. Therefore, the inertial effect on the social security deficit cannot be neglected. The same behavior is observed for the coefficients of *AUX* and *WMIN*.

Table 3

GMM estimation – INSS

Explanatory variables	Specification Eq(5)	Specification Eq(6)	Specification Eq(7)	Specification Eq(8)
Constant	0.130	5.206***	0.388	4.158**
	(0.572)	-1.562	(0.640)	-1.598
	[0.227]	[3.332]	[0.606]	[2.601]
$INSS_{t-1}$	0.804***	0.763***	0.782***	0.764***
	(0.091)	(0.076)	(0.102)	(0.084)
	[8.808]	[10.013]	[7.644]	[9.044]
AUX_{t-1}	0.279***	0.175**	0.331***	0.242**
	(0.096)	(0.083)	(0.112)	(0.100)
	[2.895]	[2.095]	[2.944]	[2.422]
$WMIN_{t-1}$	0.024	0.330**	0.109	0.284*
	(0.113)	(0.154)	(0.130)	(0.164)
	[0.209]	[2.145]	[0.836]	[1.730]
$EMPF_{t-1}$	-0.514***		-0.479***	
	(0.155)		(0.152)	
	[-3.324]		[-3.155]	
CT_PO_{t-1}		-1.816***		-1.477***
		(0.466)		(0.448)
		[-3.894]		[-3.297]
$GINI_{t-1}$	-1.567***	-1.265***		
	(0.435)	(0.421)		
	[-3.599]	[-3.001]		
$THEIL_{t-1}$			-0.653***	-0.603***
			(0.222)	(0.200)
			[-2.941]	[-3.009]
dummy	0.017	0.030**	0.029	0.041**
	(0.016)	(0.012)	(0.017)	(0.016)
	[1.122]	[2.382]	[1.629]	[2.580]
R^2	0.937	0.941	0.935	0.938
Adj. R^2	0.931	0.937	0.930	0.933
J-statistic	5.540	8.052	7.132	8.262
	p= 0.699	p = 0.529	p = 0.522	p = 0.508

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, (*) denotes 0.1. Standard errors in parentheses and t-statistics in brackets.

[12] The number of lags was defined based on Schwarz and Hannan-Quinn criteria in a VAR (see table A.2 -appendix). The test for Number of Cointegrating Relations by Model and Johansen's Cointegration Test are available from the authors on request.

In other words, both an increase in the amount of sickness benefits and an increase in the minimum wage imply a greater social security deficit. In contrast, the coefficients of the variables that measure the level of formality in the economy (*EMPF* and *CT_PO*) show that a decrease in the informality level contributes to a decrease in the *INSS*.

The coefficients related to the variables *GINI* and *THEIL* indicate that an increase in social inequality implies a decrease in the *INSS*. A possible reason for our finding is that the concentration of income in Brazil is near the limit of the social security ceiling. As the main source of social security revenue is the income of workers, an increase in the inequality means an increase in workers with higher incomes, but because most of them are below the ceiling, the result is an increase in the social security revenues.

Finally, it was observed that the coefficients of the dummies are positive, which indicates that economic crises tend to increase the *INSS*. The explanation for this phenomenon is that crises lead to an economic slowdown and, with increasing unemployment, the social security revenues tend to fall. In addition, the increase in the unemployment rates increases social security costs in two ways: (i) workers who possess the requirements for retirement, but have chosen to remain in the labor market, tend to retire in times of crisis, and (ii) the increase in the unemployment rates tends to increase the demand for social security benefits, such as unemployment insurance.

Taking as reference the estimated coefficients in the different specifications (see table 3), the effects (one standard deviation) on the *INSS* at period *t* caused by shocks transmitted by explanatory variables at period *t-1* are obtained (see table 4).[13] The shocks transmitted by *AUX* and *WMIN* cause a positive change in *INSS* of 3.18 and 3.57 b.p., respectively. In contrast, the results show that the social policies that aim to increase the level of formality in the Brazilian economy imply beneficial effects on the social security budget. The shock on *EMPF* causes a negative change in the *INSS* of 5.08 b.p. Likewise, the shock transmitted by *CT_PO* causes a negative change in the *INSS* of approximately 8.71 b.p. The shocks transmitted by *GINI* and *THEIL* also cause a negative change in the *INSS* (3.72 and 2.81 b.p., respectively).

