

# Funding Strategies of Sovereign Debt Management: A Risk Focus

Johannes Holler<sup>1</sup>

*Most sovereign debt management agencies operate on a narrow definition of risk which does not reflect the potential of sovereign debt portfolios to insure the budget against macroeconomic shocks. This paper analyzes the different forms of risk implied by the composition of the sovereign debt portfolio and discusses methods for their evaluation. By determining the risk properties of existing debt management instruments we underline the potential of certain debt management instruments to insure the budget against stylized demand and supply shocks producing strong incentives for debt management agencies to operate on a broader definition of risk. The identified risk properties further highlight that the establishment of Economic and Monetary Union reduced market, rollover and liquidity risk in the aggregate euro area debt portfolio, whereas the loss of the risk free status for euro area sovereign assets and the steepening of the yield curve, both triggered by the sovereign debt crisis, led to a shift towards more short-term debt resulting in an increase in rollover risk and market risk.*

*JEL classification: H63, E62*

*Keywords: sovereign debt management, portfolio optimization, fiscal insurance theory*

## 1 Introduction

As discussed in the economic literature of the past 50 years, the objectives of managing debt are manifold in both theory and practice and they differ significantly across countries and stages of economic development.

There are two basic perspectives on the topic of sovereign debt management. The macroeconomic perspective focuses on all welfare implications of debt management decisions while the “micro portfolio optimization perspective” (or “finance perspective”) solely focuses on debt servicing costs.

The literature approaching the subject from the macroeconomic perspective<sup>2</sup> addresses two conflicting objectives of sovereign debt management: expected cost minimization and risk minimization. Building on the optimal taxation literature by Barro (1979), Lucas and Stokey (1983) and Bohn (1990), most of the macroeconomic works support the risk minimization objective, which emphasizes the role of sovereign debt management in smoothing taxes through time-varying returns

on liabilities. Based on Faraglia et al. (2008), this risk minimization objective, which implies a smoothing (immunization) of the government budget against exogenous macroeconomic shocks, became known as the “fiscal insurance theory” of public debt management. Despite the fact that the macroeconomic literature has also produced arguments in favor of a cost minimization objective of sovereign debt management, empirical findings in favor of this objective are rare and not convincing (e.g. Missale, 1999).

Contrary to the macroeconomic literature, authors approaching the subject from a micro portfolio optimization perspective identify the expected debt servicing cost minimization objective as the indisputable objective of sovereign debt management.

The reason behind the support of different objectives by finance and macroeconomic theory ultimately lies in the different definitions of risks considered. Micro portfolio optimization incorporates a narrow concept of risk limited to the risk of servicing, issuing

<sup>1</sup> Comments by Ernest Gnan, Eva Hauth, Walpurga Köhler-Töglhofer and Lukas Reiss are gratefully acknowledged.

<sup>2</sup> For a detailed survey on the macroeconomic literature on sovereign debt management see Missale (2012).

Refereed by:  
Peter Brandner,  
Federal Ministry of  
Finance

or refinancing debt at unexpected costs. Macroeconomic theory, on the other hand, employs a broad concept of risk which includes all welfare effects that may arise from “uninsured” tax revenue reductions or expenditure increases triggered by exogenous shocks.

The different approaches toward public debt management are also mirrored at the institutional level. Sovereign debt management in OECD countries has shifted from operational bodies within finance ministries or central banks to partly or fully independent entities. This operational transformation has been accompanied by a change of debt management objectives, i.e. a shift from a macroeconomic perspective to the expected cost minimization objective (Hoogduin et al., 2010).

Nowadays most of the debt management offices worldwide follow the Guidelines for Public Debt Management published by the IMF and the World Bank in 2001: “*The main objective of public debt management is to ensure that the government’s financing needs and its payment obligations are met at the lowest possible cost over the medium to long run, consistent with a prudent degree of risk.*” These guidelines define risk as all potential increases of debt servicing costs related to market, rollover, liquidity, credit and operational risks and therefore reflect the micro portfolio optimization perspective (finance perspective) on sovereign debt management. Welfare implications of potential “uninsured” revenue/tax variations are not considered.

Recent developments have increased awareness that the composition of sovereign debt portfolios significantly affects the vulnerability of government budgets, a fact which was even reflected

by a revision of the IMF public debt management guidelines. The Stockholm Principles (IMF Forum, 2010) explicitly focused on improved communication among debt managers and monetary, fiscal and financial regulatory authorities and reflect a move toward a somewhat broader definition of risk than is applied by sovereign debt management in practice.

Our work elaborates on the existing conflict between optimal sovereign debt management strategies derived from macroeconomic theory and debt management strategies employed in practice. In this context we focus on the unexploited potential of sovereign debt portfolios to insure against or to amplify macroeconomic shocks. We underline that debt management agencies should reflect potential fiscal vulnerabilities (i.e. a broad definition of risk) arising from the composition of sovereign debt ultimately reflected by their funding strategies.<sup>3</sup>

This paper is structured as follows: Chapter 2 focuses on debt servicing costs and debt management risks. The potential sources of risk reflecting the macroeconomic and finance perspective of sovereign debt management are discussed and a selection of cost and risk indicators is presented. Chapter 3 focuses on the pool of available debt instruments and identifies their implied risk characteristics. Against this background, chapter 4 evaluates the risk implications of changing sovereign debt management strategies for EMU member states over the periods 1999 to 2007 and 2008 to 2011. Chapter 5 summarizes the findings.

To simplify the analysis, we limit our attention to the liability side of the debt management agency’s portfolio,

<sup>3</sup> For a detailed description of the debt management strategies of selected countries see Bergström et al. (2002), Bolder (2003), OECD (2005), Bolder and Rubin (2007) and Denmark’s Nationalbank (2010).

i.e. we do not address assets in the analysis.<sup>4</sup> In addition, due to complexity issues and the lack of publicly available data we do not consider derivative products, which clearly have the potential to substantially change the cost-risk profile of the debt portfolio.<sup>5</sup> Any interpretations of our results should keep these caveats in mind.

## 2 Costs and Risks Considered in the Portfolio Optimization Problem

For debt instruments that are traded on the market, evaluating the expected debt servicing costs of new issuances is straightforward. If one assumes that the issuance of debt does not change the yield curve,<sup>6</sup> one can simply observe the corresponding benchmark yields for fixed-rate instruments or the discounted margin for variable interest rate bonds.

