Sovereign Ratings, Macroeconomic Dynamics, and Fiscal Policy. Interactions within a Stock Flow Consistent Framework

by Stefanos Ioannou[1][2]

Abstract

This paper attempts to model the macroeconomic effects of sovereign ratings. Operating in the context of deregulated financial markets, credit rating agencies do not only 'provide an opinion', but also shape the views of investors and the public. Even more, by setting rating scores for entire sovereign states, rating agencies come to have a significant impact on macroeconomic dynamics. By utilizing a two-country stock flow consistent model that approximates Eurozone, my paper connects the movements of ratings with the dynamics of the financial market and the constraints for fiscal policy. With endogenous fiscal expenditures and with an endogenous rating mechanism, my model shows how following a recessionary shock, severe downgrades of a country can influence the liquidity preference of investors. Such influence comes to deepen the already ongoing recession by impeding the state's access to financial resources and pushing it to implement fiscal austerity. Besides the baseline scenario where investors switch from downgraded bills to cash, an alternative closure is established whereby investors transfer their funds to better quality bills. Furthermore a scenario of 'nervous' rating agencies is also considered. Simulation results support the key insights of the current under all specifications.

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Introduction

Credit Rating Agencies (CRAs) have long been recognized as an important driver of financial and macroeconomic dynamics. Since the outbreak of the East Asian crisis, authors such as Ferri *et al.* (1999) have pointed out their role in exaggeratedly downgrading crisis-hit countries, and re-enforcing recessionary spirals. More recently, researchers such as Arezki *et al.* (2011) and De Santis (2012) have demonstrated evidence as to how sovereign ratings have a significant impact upon interest rates, while Ioannou (2014b) has shown how ratings relate with extreme capital flow movements.

Nonetheless, there is a paradox in that no one has ever attempted to formalize the effects of sovereign ratings in a macroeconomic model. This is done in the current paper by means of a two-country stock flow consistent (SFC) model. Purpose of the model is to elucidate the links between sovereign rating movements, the financial market and the constraints for fiscal policy. Approximating the Eurozone set-up, my framework separates between a relatively weak and a relatively strong economy (labeled as South and North respectively), and includes one currency and one central bank. It also allows for the fiscal expenditure of the South to be endogenously determined. In addition I establish an endogenous mechanism that sets the sovereign rating of the South to be a function of the accumulated growth of the country's gross domestic product (GDP) as well as its debt to GDP ratio.

Based on such specification, my model connects the fluctuations of the South's sovereign rating with the domestic and international financial markets and thereby with the South's public sector. Illustrated in a nutshell the key idea

is that once a crisis episode occurs in the South, the country's 'fundamentals' deteriorate so that CRAs decide to downgrade it. The drop of the South's rating score has a negative impact on the demand for the financial assets issued by the southern government. By switching to more liquid assets, investors amplify the financial constraints that such government faces, so that the latter is forced to implement fiscal austerity. In turn fiscal austerity diminishes the already falling aggregate demand and the recessionary spiral gets deepened.

A number of alternative closures are established. Under the baseline scenario, the withdrawal of funds from the downgraded country is matched by an increase in liquidity preference and thus a rise in cash holdings. An alternative scenario where those funds are instead driven towards the bills issued by the North is also assembled. This set-up could be seen as a resemblance of the 'flight to quality' phenomenon that has commonly been observed in financial markets (see for instance De Santis, 2012). In addition, building on the insights of Ioannou (2014a) a scenario whereby CRAs exhibit an element of panic once downgrading the South is also explored.

The rest of the paper is organized as follows: section two outlines the background theory, evidence and methodology. Section three prepares the ground for the model with sovereign ratings, by discussing two alternative specifications relating with the assumptions about the behavior of the central bank. It then introduces the sovereign model and outlines the corresponding mechanism and causalities. Section four presents the results of the model, both for the baseline specification and the two alternative closures discussed above. It also includes two robustness checks, namely a set of sensitivity tests and an extension of the baseline model with prices. Lastly section five concludes. All

simulations of the current are done in R Studio. The 'PKSFC' package has been used, a package that provides a set of commands for stock flow models based on the methodology developed by Kinsella and O'Shea (2010).

Theory, Literature and Methodological Approach

Theoretical Background

CRAs have been an important part of the nexus of power throughout the neoliberal era. With globalized and deregulated financial markets, and with the incorporation of ratings into financial regulation, CRAs have been playing the role of the gatekeeper for anyone seeking for access to those markets (Sinclair, 1993; Ioannou, 2013). CRAs' ratings have been seen as a sort of a 'blessing' for rated entities, with their decisions relating directly with financial costs. Despite the numerous registered rating agencies across the globe, it is three of them that dominate the market, namely Standard and Poor's (S&P), Moody's and Fitch.

Apart from the rating products developed for entities of the private sector such as private banks and firms, CRAs have also been providing their opinion about the financial soundness of entire governments. Such opinion is usually provided in the form of sovereign ratings (for CRAs' own reports on their sovereign rating methodologies, see S&P, 2013; Fitch, 2012; and Moody's, 2013). Naturally, the views of CRAs' are primarily important for those governments that heavily rely on the private market to fund their expenditures.

Interestingly, while such reliance mainly relates with developing countries with weak domestic currencies, it is also the case for the member states of the European Monetary Union (EMU). As pointed out by a number of authors (e.g. Kelton and Wray, 2009; Papadimitriou *et al*., 2010) the establishment of the Euro has put those states in a position where they cannot control their own currency. Practically this is as if EMU member states use a foreign currency for their transactions and borrowing. Taken in conjunction with the fact that the European Central Bank (ECB) is prohibited by its own constitution to act as a lender of last resort, such architecture downgrades EMU member states to the status of developing countries (De Grawue, 2011).

The above remarks imply that CRAs do not only provide 'an opinion' as they claim, but also exercise significant power upon the elected EMU governments. As long as these agencies are taken seriously by private investors and the public and as long as European states depend upon the private market for funds, CRAs matter.

For the purposes of the current, there is one more dimension to illustrate. In particular it is interesting to observe that the power of CRAs' over the state contains an asymmetry in the way that agencies' decisions affect governments. More specifically, while it is easy to see that a government will need to apply measures of fiscal austerity in the aftermath of a severe downgrade so as to regain its access to the market, the reverse does not necessarily hold true. For example, it can hardly be the case that a triple-A rated country will take its excellent rating as a blank check and start increasing its public expenditure by investing in public services, welfare provisions and infrastructure. Rather, a sovereign rating upgrade, or the maintenance of a high rating score by CRAs, can

be seen as an encouragement for continuing to apply a frugal approach to the public budget. In a way a good rating score can be taken as a reward for exactly this kind of behaviour. If the asymmetry pointed out here is right, it should also be reflected on a model that aims to capture the macroeconomic effects of sovereign ratings.

Empirical Evidence and Literature

[Insert Figures 1 and 2 here]

Figures 1 and 2 provide an idea of the co-movement of sovereign ratings and public expenditure from 1999 to 2012 across Germany and the Eurozone periphery (including here Greece, Ireland, Italy, Portugal and Spain). As pictured in those graphs, there have been some tremendous rating downgrades in all five peripheral countries since 2008, with Greece providing the most conspicuous example. Parallel to these downgrade movements, the fiscal expenditures of these countries have either remained stagnant or followed a downward trend too. Interestingly, although Germany stands in contrast to them in that it has managed to retain its triple-A status, its public spending has exhibited a similar stagnating tendency. Although the evidence outlined here is not adequate to establish a particular line of causality, and despite the peculiarities of each country, it is interesting to observe how the recent period of economic turbulence has driven all peripheral countries towards fiscal austerity, and how CRAs have reacted by severely downgrading all five of them.

With regards to CRAs' influence on private investors, the fact that CRAs are still attached to financial regulation, thereby affecting the decision making of

agents in a compulsory manner, is itself a good piece of preliminary evidence (although it should be noted that such attachment has been reduced in the follow-up of the 2007/8 crisis, primarily in the US). Furthermore, there is by now some concrete evidence at the econometric level showing how sovereign rating fluctuations affect the movement of international capital flows. To start with Gande and Parsley (2004b) show that there is an asymmetric effect in that sovereign downgrades are detected to be significant in causing capital outflows whereas rating upgrades are shown to be highly insignificant. Furthermore, Kim and Wu (2008) provide some results confirming the importance of sovereign ratings. Nonetheless, their findings are to an extent contradictory in that while long-term ratings appear to be positively related with foreign capital inflows, the opposite seems to be the case for short-term scores. More recently Ioannou (2014b) shows that sovereign ratings matter in explaining episodes of extreme capital flow movements, and most importantly episodes of sudden stops of foreign capital inflows. Moreover, while the reported results hold both for total and speculative capital flows (i.e. total flows excluding foreign direct investment), results are more profound in the case of the latter.

Modeling Approach

The above remarks create the need to formalize the potential effects of sovereign ratings. To do so I employ an open economy stock flow consistent (SFC) model, based on the approach developed by Godley (e.g. Godley, 1999) and more recently by Godley and Lavoie (2007b). As the name suggests, the SFC methodology clearly separates between stocks and flows. Such distinction gives

an element of dynamic interaction in the model whereby different short-run periods are interrelated through the realization of flows and the corresponding change of stocks in the economy. Most importantly, the stock flow approach is based on the principle of double entry bookkeeping so that every flow needs to come from someone and go to someone else. In a similar vein, every asset is someone else's liability. Moreover, while microfounding the model is an option (see for instance Carvalho and Di Guilmi, 2013), it is not a compulsory requirement. In that sense SFC models offer a good alternative in macroeconomic modeling, by allowing the researcher to escape the flaws and limitations of mainstream modeling.

At the terrain of open economy modeling, SFC models follow similar principles. The source and destination of every domestic and foreign flow need to be explicitly incorporated into the model, so that there can be no black hole in the accounting. To do this, one needs to merge the models of two (or more) economies, so that essentially the open economy SFC approach reminds a sort of enlarged closed economy model. Although this brings along some unrealistic assumptions for the sake of the overall consistency (for example in a two country set up one country's exports need to be identical with the other country's imports), such models offer a powerful tool in studying international imbalances and transmissions of shocks across borders. For instance, by virtue of the SFC methodology the researcher can never omit the fact that a country's current account deficit is nothing but the mirror reflection of someone else's current account surplus.

Caverzasi and Godin (2015) provide the most thorough and updated literature survey of SFC models. Outlining here in brief some of the most recent

open economy SFC models, Duwicquet and Mazier (2010/11) employ a two-country set-up and study alternative stabilization policies in Eurozone, while Duwicquet *et al.* (2012) point out the need for a federal Eurozone budget. Similarly, Kinsella and Khalil (2011) study the effects of debt-deflation in a monetary union, and Greenwood-Nimmo (2014) contrasts the effectiveness of fiscal and monetary policies in a model that faces inflationary and recessionary pressures. From his side Bortz (2014) explores the implications of debt denominated in foreign currency. Larger models include Belabed *et al.* (2013) who set up a three-country model to study income distribution, and Mazier and Valdecantos (2015) who utilize a four-country framework to investigate the scenario of a Eurozone with two Euros.

The Model

The basis of my model is model REG from chapter 6 of Godley and Lavoie (Godley and Lavoie, 2007b: 170- 187). This is an open economy, demand driven regional model. It includes two economies, labeled as South and North, with two separate governments that issue bills, but there is only one currency and one central bank. While initially designed as a regional model, the single currency and central bank assumptions make it quite suitable as a tool for analyzing Eurozone. Moreover, while the two countries of the model are labeled as 'North' and 'South', one could use some imagination and think of them as Germany and Greece respectively. In addition there is nothing to prevent us from labeling the central bank as ECB.

All equations of the model can be found in Appendix A of the current. In each economy the GDP is composed of consumption, public expenditures, imports and exports. Compared with the version of the book, the only modification I have done is to add expectations (see eq. 4 and 9 in Appendix A), and to allow households to invest in both domestic and foreign assets. It is important to highlight that households' investment decisions are essentially the locus of the financial market in this model (eq. 11 to 16). In the beginning of each period, after deciding how much to consume, households estimate their end-of-period wealth and decide how to allocate it across the different financial assets. Following the SFC tradition the asset demand functions are based upon the Tobinisque logic in that the demand for each financial asset is not only a function of its own rate of return, but also links with the returns of all other available assets (see the λ_{ij} parameters below, with $i \in [1,6]$; $j \in [1,3]$). It also relates with the demand for cash for liquidity and transaction purposes (captured by the λ_{i0} and λ_{i4} parameters respectively, with $i \in [1,6]$). Households' expectations for disposable income and wealth are assumed to follow a simple adaptive rule, where the most recent observation is the expectation of the present.

With regards to notation, the 'S' and 'N' upper-scripts denote the South and the North respectively. For example C^S is the consumption of the South, while Y^N is the GDP of the North. In addition the 'h' subscript denotes actual (ex-post) holdings of households, 'e' stands for expectations, 'd' for demand and 's' for supply. In all financial assets, the upper script denotes the issuer and the lower script denotes the holder of the asset. Greek letters are used for all

behavioural parameters, while all magnitudes are expressed in a nominal form, using capital letters. Furthermore there is a quite conventional notation used for the variables of the model: YD stands for disposable income; Y denotes Gross Domestic Product (GDP); T is used for taxes; r is the interest rate; B is used for government bills; V denotes wealth; H stands for cash; r_h denotes the interest rate on cash holdings (set equal to zero); NW implies net worth; G is used for fiscal expenditure; X means exports; IM is imports; And F is profits.

Tables 1 and 2 illustrate the balance sheet and transaction matrices of the model.

[Insert Tables 1 and 2 here]

In both tables, all rows and columns must sum up to zero so as to satisfy the stock flow consistency requirements. Table 1 describes the stocks of assets and liabilities that are inherited from the past (described with a plus and minus respectively). In addition, Table 2 shows the transactions that take place within a period. Here the plus and minus signs correspond to the use and acceptance of funds. For instance households spend money in consumption and therefore C appears with a minus in their column, while they are the sole recipients of income from production (wages and profits are amalgamated in the current) so that Y appears with a plus in their account. Similarly, the households of both countries pay taxes to their governments, while they also receive interest payments from their bills holdings. Furthermore, by the end of the period they update their stock holdings of all their assets. As it can be seen from Table 1,

there are three available financial assets for households, namely cash H, southern bills B^S and northern bills B^N. The ECB is the sole issuer of cash, with cash playing here the role of money, while it also purchases government bills from both countries. Notice here that money is endogenous in that the ECB always provides any amount of cash that is demanded by households. Moreover, the double entry bookkeeping helps us illustrate the fact that all stock of debt of the two governments is nothing but wealth at the hands of the private sector. Under this system of accounting, the columns of the firms in the transaction matrix give the national income identities of the two countries.

As set, that there are a number of simplifying assumptions in my model. First, firms act in an accommodating way for the rest of the economy. They simply produce whatever is demanded. They do not undertake any productive investment, while all their profits are immediately transferred back to households. In that sense there is no economic growth in the model. Secondly my set-up does not include private banks. Those simplifications were seen as necessary sacrifices in order to allow myself to focus on the dynamics of the household sector and the state, which are important for the purposes of the current. By narrowing down the model, and making it as simple as possible, it becomes much more feasible not only to solve the model in the computer and find a steady state solution, but also to trace the channels through which a change spreads out across the two economies. Tractability simply means that under all scenarios you know what is going on in the model you have constructed.

The parameterization of the model is based upon the numbers provided by Godley and Lavoie (2007b). These are reasonable steady state values that

allow us to draw some useful inference from the model and contrast different scenarios and shocks. The arithmetical values of all parameters and stocks are provided in the end of Appendix A. As modeled the two countries are taken as identical in terms of size, with only small differences in their behavioral parameters (for instance the propensity to consume of the South is set to be 0.7, while the one of the North is set at 0.6). They are then differentiated by the different shocks that are conducted in the model.