Table 4

Economic shocks on INSS

Variable	Stand. dev.	Coefficient	Eq(N.)	Effect	Confid. interv.
AUX	0.096	0.331	7	3.18 b.p.	1.39 — 5.02
WMIN	0.108	0.330	6	3.57 b.p.	0.92 — 6.26
EMPF	0.099	-0.514	5	-5.08 b.p.	-7.59 — -2.64
CT_PO	0.048	-1.817	6	-8.71 b.p.	-12.45 — -5.02
GINI	0.024	-1.567	5	-3.72 b.p.	-5.44 — -2.01
THEIL	0.047	-0.603	8	-2.81 b.p.	-4.34 — -1.29

Note: Confidence interval was calculated by Monte Carlo simulation with 10.000 repetitions.

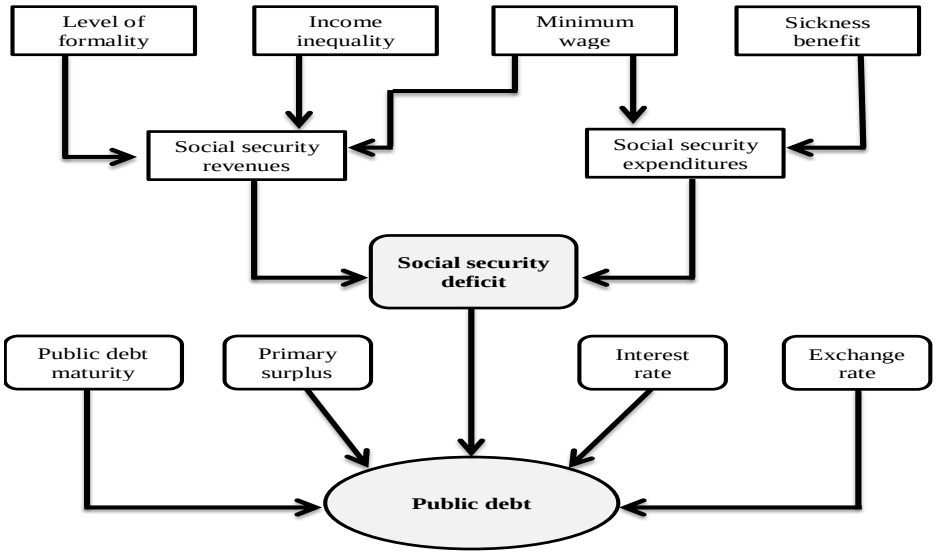
It is important to highlight that if the weighting matrix used in GMM estimation is efficient, the estimators are asymptotically normal. Due to the normality of the coefficients and the estimated standard errors (see table 3), the likelihood of the effects of economic shocks on the *INSS* being within a confidence interval was calculated (see table 4).

4.2.3. Equation system: *DEBT* and *INSS*

Based on *DEBT* and *INSS* estimations, figure 9 illustrates the interaction between these variables in the Brazilian economy. In general, one can say that in addition to the direct effects of the variables related to macroeconomic policy (interest and exchange rates, primary surplus, and average maturity of public debt), the effects of the variables that explain the social security revenues and expenditures cannot be neglected. Therefore, policies that reduce the social security deficit, as for example, the increase in the level of formality in the economy, can contribute to greater public debt sustainability.

[13] As in the previous section, the coefficients consider the highest statistical significance among the models estimated.