Evaluating the associated risks is more complex given the range of risks that have to be considered. Following the IMF/World Bank guidelines, the first part of the chapter discusses the different forms of risk that are considered in practice. We distinguish between five subcategories of risk arising from sovereign liability management: market risk, rollover risk, liquidity risk, operational risk and reputation risk. Each of the categories represents potential reactions of debt servicing costs to specific types of economic developments. The second part of the chapter focuses on the macroeconomic risks of sovereign liability management which determine the degree of fiscal vulnerability and fiscal insurance implied in the sovereign debt portfolio. We do,

however, not elaborate on the evaluation of welfare losses but only discuss the degree of insurance the debt portfolio offers against macroeconomic shocks. In the last part of the chapter we briefly describe the multi-stage process of portfolio optimization.

### 2.1 Risks Considered in the Micro Portfolio Optimization

#### Market Risk

Most references (e.g. IMF, 2001) consider market risk to be solely defined by cash flow at risk, which refers to all potential changes of sovereign debt servicing costs (principal or coupon payments) due to changes in interest rates, exchange rates, inflation, commodity prices or GDP growth rates. The sensitivity of debt servicing costs to changing market conditions is crucial for the level of cash flow at risk implied by a sovereign debt portfolio. Besides this type of market risk, debt management agencies also consider value at risk (VaR), which captures all potential changes of the market value of the issued debt as a potential source of market risk since it covers information about potential costs or revenues arising from debt switches or debt buy-backs. In principle, any change in the market value of the debt portfolio can be translated into cash flow changes via the use of financial derivatives. From the insurer perspective, VaR appears to be of limited relevance if one does not consider the use of derivative products, which is the case in our analysis. We therefore follow the standard IMF/World Bank definition of market risk, which excludes value at risk as a source of market risk.

<sup>4</sup> IMF (2012) offers a broad theoretical description of a combined asset and liability management approach that considers both sides of the governmental balance sheet.

<sup>5</sup> For a detailed description of the use of derivative products by public debt managers see Piga (2001).

<sup>6</sup> Large issuance volumes may cause price changes in different segments of the yield curve.

Market risk can be evaluated with a variety of deterministic and stochastic indicators. The most widely used indicator is the *Macaulay duration*, which corresponds to the weighted average time to maturity of the portfolio. For fixed-rate instruments, it measures how long it takes for coupon and principal cash flows to repay the price of a bond. For variable-rate bonds, future cash flows are not known and the Macaulay duration is simply defined as the time until the interest rate is re-fixed. From the issuer perspective, the longer the duration, the lower the risk of higher debt service payments due to interest rate changes. Duration is influenced by the level of coupon payments and yields, where high coupon payments and high yields imply low duration and high market risk for the issuer. Other indicators measure the *average time to re-fixing* of interest rates on outstanding principal. A low value indicates high risk, since a relatively high share of debt will have its interest rates re-fixed in a relatively short period of time.

More complex indicators of market risk use simulation techniques that build on concepts developed by private financial institutions. In the context of sovereign debt management the widely used concept of value at risk (VaR) is modified into an absolute *cost at risk* metric (CaR). CaR calculations, which come in various forms,<sup>7</sup> generate the distribution of debt servicing costs by simulating changing market conditions (e.g. the term structure of interest rates and exchange rates) and identify violations of a given benchmark (e.g. the 99<sup>th</sup> percentile of the debt servicing

costs distribution). Based on the absolute CaR measure the *conditional cost at risk (CCaR)* evaluates market risk in the case of extreme events or so-called tail risks. CCaR refers to the maximum potential increase in the debt servicing costs of a debt portfolio with a given probability over a preset horizon given that the CaR benchmark is violated. The mean of CCaR (*mean excess loss or expected shortfall*) can therefore be used as a proxy for tail risks.<sup>8</sup>

### Liquidity Risk

In the context of sovereign liability management, market liquidity risk identifies the problems of selling significant quantities of a security in a quick, anonymous way with a rather small impact on the price. The *size of the debt market* and the *composition of the investor base* are crucial elements in determining market liquidity. *Trading volume*, *bid-ask spreads* and *yield spread between on-the-run* (most recently issued and hence most liquid units of periodically issued securities) and *off-the-run* (older issues, traded at a discount to on-the-run securities) securities are additional standard measures of market liquidity. Futures offer the possibility to insure against bond price movements. This is the reason why bonds with a corresponding liquid futures market attract a broader investor base and therefore show higher liquidity premiums (e.g. a phenomenon observed for German bonds during the recent financial crisis; see Ejsing and Sihvonen, 2009). The ratio of *futures turnover and bond turnover* is a proxy for the liquidity of and activity on futures markets for sovereign debt. A larger ratio implies higher market liquidity for

<sup>7</sup> Simulations can be purely deterministic, with the size of shocks being determined by statistic properties (parametric CaR) or historic observations (historic CaR), while others are stochastic, deriving the size of shocks from a set of random numbers (Monte Carlo CaR) or stochastic dynamic optimization models.

<sup>8</sup> For a detailed description of the existing CaR methods see IMF (2012).

the bond market. Fostering derivative markets for sovereign debt can therefore increase market liquidity and reduce liquidity risk.

### Rollover Risk

The risk associated with unexpectedly high refinancing costs (e.g. higher credit risk premiums, changing market conditions) or difficulties in refinancing expiring debt can be summarized by the term rollover risk. The separation between market risk and rollover risk is not clear-cut, since rollover risk caused by potentially higher debt servicing costs for debt redemptions could also be defined as market risk. The same is true for the separation between rollover risk and liquidity risk since problems selling instruments on the market also lead to liquidity risk. Despite the problems with presenting a clear-cut distinction between the different risk categories, we follow the most commonly used IMF (2001) definition and summarize all risks connected to debt rollovers in this separate category.<sup>9</sup> The simplest way to identify rollover risk is to examine the *redemption profile* of a debt portfolio (redemption profiles of selected euro area countries can be found in the appendix). Peaks mark large concentrations of rollover needs and therefore imply large rollover risk. In practice, a variety of alternative rollover risk indicators are in use. For instance, the *residual maturity* of debt, which identifies the share of total debt falling due within a certain period of time, reflects the potential risk for the budget for a certain time frame. The *average residual maturity* of debt evaluates the weighted average length of the outstanding debt's life, with the weights of each debt instrument reflecting the amounts of outstanding principal. High

values imply low rollover risk, since relatively more redemptions are taking place in the more distant future.

