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Sustainability vs. credibility of fiscal consolidation. A Principal Components test for the Euro Zone

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Abstract

Why did some countries in the Euro Zone between 2010 and 2012 – until the European Central Bank stepped in – experience a dramatic vicious circle between hard austerity plans and rising default risk premia? Were such plans too small, and hence non credible, or too large, and hence non sustainable? These questions have prompted theoretical and empirical investigations in the line of the so-called "self-fulfilling beliefs” where beliefs of unsustainability of fiscal adjustments, and hence default on debt, feed higher risk premia which indeed make fiscal adjustments less sustainable. Detecting the sustainability factor in the evolution of spreads is uneasy because it is largely non observable, and may be proxied by different variables. In this paper we present the results of a dynamic Principal Components Factor Analysis applied to a panel data set of the eleven major EZ countries from 2000 to 2013 consisting of each country's spread of long-term interest rate over Germany as dependent variable, and an array of leading fiscal and macroeconomic indicators of solvency fiscal effort and its sustainability. We have been able to identify the role of these indicators that combine themselves as significant latent variables in boosting spreads. Moreover the large joint deterioration of these variables is identifiably located between 2009 and 2012 and particularly for the group of countries under most severe default risk (with Italy and France as borderline cases).

Key words: Euro Zone debt crisis, Models of self-fulfilling beliefs, Principal Components Analysis.
1. Introduction

The "shock therapy" of front-loaded, "ambitious" fiscal consolidation plans, also known in Europe as "austerity", hinges on the credibility approach. In this approach, governments are urged to announce and implement large fiscal adjustments that are rewarded with lower interest rate. This is crucial. Even though austerity may have short-run negative effects on aggregate demand, these may be compensated by a permanent cut of the risk premium that prompts long-term private expenditure (e.g. Corsetti et al. (2010), Roeger et al. (2013), Buti and Pench (2012)).

This approach has been called into question by the vicious circle between hard austerity plans and rising spreads with fears of default experienced by some countries in the Euro Zone (EZ) between 2010 and 2012 – until the European Central Bank (ECB) stepped in. These events have prompted theoretical and empirical investigations in the line of the so-called "self-fulfilling beliefs" where beliefs of unsustainability of fiscal adjustments, and hence default on debt, feed higher risk premia which indeed make fiscal adjustments less sustainable (Corsetti and Dedola (2011), De Grauwe (2011), Gros (2012), Cooper (2012), Ghosh et al. (2013), Tamborini (2014a)).

Were the EZ countries' fiscal plans too small, and hence non credible, or too large, and hence non sustainable? Sustainability is indeed another approach which is partly analogous to, but partly different from, the celebrated one of credibility.

In simple words, sustainability is the chance that at any point in time the government is willing or able to sustain the level of fiscal effort (say the primary surplus/GDP ratio) required by the solvency condition of its outstanding debt. Hence sustainability is a key variable in the investors' assessment of default risk, and in the determination of sovereign risk premia. As shown by Tamborini (2014a), contrary to the credibility approach, if investors care about sustainability, and hold heterogeneous beliefs about this dimension of fiscal consolidation, governments engaged in larger and larger fiscal efforts will pay higher interest rates. This happens because, as the fiscal effort increases, a larger share of investors believe that the government will opt for default, and the risk premium increases. As a consequence, one possible equilibrium is typically a "self-fulfilling default prophecy" due to the positive feedback mechanism among market beliefs of default, higher spread, higher fiscal effort, reinforcement of market beliefs.

The aim of this paper is to present an empirical analysis and test of the sustainability approach, whereby we seek to add new insights to the theoretical and empirical research on the EZ debt crisis. For continuity and
comparability of data, here we focus on the major early eleven member countries of the EZ, which may further be distinguished between the five (EZ5) under more severe debt crisis and spread escalation\textsuperscript{1}, and the remaining six (EZ6)\textsuperscript{2}. The critical time window is from the diffusion of the spread escalation to their almost complete reversion, that is 2010-13 (see Figure 1). However our data set spans from 2000 to 2013, which allows for a longer-term perspective also covering the years of financial calmness.

Figure 1. Year average of monthly spreads, 2009-13 (% points)

Detecting the sustainability factor in the evolution of spreads is uneasy because it is largely non observable, and may be proxied by different variables. Therefore, we have employed dynamic Principal Components Factor Analysis in order to combine the cross-country and time series dimensions of our panel data set of the EZ11 countries. This is a rather unusual technique with respect to standard econometric tests of models, which is particularly well suited to reduce the number of variables in a data set by extracting meaningful linear combinations from the observed variables that may concur to explain a given phenomenon (the dependent variable). These combinations, called "common factors", can be interpreted as latent, non observable variables. The aim is to detect, among the common factors, one or more that combine some variables related to the sustainability of the fiscal effort faced by each country for being solvent. Through the "factor loadings" we can see the weight and the sign of each variable in explaining this factor and the other common factors. We can also see how each single country is located with respect to these common factors

\textsuperscript{1} Greece, Ireland, Italy, Portugal, Spain.