Figure 9: *Interaction between INSS and DEBT*



One way to test the validity of the models and the coefficients presented in the previous sections is to estimate them through a system of equations (see Hallsten, 1999). For the treatment of the potential endogeneity problem (in particular, the relation between public debt and the social security deficit) the use of GMM systems is suitable for non-biased estimates. Hence, in order to provide robustness to the empirical evidence presented in previous sections, the following systems were considered (see tables 5.A and 5.B):

- *System 1*

$$\begin{cases} DEBT_t = \delta_0 + \delta_1 DEBT_{t-1} + \delta_2 INSS_{t-1} + \delta_3 MTDEBT_{t-6} + \delta_4 SURPLUS_{t-1} + \delta_5 SELIC_{t-6} + \varepsilon_t^1 \\ INSS_t = \theta_0 + \theta_1 INSS_{t-1} + \theta_2 AUX_{t-1} + \theta_3 WMIN_{t-1} + \theta_4 EMPF_{t-1} + \theta_5 GINI_{t-1} + \varphi_t^1 \end{cases}$$

- *System 2*

$$\begin{cases} DEBT_t = \delta_6 + \delta_7 DEBT_{t-1} + \delta_8 INSS_{t-1} + \delta_9 MTDEBT_{t-6} + \delta_{10} SURPLUS_{t-1} + \delta_{11} SELIC_{t-6} + \varepsilon_t^2 \\ INSS_t = \theta_6 + \theta_7 INSS_{t-1} + \theta_8 AUX_{t-1} + \theta_9 WMIN_{t-1} + \theta_{10} CT\_PO_{t-1} + \theta_{11} GINI_{t-1} + \varphi_t^2 \end{cases}$$

- *System 3*

$$\begin{cases} DEBT_t = \delta_{12} + \delta_{13} DEBT_{t-1} + \delta_{14} INSS_{t-1} + \delta_{15} MTDEBT_{t-6} + \delta_{16} SURPLUS_{t-1} + \delta_{17} SELIC_{t-6} + \varepsilon_t^3 \\ INSS_t = \theta_{12} + \theta_{13} INSS_{t-1} + \theta_{14} AUX_{t-1} + \theta_{15} WMIN_{t-1} + \theta_{16} EMPF_{t-1} + \theta_{17} THEIL_{t-1} + \varphi_t^3 \end{cases}$$

- *System 4*

$$\begin{cases} DEBT_t = \delta_{18} + \delta_{19} DEBT_{t-1} + \delta_{20} INSS_{t-1} + \delta_{21} MTDEBT_{t-6} + \delta_{22} SURPLUS_{t-1} + \delta_{23} SELIC_{t-6} + \varepsilon_t^4 \\ INSS_t = \theta_{18} + \theta_{19} INSS_{t-1} + \theta_{20} AUX_{t-1} + \theta_{21} WMIN_{t-1} + \theta_{22} CT\_PO_{t-1} + \theta_{23} THEIL_{t-1} + \varphi_t^4 \end{cases}$$

- *System 5*

$$\begin{cases} DEBT_t = \delta_{24} + \delta_{25} DEBT_{t-1} + \delta_{26} INSS_{t-1} + \delta_{27} MTDEBT_{t-6} + \delta_{28} SURPLUS_{t-1} + \delta_{29} SELIC_{t-6} + \varepsilon_t^5 \\ INSS_t = \theta_{24} + \theta_{25} INSS_{t-1} + \theta_{26} AUX_{t-1} + \theta_{27} WMIN_{t-1} + \theta_{28} EMPF_{t-1} + \theta_{29} GINI_{t-1} + \varphi_t^5 \end{cases}$$

- *System 6*

$$\begin{cases} DEBT_t = \delta_{30} + \delta_{31} DEBT_{t-1} + \delta_{32} INSS_{t-1} + \delta_{33} MTDEBT_{t-6} + \delta_{34} SURPLUS_{t-1} + \delta_{35} EXCH_{t-2} + \varepsilon_t^6 \\ INSS_t = \theta_{30} + \theta_{31} INSS_{t-1} + \theta_{32} AUX_{t-1} + \theta_{33} WMIN_{t-1} + \theta_{34} CT\_PO_{t-1} + \theta_{35} GINI_{t-1} + \varphi_t^6 \end{cases}$$