### Operational Risk

As defined by the Basel Committee, operational risk is “*the risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems, or from external events.*” Due to its nature, operational risk differs for each institutional setup and can hardly be measured by standardized indicators. In general, operational risk is positively correlated with the degree of complexity of debt instruments because more complex instruments involve a sensitive methodical framework and a larger operational body. Unlike other risk categories, operational risk does not have a direct link with debt servicing costs; high levels of operational risk do not imply low debt servicing costs.

### Reputation Risk

Debt servicing costs are crucially dependent on the record of a government as a reliable debtor. Any action that harms this reputation pushes up debt servicing costs in the medium to long run. In the extreme case, debt management agencies can severely harm a country's track record by enforcing legal changes (e.g. ex post implementation of collective action clauses) or by defaulting on debt. While such an action could be accompanied with lower debt servicing costs in the short run, medium- to long-run debt servicing costs increase due to substantially higher credit risk premiums. Various studies show that sovereign debt markets appear to have a good memory when it comes to defaults, which thus may have lasting consequences (Cruzes and Trebesch, 2013).

<sup>9</sup> Nevertheless market risk indicators such as the Macaulay duration also reflect some rollover risk.



## 2.2 Macroeconomic Risk – Budget Risk<sup>10</sup>

A welfare-maximizing approach of public debt management has to smooth taxes over time. The occurrence of macroeconomic shocks implies substantial changes in government revenues and expenditures, which can make tax adjustments inevitable. This is especially true in the light of limits to government debt levels and the non-linear behavior of yields. Budget risk captures the risk of such potentially welfare-reducing adjustments due to variations of macroeconomic variables. It directly refers to the broad definition of risk employed in the insurance theory of public debt management. From the perspective of macro-oriented sovereign debt management, budget risk is defined by the *sensitivity of debt servicing costs to changing macroeconomic environments* and especially *to economic cycles*. In particular, debt servicing costs that are positively correlated with the economic cycle (procyclical) imply that the government budget shows a positive degree of insurance against macroeconomic shocks. High positive correlations therefore imply low budget risk and vice versa. Despite the fact that the budget balance minimum target defined by the Stability and Growth Pact heightens the relevance of this type of risk, it has so far played a negligible role in the portfolio optimization process of public debt management, as debt management agencies do not employ a broad definition of risk.

## 2.3 Portfolio Optimization – A Multi-Stage Process

The first step of optimizing debt management, which is a multi-stage process, is to allocate risk weights to the individual risk categories in line with the guiding debt management objective and risk definition. If a macroeconomic approach is followed only the budget risk category is considered in an optimization problem, whereas a micro portfolio optimization has to evaluate the importance of each micro portfolio risk category (see section 2.1) via the level of risk weights. Besides the decision on the risk categories and their respective weights, debt management strategies also have to obey certain benchmarks<sup>11</sup> for debt servicing costs (e.g. maximum level of debt servicing costs to GDP) or risk levels (e.g. minimum average maturity of debt, duration bands) which are pre-determined by the government. Together with debt servicing costs, the considered risks and debt benchmarks define the set of feasible debt portfolios in the cost-risk dimension and the efficient market frontier.<sup>12</sup>

The second step is to identify the utility-maximizing cost-risk profile – i.e. the optimal debt portfolio – within the range of efficient portfolios. This can be done by means of various optimization methods (e.g. the prominent linear mean-variance optimization). In the case of predefined strategic portfolio targets (benchmarks) for debt servicing costs or overall risk, the optimization problem is a constrained return-maximization or constrained

<sup>10</sup> Budget risk as defined here should not be mixed up with the volatility of government debt servicing costs, an alternative interpretation of the term employed in practice.

<sup>11</sup> Market risk benchmarks for certain OECD countries can be found in Blommestein (2009).

<sup>12</sup> The efficient market frontier identifies all efficient portfolios that offer the highest expected return for a certain level of risk, or the lowest risk, for a certain level of expected return.

risk-minimization problem.<sup>13</sup> The third and last step of the optimization process is to determine the micro structure of the portfolio that matches the cost-risk characteristics of the optimal portfolio by selecting adequate debt instruments.

In practice, debt management agencies rarely publish information about risk weights or debt benchmarks. In the EU, the practices of debt management offices differ considerably. The tradition of transparency in northern Europe contrasts with the tradition of vague references to risk positions and debt portfolio patterns (particularly for derivative positions) in all other euro area countries.

### 3 Financial Liability Instruments Used by Sovereign Debt Managers

In order to generate the optimal risk profile, debt management agencies can draw from a variety of instruments, irrespective of which perspective they rely on. These instruments fall into three broad categories under the definition of government debt in the System of National Accounts 2008: currency and deposits, loans and debt securities.

#### 3.1 Classification of Financial Liabilities

##### Currency and Deposits

Currency captures all liabilities arising from floating banknotes and coins that are not classified as liabilities by other sectors (i.e. the central bank). Deposits can take the form of interbank positions, other transferable deposits (e.g. savings bonds) and other deposits (specifically unallocated gold deposits). Most EU countries hold only a small part of total debt in the form of currency and deposits, the exceptions being Ireland (9%), Italy (7.9%), Portugal (5.9%),

Sweden (6.1%) and the U.K. (9.7%). These liability instruments are mainly used for short-term oriented liquidity management operations.

##### Loans

Loans do not require a large institutional setup and can be issued with low operational costs. Hence loans appear to be advantageous for illiquid debt markets. For markets which are characterised by a small size and a small investor base it would be relatively costly to build up and maintain the operational body necessary to issue debt securities. Especially in a situation where individual investor needs have to be addressed with individual nonstandard debt contracts, loans appear to be advantageous. Most subnational debt markets in Europe appear to match the described characteristics. This explains why they rely extensively on loans: In the euro area, they account for about 50% of government debt at the state and provincial level. Municipalities hold their debt almost exclusively in the form of loans. In comparison, the share of loans in the euro area central governments' debt portfolio (11% of total) is relatively small. The liquidity argument in favor of loans also holds for the total sovereign debt profile of countries with relatively small capital markets. Estonia, Luxembourg and Cyprus hold large shares of debt in the form of loans in their portfolio. The large share of loans for Portugal, Greece and Ireland are a statistical artefact largely due to loans provided in the context of rescue programs by the international community. Countries with large debt markets like France, Spain and Italy do not fund themselves extensively via loans (see chart 2). The relatively large part of loans in the German debt portfolio can

<sup>13</sup> For a detailed description of existing optimization methods see Connor et al. (2010).

again be explained by the preferences of the subsectors, which are especially important for federally organized countries.