Basic Set- Up (model FEX)

In its basic version (let me call it model FEX) the model assumes that the ECB acts as a purchaser of last resort for both governments' bills (see eq. 27 and 28 below) and is happy to support any levels of deficits that arise. This means that none of the two governments can ever default and that the influence of the financial market is limited for both countries (the only impact is through the component of consumption that comes out of wealth). Figure 3 provides a visual depiction of the causalities of the model by means of a Direct Acyclical Graph[3].

[Insert Figures 3 and 4 here]

To illustrate the properties of FEX I run three separate experiments, namely: i) I raise the propensity to import μ of the South from 0.180781 to 0.20781; ii) I increase the exogenous fiscal expenditure of the South from 20 to

[3] The direct acyclical graph provided here is based on the methodology developed by Fennell *et al.* (2014).

25, and iii) I decrease the liquidity preference of southern households by raising λ_{20} from 0.35 to 0.5. Relevant results are reported in Figure 4. Regarding the first experiment (first column in Figure 4), while the GDP in the Southern country falls, there is a symmetric rise of the Northern economy. Moreover, given that the South's public expenditures are exogenous, and that the fall of GDP causes a fall of tax revenues, the southern government needs to run a permanent budget deficit so as to keep supporting its expenditures (first column/ second row). For the process to be sustainable the ECB needs to enter into ever increasing purchases of southern bills, so that the South's debt to GDP ratio permanently increases once the shock has occurred (with the reverse happening for the North; see column1/ third row). Under the second experiment, the rise of public expenditure in the South boosts growth in both countries. This is because the higher income that is produced in the South also pushes upwards the income of the North, through the channel of international trade. As with before, for the increased public expenditure to be supported, the southern government needs to run a permanent budget deficit, which in turn gives rise to an ever-increasing debt to GDP ratio on that country. Lastly, experiment three highlights the limited importance of the financial market in this model. While the fall of the liquidity preference of southern household increases the demand for southern bills, this change only manages to increase the country's GDP by less than 1% (see the GDP scale at the first row/ third column graph).

As argued by Godley and Lavoie (2007b) there is nothing in the model to drive the two economies towards balanced trade. Current account and budget imbalances are fully compatible with a steady state environment. Furthermore, by virtue of proper accounting, there is, under all scenarios, a twin deficit

situation in that the current account and budget imbalances are identical at the end of every experiment (see row 2 of Figure 4; also see the discussion at Godley and Lavoie, 2007b: 176- 180). However, as noted by Godley and Lavoie, the satisfaction of the twin deficit identity does not imply a specific line of causality in the model; it simply says that the two are always the same. Still, the identity is powerful enough to remind us that in a closed-two country set up such as the one employed here, it is not only impossible for the two countries to run trade surpluses at the same time, but it is equally futile to simultaneously push them to achieve fiscal surpluses (Godley and Lavoie, 2007b: 182- 3).

Endogenous Public Expenditure for the South (model FEXEND)

While the above model is a useful tool for reflecting on alternative policies for Eurozone, it lies on the assumption that there is an accommodative central bank that supports any imbalances that are created. This is not however a realistic assumption for describing the behavior of the ECB, which by its own constitution is forbidden to directly purchase government debt of EMU member states. Hence there is a need for modifying the model so as to get closer to the actual dynamics of Eurozone. To do this I create an alternative closure with endogenous fiscal expenditures for the South. This closure is based on chapter 12 of Godley and Lavoie (see Godley and Lavoie, 2007: 465-466 and 472-476). The key change here is to flip the G^S and ΔB_S^S terms in eq. 18, so that rather than having the southern public expenditure determining the required amount of bills to be issued, we now have the supply of bills constraining the expenses

that can be undertaken. In addition the ECB's purchasing of southern bills is set to be constant (eq. 27B below) so as to reflect the fact that it now ceases to act as a lender of last resort[4]. There is also a new equation (27A) that determines the total supply of southern bills, so that in the overall we have:

$$G^S = \Delta B^S + T^S - r^S_{-1} B^S_{S\,h-1} - r^S_{-1} B^S_{N\,h-1} \tag{18A}$$

$$B^S = B^S_{Sh} + B^S_{Nh} + B^S_{ECB} \tag{27A}$$

$$B^S_{ECB} = constant \tag{27B}$$

Doing so entirely changes the dynamics of the model. As Godley and Lavoie point out, in this version there exists a recessionary bias not only for the South, but also for the system as a whole. This is because any shock that would diminish the GDP of the South would also reduce the tax revenues of the country, which constitute the sole source of income for the state besides the issuance of new bills. In that regard, unless there is some source of additional financing, the fall in tax revenues will lead to a reduction in southern public expenditures. Nonetheless, under the new closure of the model, there is no source that could meet the southern state's need for new borrowing. With the liquidity provided by the private market being initially flat and later falling due to the fall of GDP and wealth, and with no Central Bank acting as a purchaser of last resort, there is no way to sustain any level of budget deficit once a recession hits the South. As a

[4] The precise amount of B^S_{ECB} is set equal to the figure obtained from the steady state solution of the model. Notice here that although any other level of B^S_{ECB} such as 0 would also enable us to solve the model, it would however violate the stock flow consistency requirement, since the redundant equation would not be satisfied any more.

result the fiscal expenditure of the South is pushed downwards so as to maintain the balance of the budget. In that way however the southern state is pushed to adopt an austerity policy that reinforces instead of containing the recessionary spiral. With the fiscal expenditures of the South being endogenous and falling, and with the ones of the North staying exogenous, there is no source of demand to run counter-cyclically. As a result that the global economy is driven as a whole into recession once a negative shock occurs in the South.

[Insert Figure 5 here]

The above can be seen more clearly when repeating the first experiment of the above, where the propensity to import of the south raises from 0.180781 to 0.20781. As seen in the first column of Figure 5, not only the recession is deeper than before with regards to the South, but it also affects the North. More specifically, in contrast with the model FEX, where there was a complete symmetry between the developments of the two countries, the North now sees the initial boost of its growth evaporating shortly after the shock. At the new steady state, both countries find themselves with a lower GDP than before.

On top of the above, I also conduct two more experiments, one by cutting the exogenous fiscal expenditures of the North, setting it from 20 to 15, and one by pushing the λ_{20} parameter downwards from 0.35 to 0.2 (which implies a rise in the liquidity preference of Southern households). In the first case (column 2 of Figure 5) my experiment shows how an exogenously given austerity in the North is fully transmitted to the South. Moreover, as it can be seen from the last experiment (column 3 of Figure 5), the financial market is now far more

important than in model FEX in determining economic dynamics. Namely, the demand for bills does not only affect aggregate demand indirectly through the consumption out of wealth channel, but there is also a direct link with the fiscal expenditures of the South. In contrast with the previous case where the change in the liquidity preference only had an impact of 1% upon the GDP of the South, it now affects it by more than 10% (measured in absolute terms).

At the same time, as it can be seen from the second and third rows of Figure 5, the levels of public debt never get out of hand, and the fiscal and current accounts are always balanced in a steady state environment. These results hold irrespectively of the experiment considered. We can therefore think of model FEXEND as one that replicates more precisely the dynamics of an economy like Eurozone where balanced accounts and stable public debts are the utmost policy priorities and where there are institutions such as the central bank and the financial market to discipline the countries that get out of track (also see the discussion in Godley and Lavoie, 2007b: 474). With this said, the key point of model FEXEND is to show that such priorities are not necessarily compatible with the stable growth of the economy.

Incorporating Sovereign Ratings: The SR Model

Having constructed the two alternative closures of the model, it is now time to introduce sovereign ratings. As discussed earlier sovereign ratings are one of the key means by which rating agencies exercise power over national governments, by disciplining them and enforcing the idea of 'sound finance'. Notice however that it is one thing to acknowledge and take seriously such

power, and is quite another to end up with a narrative that attributes cataclysmic forces to CRAs. As studied here, CRAs act within a specific socio-economic surrounding, that of neoliberalism, which as such already includes forces attempting to enforce the dominant frame of thought to governments and the public. In that regard it would be an exaggeration to construct a model that would put CRAs in a position where they can create a crisis *ex nihilo*. Rather, a more accurate approach is to show how CRAs can affect and reinforce already ongoing recessionary spirals. Hence out of the two models outlined above, it is the second one (model FEXEND) that is more suitable for using as a basis here. With the ECB already playing the role of enforcing fiscal discipline, it is interesting to see how the picture can be amplified once sovereign ratings are also taken on board.

In particular, we can think of a model where CRAs act as an institution that can potentially impose more severe constraints than the already established ones. This can either be conceived as a result of CRAs being more strict in their requirements for approving the continuation of financing, or because CRAs might be looking more carefully at some variables that are not incorporated into the model yet. While we can think of both scenarios holding true, it is primarily the second case that can be interesting here. More specifically, as shown in that stream of literature that studies the key determinants of sovereign ratings (see for instance Afonso *et al*., 2011; Ioannou, 2014a), and as mentioned by CRAs themselves in their reports (see for instance S&P, 2013), CRAs do not only look at the levels of public debt and the levels of fiscal and current account deficits (which can be seen as the elements already constraining the FEXEND model), but also take into account the record of GDP growth of the economy under

consideration. Simply put this means that with everything else being the same, the falling rate of growth of a country will be identified by CRAs as a factor that increases the probability of default of the corresponding government on its debt (remember here that sovereign ratings are nothing but an expression of this probability). The usual response of CRAs in such a case would be to downgrade the country under consideration. But then, it is exactly this activity of CRAs that creates the potential for a self-fulfilling prophecy, since the downgrading might make it even more difficult for the given country to reverse the falling trend of its GDP growth (for a similar point also see Ferri *et al.*, 1999). Despite what they claim for themselves, CRAs might be actually pushing a recession-hit country off the cliff.

To capture the hypothesis into the model, I create a new variable that aims to approximate severe movements of the southern sovereign rating. Let me call it SR[5]. Conceptually speaking we can think of the word 'severe' either as one big downgrade or as a cluster of smaller ones, which in either case result in augmented financial difficulties for the rated country. Recalling here that institutional investors such as pension funds are usually obliged by law to shift their portfolios when an asset drops below the BBB- notch, we could think for instance of SR as the event of a downgrade that pushes the country below that threshold and towards the speculative range.

[Insert Table 3 here]

[5] Hereafter, SR will be used to denote the SR model whereas *SR* in italics will denote the sovereign rating variable.

Naturally, the SR variable needs to be a function of the magnitudes that matter for sovereign ratings. In the context of the current model, such variables are the South's ratio of Debt to GDP as well as the country's accumulated GDP growth. Table 3 provides a quick overview of those variables for the EMU peripheral countries.

In order to define whether an SR downgrading episode occurs we need to set some thresholds for its determinants, which if crossed would increase SR's value. To do so I construct a dummy composition mechanism, which works as follows:

$$SR1 = 1 \; if \; acummulated \; GDP \; growth < -15\% \tag{34}$$

$$SR2 = 1 \; if \; Debt \; to \; GDP > 85\% \tag{35}$$

$$z = 1 \; if \; both \; SR1 > 0 \; and \; SR2 > 0 \tag{36}$$

$$SR = SR1 + SR2 - 0.8 * z \tag{37}$$

Needless to say, the -15% and 85% thresholds are partly arbitrary. In that sense, my model captures the effects of sovereign ratings in a world where those thresholds exist. With this said, it is easy to see how within a certain range, changing the thresholds would only alter the timing of the SR change. Furthermore, in the SR expression I have added another dummy, the z one, so as to distinguish between the impacts of the different determinant in terms of

timing. The hypothesis here is that SR will switch from 0 to 1 once the first variable crosses its threshold, but will only rise for another 0.2 once the second one follows. The idea is based on the simple fact that once a country has suffered from a severe downgrade, any further drop of the rating only does little more in deteriorating further the economy's financial environment[6]. Moreover the SR variable does not change more than two times. That is, once SR has switched to 1 and/or to 1.2 it does not go back to zero at any point. This is simply for the purpose of being able to extract some meaningful inference from the model, since if I were to let SR to fluctuate freely I would create a repetitive loop that would strip the model from any meaningful economic results. We can think of my set-up as a two-step experiment: at first we need to change a parameter so as to generate a recession in the South. We then need to wait and see how and when the SR variable will respond. In a way the process described here is not that different from the usual modeling simulation routines, with the main difference being that instead of studying a one-off experiment my paper focuses on a two-stage process.

Given the above mechanism, I set the sovereign rating (SR) of the South as a determinant of the liquidity preference parameters of both southern and northern households that relate with the demand for southern bills[7]. Expressed in a formal way this implies endogenizing the λ_{20} and λ_{60} parameters of equations 11 and 15 respectively as follows:

[6] We could just remove the z dummy and any results we get would just be intensified.

[7] The way liquidity preference parameters are endogenized is influenced by Dafermos (2012).

$$\lambda_{20} = \zeta_{20} + \zeta_{21}SR;\ \zeta_{21} \leq 0 \tag{38}$$

$$\lambda_{60} = \zeta_{60} + \zeta_{61}SR;\ \zeta_{61} \leq 0 \tag{39}$$

Here, we can think of ζ_{20} and ζ_{60} as the default values of λ_{20} and λ_{60} respectively. Furthermore the ζ_{21} and ζ_{61} parameters capture the power of CRAs. Measured in absolute terms, the greater the value of those parameters, the greater the influence of sovereign ratings upon households' decision making (also see the sensitivity tests below). Both ζ_{21} and $\zeta_{61}$are set to be negative (or zero), implying here that a rise in SR would increase the liquidity preference of households by causing a fall in λ_{20} and λ_{60}. Such development would shift demand away from southern bills and towards interest- free cash. Interestingly, in accordance with the literature discussed earlier, the ζ_{61} can be seen as a reflection of the degree of influence of CRAs upon foreign capital flows. Furthermore, as constructed, the model provided here is a more general case of the corresponding model of Godley and Lavoie (2007b), with the latter being equivalent with the special case where $\zeta_{21} = \zeta_{61} = 0$.

As the SR model is set, there is a chain of causality running from sovereign rating events to the fiscal expenditure of the South. To facilitate the illustration of the channel I put together the most relevant equations, setting in bold the variables that link directly with the sovereign rating influence:

$$\boldsymbol{G^S} = \boldsymbol{\Delta B^S} + T^S - r^S_{-1}B^S_{S\,h-1} - r^S_{-1}B^S_{N\,h-1} \tag{18A}$$

$$\boldsymbol{B^S} = \boldsymbol{B^S_{Sh}} + B^S_{Nh} + B^S_{ECB} \tag{27A}$$

$$\boldsymbol{B^S_{Sh}} = \boldsymbol{V^S_e}(\boldsymbol{\lambda_{20}} - \lambda_{21} r_h + \lambda_{22} r^S - \lambda_{23} r^N - \lambda_{24} \frac{YD^S_e}{V^S_e}) \tag{11}$$

$$\boldsymbol{\lambda_{20}} = \zeta_{20} + \zeta_{21} \boldsymbol{SR};\ \zeta_{21} \leq 0 \tag{38}$$

Equation 18A shows the endogenous determination of the southern fiscal expenditure, 27A determines the total supply of southern bills, equation 11 sets the demand of southern bills by households that reside in the South, and equation 38 shows the abovementioned mechanism that links the sovereign rating of the south with the liquidity preference of southern households.

Reading those expressions from bottom to top, it can be seen that when SR changes, causing λ_{20} to change, we have $\Delta B^S_{Sh} = V^S_e * \Delta\lambda_{20}$. This implies that other than the power of CRAs, which as mentioned before is reflected by the ζ_{21} parameter, what matters in determining the overall effect of SR upon the southern fiscal expenditure is the total amount of wealth of the southern households: ceteris paribus, the greater the volume of wealth, the greater will be the exposure of the southern state to the sentiment of the financial market, and thus the greater the reduction in public expenditures it will need to confront when an SR shock occurs. This link is of course a manifestation of the simple truth that the greater the stock of bills held by southern households, the greater the amount of bills they can get rid of at any point of time. From here it would also be quite straightforward to expand and show how

a similar mechanism also operates in the model at the terrain of foreign flows (i.e. in that part of the model where northern households demand southern bills).