- *System 7*

$$\begin{cases} DEBT_t = \delta_{36} + \delta_{37} DEBT_{t-1} + \delta_{38} INSS_{t-1} + \delta_{39} MTDEBT_{t-6} + \delta_{40} SURPLUS_{t-1} + \delta_{41} EXCH_{t-2} + \varepsilon_t^7 \\ INSS_t = \theta_{36} + \theta_{37} INSS_{t-1} + \theta_{38} AUX_{t-1} + \theta_{39} WMIN_{t-1} + \theta_{40} EMPF_{t-1} + \theta_{41} THEIL_{t-1} + \varphi_t^7 \end{cases}$$

- *System 8*

$$\begin{cases} DEBT_t = \delta_{42} + \delta_{43} DEBT_{t-1} + \delta_{44} INSS_{t-1} + \delta_{45} MTDEBT_{t-6} + \delta_{46} SURPLUS_{t-1} + \delta_{47} EXCH_{t-2} + \varepsilon_t^8 \\ INSS_t = \theta_{42} + \theta_{43} INSS_{t-1} + \theta_{44} AUX_{t-1} + \theta_{45} WMIN_{t-1} + \theta_{46} CT\_PO_{t-1} + \theta_{47} THEIL_{t-1} + \varphi_t^8 \end{cases}$$

where $\varepsilon_t \sim N(0,\sigma^2)$ and $\varphi_t \sim N(0,\sigma^2)$.

Table 5.A

GMM systems estimation DEBT and INSS

System 1				System 2				System 3				System 4			
Explanatory variables	DEBT	Explan. variables	INSS	Explanatory Variable	DEBT	Explan. variables	INSS	Explanatory variables	DEBT	Explan. variables	INSS	Explanatory variables	DEBT	Explan. variables	INSS
Constant	0.001	*Constant*	0.330	*Constant*	0.056	*Constant*	5.183***	*Constant*	0.018	*Constant*	0.445	*Constant*	0.077	Constant	4.292***
	(0.321)		(0.512)		(0.327)		-1.323		(0.330)		(0.574)		(0.324)		-1.372
	[0.002]		[0.644]		[0.172]		[3.916]		[0.055]		[0.776]		[0.237]		[3.129]
$DEBT_{t-1}$	0.711***	$INSS_{t-1}$	0.796***	$DEBT_{t-1}$	0.713***	$INSS_{t-1}$	0.769***	$DEBT_{t-1}$	0.715***	$INSS_{t-1}$	0.792***	$DEBT_{t-1}$	0.718***	$INSS_{t-1}$	0.774***
	(0.070)		(0.079)		(0.069)		(0.063)		(0.067)		(0.090)		(0.063)		(0.073)
	[10.194]		[10.076]		[10.316]		[12.207]		[10.730]		[8.783]		[11.297]		[10.615]