\textsuperscript{2} Austria, Belgium, Finland, France, Germany, Netherlands-
and even the dynamics of this location, that is whether it is stable or not through the years, in particular after 2009. The instability could be a sign of possible default.

We begin in section 2 by displaying some "stylized facts" concerning the evolution of spreads in the EZ in the critical period 2010-12 that challenge the common wisdom of the austerity doctrine and are in search of a theory. Section 3 introduces to the literature on "self-fulfilling beliefs", and in particular the model with heterogeneous beliefs about the government's threshold of sustainable fiscal effort put forward by Tamborini (2014a), which is adopted as the frame for the subsequent empirical analysis. Section 4 expounds and discusses the results of our dynamic Principal Components Factor Analysis, whereby we can identify and confirm the role of some key indicators of higher fiscal effort and less sustainability, of both short and longer-term nature, that combine themselves as significant latent variables in boosting spreads. Section 5 summarizes and concludes with some policy implications.

2. Facts in search of theory

Empirical research on risk premia in the EZ debt crisis is burgeoning. Challenging technical problems aside, some convergence can be detected. Overall, the EZ turmoil has shaken the reliance on financial market efficiency in providing the right stick and carrot mix that should drive fiscal consolidation.\(^3\) Evidence has been found that post-2009 spreads not only reflect country-specific fundamentals, but are also highly sensitive to "systemic risk" and other exogenous factors (Manganelli and Wolswijk (2009), Sgherri and Zoli (2009), Attinasi et al. (2009), Caceres et al. (2010), Favero and Missale (2011)). Also, there is evidence of "contagion", that is, the transmission of high spreads across countries via non-fundamental channels (Caceres et al. (2010), De Grauwe and Ji (2013), Tola and Wäldi (2012)). De Grauwe and Ji support the hypothesis of "self-fulfilling beliefs" via the positive feedback mechanism among market beliefs of default, higher spread, higher fiscal effort, reinforcement of market beliefs.

This last phenomenon, among the others, is worthy of particular attention owing to its implications for the austerity doctrine enforced in the EZ. The fact that governments engaged in large fiscal adjustments are punished with higher interest rates, rather than being rewarded with lower interest rates, contradicts the key rationale of austerity as the necessary policy for governments under serious financial distress. To begin with facts,

\(^3\) See Bowdler and Esteves (2013) for an overview.
let us examine the statistical relationship between the evolution of spreads and an indicator of fiscal consolidation.

Fiscal consolidation can be measured in various ways, also depending on the consolidation aim. If priority is given to debt stabilization relative to GDP, or convergence of the debt/GDP ratio towards a given target, it is well-known that the key variable is the primary balance/GDP ratio \( b \), since the year change in the debt/GDP ratio \( d \) is driven by

\[
\Delta d_{t+1} = d_{t+1} - d_t = (i_t - n_{t+1})d_t - b_{t+1} + z_{t+1}
\]

where \( i_t \) is the average nominal interest rate on outstanding debt, \( n_{t+1} \) is the nominal growth rate of GDP, and \( z_{t+1} \) are unanticipated shocks to debt. Given a target \( \Delta d^*_t+1 \), the government should aim at the primary balance \( b^*_t+1 \) such that

\[
b^*_t+1 = (i_t - n_{t+1})d_t - \Delta d^*_t+1
\]

Fiscal consolidation is the path of \( b^* \) consistent with \( \Delta d^* \), while its intensity can be measured by the actual year change \( \Delta b \), where \( \Delta b > 0 \) indicates "austerity".

Official institutions, such as the European Commission (EC), have introduced so-called "cyclically adjusted", or "structural" fiscal variables. These are computed subtracting from observed variables their estimated cyclical component, that is the amount related to deviations of GDP from its long-run trend, or "potential" level. The purpose of structural fiscal variables is to provide information on the "ex ante" fiscal stance of government, e.g. with respect to fiscal plans agreed upon with the Commission, though "ex post" actual fiscal variables may deviate from the plan owing to unforeseen contingencies. Apart from the unsettled econometric problems involved in the estimation of potential GDP and of the elasticity of fiscal variables to GDP fluctuations, structural fiscal variables may not be fully suited for other purposes. The problem of interest here is the attitude of investors towards the evolution of public finances and debt. To this end, the relevant information is the impact of fiscal consolidation on real economic variables, and hence the economy's capacity to sustain changes in taxation and/or public expenditure. Therefore, actual fiscal variables may be more relevant than hypothetical structural ones.