### Debt Securities

Unlike loans, the issuance and management of debt securities requires a sophisticated institutional setup and implies large fixed costs. This is the main reason why only relatively large debt markets with a sufficient level of liquidity issue debt securities to raise funds. Chart 1 shows that debt securities account only for a very small part of the debt portfolio of local governments (7% of total debt) while they dominate the state and provincial government portfolios (51% of total debt) and especially the central government portfolio (84% of total debt).

Debt securities are standardized products that are easy to trade via markets.

### 3.2 Characteristics of Financial Liabilities

The described financial instruments differ in terms of maturity, interest rate structure and currency denomination. These characteristics to a large extent decide about costs and risks of certain debt instruments. In the following subsections we describe the potential benefits of all characteristics, determine their influence on the various types of debt management risks and discuss their importance throughout the euro area.

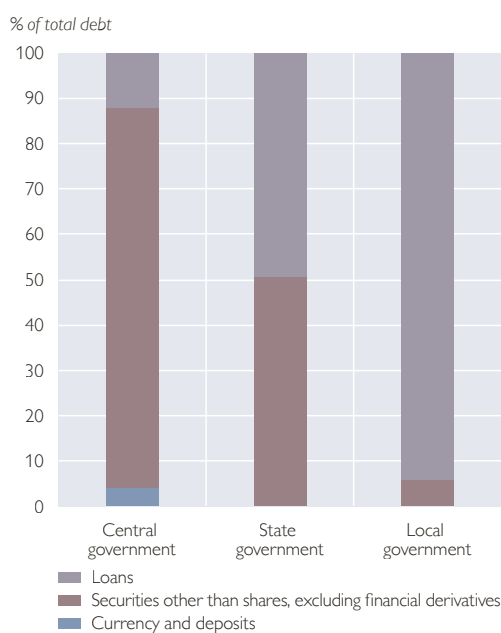
#### Maturity

In “normal times” (i.e. in times of moderate expectations about future inflation and economic growth and moderate default probabilities) the yield curve (interest rate profile for different maturities), is upward sloping<sup>14</sup>. This implies that yields increase with maturity, since investors have a preference for short maturities given lower uncertainty and lower moral hazard. Debt with short maturities will be the instrument of choice if cost minimization is the main objective of debt management despite the substantial amount of implied rollover risk. Under special economic circumstances (e.g. expectations about strong economic slowdowns or low future inflation) the yield curve can become inverted. In these cases, issuing on the short end of the curve can imply higher debt servicing costs than issuing on the long end.

Short-term debt issuance supports anti-inflationary credibility since the interest rate is readjusted continuously in line with changing inflation rates.

Chart 1

#### Subnational Use of Debt Securities in the Euro Area: Q4 12



Source: Eurostat.

<sup>14</sup> For a detailed description of the various arguments for an upward sloping yield curve see Fabozzi and Mann (2005).



Missale and Blanchard (1994) show that for governments with low anti-inflationary credibility it is optimal to issue short-run or price level-indexed debt.

Concerning macroeconomic risk, debt instruments with long maturities and fixed interest rates imply constant (acyclical) debt service costs over a long horizon, unaffected by changing macroeconomic conditions. Hence debt instruments with long maturities and fixed interest rates (cash flow is fixed until maturity) imply high macro/budgetary risk if refinancing costs are low during economic downturns (act procyclically) and vice versa.

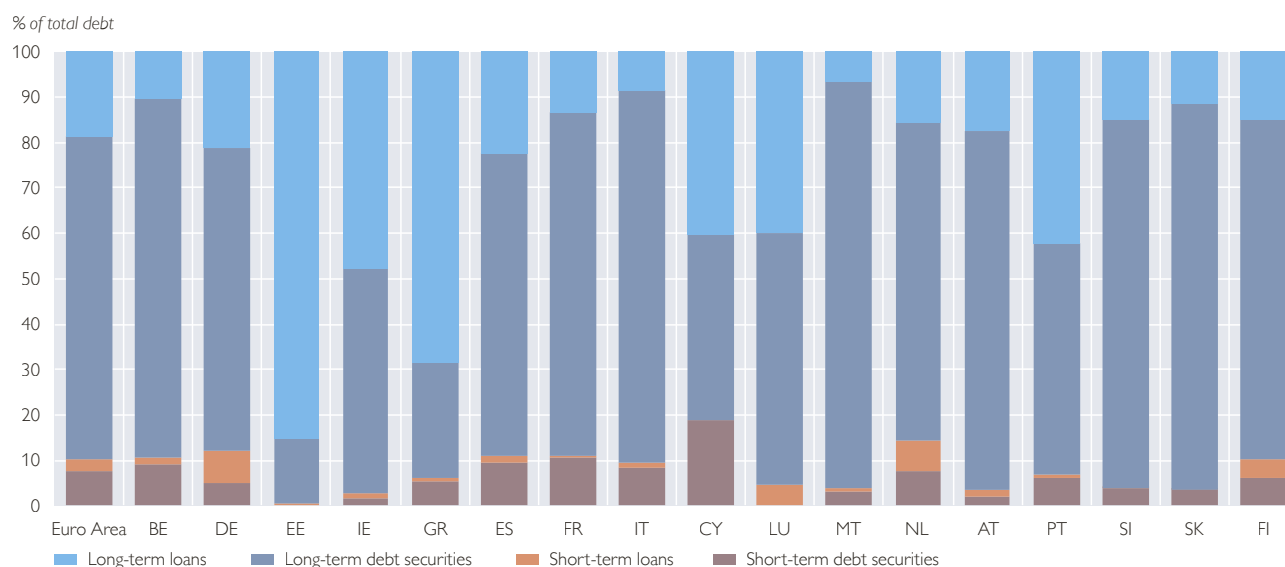
In a model world where sovereign assets are risk-free, the cyclical behavior of refinancing costs follows the cyclical behavior of interest rates. Yet if sovereign assets carry risk, economic cycles also influence country risk premiums. This implies that the cyclical behavior of refinancing costs is not solely determined by the cyclical behavior of interest rates but also by the change of the country risk premiums. This is evidenced by

the divergent effects of the most recent economic downturn on the refinancing costs of Germany, a low-risk country, and Greece, a high-risk country. Despite the fact that the common monetary policy counteracted the economic slow-down by cutting interest rates, German refinancing costs decreased while Greek refinancing costs rose due to substantially increased country risk premiums. If debt management tries to reduce macroeconomic risk implied in the debt portfolio, it has to consider how sensitive country risk premiums react to macroeconomic shocks. Countries that put a strong emphasis on insuring against future increases of country risk premiums should issue debt with long maturity (see Missale, 2012).