$INSS_{t-1}$	0.097***	AUX_{t-1}	0.257***	$INSS_{t-1}$	0.096***	AUX_{t-1}	0.157***	$INSS_{t-1}$	0.096***	AUX_{t-1}	0.289***	$INSS_{t-1}$	0.092***	AUX_{t-1}	0.213**
	(0.028)		(0.082)		(0.027)		(0.067)		(0.027)		(0.095)		(0.026)		(0.082)
	[3.503]		[3.140]		[3.586]		[2.326]		[3.552]		[3.041]		[3.521]		[2.597]
$MTDEBT_{t-6}$	0.186***	$WMIN_{t-1}$	0.039	$MTDEBT_{t-6}$	0.171***	$WMIN_{t-1}$	0.330**	$MTDEBT_{t-6}$	0.176***	$WMIN_{t-1}$	0.088	$MTDEBT_{t-6}$	0.163***	$WMIN_{t-1}$	0.299**
	(0.058)		(0.101)		(0.060)		(0.135)		(0.061)		(0.114)		(0.062)		(0.141)
	[3.181]		[0.386]		[2.845]		[2.435]		[2.880]		[0.768]		[2.614]		[2.121]
$SURPLUS_{t-1}$	-0.022**	$EMPF_{t-1}$	-0.508***	$SURPLUS_{t-}$	-0.020**	CT_PO_{t-1}	-1.765***	$SURPLUS_{t-1}$	-0.022***	$EMPF_{t-1}$	-0.440***	$SURPLUS_{t-}$	-0.019**	CT_PO_{t-1}	-1.468***
	(0.009)		(0.119)		(0.009)		(0.364)		(0.008)		(0.133)		(0.008)		(0.364)
	[-2.554]		[-4.274]		[-2.306]		[-4.847]		[-2.679]		[-3.311]		[-2.251]		[-4.028]
$SELIC_{t-6}$	0.117***	$GINI_{t-1}$	-1.361***	$SELIC_{t-6}$	0.111***	$GINI_{t-1}$	-1.120***	$SELIC_{t-6}$	0.116***	$THEIL_{t-1}$	-0.573***	$SELIC_{t-6}$	0.108***	$THEIL_{t-1}$	-0.508***
	(0.028)		(0.278)		(0.029)		(0.250)		(0.030)		(0.135)		(0.030)		(0.120)
	[4.186]		[-4.890]		[3.879]		[-4.475]		[3.906]		[-4.231]		[3.563]		[-4.246]
dummy	-0.046***	*dummy*	0.018	*dummy*	-0.043**	*dummy*	0.033***	*dummy*	-0.040**	*dummy*	0.025*	*dummy*	-0.040**	dummy	0.044***
	(0.017)		(0.013)		(0.017)		(0.010)		(0.016)		(0.014)		(0.017)		(0.012)
	[-2.725]		[1.392]		[-2.541]		[3.169]		[-2.421]		[1.734]		[-2.401]		[3.687]
Adj. R^2	0.915	Adj. R^2	0.936	Adj. R^2	0.918	Adj. R^2	0.938	Adj. R^2	0.917	Adj. R^2	0.935	Adj. R^2	0.920	Adj. R^2	0.936
J-statistic		0.100		J-statistic		0.119		J-statistic		0.133		J-statistic		0.126	
		p = 0.882				p = 0.840				p = 0.702				p = 0.804	