Table 1 in Appendix shows the fiscal variables \( b \) and \( \Delta b \), and the spreads of long-term interest rates over Germany, for the EZ countries from 2009, the year of the Great Recession, up to 2013. As can be seen, after the generalized fiscal stimulus of 2009, the EZ as a whole moved into austerity in 2010 with an additional surplus of 2.2% of GDP. This was actually the

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4 This is in fact what is prescribed by the revision of the Stability and Growth Pact for the EZ countries called "Fiscal Compact", namely a debt/GDP reduction path of 1/20th per year of the excess over 60%.
combination of a neutral fiscal stance of the EZ6 group and a strong restriction by the EZ5 group (2.9% of GDP). By 2011 all countries were in the austerity regime (averaging to 2.5% of GDP for the EZ as a whole), which was then relaxed in 2012 and 2013\(^5\). Note, therefore, that the timing of austerity overlaps with the period of the escalation of spreads in Figure 1, and particularly so for the EZ5 group.

In order to track the evolution of spreads _vis-à-vis_ fiscal adjustments, it should be considered that each year's spread and \(\Delta b\) may reflect a number of disturbances, or the spread may not promptly react to \(\Delta b\) because the effect of the fiscal adjustment materializes over time as the former is consistently enacted and hence becomes _credible_. Therefore, Figure 2 plots for each country the year average of monthly spreads against the cumulated fiscal adjustment (\(CFA_t\)), the sum of fiscal adjustments \(\Delta b\) up to year \(t\).

Figure 2. Year average of monthly spreads and _CFA_, 2010-12

![Figure 2](image)

EZ5 countries: correlation coefficient 0.74. OLS interpolation function \(y = 0.43x^2 - 2.52x + 5.08\), \(R^2 = 0.83\).

Source: Table 1

\(^5\) A drawback of the indicator \(\Delta b = B_t/Y_t - B_{t-1}/Y_{t-1}\) is the so-called "denominator bias", that is the part of the change which is due to the change in GDP. It is easily seen that the indicator is biased towards restriction when GDP increases and towards expansion when GDP decreases. To correct for this bias, Tamborini (2014b) measures the fiscal adjustment in one year as the change in the primary deficit \(F_t\) over the current GDP, that is \(FA_t = (F_t - F_{t-1})/Y_t\). Since the primary deficit is also the net contribution of the public sector to income formation, \(FA_t < 0\) measures the actual "fiscal effort" of the economy. According to this measure, austerity extended well into 2012 and 2013 especially in the EZ5 countries.
The largest part of observations lie in the positive quadrant with rising CFA and rising spreads during the runup of the sovereign debt crisis. However, this phenomenon has been much stronger for the EZ5 countries; for them, the correlation coefficient between CFA and spread is 0.74. The best OLS interpolation is quadratic, suggesting that the correlation has been accelerating. Along this function, differences in CFA account for 83% of differences in spreads.

This evidence can be interpreted in two ways. The first is that in financially distressed countries, spreads have been strong drivers of fiscal adjustments, as they should be, to the point that governments have been chasing their spreads with repeated doses of austerity. However, reverse causality is also possible, that is, the above-mentioned "positive feedback" mechanism going from austerity to higher spreads to more austerity and so on. Causality is an issue that can hardly be settled once and for all by pure statistics, especially in a context of limited availability of data and in times of exceptional events. As said above, De Grauwe and Ji (2013) provide an econometric test that supports the reverse causality hypothesis. At any rate, what seems indisputable in the data is that, over time, consistent CFAs have failed to deliver lower spreads. Parallely, they have also failed to curb debt growth (Tamborini (2014b)). Of course, the two failures may be the sides of the same coin. The true turning point occurred in the second half of 2012, and to many observers it was only due to the credible launch of the ECB Outright Monetary Transactions programme (the safety net for sovereign debt prices and spreads) and to President Draghi’s celebrated commitment that "the ECB will do whatever it takes". Thereafter, spreads fell though debt/GDP ratios went on rising. It may be argued that austerity paved the way, both financially and politically, to the ECB intervention (Buti and Carnot (2013)). However, the ECB intervention mechanism is heterodox, not complementary, with respect to the austerity doctrine, and it was in fact fiercely opposed by integral supporters of the doctrine. So in the end the question remains: Why was austerity by itself ineffective on spreads? Was austerity too little or too much?