Simulation Results

Baseline SR Model

Having established the SR model, I now need to generate a recession in the South so as to see how the sovereign rating mechanism responds. For this purpose, I repeat the first experiment of the above, whereby the southern propensity to import rises from 0.18781 to 0.20781. With regards to the ζ parameters, ζ_{20} and ζ_{60} obtain the steady state values of λ_{20} and λ_{60} (0.35 and 0.32 respectively), while ζ_{21} and ζ_{61} are both set equal with -0.10. Figure 6 shows the most essential simulation results of the model. For the clarity of the comparison Figure 6 combines the results of the SR model with those generated by the same experiment in model FEXEND.

[Insert Figure 6 here]

As it can be seen, shortly after the generation of the recession, the sovereign rating mechanism is activated. Due to the deterioration of the sovereign rating score of the South, the households of both countries attempt to reduce their holdings of southern bills. With the ECB maintaining a passive role

in purchasing a fixed amount of southern bills, the government of the South is pushed to implement fiscal austerity by cutting sharply its expenditures. The key results are twofold. First, the trends of the debt to GDP ratios are reversed in both countries. On one hand the South is forced to issue fewer bills as a result of the downgrade, while the North needs to sell an increased amount of its bills to the ECB so as to maintain its own (exogenous) fiscal expenditure. Secondly the GDP of both countries falls. While the loss of national income is naturally more profound for the South, it is interesting that the North is also affected. This is mainly due to its foregone exports as well as the lower amount of wealth that the northern households end up with at the new steady state (recall that northern households give up southern bills and increase their holdings of cash).

Notice that the fall of GDP caused by sovereign ratings is gradually recovered. This is a result of the non-realistic assumption of fixed interest rates. Once the government of the south issues fewer bills, it automatically faces lower interest payments to conduct in the following periods, and hence the implemented austerity is reversed. Nonetheless, with a dose of imagination one could still think of such development as a real world outcome. It could for instance describe the case where the sovereign rating event causes an at least partial default of the downgraded government on its debt. In a similar fashion one could think of the reversal of the trend of the South's debt to GDP ratio as a result of debt restructuring.

While it is important to generate a recession so as to activate the sovereign rating mechanism, there are more than one ways of doing that in the SR model. An alternative could have been to generate a recession by repeating the second experiment of the FEXEND model whereby the public expenditure of

the North falls from 20 to 15. Preserving again the relevant FEXEND results as the benchmark, Figure 7 shows how the dynamics of the two economies are affected once there is an episode of a severe rating downgrade of the South. Most importantly, one can observe that all results reported above remain qualitatively unchanged. As with before there is a fall of the GDP for both countries due to the drop of the South's rating score, while in both countries the trends of their debt to GDP ratios are reversed.

[Insert Figure 7 here]

Alternative Specifications

[Insert Figure 8 here]

Shift of Demand towards the Bills of the North

The above specification is based on the assumption that once households get the news about the downgrade of the South, they will move funds away from southern bills and keep them in the form of cash. The logic here is that the downgrade will be seen as the reflection of upcoming uncertainty in the global economy. According to Keynes (1936), in such cases people start moving towards more liquid assets so as to protect themselves against violent economic fluctuations (hence the term 'liquidity preference'). In its most extreme form such movement is driven towards money (cash in this model), as being the most liquid asset of the economy, or else the 'ruler of the roost'.

Nonetheless, it would be fair to argue that a run towards cash does not always have to be the response to a downgrade. In that sense we could also think of a scenario where once the southern downgrade takes place, the households of both countries move towards northern bills instead. Although not the most liquid asset of the model, it would suffice for the hypothesis if we were to think of the northern bills as a relatively more liquid asset than the southern ones.

Given the above, I set an alternative specification of the model where not only the liquidity preference parameters of the southern bills' demand functions are endogenous (λ_{20} and λ_{60}), but also the ones related with the demand for northern bills. The endogenous mechanism is dictated by a similar logic with before, so that on top of equations 38 and 39, my model now also includes:

$$\lambda_{30} = \zeta_{30} + \zeta_{31}SR;\ \zeta_{31} \geq 0 \tag{40}$$

$$\lambda_{50} = \zeta_{50} + \zeta_{51}SR;\ \zeta_{51} \geq 0 \tag{41}$$

where λ_{30} and λ_{50} are the liquidity preference parameters of the demand for bills of the North by southern and northern households respectively (see equations 12 and 14). Same as before, ζ_{30} and ζ_{50} take the steady state values of λ_{30} and λ_{50}. In addition the ζ_{31} and ζ_{51} parameters are set to be equal or greater than zero and are meant to capture the positive influence of CRAs on the demand for northern bills. It is easy to see how the greater the value of those parameters, the greater the positive impact of a southern downgrade upon the

demand for bills of the North. Assuming for the sake of simplicity a similar influence of CRAs as before (in absolute terms), I set $\zeta_{31} = \zeta_{51} = 0.1$.

To evaluate the model, I repeat the first experiment of the above where a recession is caused by increasing the propensity to import of the South. The second column of Figure 8 illustrates the results of the model. Keeping the relevant results of the baseline specification in the first column of the figure, one can see that the key results remain qualitatively similar. The SR shock is still activated at the same point of time, while the recession is equally deep in both countries. The main noteworthy change is that instead of bouncing back to the steady state that would have occurred had the SR shock not been there, the new steady state values of the GDP in both countries move to a slightly higher level (contrast the first two graphs of the first row, from left to right). This is a result of the augmented consumption out of wealth that arises in both countries due to the increased popularity of the northern bills.

'Nervous' CRAs

Another alternative to the baseline specification of the SR model is to consider the hypothesis that similar with all other economic agents, CRAs can also be liable to feelings of euphoria and panic. Such feelings can be the result of amplified uncertainty, and as such can become more conspicuous in times of economic turbulence. Formally speaking they can be seen as a product of the 'qualitative' side of the analysis behind sovereign ratings. While Ferri *et al.* (1999) investigate econometrically a similar hypothesis at the terrain of the East

Asian crisis Ioannou (2014a) provides some more recent evidence on the affirmative for the sovereign ratings of the periphery states of Eurozone. In both cases there is a robust post-crisis gap between the actual ratings of the main CRAs and the ones generated by a dry econometric model that encompasses the key variables that are supposed to matter for sovereign ratings (e.g. real GDP growth, Debt to GDP, inflation etc.).

In the context of the current model, a way of approximating the above hypothesis can be by letting a random shock to influence the SR variable once both its determinants have crossed their thresholds. In a sense the specification provided here can be seen as one where CRAs 'get nervous' once they fully downgrade the southern state. Formally expressed this implies expanding equation 37 as follows:

$$SR = SR1 + SR2 - 0.8 * z + \tag{37A}$$

$$SR1 * SR2 * rnorm(mean = 0, st.dev. = 0.1)$$

Recalling that the $SR1$ and $SR2$ dummies relate with the accumulated GDP growth and the debt to GDP ratio of the South respectively, the mechanism established here will add an element of random volatility once both of those dummies get activated. While the zero mean of the random shock implies that the recession created by the sovereign downgrade is not made deeper, it can be easily seen how this could be the case under a positive mean[8]. The third column

[8] The mean would have to be positive so as to turn negative in its relation with the lambda parameters of the southern bills demand functions that the *SR* variable affects.

of Figure 8 portrays the results obtained when the updated SR function is incorporated into the baseline model. As it can be seen, the augmented volatility arising from the temperament of CRAs is communicated to all the important variables of the model. Additionally, it is transmitted to both countries.

Further Robustness Checks

Sensitivity Tests

[Insert Table 4 here]

In order to examine the sensitivity of the underlying model, I repeat the baseline simulations by trying different sets of numbers for the behavioral parameters. In particular, I focus on the numerical values of the propensities to import of the two countries (μ^S and μ^N), the propensities of households to consume out of disposable income (α_1^S and α_1^N), the liquidity preference that relate with the demand of domestic assets (λ_{20} and λ_{50}), as well as the zeta parameters that capture the influence of CRAs in the demand for southern bills (ζ_{21} and ζ_{61}). In the first three cases, I set every pair of parameters equal to the 90% and the 110% of the baseline values, and repeat the simulations in the FEXEND model. In the forth case, I set the zeta parameters equal with the 80% and the 120% of their default figures (measured in absolute terms), and re-run the baseline SR model (the only reason why I chose a wider gap here was to facilitate the diagrammatical illustration). Every scenario is examined

separately. That is, when I change for instance the propensities to import, all other behavioral parameters retain their baseline values. Moreover, for every pair of parameters the values of both countries are jointly set to either the 90% or the 110% levels. Table 4 reports the relevant numerical values for all sensitivity tests. In addition, Figures 9 and 10 illustrate the response of the different specifications to the first experiment of the above whereby a recession is caused by increasing the propensity to import of the southern economy.

[Insert Figures 9 and 10 here]

As it can be seen, in three out of the four experiments, there is no qualitative difference between the default parameterization and the alternative scenarios. To start with, all the trials based on different sets of propensities to import (see the first row of Figure 9) show that once the propensity to import of the South rises, there is a recession caused in the southern economy, while a fragile growth is experienced in the North. In all occasions the GDP is higher in the North under the new steady state. Moreover it is quite straightforward to see how the volume of the recession depends on the overall difference between the initial propensity to import of the southern economy (which varies under the relevant sensitivity tests) and the number introduced by the shock (same with the above experiment this is 0.20781). Similarly, it can be seen that under all trials the new steady state gives a higher debt to GDP ratio for the South compared with the North.

Sensible results are also produced under the different specifications of the lambda and zeta parameters. In the case of the first, the lower the values of

λ_{20} and λ_{50}, i.e. the lower the autonomous demand for domestic bills, the deeper the recession for both countries. Additionally, while the debt to GDP of the South always ends up being higher than the North's under the new steady state, the gap between the two widens as we increase the values of the lambdas. Regarding the trials of the SR model with different zeta parameters (second row in Figure 10), it is easy to see how the greater the absolute values of ζ_{21} and ζ_{61}, or else the greater the power of CRAs, the deeper the recession. Furthermore, the greater such influence, the lower the new steady state debt to GDP ratio for the South at the end of the recession. The opposite holds for the North.

The only case of 'puzzling' results is when I try out different propensities to consume out of disposable income. In particular, as it can be seen from the second row of Figure 9, when setting α_1^S and α_1^N equal with the 90% of their baseline values, the recession caused by the rise of the propensity of imports of the South is initially deepened but the GDP of both countries in the new steady state is higher than before. The reverse holds when the alphas are set at the 110% level. At the same time the recession is still effective in that the GDP of the South ends up significantly lower than its initial level under all specifications. Moreover, despite the fact that under all specifications the debt to GDP of the South ends up being higher than that of the North, we can observe some qualitatively different dynamics being developed. On one hand the 90% setting gives a higher debt to GDP ratio for both countries compared with their baseline specification, while the opposite holds true under the 110% regime.

There is a simple explanation for such results. They reflect the limitations of my model. Recall that my model has no active firms, and no private banks. At

the same time, by construction model FEXEND positively associates fiscal expenditures with household savings and wealth. In that regard, given the lack of investment and banking credit, there is a sort of neoclassical slip in that increased aggregate savings expand aggregate expenditure, rather than the other way around. More precisely, when the alpha one propensities to consume equal with the 90% of the baseline, more savings are generated which in turn raise the demand for government bills, therefore giving rise to an initial overshooting of the southern fiscal expenditure (not reported here). Following, the fiscal expenditure of the south converges to the new baseline steady state, but as shown above the overshooting is sufficient to ameliorate the new steady state for the GDP of both countries.

With this said, let me note that it is precisely because of the limitation pointed out here that I have abstained from conducting experiments with the propensities to consume in the current. To avoid misleading insights, such experiments would require a more rigorous modeling of the corporate and banking sectors, as for instance done in chapter 7 of Godley and Lavoie (2007b).

A Version of the Model with Prices

Another evident limitation of the model as developed so far has been the assumption of fixed prices. In particular, there has been no consideration of inflationary dynamics, which in an open economy environment might be thought to matter for international trade, most notably by affecting the competitiveness of trading countries. For instance it could be said that the enlargement of the current account deficit in a country would push the latter to conduct some

internal devaluation (given the assumption of fixed exchange rates) by cutting its production costs, mainly wages, so as to regain its competitiveness. As a result, such policy could prevent a crisis from building up, and in that way prevent episodes of severe downgrades such as the ones described above[9].

Although the assumption of fixed prices has been a deliberate choice so as to keep the model simple and allow myself to illustrate clearly the mechanism developed above, it is interesting to see how results are affected once prices are incorporated into the model. In particular, building on the insights of chapter 12 of Godley and Lavoie (2007b), I introduce five price indices per country into the FEXEND model. These include the GDP deflator p_y, the sales and domestic sales indices (p_s and p_{ds} respectively), as well as the prices of imports and exports (p_m and p_x). All new and modified equations can be found in Appendix B. Following the conventional notation, small Latin letters denote real variables, while capital Latin letters stand for nominal ones. Furthermore, to avoid confusion notice that when found in front of a price index, the lower-script s stands for 'sales' (and not 'supply' as before). Most notably, the model now includes a standard Kaleckian mark-up mechanism for the sales of each country (eq. 62 and 77) while following the insights of chapter 9 there is also a mechanism of endogenous wage determination in each country (eq. 65, 66, 80 and 81). Illustrated here for the case of the South:

[9] This line of thought, often associated with austerity policies, lies in some quite shaky assumptions such as for instance the idea that falling wages will translate into falling prices. Nonetheless, its in-depth critique of it goes beyond the purpose of the current.

$$p_s^S = (1+\varphi^S)\frac{W_{-1}^S N_{-1}^S + IM_{-1}^S}{s_{-1}^S} \tag{62}$$

$$\omega_T^S = (\frac{W^S}{p_S^S})_T = \Omega_{10} + \Omega_{11} pr^S + \Omega_{12}(\frac{N^S}{N_{fe}^S}) \tag{65}$$

$$W^S = W_{-1}^S[1 + \Omega_{13}\left(\omega_{T-1}^S - \frac{W_{-1}^S}{p_{S-1}^S}\right)] \tag{66}$$

where φ denotes the exogenously given mark-up, W is the nominal wage rate and s stands for real sales. In addition ω_T is the real wage target of workers, which is set to be a function of the exogenously given productivity (pr) and the degree of employment ($\frac{N}{N_{fe}}$). As set there is an adaptive mechanism in which the wage rate is updated in every period based on the discrepancy between last period's targeted and actual real wage. Also note that in the new version of the model households' consumption decisions and expectations are based on real variables. Furthermore the imports of the two countries are not only a function of domestic income anymore but also associate with relative prices.

An issue that arises in this version of the model is the non-linearity of the system once the mark-up equation has been established. To circumvent the problem I allow all price mechanisms to operate with a lag so as to break the non-linear system into smaller linear ones. At the terrain of economic logic such approach can be thought as a sort of price stickiness dynamic.

[Insert Figure 11 here]

Having defined the model I now repeat the same experiments as in Figure 5. Figure 11 reports the relevant results. In the first experiment I raise the autonomous southern propensity to import (column 1). In the second one (column 2) I decrease the exogenous fiscal expenditure of the North, while in the third one (column 3) I drop the λ_{20} parameter from 0.35 to 0.2. In order to facilitate the comparison with the simple FEXEND model, Figure 11 preserves a one to one correspondence with Figure 5 in the mapping of all graphs.

As it can be seen the incorporation of prices creates some cyclicality, which obscures the inference beyond the short and medium run. This is a result of having endogenous fiscal expenditures and lagged prices (although not reported here, the version of the model with exogenous southern fiscal expenditures was much more stable). With this said notice that all the essential short-term dynamics are similar with the ones developed in the simple FEXEND model. For example, once the autonomous propensity to import of the South increases, a recession is created in the South, while a fragile growth arises in the North. Similarly there is a rise of the southern debt to GDP ratio and a decline of the northern one. Moreover a recession is caused in both countries when either the northern fiscal expenditure drops or the liquidity preference of the south increases. The only substantial short-run difference with before is the fact that under experiment two, not only the debt to GDP ratio of the South but also that of the north increases (in contrast with the simple FEXEND model where the debt to GDP ratio of the North was experiencing a decline).