Within the euro area, sovereign debt portfolios differ substantially in terms of their maturity structure (see chart 2). On the one hand, Estonia, Ireland, Greece, Luxembourg, Austria and Poland almost exclusively hold long-term debt. Countries like Germany, France, Cyprus and the Netherlands on

Chart 2

### Public Debt Portfolio in the Euro Area: General Government – Q4 12



Source: Eurostat.

the other hand, hold short-term debt (debt with residual maturity of up to one year) representing well above 10% of total debt.

### Interest Rate Structure

The cost-risk profile of debt instruments further depends on whether cash flows are fixed (fixed-rate bonds) or variable over time (floating-rate bonds). Coupon payments of floating-rate bonds are linked to certain reference indices. The (market) risk of interest changes is carried in full by the sovereign. The reference indices of floating-rate bonds can take various forms, traditional benchmarks being money market rates like LIBOR or EURIBOR.<sup>15</sup> Since floating-rate bonds are often linked to short-term interest rates, an upward sloping yield curve implies lower debt servicing costs for floaters than for fixed-rate bonds with equal maturities. Floating-rate bonds are mainly demanded by investors like banks that prefer to lend money at variable interest rates. As coupons of floaters are usually adjusted every few months (typically every 6 months), they are only valuable for debt with maturities exceeding the re-fixing time interval. The insurance value for investors which is generated by floaters increases with the maturity of the instrument. Therefore floating-rate bonds are concentrated in the long-term debt market.

To identify the effect of the interest rate structure of debt on macroeconomic risk, one has to determine the factors behind the interest rate dynamics. Theory identifies economic growth and inflation as the main drivers of interest rate movements. Depending

on the type of shock that causes deviations from the trend output, a positive or negative correlation between economic growth, inflation and interest rates can be observed. In order to derive clear-cut results about the influence of the interest-rate structure on macroeconomic risk, one has to differentiate between different types of economic shocks and monetary policy reactions. In the following we discuss a special case of supply and a special case of demand shock to clarify the dynamics at work.

First we consider a negative demand shock scenario in which monetary policy follows a simple Taylor rule that implies expansionary monetary policy. Such a shock implies a positive correlation between growth and interest rates and therefore causes debt servicing costs for variable-interest debt instruments to react procyclically, creating fiscal space for countercyclical manoeuvre and reducing budgetary risk (increasing budgetary insurance).<sup>16</sup> If the demand shocks go hand in hand with a reduction of inflation, the argument also holds for inflation-indexed debt.

Second we look at a cost-push supply shock scenario in which monetary policy is contractionary. In this case variable-interest debt implies relatively high levels of budgetary risk since debt servicing costs increase (act countercyclically). For this type of shock, inflation-indexed debt amplifies budget risk.

The use of variable-interest bonds is widespread in the euro area but shows substantial differences across countries. The share of more than 40% in overall

<sup>15</sup> A large share of variable interest rate debt can lead to substantial problems for monetary policy.

<sup>16</sup> This argument is of course only true if we assume that the country risk of the sovereign is constant and not affected by economic cycles.

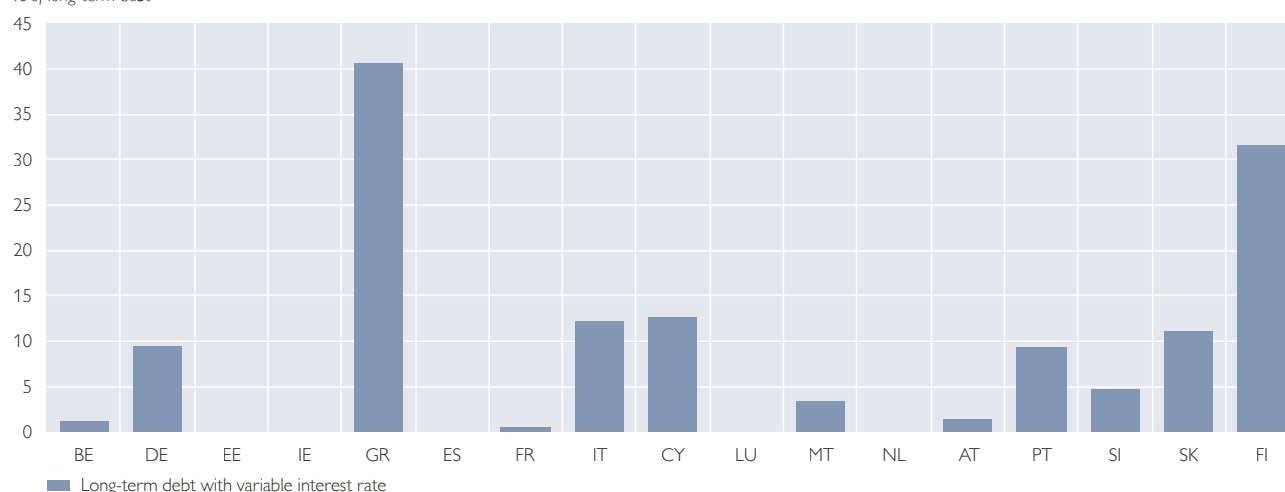
Greek long-term debt reflects the recent restructuring of sovereign debt, which included a debt exchange of fixed-rate bonds for variable-interest bonds. Among the other euro area

countries, only the Finish debt portfolio shows a large proportion of total long-term debt (more than 30%) held in the form of variable-interest debt (see chart 3).

Chart 3

### Long-Term General Government Debt with Variable Interest Rates in the Euro Area – 2011

% of long-term debt



Source: ECB.