3. Models of "self-fulfilling beliefs"

De Grauwe and Ji (2013) make explicit reference to models of "self-fulfilling beliefs" (SFB). This is in fact a growing literature on sovereign-debt crises that embeds the above-mentioned positive feedback mechanism and challenges both the efficient market hypothesis and the austerity doctrine. More recent examples include Corsetti and Dedola (2011), De Grauwe (2011), Gros (2012), Cooper (2012), Ghosh et al. (2013), Tamborini
This approach has also obtained an authoritative endorsement in the ECB president's speech where the OMT programme was announced:

(...) we are in a situation now where you have large parts of the euro area in what we call a "bad equilibrium", namely an equilibrium in which you may have self-fulfilling expectations that feed upon themselves and generate very adverse scenarios. So, there is a case for intervening, in a sense, to "break" these expectations (...) But then, we should not forget why countries have found themselves in a bad equilibrium to start with (Draghi (2012, p. 4)).

SFB models present two key features. The first is that solvency or default are treated as the result of the government’s cost-benefit analysis of the two options. This view arises from consideration of the special status of a sovereign. A sovereign, and only a sovereign, has the power of being ever solvent to the extent that it can control its fiscal revenue and money creation. In fact, by imposing taxation, a sovereign can raise its revenues, while by monetization it can expand its ability to pay, in ways that are precluded to any other ordinary debtor. Where does a sovereign's solvency problem come from? It may only come from constraints imposed, or self-imposed, on its ability to manipulate these two variables. This view is supported by extensive historical evidence showing that default is almost always a government choice not necessarily forced by immediate inability to pay (Tomz and Wright (2013), Buiter and Rahbari (2013)). The EZ provides a clear case of an institutional setup where member governments have no access to monetization, and hence can only rely on the adjustment of fiscal variables. De Grauwe (2011) and De Grauwe and Ji (2013) draw attention to this fact as an explanation of the higher spreads paid by EZ members relative to "stand alone" countries facing the same fiscal fundamentals. In fact, the adjustment of fiscal variables, namely expenditure and/or taxation, presents various costs – economic, social, political – that are typically increasing in the extent of the required adjustment. Default has of course its own costs, depending on its entity and implementation. As a consequence, the government is willing to stay solvent as long as the costs of solvency do not exceed the costs of default. This is the basic notion of sustainability of fiscal consolidation.

The second key feature of SFB models is that multiple equilibria are possible. An equilibrium is a state of the sovereign bond market such that

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6 Indeed, SFB are a long-standing research field (e.g. Farmer (1993)). Financial and currency markets are natural fields where this class of models has proved able to provide valuable insights into complex phenomena such as bubbles, crashes, or speculative attacks. The relevant literature dates back to the various "generations" of models of currency crisis and exchange-rate regime collapse of the 1980s and 1990s (e.g. Obstfeld (1995)). Early extensions to sovereign debt also appeared with special reference to emerging economies (e.g. Calvo (1988), Cole and Kehoe (2000)).
the interest rate demanded by the investors generates a fiscal stance sustainable by the government. Therefore, an equilibrium implies that the investors' beliefs about sustainability — i.e. the government's solvency/default choice — are fulfilled. However, the fiscal stance faced by the government is not independent of the investors' beliefs about its sustainability. If say investors attach high probability to sustainability, the interest rate remains low and the solvency costs also remain low. This is what Draghi refers to as a "good equilibrium". However, if investors attach lower probability to sustainability, the interest rate will rise, and so will the solvency costs. This may become a "bad equilibrium". Further, the positive feedback mechanism between investors' beliefs and solvency costs may be so large to force the government into the default choice, though the initial conditions are sustainable. In this literature, the dimension and timing of consolidation plans is a double-edged blade: if small and progressive, the plan may strain credibility, if large and immediate it may be judged unsustainable.

SFB models differ in the treatment of the source of investors' uncertainty. In models obeying to the rational expectations hypothesis the representative investor is assumed to know all the relevant fiscal fundamentals with certainty, including the threshold of fiscal adjustment that triggers default. Uncertainty is generally due to unanticipated fiscal shocks, so that the probability of default is the probability of a shock large enough to require a fiscal adjustment beyond the default threshold. Gros (2012) introduces a different source of uncertainty: in his model investors know the fiscal fundamentals with certainty, except the default threshold. Here the probability of default is the probability evaluated by investors that the given and known solvency fiscal adjustment exceeds the default threshold. This asymmetry between investors and government is attributed to the lack of information about all the specific determinants of the government's choice, and in particular those concerning the political process leading to it (think e.g. of the proposal of the Greek Prime Minister Papandreu of a referendum about the "Troika" rescue plan of Greece). Still, Gros's investors hold an equal and "objective" probability distribution of possible default thresholds of the government. Tamborini (2014a) relaxes this latter assumption and allows for heterogeneous beliefs of investors, which seems more suited to the complex political environment considered by Gros and to the uniqueness of default events.

In this model, solvency is defined à la Bohn (1995), namely keeping the debt/GDP ratio on a non-increasing path\textsuperscript{7}. Accordingly, the relevant fiscal variable is the primary-surplus/GDP ratio to which the government commits.