[Insert Figure 12 here]

Coming to the inclusion of my sovereign rating mechanism, Figure 12 contrasts the results of the simple SR model (left-hand column) with the ones obtained from the SR model with prices (right-hand). Same as before recession is caused by an increase in the propensity to import μ^S in the case of the simple model. At the same time, a similar recession is caused in the price model by increasing μ_{10}, the autonomous propensity to import of the South. As documented in the relevant graphs, all key dynamics remain unchanged. The SR mechanism is still activated once the accumulated growth of the South and/ or the debt to GDP ratio of the country crosses a certain threshold (-14% for accumulated growth and 85% for the debt to GDP ratio). The downgrade of the southern economy drives households' demand away from southern bills and towards cash. Such development reduces the fiscal expenditure of the southern state, and as a result both counties are driven deeper into recession. In addition, same as before, the debt to GDP ratios reverse their trends.

Conclusion

The paper provides the first attempt to capture the effects of sovereign ratings in a macroeconomic model. Employing an open economy SFC model, I show how sovereign ratings can contribute to an already ongoing recession by impeding a government's access to financial resources and by pushing it to implement fiscal austerity. The model sets a mechanism where sovereign ratings are first determined endogenously and then come to influence the wealth

allocation decisions of households. A number of possible closures are considered and a set of robustness checks is conducted.

To facilitate the tractability and illustration of the model, a number of simplifications have been allowed. Most notably, no active firms and private banks are considered. It is quite straightforward to see how such simplifications limit the scope of my construct. In that sense, a promising extension of the current could be to develop a model with a more rigorous treatment of those sectors, so that further links between sovereign ratings and the macro-economy can be explored. For instance sovereign ratings could be thought not only to affect public expenditures, but also to influence the decisions of banks regarding their provision of credit.

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Table 1. Balance Sheet Matrix

	South			ECB	North			
	Households	Firms	Government		Households	Firms	Government	**Σ**
Cash	$+H_h^S$			$-H$	$+H_h^N$			0
Southern Bonds	$+B_{Sh}^S$		$-B^S$	$+B_{ECB}^S$	$+B_{Nh}^S$			0
Northern Bonds	$+B_{Sh}^N$			$+B_{ECB}^N$	$+B_{Nh}^N$		$-B^N$	0
Balance	$-V_h^S$		$-NW_g^S$		$-V_h^N$		$-NW_g^N$	0
Σ	0		0	0	0		0	0

Notes: plus and minus denote assets and liabilities respectively

Table 2. Transactions Flow Matrix

		South			ECB		North			
		Households	Firms	Government			Households	Firms	Government	Σ
					C	K				
	Consumption	$-C^S$	$+C^S$				$-C^N$	$+C^N$		0
	Govt. Exp.		$+G^S$	$-G^S$				$+G^N$	$-G^N$	0
	Trade		$-IM^S$					$+X^N$		0
			$+X^S$					$-IM^N$		0
	GDP [Memo Item]	$+Y^S$	$-Y^S$				$+Y^N$	$-Y^N$		0
	ECB' Profits			$+r^S_{-1}B^S_{ECB-1}$	$-F_{ECB}$				$+r^N_{-1}B^N_{ECB-1}$	0
	Taxes	$-T^S$		$+T^S$			$-T^N$		$+T^N$	0
Interest On	Southern Bonds	$+r^S_{-1}B^S_{Sh-1}$		$-r^S_{-1}B^S_{-1}$	$+r^S_{-1}B^S_{ECB-1}$		$+r^S_{-1}B^S_{Nh-1}$			0
	Northern Bonds	$+r^N_{-1}B^N_{Sh-1}$			$+r^N_{-1}B^N_{ECB-1}$		$+r^N_{-1}B^N_{Nh-1}$		$-r^N_{-1}B^N_{-1}$	0
Change in the Stock of	Southern Bonds	$-\Delta B^S_{Sh}$		$+\Delta B^S$		$-\Delta B^S_{ECB}$	$-\Delta B^S_{GERh}$			0
	Northern Bonds	$-\Delta B^N_{Sh}$				$-\Delta B^N_{ECB}$	$-\Delta B^N_{GERh}$		$+\Delta B^N$	0
	Cash	$-\Delta H^S_h$				$+\Delta H$	$-\Delta H^N_h$			0
	Σ	0	0	0	0	0	0	0	0	0

Notes: plus and minus denote revenues and expenditures respectively

Table 3. Accumulated GDP Growth and Public Debt to GDP for EMU Peripheral Countries

		2008	2009	2010	2011	2012
Greece	Accumulated Real GDP growth	-0.22	-3.40	-8.35	-15.45	-21.82
	Public Debt to GDP	112.90	129.69	148.33	170.31	156.87
Ireland	Accumulated Real GDP growth	-2.17	-8.56	-9.63	-7.41	-7.31
	Public Debt to GDP	44.16	64.42	91.19	104.08	117.40
Italy	Accumulated Real GDP growth	-1.21	-6.68	-4.94	-4.48	-6.99
	Public Debt to GDP	106.09	116.42	119.29	120.70	126.96
Portugal	Accumulated Real GDP growth	-0.03	-2.95	-0.94	-2.22	-5.47
	Public Debt to GDP	71.69	83.70	93.99	108.25	124.07
Spain	Accumulated Real GDP growth	0.85	-3.00	-3.21	-3.14	-4.80
	Public Debt to GDP	40.17	53.98	61.66	70.47	85.97

Notes: real GDP growth and Public Debt to GDP are both measured in % units; source: Eurostat and author's elaboration

Table 4. Sensitivity Tests (as percentages of baseline values)

Parameter	Baseline	90%	110%	90%	110%	90%	110%	80% (in abs. values)	120% (in abs. values)
μ^S	0.187	0.1683	0.2057	-	-	-	-	-	-
μ^N	0.187	0.1683	0.2057	-	-	-	-	-	-
λ_{20}	0.35	-	-	0.315	0.385	-	-	-	-
λ_{50}	0.35	-	-	0.315	0.385	-	-	-	-
α_1^S	0.7	-	-	-	-	0.63	0.77	-	-
α_1^N	0.6	-	-	-	-	0.54	0.66	-	-
ζ_{21}	-0.1	-	-	-	-	-	-	-0.08	-0.12
ζ_{61}	-0.1	-	-	-	-	-	-	-0.08	-0.12

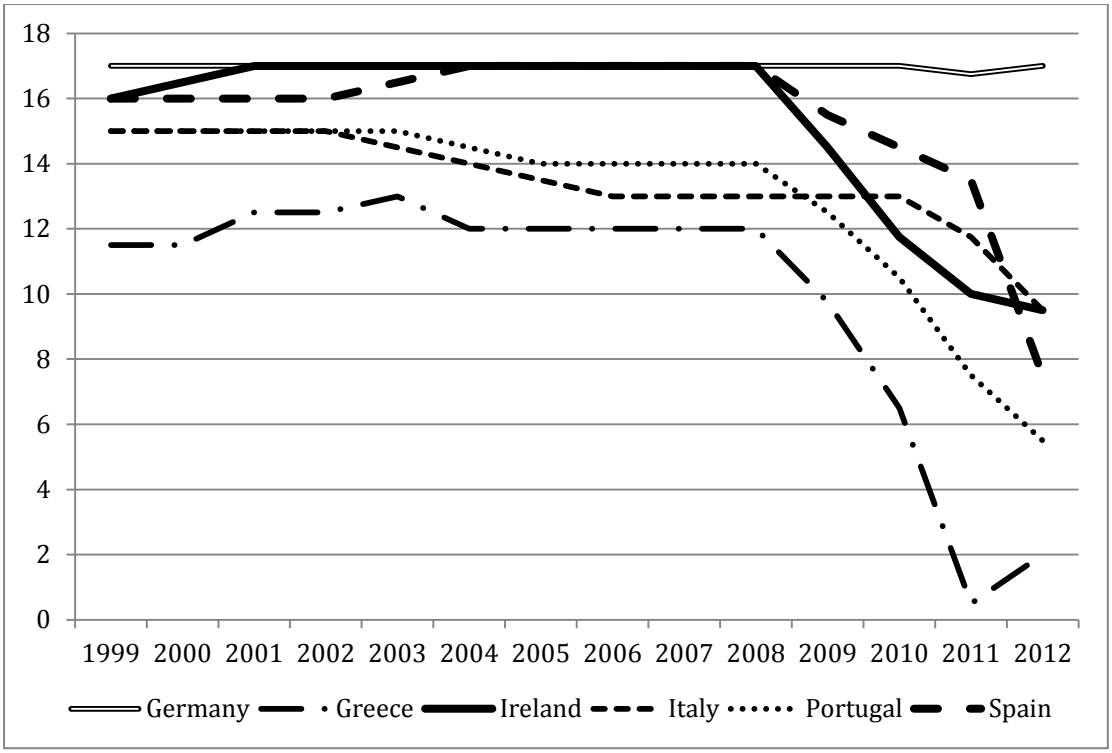

Figure 1. S&P sovereign ratings of a selection of EMU countries; ratings measured in a 1 to 17 scale with 17 corresponding to AAA and 1 corresponding to any rating from CCC+ and below; source: S&P website and author's elaboration.

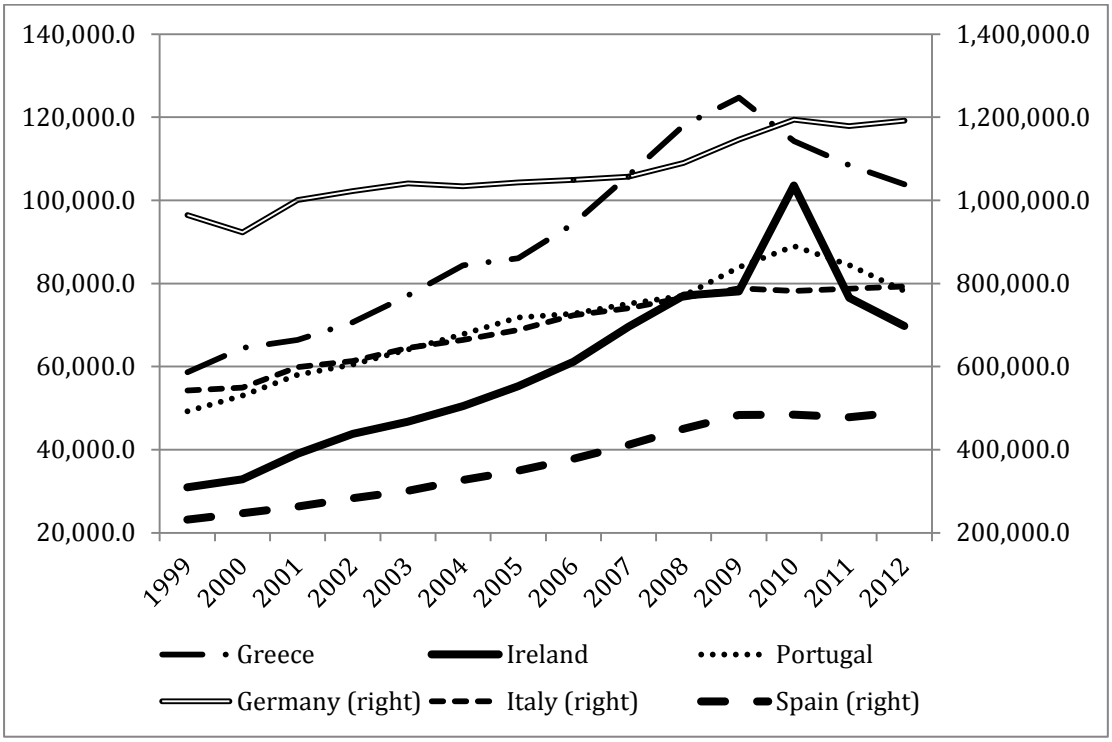

Figure 2. Total Public Expenditures of a selection of EMU countries; unit: millions of Euro; source: Eurostat.

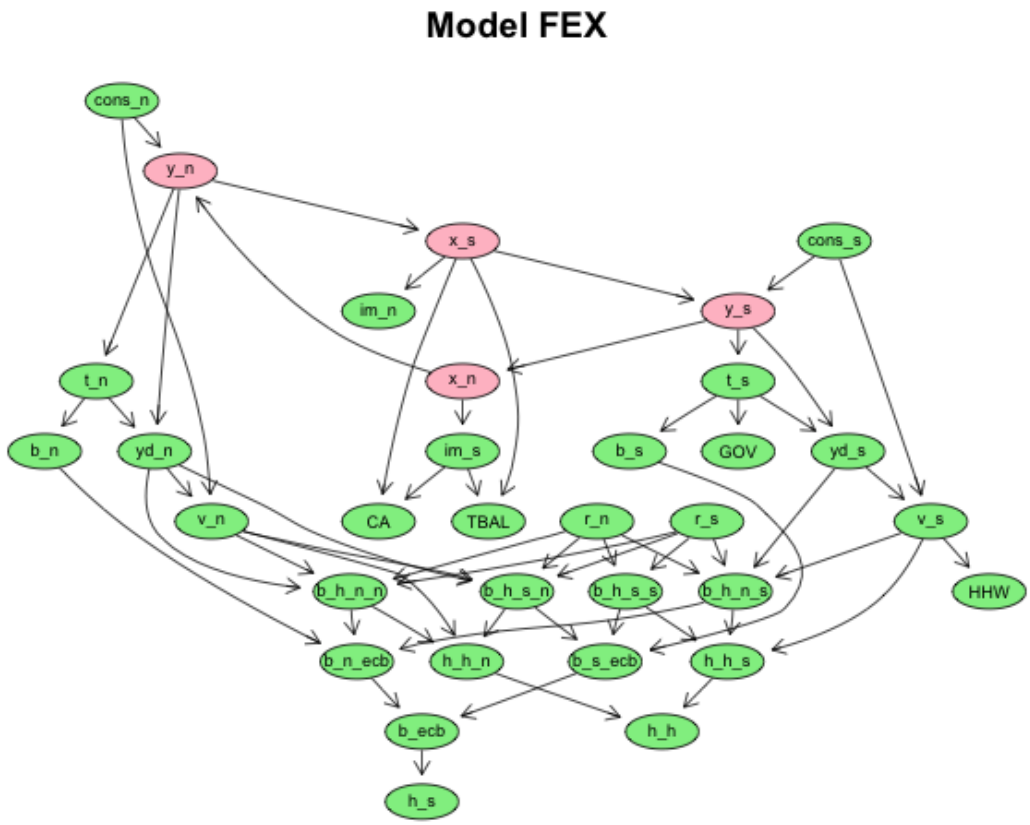

Figure 3. DAG of model FEX; green nodes denote a clear hierarchical causality; red nodes denote the variables that are simultaneously determined