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, (*) denotes 0.1. Standard errors in parentheses and t-statistics in brackets.

Table 5.B

GMM systems estimation DEBT and INSS

System 5				System 6				System 7				System 8			
Explanatory variables	DEBT	Explan. variables	INSS	Explanatory variables	DEBT	Explan. variables	INSS	Explanatory variables	DEBT	Explan. variables	INSS	Explanatory variables	DEBT	Explan. variables	INSS
Constant	1.431***	Constant	0.121	*Constant*	1.258***	*Constant*	5.153***	*Constant*	1.216***	*Constant*	0.230	*Constant*	1.207***	Constant	4.305***
	(0.326)		(0.539)		(0.318)		-1.353		(0.309)		(0.573)		(0.314)		-1.432
	[4.391]		[0.225]		[3.954]		[3.809]		[3.937]		[0.401]		[3.837]		[3.006]
$DEBT_{t-1}$	0.544***	$INSS_{t-1}$	0.766***	$DEBT_{t-1}$	0.575***	$INSS_{t-1}$	0.740***	$DEBT_{t-1}$	0.595***	$INSS_{t-1}$	0.743***	$DEBT_{t-1}$	0.590***	$INSS_{t-1}$	0.741***
	(0.076)		(0.079)		(0.076)		(0.063)		(0.072)		(0.091)		(0.074)		(0.074)
	[7.182]		[9.631]		[7.539]		[11.660]		[8.259]		[8.187]		[7.940]		[10.038]
$INSS_{t-1}$	0.149***	AUX_{t-1}	0.302***	$INSS_{t-1}$	0.157***	AUX_{t-1}	0.185***	$INSS_{t-1}$	0.143***	AUX_{t-1}	0.347***	$INSS_{t-1}$	0.149***	AUX_{t-1}	0.246***
	(0.036)		(0.081)		(0.032)		(0.070)		(0.036)		(0.095)		(0.031)		(0.083)
	[4.176]		[3.735]		[4.891]		[2.647]		[3.937]		[3.637]		[4.783]		[2.975]
$MTDEBT_{t-6}$	0.010	$WMIN_{t-1}$	0.009	$MTDEBT_{t-6}$	0.027	$WMIN_{t-1}$	0.315**	$MTDEBT_{t-6}$	0.021	$WMIN_{t-1}$	0.057	$MTDEBT_{t-6}$	0.027	$WMIN_{t-1}$	0.290*
	(0.037)		(0.102)		(0.033)		(0.139)		(0.037)		(0.112)		(0.032)		(0.147)
	[0.268]		[0.087]		[0.811]		[2.274]		[0.565]		[0.514]		[0.828]		[1.968]
$SURPLUS_{t-1}$	-0.035***	$EMPF_{t-1}$	-0.544***	$SURPLUS_{t-1}$	-0.033***	CT_PO_{t-1}	-1.809***	$SURPLUS_{t-1}$	-0.030***	$EMPF_{t-1}$	-0.444***	$SURPLUS_{t-1}$	-0.029***	CT_PO_{t-1}	-1.510***
	(0.010)		(0.125)		(0.010)		(0.367)		(0.010)		(0.130)		(0.010)		(0.383)
	[-3.274]		[-4.347]		[-3.134]		[-4.926]		[-2.894]		[-3.412]		[-2.850]		[-3.943]
$EXCH_{t-2}$	0.056***	$GINI_{t-1}$	-1.675***	$EXCH_{t-2}$	0.058***	$GINI_{t-1}$	-1.273***	$EXCH_{t-2}$	0.056***	$THEIL_{t-1}$	-0.645***	$EXCH_{t-2}$	0.057***	$THEIL_{t-1}$	-0.561***
	(0.012)		(0.298)		(0.012)		(0.243)		(0.012)		(0.156)		(0.012)		(0.126)
	[4.591]		[-5.628]		[4.909]		[-5.244]		[4.620]		[-4.141]		[4.898]		[-4.461]
dummy	-0.036**	dummy	0.018	*dummy*	-0.031**	*dummy*	0.031***	*dummy*	-0.026*	*dummy*	0.026*	*Dummy*	-0.030**	dummy	0.047***
	(0.015)		(0.014)		(0.015)		(0.011)		(0.014)		(0.015)		(0.014)		(0.013)
	[-2.484]		[1.259]		[-2.156]		[2.762]		[-1.805]		[1.758]		[-2.103]		[3.734]
Adj. R^2	0.904	Adj. R^2	0.931	Adj. R^2	0.907	Adj. R^2	0.937	Adj. R^2	0.912	Adj. R^2	0.932	Adj. R^2	0.912	Adj. R^2	0.933
J-statistic		0.104		J-statistic		0.133		J-statistic		0.151		J-statistic		0.144	
		p = 0.865				p = 0.766				p = 0.590				p = 0.706	

Note: Marginal significance levels: (***) denotes 0.01, (**) denotes 0.05, (*) denotes 0.1. Standard errors in parentheses and t-statistics in brackets.

Tables 5.A and 5.B present the GMM systems estimation (same instrumental variables and lags applied in the individual equations estimation). All coefficients of *DEBT* have signs in agreement with the theoretical argument and statistical significance. The exception, as observed in the case of individual estimation, is the *MTDEBT*. The *INSS* estimations also do not show considerable difference from individual estimations. In short, although the standard errors are smaller in most of the systems, the estimated coefficients have similar magnitudes to those observed for the individual estimations.

Taking into account the results from GMM individual and systems estimation for the *DEBT* and *INSS*, table 6 summarizes the effects of shocks transmitted by the variables considered in the models. The results indicate that the magnitude of the shocks is similar between the methods considered (individual and system). Therefore, the results leave no doubt that management of the social security system for the fiscal budget cannot be neglected in order to ensure public debt sustainability.