\textsuperscript{7} See also Ghosh et al. (2013), Buiter and Rahbari (2013).
itself in order to comply with this target in the next year. From (2), the resulting expression is
\[ b^*_{t+1} = (i_t - n_{t+1})d \]
where \( d \) is the constant debt/GDP. For simplicity GDP is assumed to be on a constant trend, so that \( n_{t+1} \) can be understood as cyclical fluctuations. As said above, all the fundamentals in equation (3) are given and common knowledge at the time \( t \) of the fiscal plan. If the government fulfils (3) at all times, the debt/GDP ratio remains constant and the debt stock should be willingly held by investors at the correspondent equilibrium market interest rate \( i^* \). Solvency is then seen as a long-run steady-state equilibrium (time subscripts are dropped) such that at all times \( \{z, n\} = 0 \), and
\[ b^* = i^*d. \]

Equation (4) is called "government's reaction function" (GR) since it yields the solvency fiscal stance \( b^* \) for any possible interest rate \( i^* \) associated with the target debt/GDP ratio \( d \). However, the government is willing to stay solvent al long as \( b^* < \bar{b} \), where \( \bar{b} \) is the threshold value that equates the marginal cost of solvency with the marginal cost of default.

As said above, the investors' problem is uncertainty about \( \bar{b} \). This is represented as a distribution of individual subjective beliefs \( \bar{b}_n \). Each investor at time \( t \) is willing to hold the government’s debt if \( b^*_{t+1} < \bar{b}_n \), otherwise he/she is willing to sell and switch to a safe asset with interest rate \( \bar{i} \). Hence, in the market as a whole, demand is expressed by the cumulated share of investors for whom \( b^*_{t+1} < \bar{b}_n \), and supply is expressed by the complement share of those for whom \( b^*_{t+1} > \bar{b}_n \). As demonstrated by Tamborini, the consequence is that the larger is \( b^*_{t+1} \), the larger is the share of investors who wish to sell, and the higher is the interest rate (or the spread over the safe asset). The result is therefore the "investors' reaction function" (IR) which yields the interest rate \( i_t \) as an aggregate response of the market for any given fiscal stance \( b^*_{t+1} \) of the government. Tamborini also shows that for distributions of beliefs with standard properties (certainly the Normal and the Uniform) the IR function is increasing and convex.

As shown by Figure 3, the geometry of the GR-IR functions allows for multiple equilibria. The figure represents the case where \( G \) is a "good" equilibrium (low \( b^* \) and \( i^* \)), \( B \) is a "bad" equilibrium (high \( b^* \) and \( i^* \)). \( D \) is the default state, and \( i^D \) is the interest rate that triggers default.\(^8\) Now

\(^8\) The bad equilibrium is not necessarily the default state, and the default state is not necessarily an equilibrium; this may be the case only if IR intersects GR
suppose the market is in a good equilibrium \((b^*_0, i^*_0)\) when, owing to an (anticipated) adverse change in fiscal fundamentals (the GR function shifts outwards), the government should implement a larger solvency primary surplus \(b^*_1 > b^*_0\). Note that at the given initial conditions, including \(i^*_0\), the government is ready to stay solvent. However, if the shock is large enough (technically speaking, no equilibrium exists for the new GR function), the response of the market to \(b^*_1\) is a higher \(i_1\). As the graphical treatment shows, the government is bound to default though initial conditions are sustainable. In other words, the role of fiscal fundamentals cannot be disentangled from investors’ beliefs (precisely, the first two moments of the distribution of beliefs; Tamborini (2014a), pp.19-20, 23 and ff.).

**Figure 3. The GR-IR model**

One interesting implication of this model for empirical analysis is that the relationship between post-shock fiscal adjustments and the spread over the safe asset is convex, as is the case with the EZ data in Figure 2. Another one is that the acceleration of the spread is not driven by entirely spurious variables, but by a fundamental variable such as the entity of the solvency fiscal adjustment \(b^*\) (and up to a certain point realized) by the government as it is filtered through the investors’ assessment of sustainability. The latter is not observable (more precisely, we do not know the distribution of investors’ beliefs and hence the IR function) but the model predicts that the

\[ \text{exactly at } i^D. \]

When the default state is not an equilibrium, some investors remain entrapped and bear losses, as is often the case in real world defaults.
larger is $b^*$ the worse is the assessment of sustainability by the market as a whole. This feature can be captured in a correlation graph (see Figure 4), plotting the same spread data of Figure 2 against each country's fiscal adjustment gap $FAG_t = b^* - b_t$, where $b^*_t$ is calculated according to equation (3). Note that, as a consequence of low nominal growth and rising interest rates, the gap has been continuously rising for all the EZ countries.