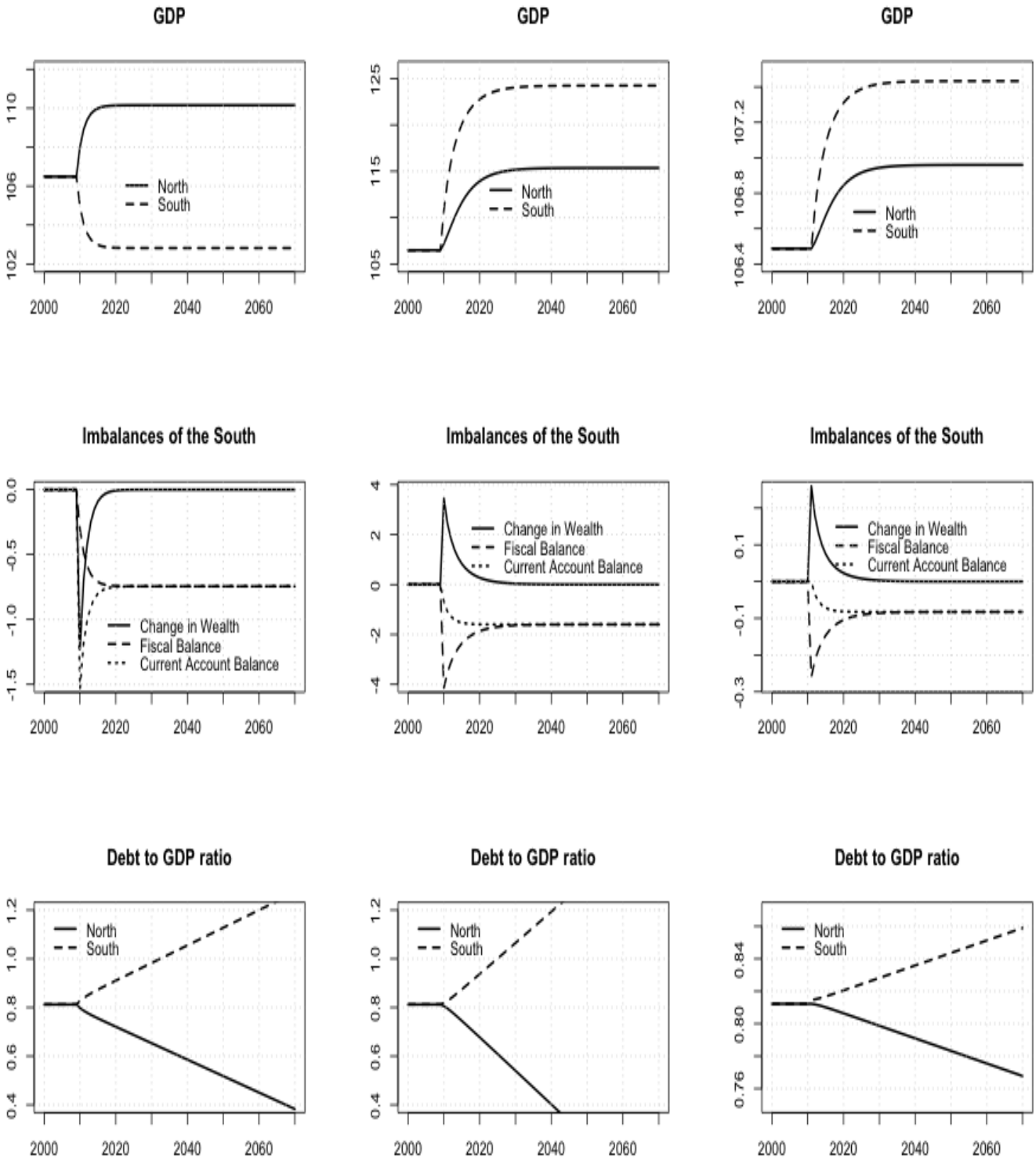

Figure 4. Three experiments with FEX; experiment 1 (1st column): increase the propensity to consume of the South from 0.18781 to 0.20781; experiment 2 (2nd column): increase the (exogenous) fiscal expenditures of the South from 20 to 25; experiment 3 (3rd column): reduce the liquidity preference of southern households by setting λ_{20} from 0.35 to 0.5. First row describes the development of GDP across all three experiments, the second row shows the developments of the change in private wealth, as well as the fiscal and current account imbalances, while row three shows the development of the debt to GDP ratio for the two countries.

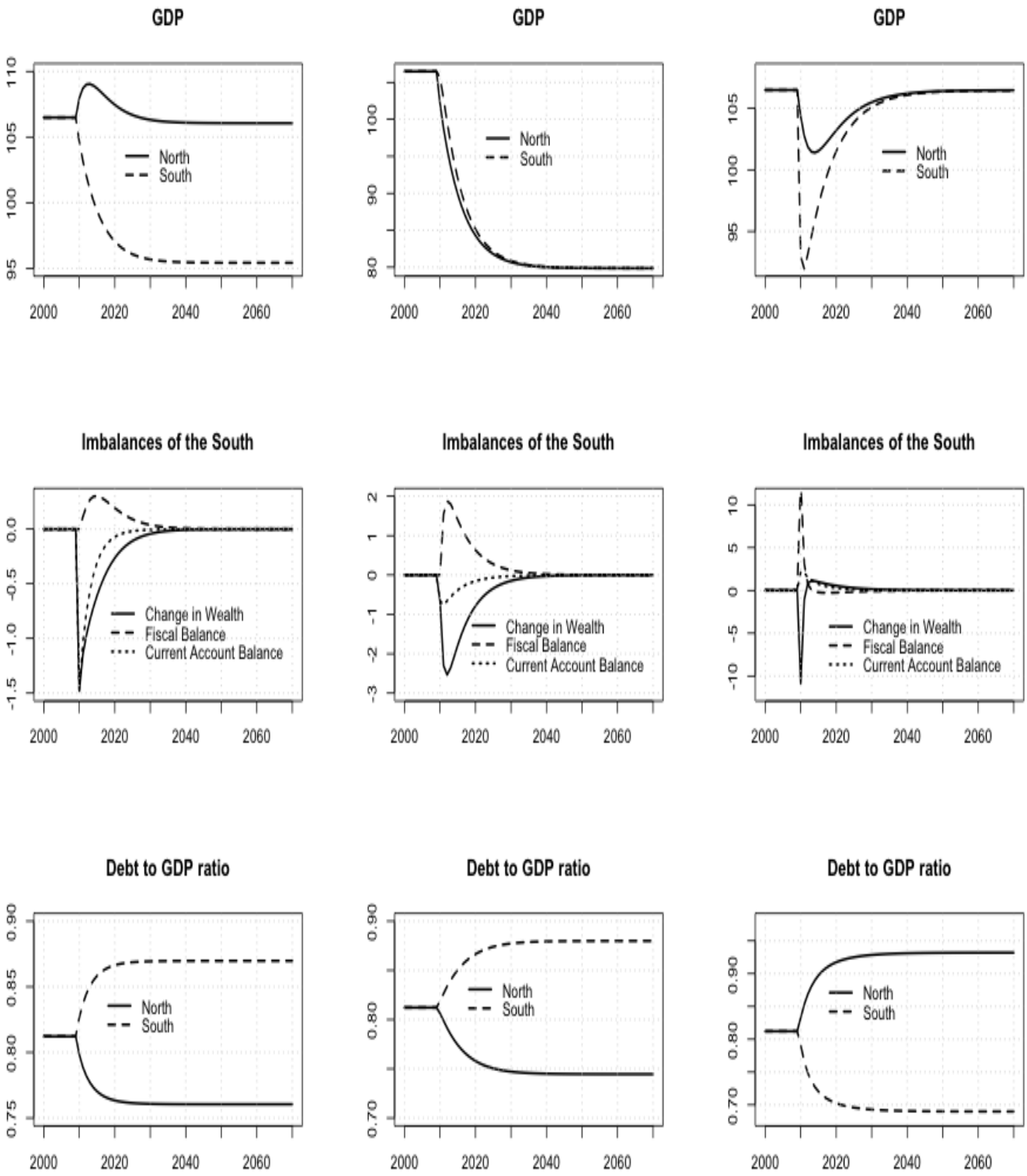

Figure 5. Three experiments with model FEXEND; experiment 1 (1st column): increase the propensity to consume of the South from 0.18781 to 0.20781; experiment 2 (2nd column): decrease the (exogenous) fiscal expenditures of the North from 20 to 15; experiment 3 (3rd column): increase the liquidity preference of southern households by reducing λ_{20} from 0.35 to 0.2. First row describes the development of GDP across all three experiments, the second row shows the developments of the change in private wealth, as well as the fiscal and current account imbalances, while row three shows the development of the debt to GDP ratio for the two countries.

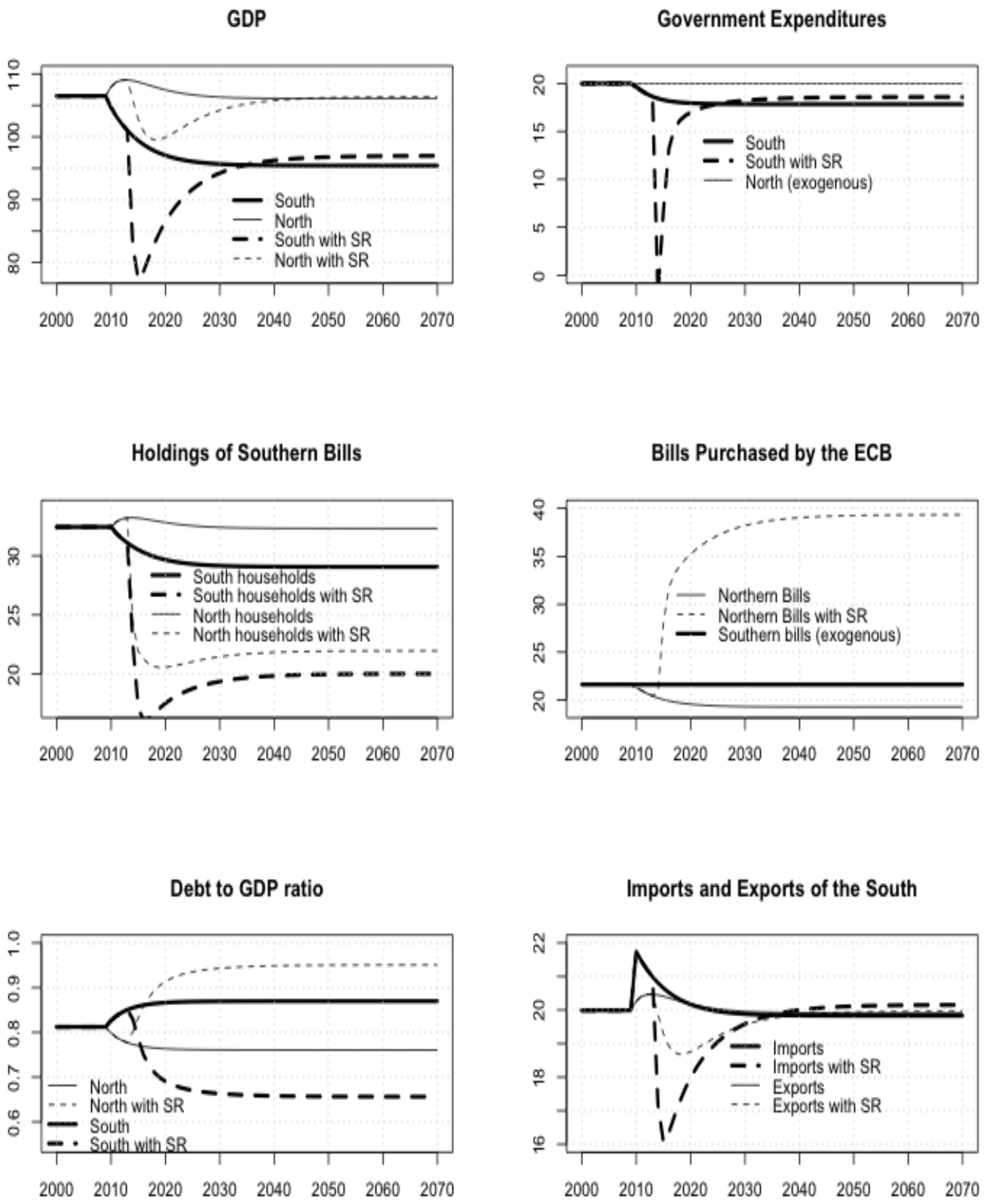

Figure 6. Key results of the baseline SR model when a recession is caused by the increase of the South's propensity to import. Model FEXEND (continuous lines) used as a benchmark of comparison for the evaluation of the effects of the sovereign rating downgrade of the South.

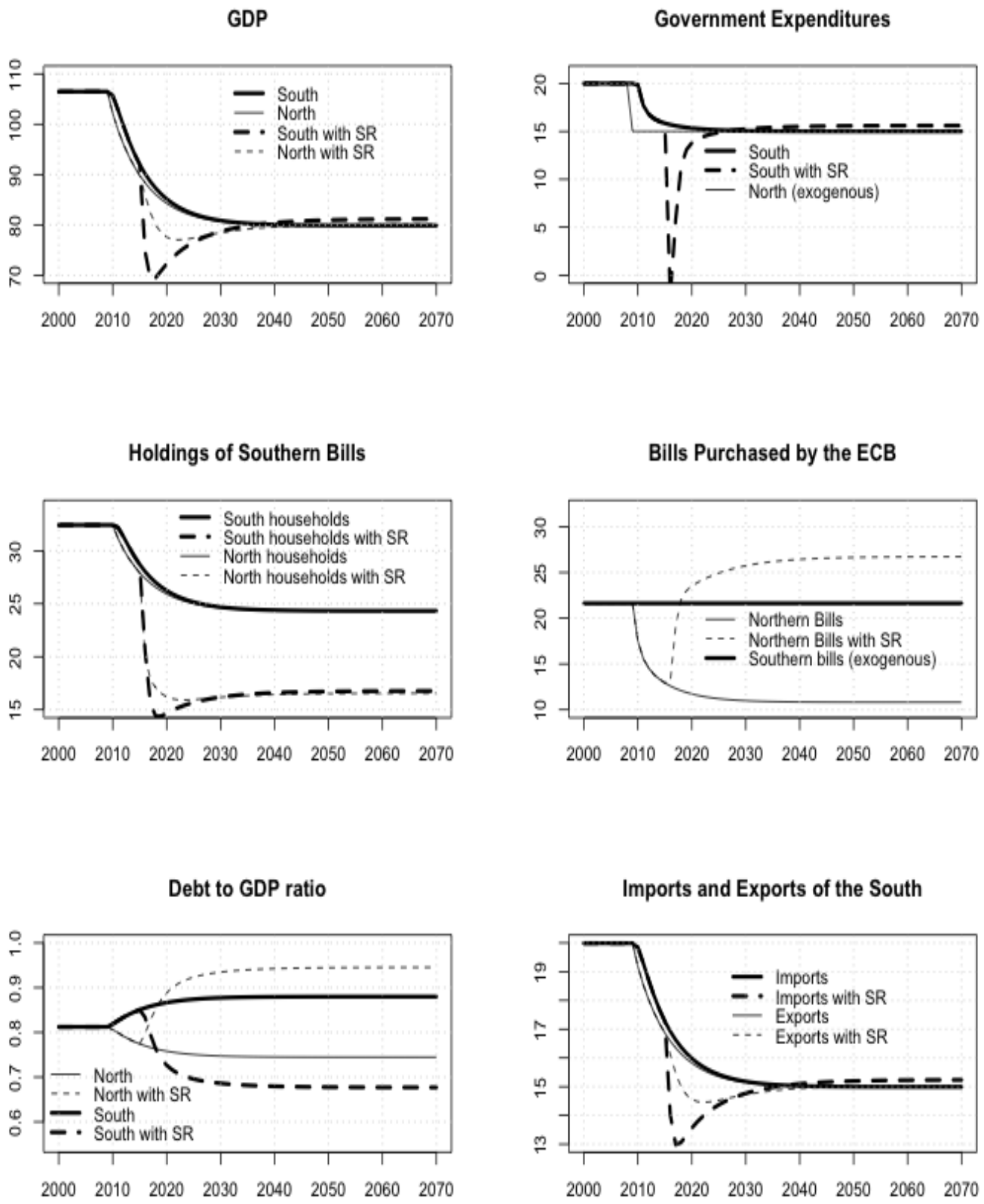

Figure 7. Key results of the baseline SR model when a recession is caused by the fall of the public expenditure of the North. Model FEXEND (continuous lines) used as a benchmark of comparison for the evaluation of the effects of the sovereign rating downgrade of the South.