Table 6

Economic shocks on DEBT and INSS

Variable/ method	Effects on DEBT				Variable/ method	Effects on INSS			
		Individual		System			Individual		System
	Eq(n.)	GMM	System	GMM		Eq(n.)	GMM	System	GMM
INSS	2	2.23 b.p.	6	2.26 b.p.	*AUX*	7	3.18 b.p.	5	2.91 b.p.
MTDEBT	1	3.53 b.p.	1	2.90 b.p.	*WMIN*	6	3.57 b.p.	2	3.56 b.p.
SURPLUS	2	-1.74 b.p.	5	-1.61 b.p.	*EMPF*	5	-5.08 b.p.	5	-5.37 b.p.
SELIC	1	3.44 b.p.	1	2.96 b.p.	*CT_PO*	6	-8.71 b.p.	6	-8.68 b.p.
EXCH	2	0.99 b.p.	6	1.06 b.p.	*GINI*	5	-3.72 b.p.	5	-3.98 b.p.
					THEIL	8	-2.81 b.p.	8	-2.62 b.p.

5. Conclusion

The empirical evidence in this study shows that the financing of social security is important to explain the Brazilian public debt. In addition, other variables used in the model (primary surplus, interest rates, exchange rates, and average maturity of public debt) are also relevant. An important result of this analysis is with respect to the effects of the social security deficit. The findings confirm that the social security deficit is significant to the increase in the public debt/GDP ratio. Therefore, an efficient management of social security, which could reduce the deficit, is important for the success of the management of public debt.

Another important issue that had not been explored in the literature on social security was with respect to the effects of income inequality. The empirical evidence in this study shows that a reduction in the Brazilian income inequality would imply an increase in the social security deficit. This result deserves attention because the adoption of measures to reduce income inequality is essential. Hence, it is imperative that we search for mechanisms to mitigate the impact on the social security deficit of the successful adoption of social policies.

It is important to highlight that the results of this study showed that the policy to increase the level of formality in the Brazilian economy has a strong influence in reducing the social security deficit. Therefore, it is important that the federal government strengthens this policy as a means to improve the management of the social security system. Another important observation is the increase in the social security deficit caused by both the real increase in the minimum wage and the sickness benefit. Therefore, these variables have a crucial role in the search for an efficient social security management system and cannot be neglected in ensuring fiscal sustainability.

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Appendix

Table A.1: *Unit root tests (ADF, PP, and KPSS)*

	ADF						PP					
				Critical values						Critical values		
Series	**I/T**	**Lag**	**Test**	**1%**	**5%**	**10%**	**I/T**	**Band**	**Test**	**1%**	**5%**	**10%**
AUX	C	1	-2.115	-3.512	-2.897	-2.586	I/T	18.1	-2.631	-4.072	-3.465	-3.159
ΔAUX		0	-2.234	-2.593	-1.945	-1.614		0.92	-2.234	-2.593	-1.945	-1.614
CT_PO	I/T	1	-2.938	-4.074	-3.466	-3.159	I/T	11.7	-4.457	-4.072	-3.465	-3.159
ΔCT_PO	C	0	-3.618	-3.512	-2.897	-2.586						
DEBT	C	1	-2.128	-3.512	-2.897	-2.586		4.56	-0.933	-2.593	-1.945	-1.614
ΔDEBT		0	-5.993	-2.593	-1.945	-1.614		0.798	-5.993	-2.593	-1.945	-1.614
EMPF	I/T	2	-3.813	-4.075	-3.466	-3.160		8.17	8.838	-2.593	-1.945	-1.614
ΔEMPF							C	3.09	-4.265	-3.512	-2.897	-2.586
EXCH		1	-1.518	-2.593	-1.945	-1.614		4.86	-1.470	-2.593	-1.945	-1.614
ΔEXCH		0	-5.749	-2.593	-1.945	-1.614		0.236	-5.749	-2.593	-1.945	-1.614
GINI	I/T	3	-5.781	-4.077	-3.467	-3.160	I/T	1.12	-4.569	-4.072	-3.465	-3.159
INSS		0	-1.019	-2.593	-1.945	-1.614		0.974	-1.019	-2.593	-1.945	-1.614
ΔINSS		0	-9.304	-2.593	-1.945	-1.614		0.178	-9.304	-2.593	-1.945	-1.614
MTDEBT		6	0.892	-2.595	-1.945	-1.614		0.939	1.277	-2.593	-1.945	-1.614
ΔMTDEBT		5	-1.744	-2.595	-1.945	-1.614		0.455	-8.505	-2.593	-1.945	-1.614
SELIC	I/T	1	-3.742	-4.074	-3.466	-3.159		16.4	-0.945	-2.593	-1.945	-1.614
ΔSELIC								0.472	-2.548	-2.593	-1.945	-1.614
SURPLUS		2	-1.111	-2.594	-1.945	-1.614		3.77	-1.253	-2.593	-1.945	-1.614
ΔSURPLUS		1	-7.793	-2.594	-1.945	-1.614		1.79	-6.803	-2.593	-1.945	-1.614
THEIL	I/T	3	-5.003	-4.077	-3.467	-3.160	I/T	0.698	-4.933	-4.072	-3.465	-3.159
WMIN	I/T	3	-3.017	-4.077	-3.467	-3.160		5.55	2.397	-2.593	-1.945	-1.614
ΔWMIN		2	-2.045	-2.594	-1.945	-1.614	C	2.18	-5.397	-3.512	-2.897	-2.586