**Figure 4. Year average of monthly spreads and $FAG$ 2010-12**

*EZ6 □ EZ5*

EZ5 countries: correlation coefficient 0.76. OLS interpolation function $y = 0.006x^2 + 0.23x + 2.37$, $R^2 = 0.87$.

Source Table 1

Again, the best OLS interpolation for the EZ5 countries is (weakly) convex. Its explanatory power is even higher than that of the actual fiscal adjustments. These data lend support to the model's hypothesis: if on the one hand the actual fiscal adjustments were too small, on the other hand the required ones were deemed too large to be accomplished, and were enlarged by the reaction of the investors themselves. The kind of failure of the austerity doctrine that results is not due to waves of irrationality, but to a large mass of investors who individually make a rational use of the limited knowledge and information they have. Testing this hypothesis rigorously is, however, particularly challenging because it involves unobservable variables.

4. A Principal Components analysis

As said above, the critical problem of the sustainability approach is that the main driver(s) of investors' behaviour may be one (or more)
unobservable variable(s) that they use to assess sustainability. Meanwhile, more than one observable variable may reasonably be conceived of as proxying the unobservable(s). These problems can be dealt with by means of well-established statistical techniques.

In this section we present the results of a dynamic Principal Components Factor Analysis (PCFA). This technique allows to reduce the number of variables in a data set by extracting meaningful linear combinations from the observed variables that may concur to explain a given phenomenon (the dependent variable)\(^9\):

\[ y_{ij} = z_{i1}\lambda_{1j} + z_{i2}\lambda_{2j} + \ldots + z_{iq}\lambda_{qj} + e_{ij}, \]

where \( y_{ij} \) represents the observation on the \( j \)-th variable relative to the \( i \)-th statistical unit, \( z_{iq} \) the observation on the \( q \)-th common factor relative to the same \( i \)-th unit, \( \lambda_{iq} \) the factor loading and \( e_{ij} \) a unique factor proper of the \( j \)-th variable. The "common factors" can be considered as unmeasured latent variables which are described through their relation with the analysed variables. Using this technique which decomposes the observed correlation matrix, we obtain few common factors together with their loadings which show the weight of each variable in explaining the factors. The appropriate number of factors can be chosen on the basis of the eigenvalues obtained from the decomposition or on the basis of the percentage of explained variance. Once the factors and their loadings have been estimated, they can be interpreted according to the values assumed by the loadings. These can also be seen as correlation coefficients, and upon multiplying them by the standardised observed data, we get a set of factor scores which can be represented in the factorial space.

It is to be noticed that the database used for the analysis has the cross-section dimension given by the different countries \( i \) and the time series dimension given by the years of observation \( t \). Therefore the kind of empirical analysis that we have performed is a dynamic PCFA on observations of the type \( y_{ijt} \), where the role of the units is played by the pair \( i, t \). The aim is to test the hypothesis that sustainability (meant as a combination of different indicators for each country) is a significant latent variable in the explanation of each country’s spread. The time dimension of the observations will allow us to identify groups of countries in the Euro Zone according to some similarities emerging from their dynamic analysis and then to interpret the evolution of the resulting factor scores in terms of our model.

\(^9\) We use the same notation as in STATA 13 documentation.
4.1. The data set

Drawing on the relevant literature expounded in section 3, we have created a data set including the annual data for the EZ11 group of countries from 2000 to 2013:

- **Real growth rate of GDP, long term interest rate, inflation rate**: they can combine to yield the solvency primary surplus (e.g. \( b^* \) in section 3); low growth, low inflation and high interest rate *cet. par.* increase the solvency primary surplus and hence decrease sustainability.

- **Deficit/GDP, primary surplus/GDP, debt/GDP ratios**: they are standard indicators of sustainability

- **Fiscal space**: it is an alternative measure of debt sustainability, defined as the ratio of the government gross debt to total tax revenue, proposed by Aizenman and Hutchinson (2012) on the grounds that total tax capacity is a better measure of sustainability than GDP *per se*.

- **Current account/GDP ratio, real effective exchange rate**: current account deficits increase the net foreign debt of the country. The real effective exchange rate is an indicator of external competitiveness impinging upon the current account. According to a strand of literature on the sovereign debt crisis, the countries mostly affected also had large current account imbalances triggering high default risk for foreign investors and hence massive sales of bonds (e.g. Gros (2013), Alessandrini et al. (2012)).

Unless otherwise stated, henceforth all fiscal variables and the current account will be understood as GDP ratios.