Box 1

#### Debt Indexation

*Inflation-indexed, GDP-indexed or commodity price-indexed bonds can be interpreted as floating-rate bonds with special reference indices.*

*In the sovereign debt markets, inflation-indexed bonds became prominent through the issuance of inflation-indexed gilts by the U.K. in 1981. Since then, various other countries (e.g. U.S.A., France, Canada, Australia, Germany, Greece, Hong Kong, Italy, Japan, Sweden, Israel and Iceland) have also issued inflation-indexed debt. Patterns differ since some instruments only index the coupons while others also index the underlying principal. Inflation-indexed bonds can normally be placed on the market at lower debt servicing costs since the inflation risk is transferred from the investor to the government.<sup>1</sup> In addition to the insurance feature of inflation-indexed bonds they additionally serve as anti-inflationary commitment devices for monetary policy.<sup>2</sup> Anti-inflationary credibility can be gained by increasing the share of long-term debt that is indexed to the price level (Calvo, 1988). Countries with low reputation and low credibility in the field of monetary policy can use inflation-indexed bonds to reduce the slope of the yield curve. Membership in currency unions that have price stability as their primary goal goes hand in hand with higher credibility for anti-inflationary policies and reduces the use of inflation-indexed bonds as an insurance device. In such a case, the motive*

<sup>1</sup> Constrained market liquidity for inflation-indexed bonds can lead to a situation of higher debt servicing costs for inflation-indexed bonds than fixed-rate bonds.

<sup>2</sup> However, the emission of inflation-indexed bonds could also reduce the inflation aversion of a country's population. This was the reason behind the ban of inflation-indexation which existed in Germany until EMU membership.

for diversifying the portfolio in order to attract a large investor base becomes the main motive of inflation-indexed debt issuance.

The issuance of inflation-indexed bonds clearly increases market risk, since the government debt servicing costs additionally react to price fluctuations. As a consequence of the price or wage indexation of pension benefits that exists in various OECD countries, pension funds are natural investors seeking inflation protection via inflation-indexed bonds.

GDP-indexed bonds, i.e. instruments with cash flows that are linked to economic growth rates, would provide the most efficient and direct protection for budget variations caused by the described demand shock. Despite the fact that GDP-indexed bonds are theoretically very appealing, the implementation of such bonds faces substantial obstacles. While moral hazard problems arising through the implicit incentives of governments to reduce economic growth (Sandleris et al., 2011) and therefore to lower debt servicing costs appear to be solely of theoretical use, the treatment of data revisions due to the lagged realization of output data appears to be substantial and prevents an objective pricing of the instrument. Until today, the obstacles and the lack of a clear-cut investor base for the product have prevented the regular issuance of GDP-indexed bonds. Nevertheless these instruments have found their application in certain debt restructuring arrangements. Argentina, Bulgaria, Costa Rica and Bosnia-Herzegovina have used GDP-indexed bonds in their debt restructurings by linking them to bond exchanges.

### Currency Denomination

Countries with mature debt markets can issue debt in both domestic and foreign currency. Issuing foreign currency-denominated debt broadens the investor base, and the implied transfer of exchange rate risk from the investor to the government makes such instruments attractive to foreign investors with limited or low risk-taking capacity. This argument is especially relevant for small countries with currencies that have low international reputation. Increasing demand for a debt instrument further implies improved liquidity for the debt instrument. The resulting lower liquidity premiums together with the risk transfer reduce emission yields. Therefore, foreign currency debt trades at substantially lower yields to maturity than domestic debt for countries with devaluation risk. Due to the exchange rate-dependent coupon and principal payments, foreign currency-denominated debt carries substantially amplified market risk for the issuing sovereign.

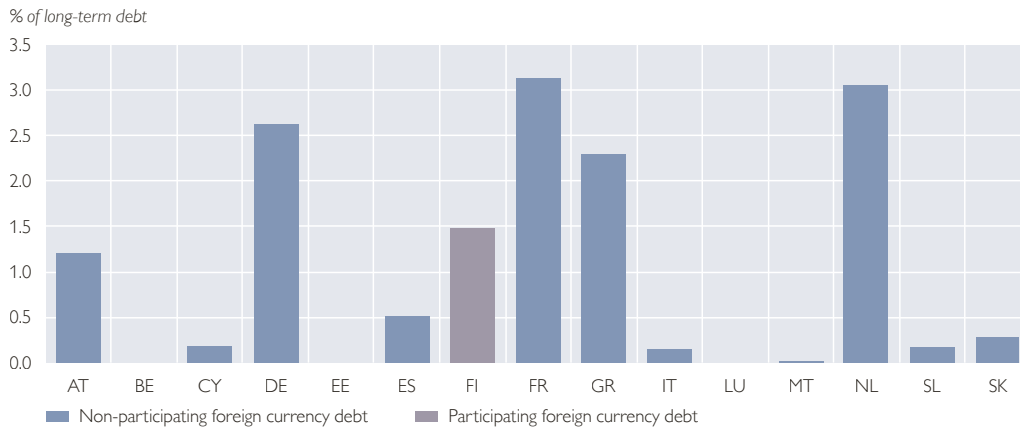
In order to determine the influence of currency denomination for macro-

economic risk, we first have to discuss the correlation between interest rates and exchange rates. If the uncovered interest parity holds, domestic economic booms that lead to higher domestic interest rates imply appreciation expectations for the domestic currency. Debt servicing costs of foreign currency debt therefore react countercyclically. The budgetary risk position of the portfolio implied by shocks that cause local currency depreciations hence increases with the share of foreign currency-denominated debt. The opposite is true for shocks that cause local currency appreciation.

The “fear of floating” literature (Calvo and Reinhart, 2002) discusses the potential of foreign currency debt to serve as a commitment to anti-inflationary policy. Similar to inflation-indexed debt, a large share of foreign currency-denominated debt causes a situation where monetary policy has strong incentives not to cause depreciations by loose policy and thus reduces monetary policy flexibility and fostering anti-inflationary credibility.

Chart 4

### Foreign Currency Denomination of General Government Debt in the Euro Area – 2011



Source: ECB.

In 2011 only a few countries (Germany, France, Greece and the Netherlands) in the euro area had more than 2% of their debt in foreign currencies (see chart 4). Finland is the only country in the euro area with an ERM II participating foreign currency-denominated debt (Danish krone) in its portfolio.

#### Combining Debt Characteristics

By combining different instruments debt managers can tailor the cost-risk profile of the sovereign debt portfolio. The issuance of a wide range of products with the aim of increasing the investor base entails reduced liquidity for each instrument, since the instruments partly serve as substitutes. The lower the liquidity, the higher the liquidity premium, which increases debt servicing costs. In reality, the existing tradeoff between liquidity premiums and the depth of the debt market is the reason why debt management agencies issue a limited variety of debt titles. Strict risk management benchmarks and a focus on a liquidity-enhancing strategy can

create a natural base for the use of financial derivatives. Due to a lack of detailed information, we exclude derivatives from the analysis and do not elaborate on their effect on the characteristics of the debt portfolio characteristics.