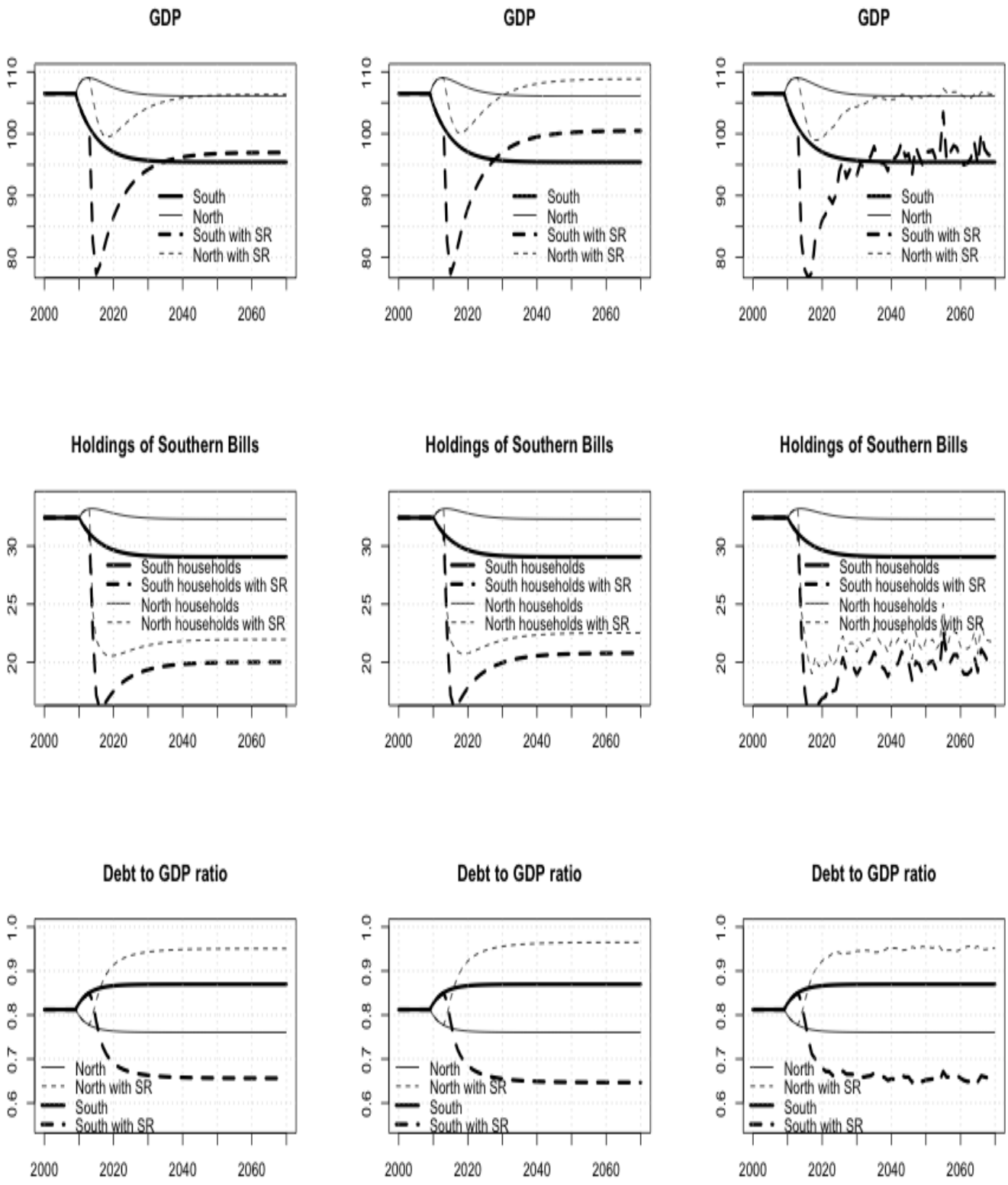

Figure 8. Alternative specifications of the SR model: Column 1 preserves the relevant results of the baseline specification; column 2 illustrates the model with endogenous liquidity parameters in the northern bills' demand functions; column 3 illustrates a version of the baseline model with a random shock in the *SR* specification.

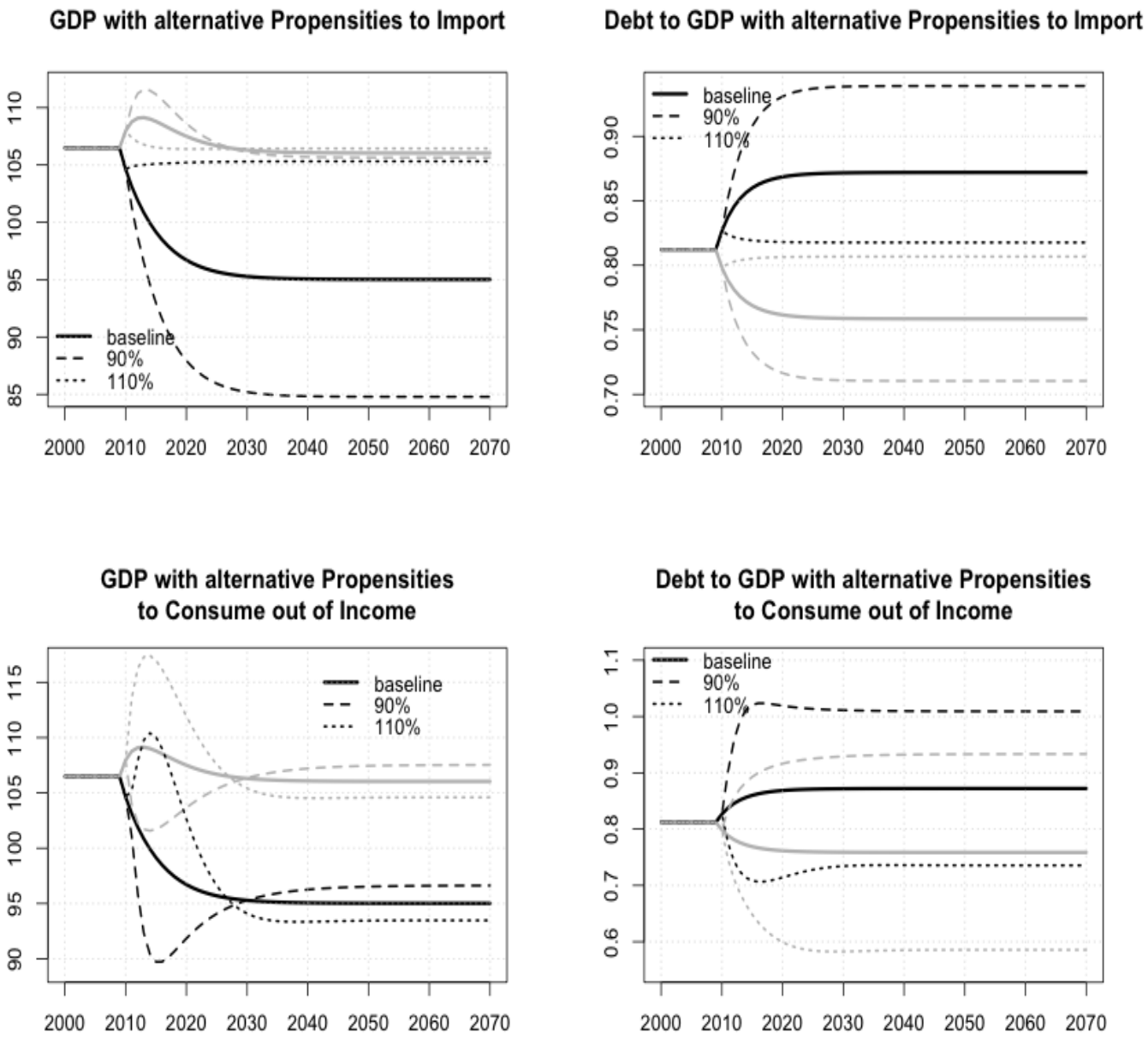

Figure 9. Sensitivity tests with different values for the propensities to import and the propensities to consume out of income; illustration is based on experiment 1, where the propensity to import of the South increases; in all graphs the South is in black and the North in grey; each set of propensities is changed simultaneously for both countries, either in the 90% or in the 110% level of their default values. All tests are done in model FEXEND.

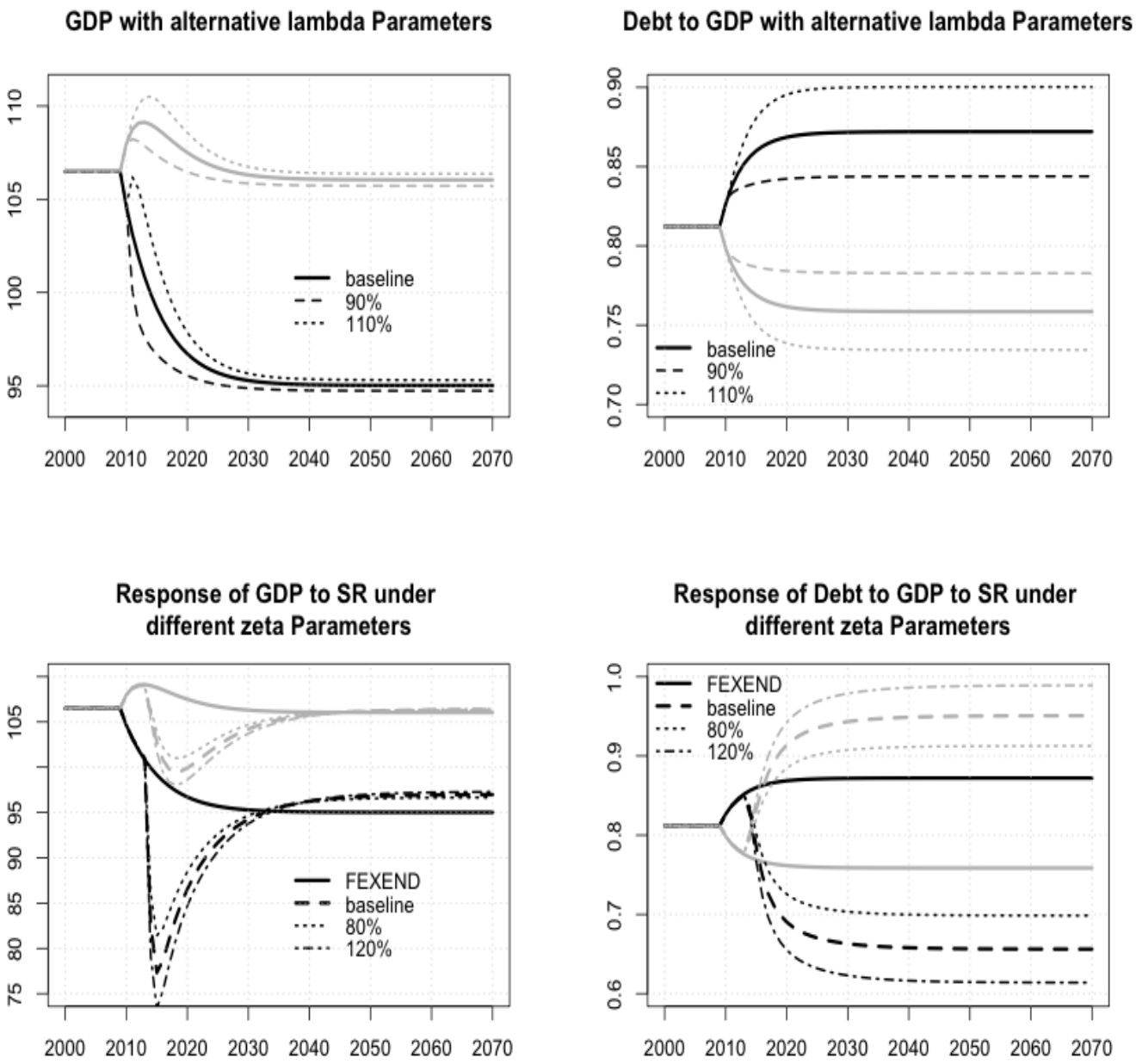

Figure 10. Sensitivity tests with different values for the lambda and zeta parameters; illustration is based on experiment 1, where the propensity to import of the South increases; in all graphs the South is in black and the North in grey; each set of parameters is changed simultaneously for both countries; in the case of the lambda parameters the 90% and the 110% are tested and the underlying model is the FEXEND one; in the case of the zeta parameters, FEXEND is included for the facilitation of the comparison, and the tests are conducted in the baseline SR model; the zeta values are reset to the 80% and 120% levels, measured in absolute terms.

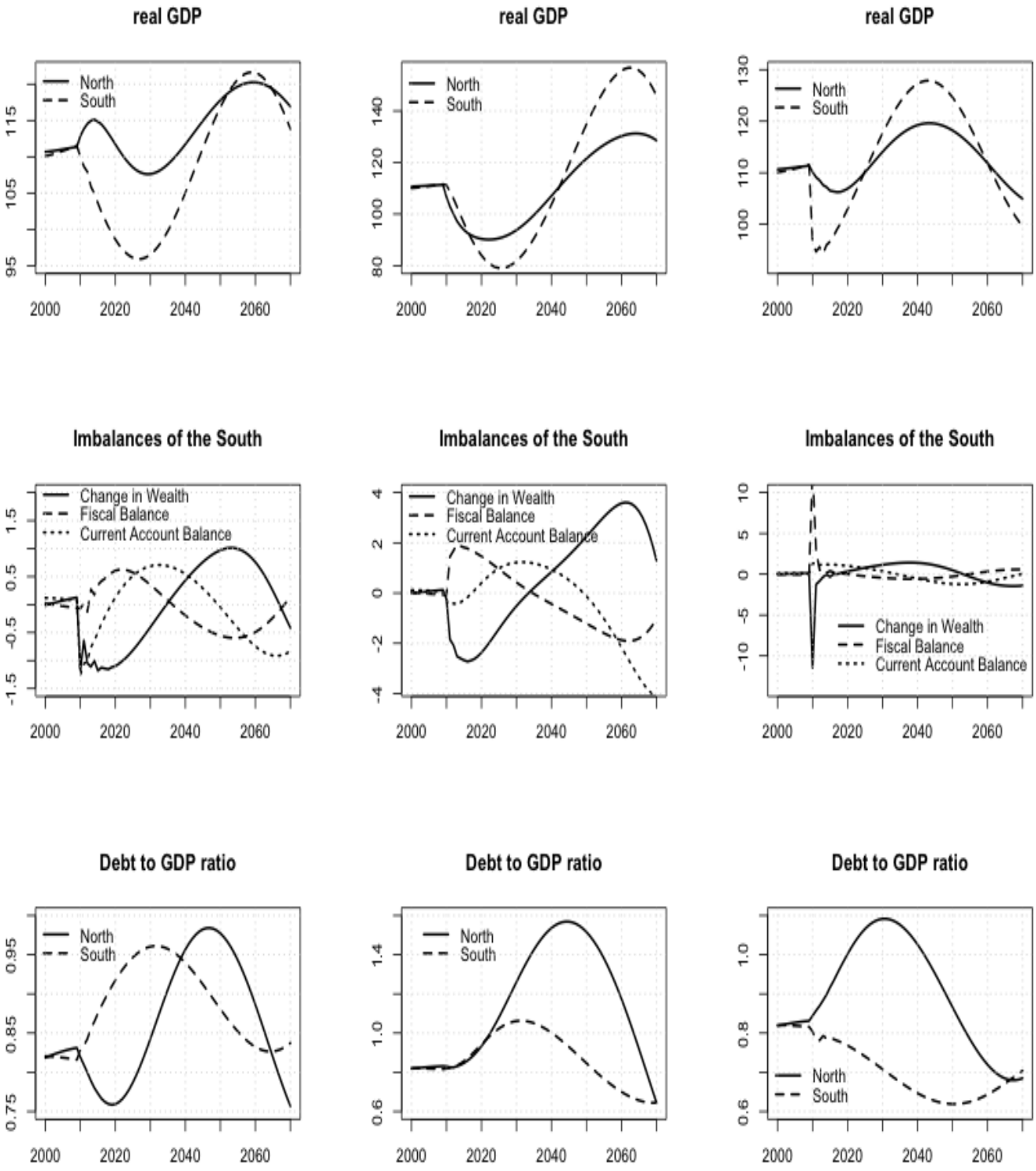

Figure 11. Three experiments with the version of FEXEND model with prices; experiment 1 (1st column): increase the propensity to consume of the South from 0.18781 to 0.20781; experiment 2 (2nd column): decrease the (exogenous) fiscal expenditures of the North from 20 to 15; experiment 3 (3rd column): increase the liquidity preference of southern households by reducing λ_{20} from 0.35 to 0.2. First row describes the development of GDP across all three experiments, the second row shows the developments of the change in private wealth, as well as the fiscal and current account imbalances, while row three shows the development of the debt to GDP ratio for the two countries.