4.2. The average factorial structure over time

The first step of analysis aims to trace the differential dynamics scored by the countries over the years with respect to the factorial structure emerging from the decomposition of matrix \( S_T \), defined as the average dispersion matrix within times, which aggregates two sources of variability, the one due to the static structure of the units and the one due to the interaction between units and times. This decomposition will give us an overall structure with respect to which we are going to discuss the differences among countries. Formally (Federici and Mazzitelli, 2005):

\[
S_T = \frac{1}{T} \sum_{t=1}^{T} S(t),
\]

where \( S(t) \) represents the estimated variance and covariance matrix at time \( t \). Performing PCFA on the standardized data (where standardization is

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10 The source of all macroeconomic data is the EUROSTAT, online database AMECO ([http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm](http://ec.europa.eu/economy_finance/db_indicators/ameco/index_en.htm)); the source of long-term interest rates is ECB, Interest rate statistics ([www.ecb.org](http://www.ecb.org)).
computed on the pooled observations), on the basis of the resulting eigenvalues we get three factors mainly explained by the following variables (output is reported in Table 2 in Appendix):

- Factor 1: government deficit, primary surplus, and current account
- Factor 2: long term interest rate, real effective exchange rate, debt, fiscal space
- Factor 3: inflation rate

We can interpret Factors 1 and 2 as "sustainability factors", since they combine variables that are generally used for sustainability assessment, though in a way that is not so neat according to theoretical models. Among the common features of the variables underlying each factor, one may say that those in Factor 1 are shorter-term indicators, whereas those in Factor 2 are longer-term indicators.

What matters here is their joint dynamic pattern based on the standardized data. It is possible to say that the greater the values scored on the factors, the worse the sustainability assessment is. The results represented in Figure 1 in Appendix have been grouped according to their similarities. Even though the representations show some general similarities, we can distinguish a first group given by Greece (the extreme situation), Ireland, Portugal and Spain, which overlaps with the EZ5 group, characterized by a prolonged joint deterioration in short as well as longer-term sustainability, followed by a relative little cycle at the end indicating a reversal. Italy and France can be considered as a borderline different group, because they display a more complex pattern at the beginning and a relative bigger cycle at the end like the second group, formed by Netherlands, Belgium, Finland and Austria. This last country shows a particular pattern which approaches the behaviour of Germany. Germany can be considered as having a pattern of its own and therefore representing a third group. Germany's circular pattern over a limited range suggests the absence of the large, systematic movements in the factors observed for other countries. Furthermore, what differentiates groups 2 and 3 from group 1 is the fact that the values assumed by the factors are both mainly positive, whereas, for group 1, Factor 2 becomes negative (a consequence of the fact that the variables are below the mean and/or are above the mean but with negative loadings). We can also add that factorial patterns have been more markedly different across the groups since 2009.

4.3. The factorial structure year by year

We have also performed PCFA year by year on the data normalized by dividing each observation $y_{ijt}$ by the mean $y_{.j}$ computed for each variable over units and times as suggested in Fantozzi e Marotta (2006). This kind of
analysis should be more informative about each country’s movements year by year along the factorial axes. The output is a set of common factors determined by the decomposition of the observed correlation matrix for each year (hence we do not report them all). The eligible number of factors is not the same for all years: they vary between two and three. Forcing the analysis to give the results in terms of three factors and relative loadings, we have been able to give the following interpretations to them:

- **Factor 1** is mainly explained by debt and fiscal space. These are two sustainability measures, hence this factor can be interpreted as a "sustainability factor", and like Factor 2 in section 4.2 it can interpreted as long-term indicator. The composition of this factor remains quite constant through the years considered.

- **Factor 2** does not have a stable composition. Its main components are government deficit, primary surplus and the current account. i.e. shorter-term indicators.

- **Factor 3** is often explained by inflation and/or real growth rate. In many cases, also the real effective exchange rate is significant. It can represent the nominal rate of growth. This factor has not been plotted and considered in any further analysis.

Computing the factor scores for each country using the results of the decomposition performed year by year, we get the values which have been plotted in Figure 2 in Appendix. Results are broadly similar to the previous ones. We have been able to identify three different groups, not completely separated from each other. A first group again includes Greece, Portugal, Spain. The graphs of these countries share a kinked shape, namely large joint deterioration of short and long-term sustainability, and then reversal. Italy is less pronounced and borderline with Ireland, which constitutes, alone, the second group with an inverse movement in the two factors. The third and last group is composed by France (which shares many aspects with Ireland and Italy), followed by Austria, Belgium, Finland, Germany and Netherlands.