#### 3.3 Issuance and Placement Techniques

Debt management agencies can choose from a variety of issuance and placement techniques.<sup>17</sup> The method of placing debt on the primary market is especially relevant for curbing liquidity risk. The various existing distribution channels ensure that a broad investor base is attracted and issuance prices reflect real market values. Addressing the same issue of maximizing liquidity, sovereign debt managers often rely on primary dealers for the placement of their issuances. Primary dealers promote securities and serve as market makers, bid at auctions and buy part of the issued debt. Today, all euro area countries except Germany rely on

<sup>17</sup> For a detailed description of issuance techniques among other institutional aspects see Brandner et al. (2007) or OECD (2012).

the services of primary dealers, which increase the attention of foreign investors via their international distribution channels.

In general, debt can be issued via auctions, syndications<sup>18</sup> or tap issuances.<sup>19</sup> In practice, sovereign debt managers use a combination of all available options in order to maximize liquidity by matching certain investor needs. Syndications have the advantage that liquidity can be ensured via pre-issuance negotiations since this technique is based on over-the-counter (OTC) trades.<sup>20</sup> Especially for small countries with a small investor base or in situations of economic unrest and high uncertainty, syndications can ensure a placement on the market and reduce rollover risk. However, prices negotiated between a few market participants do not necessarily reflect the “true” market rates. In this respect auctions are clearly the most efficient instrument, producing price signals that are determined by the full investor base. At the same time, auctions carry the risk of not fully covered debt issues since demand and price are not prenegotiated. If demand and supply for a certain bond series significantly deviate from those of other bond series, a discontinuous pattern of the term structure can emerge. In such a case, tap issuances can be used to fine-tune the portfolio in order to produce smooth benchmark yield curves. Debt management agencies further have the opportunity to smooth the redemption profile or change the characteristics of the debt portfolio by debt buyback operations.

To increase transparency, debt managers announce their issuance plans well in advance via their issuance calendar. The missing coordination of debt issuances in the past has occasionally caused liquidity problems, especially for small countries. This might be the reason why debt issuance coordination was specifically addressed in the Van Rompuy report “Towards a genuine economic and monetary union” (European Council, 2012).

Further important technical aspects of sovereign debt issuance are the legal clauses of issued debt contracts. The applicable legal jurisdiction and the existence of collective action, negative pledge and cross-default clauses imply substantial differences for the exposure of investors to country default risk. By implementing such clauses or issuing debt under domestic jurisdiction, debt managers can minimize default costs, which imply higher credit risk and higher debt servicing costs.

#### 4 Changes in the Euro Area’s Sovereign Debt Management Funding Strategy

A popular way to identify debt management strategies is to track changes in the gross issuance of debt. However, such an approach does not consider the effect of debt redemptions: an issuance that simply replaces an expiring instrument does not imply a change in the debt management strategy. Net issuance statistics address this issue by adjusting gross values for debt redemptions. Nevertheless, one also has to be careful in the interpreta-

<sup>18</sup> Debt syndication is a process of distributing debt to a consortium of banks, where one or several banks can fulfil the role of the arranger.

<sup>19</sup> The nominal value of an already placed issuance is increased by selling the instrument at the original face value, original maturity and original coupon rate, but at the actual market price.

<sup>20</sup> OTC trades are nonstandard bilateral trades that are performed and settled directly between the contracting parties.



tion of net issuance changes, since they can be driven by overall debt dynamics. Only the relative weight and not the absolute level of debt instruments in the debt portfolio carries information about the employed strategy. Any dynamics of these weights correspond to changes in the debt management funding strategy.

#### **4.1 The Impact of EMU on Sovereign Debt Management Strategies**

The sovereign debt management of euro area countries has been substantially influenced by their membership in Economic and Monetary Union (EMU), which triggered a convergence of debt management strategies. Over the period from 1999 to 2007 the debt portfolio of euro area sovereigns became more homogenous with respect to maturity structure and currency denomination. Nevertheless substantial differences remained.

A significant part of the maturity convergence of euro area countries' debt portfolios was triggered by substantially decreasing long-run interest rates during the 1990s, which flattened the yield curve and led to relative cost advantages of long-run debt issuance. The shift from short-run to long-run instruments was especially strong for Spain, Italy and Greece.

The larger investor base for domestic (euro-denominated) debt allowed countries with smaller debt markets to issue domestic currency debt on markets that did not attract investors before EMU. This was especially the case for illiquid short-run debt markets. The strong increase in the issuance of treasury bills by the Netherlands, Finland and Portugal can be interpreted as a direct consequence. Countries with traditionally low levels of short-run debt like Germany and Austria only

slightly increased their share of short-term debt, further relying on fixed-rate long-term instruments.

Another direct result of the increased investor base was the substantial reduction of the share of debt issued in foreign currency, which decreased to historical lows of less than 1% of total debt.

Interestingly, despite the fact that the credibility of the price stability objective increased for most members of EMU, the issuance of inflation-indexed debt gained in momentum. From 1999 to 2007, the amount of outstanding inflation-indexed bonds – issued by France, Greece, Italy, Germany and Spain – increased from EUR 21 billion to EUR 242 billion. The impressive growth rates can be explained by the wish to broaden the investor base combined with special demand requirements for inflation indexation, especially from pension funds. Nevertheless, the overall amount of floating-rate debt instruments did not increase substantially, since the increase of inflation-indexed debt was offset by the substantial decrease in variable-interest debt instruments.

Due to the increased importance of electronic trading systems and the larger investor base, standardized debt instruments in the form of securities gained importance, leading to a decrease in the reliance on nonmarketable debt financing.

#### **Risk Dynamics**

The substantial change in the structure of debt had various implications for the overall risk position of the euro area's sovereign debt portfolio. Market risk decreased due to lower currency risk and the focus on long-term instruments. The broader investor base increased liquidity in all European bond markets. Bid-ask spreads below

0.05% of the mid quote<sup>21</sup> (ECB, 2007) in 2006 point toward historical lows of liquidity risk.