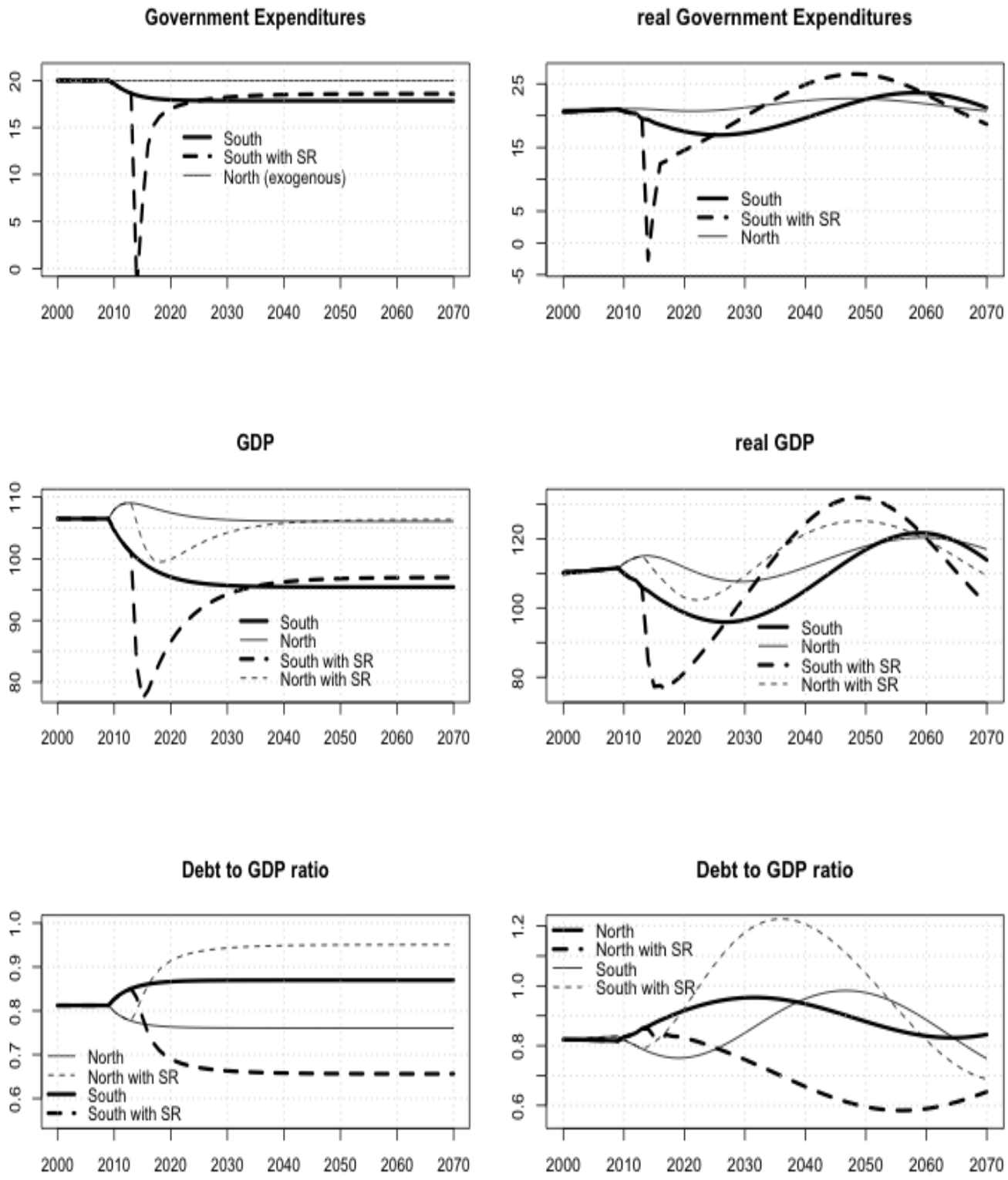

Figure 12. Comparison of the baseline SR model in the nominal version (left hand) and the version with price fluctuations (right hand column); recession generated by the rise of the autonomous propensity to import of the South; in all cases the corresponding FEXEND model (captured by the continuous lines) is used as a benchmark of comparison for the evaluation of the effects that arise out of the sovereign rating downgrade of the South.

Appendix A- Equations of the Simple Model

Remarks

- The 'S' and 'N' upper-scripts denote the South and the North respectively
- Only the equations that are actually used in simulations are numbered.
- In all financial assets, the upper script denotes the issuer and the lower script denotes the holder of the asset.
- Lower scripts 'd', 's', 'h', and 'e' denote demand, supply, actual holdings and expectations respectively

Exogenous parameters

- α propensities to consume
- λ_{ij} tobinisque parameters ($i = 1,2,..6; j = 1,2,..5$)
- θ^S, θ^N taxation rates
- r^S, r^N government bills interest rates
- μ propensities to import
- G public expenditure of both countries

Household Sector

South

Income and Wealth (ex post)

$$YD^S = Y^S - T^S + r^S_{-1}B^S_{Sh-1} + r^N_{-1}B^N_{Sh-1} \tag{1}$$

$$V^S = V^S_{-1} + (YD^S - C^S) \tag{2}$$

Equations related with the consumption and investment decisions of households

.

$$C^S = \alpha^S_1 YD^S_e + \alpha^S_2 V^S_{-1} \tag{3}$$

$$YD^S_e = YD^S_{-1} \tag{4}$$

$$V^S_e = V^S_{-1} + (YD^S_e - C^S) \tag{5}$$

North

Income and Wealth (ex post)

$$YD^N = Y^N - T^N + r^N_{-1} B^N_{Nh-1} + r^S_{-1} B^S_{Nh-1} \tag{6}$$

$$V^N = V^N_{-1} + (YD^N - C^N) \tag{7}$$

Equations related with the decisions of households

$$C^N = \alpha^N_1 YD^N_e + \alpha^N_2 V^N_{-1} \tag{8}$$

$$YD^N_e = YD^N_{-1} \tag{9}$$

$$V^N_e = V^N_{-1} + (YD^N_e - C^N) \tag{10}$$

Asset Demand Functions

South

$$\frac{H^S_d}{V^S_e} = \lambda_{10} + \lambda_{11} r_h - \lambda_{12} r^S - \lambda_{13} r^N + \lambda_{14} \frac{YD^S_e}{V^S_e}$$

$$\frac{B^S_{Sh}}{V^S_e} = \lambda_{20} - \lambda_{21} r_h + \lambda_{22} r^S - \lambda_{23} r^N - \lambda_{24} \frac{YD^S_e}{V^S_e} \tag{11}$$

$$\frac{B_{Sh}^{N}}{V_e^S} = \lambda_{30} - \lambda_{31} r_h - \lambda_{32} r^S + \lambda_{33} r^N - \lambda_{34} \frac{YD_e^S}{V_e^S} \tag{12}$$

$$H_d^S = V_e^S - B_{Sh}^S - B_{Sh}^N$$

$$H_h^S = V^S - B_{Sh}^S - B_{Sh}^N \tag{13}$$

North

$$\frac{H_d^N}{V_e^N} = \lambda_{40} + \lambda_{41} r_h - \lambda_{42} r^N - \lambda_{43} r^S + \lambda_{44} \frac{YD_e^N}{V_e^N}$$

$$\frac{B_{Nh}^{N}}{V_e^N} = \lambda_{50} - \lambda_{51} r_h + \lambda_{52} r^N - \lambda_{53} r^S - \lambda_{54} \frac{YD_e^N}{V_e^N} \tag{14}$$

$$\frac{B_{Nh}^{S}}{V_e^N} = \lambda_{60} - \lambda_{61} r_h - \lambda_{62} r^N + \lambda_{63} r^S - \lambda_{64} \frac{YD_e^N}{V_e^N} \tag{15}$$

$$H_d^N = V_e^N - B_{Nh}^N - B_{Nh}^S$$

$$H_h^N = V^N - B_{Nh}^N - B_{Nh}^S \tag{16}$$

Following the Tobinisque principles for each country, the vertical conditions are

$$\lambda_{10} + \lambda_{20} + \lambda_{30} = 1$$

$$\lambda_{11} + \lambda_{21} + \lambda_{31} = 0$$

$$\lambda_{12} + \lambda_{22} + \lambda_{32} = 0$$

$$\lambda_{13} + \lambda_{23} + \lambda_{33} = 0$$

$$\lambda_{14} + \lambda_{24} + \lambda_{34} = 0$$

for the South and

$$\lambda_{40} + \lambda_{50} + \lambda_{60} = 1$$

$$\lambda_{41} + \lambda_{51} + \lambda_{61} = 0$$

$$\lambda_{42} + \lambda_{52} + \lambda_{62} = 0$$

$$\lambda_{43} + \lambda_{53} + \lambda_{63} = 0$$

$$\lambda_{44} + \lambda_{54} + \lambda_{64} = 0$$

for the North. In turn the symmetry conditions are

$$\lambda_{12} = \lambda_{21}$$

$$\lambda_{13} = \lambda_{31}$$

$$\lambda_{23} = \lambda_{32}$$

and

$$\lambda_{51} = \lambda_{42}$$

$$\lambda_{61} = \lambda_{43}$$

$$\lambda_{62} = \lambda_{53}$$

for the South and the North respectively. Also note that the fulfillment of the vertical and symmetry conditions automatically satisfies the horizontal conditions too (Godley and Lavoie, 2007b: 145).

The Government Sector

South

$$T^S = \theta^S(Y^S + r_{-1}^S B_{Sh-1}^S + r_{-1}^N B_{Sh-1}^N) \tag{17}$$

$$\Delta B^S = G^S - T^S + r_{-1}^S B_{S\,h-1}^S + r_{-1}^S B_{N\,h-1}^S \tag{18}$$

$$-NW_g^S = B^S$$

North

$$T^N = \theta^N(Y^N + r_{-1}^N B_{Nh-1}^N + r_{-1}^S B_{Nh-1}^S) \tag{19}$$

$$\Delta B^N = G^N - T^N + r_{-1}^N B_{N\,h-1}^N + r_{-1}^N B_{S\,h-1}^N \tag{20}$$

$$-NW_g^N = B^N$$

GDP, Imports and Exports

South

$$Y^S = C^S + G^S + X^S - IM^S \tag{21}$$

$$IM^S = \mu^S Y^S \tag{22}$$

$$X^S = IM^N \tag{23}$$

North

$$Y^N = C^N + G^N + X^N - IM^N \tag{24}$$

$$IM^N = \mu^N Y^N \tag{25}$$

$$X^N = IM^S \tag{26}$$

The ECB

$$B^S_{ECB} = B^S - B^S_{Sh} - B^S_{Nh} \tag{27}$$

$$B^N_{ECB} = B^N - B^N_{Nh} - B^N_{Sh} \tag{28}$$

$$B_{ECB} = B^N_{ECB} + B^S_{ECB} \tag{29}$$

$$H_h = H^N_h + H^S_h \tag{30}$$

$$\Delta H_s = \Delta B_{ECB} \tag{31}$$

$$r^S = \overline{r^S} \tag{32}$$

$$r^N = \overline{r^N} \tag{33}$$

$$F_{ECB} = r^N_{-1} B^N_{ECB-1} + r^S_{-1} B^S_{ECB-1}$$

$$H_s = H_h$$
$$(redundant\ equation)$$

Current and Financial Account Identities

TB = Trade Balance; CA = Current Account; FA = Financial Account

South

$$TB^S = (X^S - IM^S)$$

$$CA^S = (X^S - IM^S) + \left(r^N_{-1} B^N_{S\,h-1} - r^S_{-1} B^S_{N\,h-1}\right)$$

$$FA^S = \left(\Delta B^S_{Nh} - \Delta B^N_{Sh}\right) + \Delta B^S_{ECB}$$

North

$$TB^N = (X^N - IM^N)$$

$$CA^N = (X^N - IM^N) + \left(r^S_{-1} B^S_{N\,h-1} - r^N_{-1} B^N_{S\,h-1}\right)$$

$$FA^N = \left(\Delta B^N_{Sh} - \Delta B^S_{Nh}\right) + \Delta B^N_{ECB}$$

Parameter and Steady State Values

α_1^S	0.7	South's prop. to consume out of disposable income	Y^S	106.4869	GDP of the South
α_2^S	0.3	South's prop. to consume out of wealth	Y^N	106.4869	GDP of the North
α_1^N	0.6	North's prop. to consume out of disposable income	YD^S	86.4869	Disposable income of the South
α_2^N	0.4	North's prop. to consume out of wealth	YD^N	86.4869	Disposable income of the North
μ^S	0.187	South's prop. to import	T^S	21.62172	Tax revenues of the South
μ^N	0.187	North's prop. to import	T^N	21.62172	Tax revenues of the North
θ^S	0.2	South's taxation rate	B_S^S	32.4325	Southern bills held by southern households
θ^S	0.2	North's taxation rate	B_S^N	32.4365	Northern bills held by southern households
λ_{20} (= ζ_{20})	0.35	Tobinisque parameters for the asset demand functions of Southern households	B_N^N	32.4325	Northern bills held by northern households
λ_{22}	4.8		B_N^S	32.4365	Southern bills held by northern households
λ_{23}	1		V^S	86.49062	Total wealth of the South
λ_{24}	0.07		V^N	86.49062	Total wealth of the North
λ_{30} (= ζ_{30})	0.32		C^S	86.4869	Consumption of the South
λ_{32}	1		C^N	86.4869	Consumption of the North
λ_{33}	4.4		H_h^S	21.62162	Actual cash holdings of the South
λ_{34}	0.03		H_h^N	21.62162	Actual cash holdings of the North
λ_{50} (= ζ_{50})	0.35	Tobinisque parameters for the asset demand functions of Northern households	G^S	20	Public expenditure of the South
λ_{52}	4.79		X^S	19.99	Exports of the South
λ_{53}	1		IM^S	19.99	Imports of the South
λ_{54}	0.07		G^N	20	Public expenditure of the North
λ_{60} (= ζ_{60})	0.32		X^N	19.99	Exports of the North
λ_{62}	1		IM^N	19.99	Imports of the North
λ_{63}	4.4		B_{ECB}^S	21.62162	Southern bills held by the central bank
λ_{64}	0.03		B_{ECB}^N	21.62162	Northern bills held by the central bank
ζ_{21}	-0.1	Parameters related with the influence of credit rating agencies	B^S	86.49062	Total stock of southern bills (public debt of the South)
ζ_{31}	0.1		B^N	86.49062	Total stock of northern bills (public debt of the North)
ζ_{51}	0.1		H_s	43.24324	Total supply and holdings of cash (satisfied by the redundant equation)
ζ_{61}	-0.1		H_h	43.24324	
r^S	0.025	Interest rate of the South	r^N	0.025	Interest rate of the North

Appendix B- Equations of the Model with Prices

Remarks:

- Only the equations that are actually used in simulations are numbered.
- The equations that are identical with the simple model retain the same numbers
- In all financial assets, the upper script denotes the issuer and the lower script denotes the holder of the asset.
- Capital letters correspond to nominal and small case ones correspond to real variables.
- Variables in bold denote natural logarithms

Exogenous parameters and variables

- α propensities to consume
- λ_{ij} tobinisque parameters ($i = 1,2,..6; j = 1,2,..5$)
- θ^{GR}, θ^{GER} taxation rates
- r^{GR}, r^{GER} government bills interest rates
- μ propensities to import
- G public expenditure of both countries
- pr level of productivity in the two countries
- Ω parameters for wage setting