This analysis has been redone forcing two output factors (Figure 3 in Appendix). The previous results are broadly confirmed. In particular, Portugal, Spain and Greece show a V pattern, with two distinct periods clearly identifiable. Finland, Netherlands and Austria show a U pattern. Italy and Ireland have two confused patterns whereas, finally, Germany and France have two unique patterns (for this reason, these last two countries has not been classified). In general, we can say that the stronger dynamics is horizontal, along the first factor, and that this factor has undergone one relevant change in the 2008-2010 period.
5. Conclusions

The EZ sovereign debt crisis in 2010-12 has challenged the common wisdom and expected results of the austerity policies enforced with particular intensity onto the countries under most severe financial distress (the EZ5). Until the ECB has intervened promising a backstop against the escalation of spreads, austerity policies have been unable to curb large risk premia and the growth of debts relative to GDP. The models of "self-fulfilling beliefs" of default that we have discussed provide a consistent explanation of these phenomena. In particular that large and fast fiscal adjustments may be deemed unsustainable by investors thus increasing, instead of decreasing, their perceived risk of default. The preliminary correlation analysis presented in section 2 has provided evidence that, in fact, cumulated fiscal adjustments and spreads of the EZ5 countries in 2010-12 are positively correlated, and that the best correlated variable with spreads is the growing gap between the actual fiscal adjustment and the one required to stabilize the debt/GDP ratio.

However, bringing the sustainability hypothesis to the data is not an easy task, first because investors' beliefs are not observable, and second because such beliefs may be generated by a number of different indicators of sustainability. Addressing in particular the latter problem, we have presented the results of a dynamic Principal Components Factor Analysis applied to the panel data set of the eleven major EZ countries from 2000 to 2013 including each country's spread of long-term interest rate over Germany as dependent variable, and an array of leading fiscal and macroeconomic indicators of solvency fiscal effort and its sustainability. We have been able to identify and confirm the role of these variables, of both short and longer-term nature, combining themselves as significant latent variables in boosting spreads. Moreover the large joint deterioration of these variables is identifiably located between 2009 and 2012 and particularly for the EZ5 group (with Italy and France as borderline cases).

The shift from a credibility to a sustainability paradigm by investors is probably playing a role in making the EZ debt crisis so difficult to manage. This shift of paradigm may have caught policy makers brought up in the credibility doctrine by surprise. The latter, in the different market context focused on sustainability, may in fact provide misleading policy prescriptions. The point of the sustainability approach is that when a government is caught in the self-fulfilling prophecy trap, announcing and implementing harder fiscal plans may not be the right move because, as explained above, it boosts the risk premium even though the plans are initially sustainable. This different understanding of how investors behave...
also helps explain the success of the OMT programme as a means to create a self-fulfilling "good equilibrium", and why such a role of the central bank in sovereign debt crisis may be indispensible.

References


### Appendix

#### Table 1. Fiscal adjustment indicators 2009-13 (% of GDP) and spreads (%) 2010-13

<table>
<thead>
<tr>
<th>Country</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
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<td>-1.3</td>
<td>0.00</td>
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</table>

| EZ6     | -2.0 | -2.0 | 0.1  | 0.35 | -0.5 |
| GRE     | -10.4| -4.7 | 5.7  | 7.78 | -2.2 |
| IRE     | -12.0| -6.4 | 5.6  | 3.71 | -6.1 |
| ITA     | -7.3 | -7.0 | 0.4  | 3.33 | -0.4 |
| POR     | -9.4 | 7.4  | 2.0  | 1.87 | -6.1 |

| EZ5     | -8.0 | -5.1 | 2.9  | 3.64 | -2.8 |
| EZ11    | -6.7 | -4.5 | 2.2  | 1.85 | -2.0 |

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<th>Spread</th>
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\( \Delta \) = year change

- \( b \) = primary balance/GDP ratio
- \( \Delta b \) = primary balance/GDP change
- \( \text{spread}^a \) = Year average of monthly values of spreads of long-term interest rates over German bonds
- \( \text{spread}^b \) = Excluded Germany

Source: EUROSTAT, online database AMECO; ECB, Interest Rates Statistics.
Table 2. Factors after the rotation.
With a red circle, the main loadings of the factors.

<table>
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Legend: a1 = long term interest rate, a2 = inflation rate, a3 = real effective exchange rate, a4 = deficit/GDP ratio, a5 = primary surplus/GDP ratio, a6 = debt/GDP ratio, a7 = fiscal space, a8 = real growth rate, a9 = current account/GDP ratio. Uniqueness is given by the variability of a given variable minus the communality (given by the amount of the variability of a variable not explained by all factors jointly). It may be interpreted as a measure of the reliability of the factors.
Figure 1. The complete joint dynamics of Factor 1 (horizontal axis) and Factor 2 (vertical axis)
Figure 2. The complete joint dynamics of Factor 1 (horizontal axis) and Factor 2 (vertical axis) for each country when three factors have been extracted.
Figure 3. The complete joint dynamics of Factor 1 (horizontal axis) and Factor 2 (vertical axis) for each country when two factors have been extracted.
Neatherlands

Germany

France
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