KPSS			
Series	**Band**	**Test**	**10%**
CT_PO	19.1	0.125	0.119
ΔCT_PO	12.2	0.115	0.119
EMPF	39.9	0.193	0.119
ΔEMPF	8.1	0.080	0.347
SELIC	57.8	0.341	0.119
ΔSELIC	16.4	0.099	0.347

Note: Augmented Dickey-Fuller test (ADF) – based on Schwarz criterion, the final choice of lag was made. Phillips-Perron and KPSS test – bandwidth is Andrews using Bartlett kernel. Based on Schwarz criterion, intercept (I) or time trend (T) was applied.

Table A.2

AIC, SC and HQ criteria for VAR

		With constant			Without constant		
	Lag	**AIC**	**SC**	**HQ**	**AIC**	**SC**	**HQ**
Equation 1	0	-77.890	-76.401	-77.293			
	1	-191.430	-182.497	-187.849	-188.745	-181.301	-185.761
	2	-20.4110*	-18.7734*	-19.7544*	-20.2009*	-18.7121*	-19.6040*
	3	-203.988	-180.168	-194.438	-201.864	-179.532	-192.911
	4	-201.425	-170.161	-188.891	-199.870	-170.095	-187.932
Equation 2	0	-71.408	-69.919	-70.811			
	1	-184.003	-17.5071*	-180.422	-183.994	-17.6550*	-181.010
	2	-18.8311*	-171.935	-18.1746*	-18.8181*	-173.294	-18.2212*
	3	-186.934	-163.114	-177.384	-186.881	-164.549	-177.928
	4	-184.718	-153.454	-172.183	-184.176	-154.400	-172.238
Equation 3	0	-114.172	-112.981	-113.695			
	1	-272.586	-266.631	-270.199	-270.653	-265.889	-268.743
	2	-293.301	-28.2582*	-28.9003*	-292.337	-28.2809*	-28.8517*
	3	-29.3957*	-278.474	-287.749	-29.3035*	-278.743	-287.305
	4	-293.120	-272.873	-285.003	-292.204	-273.148	-284.564
Equation 4	0	-134.274	-133.083	-133.797			
	1	-285.137	-279.182	-282.750	-280.718	-275.954	-278.808
	2	-31.1288*	-30.0569*	-30.6991*	-30.9057*	-29.9529*	-30.5237*
	3	-310.406	-294.923	-304.199	-308.719	-294.426	-302.988
	4	-310.885	-290.638	-302.767	-308.649	-289.593	-301.009

Note: (*) denotes lag order selected by the criterion. AIC – Akaike criterion. SC – Schwarz criterion. HQ – Hannan-Quinn criterion.