Price Indices

- p_y GDP deflator
- p_s sales index
- p_{ds} domestic sales index
- p_m imports prices
- p_x exports prices

Household Sector

South

Income and Wealth (ex post)

$$YD^S = Y^S - T^S + r_{-1}^S B_{Sh-1}^S + r_{-1}^N B_{Sh-1}^N \quad (1)$$

$$yd^S = \frac{YD^S}{p_{ds}^S} - \frac{\pi_{ds}^S V_{-1}^S}{p_{ds}^S} \quad (42)$$

$$V^S = V_{-1}^S + (YD^S - C^S) \quad (2)$$

$$v^S = \frac{V^S}{p_{ds}^S} \quad (43)$$

Equations related with the consumption and investment decisions of households

.

$$c^S = \alpha_{11} yd_e^S + \alpha_{12} v_{-1}^S \quad (44)$$

$$C^S = c^S p_{ds}^S \quad (3A)$$

$$yd_e^S = yd_{-1}^S \tag{45}$$

$$YD_e^S = p_{ds}^S yd_e^S + \frac{\pi_{ds}^S V_{-1}^S}{p_{ds}^S} \tag{4A}$$

$$V_e^S = V_{-1}^S + (YD_e^S - C^S) \tag{5}$$

North

Income and Wealth (ex post)

$$YD^N = Y^N - T^N + r_{-1}^N B_{Nh-1}^N + r_{-1}^S B_{Nh-1}^S \tag{6}$$

$$yd^N = \frac{YD^N}{p_{ds}^N} - \frac{\pi_{ds}^N V_{-1}^N}{p_{ds}^N} \tag{46}$$

$$V^N = V_{-1}^N + (YD^N - C^N) \tag{7}$$

$$v^N = \frac{V^N}{p_{ds}^N} \tag{47}$$

Equations related with the decisions of households

$$c^N = \alpha_{21} yd_e^N + \alpha_{22} v_{-1}^N \tag{48}$$

$$C^N = c^N p_{ds}^N \tag{8A}$$

$$yd_e^N = yd_{-1}^N \tag{49}$$

$$YD_e^N = p_{ds}^N yd_e^N + \frac{\pi_{ds}^N V_{-1}^N}{p_{ds}^N} \tag{9A}$$

$$V_e^N = V_{-1}^N + (YD_e^N - C^N) \tag{10}$$

Asset Demand Functions

South

$$\frac{H_d^S}{V_e^S} = \lambda_{10} + \lambda_{11} r_h - \lambda_{12} r^S - \lambda_{13} r^N + \lambda_{14} \frac{YD_e^S}{V_e^S}$$

$$\frac{B_{Sh}^S}{V_e^S} = \lambda_{20} - \lambda_{21} r_h + \lambda_{22} r^S - \lambda_{23} r^N - \lambda_{24} \frac{YD_e^S}{V_e^S} \tag{11}$$

$$\frac{B_{Sh}^N}{V_e^S} = \lambda_{30} - \lambda_{31} r_h - \lambda_{32} r^S + \lambda_{33} r^N - \lambda_{34} \frac{YD_e^S}{V_e^S} \tag{12}$$

$$H_d^S = V_e^S - B_{Sh}^S - B_{Sh}^N$$

$$H_h^S = V^S - B_{Sh}^S - B_{Sh}^N \tag{13}$$

North

$$\frac{H_d^N}{V_e^N} = \lambda_{40} + \lambda_{41} r_h - \lambda_{42} r^N - \lambda_{43} r^S + \lambda_{44} \frac{YD_e^N}{V_e^N}$$

$$\frac{B_{Nh}^N}{V_e^N} = \lambda_{50} - \lambda_{51} r_h + \lambda_{52} r^N - \lambda_{53} r^S - \lambda_{54} \frac{YD_e^N}{V_e^N} \tag{14}$$

$$\frac{B_{Nh}^S}{V_e^N} = \lambda_{60} - \lambda_{61} r_h - \lambda_{62} r^N + \lambda_{63} r^S - \lambda_{64} \frac{YD_e^N}{V_e^N} \tag{15}$$

$$H_d^N = V_e^N - B_{Nh}^N - B_{Nh}^S$$

$$H_h^N = V^N - B_{Nh}^N - B_{Nh}^S \tag{16}$$

Following the Tobinisque principles for each country, the vertical conditions are

$$\lambda_{10} + \lambda_{20} + \lambda_{30} = 1$$

$$\lambda_{11} + \lambda_{21} + \lambda_{31} = 0$$

$$\lambda_{12} + \lambda_{22} + \lambda_{32} = 0$$

$$\lambda_{13} + \lambda_{23} + \lambda_{33} = 0$$

$$\lambda_{14} + \lambda_{24} + \lambda_{34} = 0$$

for the South and

$$\lambda_{40} + \lambda_{50} + \lambda_{60} = 1$$

$$\lambda_{41} + \lambda_{51} + \lambda_{61} = 0$$

$$\lambda_{42} + \lambda_{52} + \lambda_{62} = 0$$

$$\lambda_{43} + \lambda_{53} + \lambda_{63} = 0$$

$$\lambda_{44} + \lambda_{54} + \lambda_{64} = 0$$

for the North. In turn the symmetry conditions are

$$\lambda_{12} = \lambda_{21}$$

$$\lambda_{13} = \lambda_{31}$$

$$\lambda_{23} = \lambda_{32}$$

and

$$\lambda_{51} = \lambda_{42}$$

$$\lambda_{61} = \lambda_{43}$$

$$\lambda_{62} = \lambda_{53}$$

for the South and the North respectively. Also note that the fulfillment of the vertical and symmetry conditions automatically satisfies the horizontal conditions too (Godley and Lavoie, 2007b: 145).

The Government Sector

South

$$T^S = \theta^S(Y^S + r_{-1}^S B_{Sh-1}^S + r_{-1}^N B_{Sh-1}^N) \tag{17}$$

$$\Delta B^S = G^S - T^S + r_{-1}^S B_{S\,h-1}^S + r_{-1}^S B_{N\,h-1}^S \tag{18}$$

$$-NW_g^S = B^S$$

$$g^S = \frac{G^S}{p_{ds}^S} \tag{50}$$

North

$$T^N = \theta^N(Y^N + r_{-1}^N B_{Nh-1}^N + r_{-1}^S B_{Nh-1}^S) \tag{19}$$

$$\Delta B^N = G^N - T^N + r_{-1}^N B_{N\,h-1}^N + r_{-1}^N B_{S\,h-1}^N \tag{20}$$

$$-NW_g^N = B^N$$

$$g^N = \frac{G^N}{p_{ds}^N} \tag{51}$$

GDP, Imports and Exports

South

$$s^S = c^S + g^S + x^S \tag{52}$$

$$S^S = s^S p_s^S \tag{53}$$

$$y^S = s^S - im^S \tag{54}$$

$$Y^S = S^S - IM^S \tag{21A}$$

$$p_y^S = \frac{Y_{-1}^S}{y_{-1}^S} \tag{55}$$

$$im^S = \mu_{10}\left(\frac{p_y^S}{p_m^S}\right)^{\mu_{11}} (y^S)^{\mu_{12}}$$

$$or\ else$$

$$\boldsymbol{im^S} = \mu_{10} + \mu_{11}\left(\boldsymbol{p_y^S} - \boldsymbol{p_m^S}\right) + \mu_{12}(\boldsymbol{y^S}) \tag{56}$$

$$IM^S = im^S p_m^S \tag{22A}$$

$$x^S = im^N \tag{57}$$

$$X^S = x^S p_x^S \tag{23A}$$

$$p_m^S = p_x^N \tag{58}$$

$$p_x^S = p_m^N \tag{59}$$

$$N^S = \frac{y^S}{pr^S} \tag{60}$$

$$pr^S = \overline{pr^S} \tag{61}$$

$$p_s^S = (1 + \varphi^S)\frac{W_{-1}^S N_{-1}^S + IM_{-1}^S}{s_{-1}^S} \tag{62}$$

$$p_{ds}^S = \frac{S_{-1}^S - X_{-1}^S}{s_{-1}^S - x_{-1}^S} \tag{63}$$

$$\pi_{ds}^{S} = \frac{p_{ds}^{S} - p_{ds-1}^{S}}{p_{ds-1}^{S}} \tag{64}$$

$$\omega_{T}^{S} = (\frac{W^{S}}{p_{s}^{S}})_{T} = \Omega_{10} + \Omega_{11} pr^{S} + \Omega_{12}(\frac{N^{S}}{N_{fe}^{S}}) \tag{65}$$

$$W^{S} = W_{-1}^{S}[1 + \Omega_{13}\left(\omega_{T-1}^{S} - \frac{W_{-1}^{S}}{p_{s-1}^{S}}\right)] \tag{66}$$

North

$$s^{N} = c^{N} + g^{N} + x^{N} \tag{67}$$

$$S^{N} = s^{N} p_{s}^{N} \tag{68}$$

$$y^{N} = s^{N} - im^{N} \tag{69}$$

$$Y^{N} = S^{N} - IM^{N} \tag{24A}$$

$$p_{y}^{N} = \frac{Y_{-1}^{N}}{y_{-1}^{N}} \tag{70}$$

$$im^{N} = \mu_{20}\left(\frac{p_{y}^{N}}{p_{m}^{N}}\right)^{\mu_{21}} (y^{N})^{\mu_{22}}$$

$$or\ else$$

$$\boldsymbol{im^{N}} = \mu_{20} + \mu_{21}(\boldsymbol{p_{y}^{N}} - \boldsymbol{p_{m}^{N}}) + \mu_{22}(\boldsymbol{y^{N}}) \tag{71}$$

$$IM^{N} = im^{N} p_{m}^{N} \tag{25A}$$

$$x^{N} = im^{S} \tag{72}$$

$$X^{N} = x^{N} p_{x}^{N} \tag{26A}$$

$$\boldsymbol{p_{m}^{N}} = \nu_{0} + (1 - \nu_{1})\boldsymbol{p_{y}^{N}} + \nu_{1}\boldsymbol{p_{y}^{S}} \tag{73}$$

$$where\ 0 < \nu_{1} < 1$$

$$\boldsymbol{p_x^N} = \upsilon_0 + (1 - \upsilon_1)\boldsymbol{p_y^N} + \upsilon_1 \boldsymbol{p_y^S} \tag{74}$$

$$where\ 0 < \upsilon_1 < 1$$

$$N^N = \frac{y^N}{pr^N} \tag{75}$$

$$pr^N = \overline{pr^N} \tag{76}$$

$$p_s^N = (1 + \varphi^N)\frac{W_{-1}^N N_{-1}^N + IM_{-1}^N}{s_{-1}^N} \tag{77}$$

$$p_{ds}^N = \frac{S_{-1}^N - X_{-1}^N}{s_{-1}^N - x_{-1}^N} \tag{78}$$

$$\pi_{ds}^N = \frac{p_{ds}^N - p_{ds-1}^N}{p_{ds-1}^N} \tag{79}$$

$$\omega_T^N = (\frac{W^N}{p_s^N})_T = \Omega_{20} + \Omega_{21} pr^N + \Omega_{22}(\frac{N^N}{N_{fe}^N}) \tag{80}$$

$$W^N = W_{-1}^N[1 + \Omega_{23}\left(\omega_{T-1}^N - \frac{W_{-1}^N}{p_{s-1}^N}\right)] \tag{81}$$

The ECB

$$B_{ECB}^S = B^S - B_{Sh}^S - B_{Nh}^S \tag{27}$$

$$B_{ECB}^N = B^N - B_{Nh}^N - B_{Sh}^N \tag{28}$$

$$B_{ECB} = B_{ECB}^N + B_{ECB}^S \tag{29}$$

$$H_h = H_h^N + H_h^S \tag{30}$$

$$\Delta H_s = \Delta B_{ECB} \tag{31}$$

$$r^S = \overline{r^S} \tag{32}$$

$$r^N = \overline{r^N} \tag{33}$$

$$F_{ECB} = r^N_{-1} B^N_{ECB-1} + r^S_{-1} B^S_{ECB-1}$$

$$H_s = H_h$$
$$(redundant\ equation)$$

Current and Financial Account Identities

TB = Trade Balance; CA = Current Account; FA = Financial Account

South

$$TB^S = (X^S - IM^S)$$

$$CA^S = (X^S - IM^S) + \left(r^N_{-1} B^N_{S\,h-1} - r^S_{-1} B^S_{N\,h-1}\right)$$

$$FA^S = \left(\Delta B^S_{Nh} - \Delta B^N_{Sh}\right) + \Delta B^S_{ECB}$$

North

$$TB^N = (X^N - IM^N)$$

$$CA^N = (X^N - IM^N) + \left(r^S_{-1} B^S_{N\,h-1} - r^N_{-1} B^N_{S\,h-1}\right)$$

$$FA^N = \left(\Delta B^N_{Sh} - \Delta B^S_{Nh}\right) + \Delta B^N_{ECB}$$

Parameter and Steady State Values of the Model with Prices

$\boldsymbol{\mu_{10}}$	0.6389787	Autonomous propensity to import of the South	$\boldsymbol{\upsilon_0}$	0	Autonomous component of exports prices of the North
$\boldsymbol{\mu_{20}}$	0.6389787	Autonomous propensity to import of the North	υ_0	0	Autonomous component of imports prices of the North
$\boldsymbol{\mu_{11}}$	0.7	Imports price coefficient of the South	υ_1	0.5	Relative weight of foreign prices upon export prices of the North
$\boldsymbol{\mu_{21}}$	0.7	Imports price coefficient of the North	υ_1	0.7	Relative weight of foreign prices upon import prices of the North
$\boldsymbol{\mu_{12}}$	0.5	Imports income coefficient of the South	N_{fe}^S	111.3309	South's full employment
$\boldsymbol{\mu_{22}}$	0.5	Imports income coefficient of the North	N_{fe}^N	111.3309	North's full employment
$\boldsymbol{pr^S}$	1	Productivity of the South	N^S	111.3342	South's employment
$\boldsymbol{pr^N}$	1	Productivity of the North	N^N	111.3343	North's employment
$\boldsymbol{\Omega_{10}}$	0.2731589	Wage targeting autonomous parameter of the South	S^S	125.6098	South's nominal sales
$\boldsymbol{\Omega_{20}}$	0.2731589	Wage targeting autonomous parameter of the North	S^N	125.6098	North's nominal sales
$\boldsymbol{\Omega_{11}}$	0.1	Wage targeting productivity coefficient of the South	ω_T^S	0.7731709	South's wage target
$\boldsymbol{\Omega_{21}}$	0.1	Wage targeting productivity coefficient of the North	ω_T^N	0.7731709	North's wage target
$\boldsymbol{\Omega_{12}}$	0.4	Wage targeting employment coefficient of the South	W^S	0.7395176	South's nominal wage rate
$\boldsymbol{\Omega_{22}}$	0.4	Wage targeting employment coefficient of the North	W^N	0.7395176	North's nominal wage rate
$\boldsymbol{\Omega_{13}}$	0.3	Nominal wage adjustment parameter of the South	p_{ds}^S	0.9564807	South's domestic sales index
$\boldsymbol{\Omega_{23}}$	0.3	Nominal wage adjustment parameter of the North	p_{ds}^N	0.9564806	North's domestic sales index
$\boldsymbol{p_y^S}$	0.9564807	South's GDP deflator	p_m^S	0.9564807	South's imports prices
$\boldsymbol{p_y^N}$	0.9564806	North's GDP deflator	p_x^S	0.9564807	South's exports prices
$\boldsymbol{p_s^S}$	0.9564835	South's sales index	p_m^N	0.9564807	North's imports prices
$\boldsymbol{p_s^N}$	0.9564835	North's sales index	p_x^N	0.9564807	North's exports prices
$\boldsymbol{\varphi^N}$	0.2381	Mark-up of the North	φ^S	0.2381	Mark-up of the South

Note: only the new parameters and stocks of the model are reported here; everything else is essentially identical with the simple model