The share of debt with residual maturity of up to one year, an indicator for rollover risk, was substantially reduced due to the adjustments before entering the common currency area. This trend was prolonged in the first years of monetary union but started to reverse in 2000. By 2007 the share of short-run debt with a residual maturity up to one year had returned to pre-euro era levels of around 22% of total debt. These figures indicate an increase of rollover risk. However, average residual maturity shows the opposite. As shown in Table 1, a short-lasting decrease of the average residual maturity in 2001 and 2002, reflecting mainly the implementation of new short-run bond instruments, was more than offset by a clear and continuous upward trend until 2007. Looking at the whole spectrum of maturities, rollover risk was thus substantially reduced over the period.

The funding strategy of sovereign debt managers in the euro area also affected the insurance of government budgets against macroeconomic shocks. In order to discuss macroeconomic risk dynamics over time we again make use of our stylized demand and supply shock scenarios as defined above.

In the case of the negative demand shock which triggers expansionary monetary policy, the lower share of debt denominated in foreign currency over the period 1999 to 2007 decreased budget risk, while the reduction of the share of variable-interest bonds and the increasing share of long-run debt over the same period increased budget risk.<sup>22</sup> Overall, budget risk implied by the negative demand shock increased due to the dominating effect of the switch to longer maturity.

In the case of the cost-push supply shock, where monetary policy acts contractionary and the uncovered interest parity holds, the decreasing share of foreign currency debt increased budget risk, while the decreasing share

Table 1

### Funding Strategy of Euro Area Sovereign Debt Management

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	<i>% of total debt</i>												
<b>Short-term debt</b>	10.2	9.4	10.3	11.2	11.3	11.0	11.0	10.7	10.8	14.3	15.1	15.2	14.5
<b>Long-term debt</b>	89.8	90.6	89.7	88.8	88.7	89.0	89.0	89.3	89.2	85.7	84.9	84.8	85.5
of which: variable interest rate	10.9	10.1	8.8	8.7	8.2	7.6	7.3	7.1	7.3	8.3	7.4	7.2	8.4
of which: inflation-indexed*	n.a.	0.3	0.5	0.7	1.3	2.2	2.9	3.6	4.5	4.5	4.7	4.7	4.7
<b>Debt denominated in</b>													
local currency	96.9	96.7	97.7	98.0	98.5	98.4	98.3	98.8	99.0	98.6	98.6	98.6	98.1
nonparticipating foreign currency	2.4	2.3	2.0	1.7	1.3	1.4	1.5	1.1	0.8	1.3	1.4	1.3	1.9
<b>Residual maturity below 1 year</b>	18.8	19.3	20.1	22.8	21.5	21.1	21.0	20.9	21.8	25.2	24.4	24.8	23.9
	<i>In years</i>												
<b>Average residual maturity</b>	5.9	5.9	5.8	5.7	5.9	6.1	6.6	6.8	6.9	6.8	6.6	6.7	6.7

Source: ECB, \*OECD.

<sup>21</sup> The price between the lowest price the sellers of the bond are willing to accept (ask price) and the highest price the buyers of a bond are willing to pay (bid price).

<sup>22</sup> This is of course only true if refinancing costs are assumed to react countercyclically.

of interest rate-dependent debt and the higher share of long-term debt decreased budget risk. Since the increase in the share of floating debt instruments for the euro area was almost identical with the decrease in the share of foreign currency debt, the overall change of budget risk was again dominated by the strong change in the maturity profile. Overall, the dynamics indicate that budget risk due to cost-push supply shocks decreased over the period from 1999 to 2007.

#### **4.2 The Impact of the Global Crisis on Sovereign Debt Management Strategies**

In the aftermath of the collapse of Lehman Brothers in September 2008, European interbank markets dried up, causing substantial liquidity problems. To prevent a complete breakdown of the interbank markets, central banks reacted with liquidity-providing operations and governments created rescue packages for the financial sector. Stimulus packages together with banking rescue funds, lower government revenues and higher government expenditure due to the automatic stabilizers created the need for governments to raise additional funds on short notice.

The large increase of government debt together with the increase of contingent liabilities due to potential future bank bailouts and the materialization of substantial structural problems of some member states triggered a new regime for euro area sovereign debt markets. For a wide range of euro area countries risk premiums of sovereign assets substantially increased. The new regime of “risky” euro area sovereign debt caused substantial country heterogeneities in the demand for sovereign debt. Countries with high credit risk had no access to long-term financing and were forced into short-term debt

financing at extraordinarily high yields. Overall, the share of euro area short-term debt constantly increased until the second quarter of 2009, when it peaked at a level of 16.5% of total debt. Following historical patterns, long-term securities issuance was concentrated in the fixed-coupon segment. In the second half of 2008, and especially in 2009 and 2010, market tension and large uncertainties substantially increased bid-ask spreads for many euro area countries, implying severe problems to place debt.

The large uncertainties and the increase in overall risk aversion of market participants triggered an increased demand for safe assets, a so-called “flight to quality.” Among the euro area countries with low credit risk, especially Germany, but to a lesser extent also the Netherlands, Finland, France and Austria experienced large demand for their sovereign debt. This, together with expectations about low future economic growth, resulted in historical lows of their benchmark yields. Nevertheless, even for these countries small changes in economic signals caused strong and volatile market reactions, which underlined the strong interlinkages between euro area member states.

Due to the emerging euro area country heterogeneity in the demand for debt instruments and debt servicing costs, euro area member states’ debt management funding strategies faced different challenges. Countries with low credit risk mainly focused on cost minimization and increased their reliance on short-term debt issuance in order to realize relative cost advantages that arose due to the strong steepening of the yield curve (see chart 5).

While the countries with low credit risk premiums further focused on cost minimization and continued to rely more heavily on short-term debt, coun-

Chart 5

**Euro Area Funding Strategy – Maturity Choice and the Slope of the Yield Curve**

Source: ECB, Eurostat.

tries with elevated levels of credit risk (e.g. Spain) constantly tried to reduce the high shares of short-term debt over time. This development reflects the fact that especially for the group of high credit risk member states the avoidance of rollover risk gained in importance. Among the low credit risk member states Austria appears to be an outlier due to its very low shares of short-term debt. Despite a doubling of short-term debt from 2007 to 2008, in 2011 only about 3% of total debt were held in the form of short-term debt.<sup>23</sup> This strong persistent focus toward long-term financing could be interpreted as a strong preference for insurance against potential credit risk increases in the future.

The share of variable-interest and inflation-indexed debt for the euro area remained broadly unchanged, while the share of foreign currency-denominated

debt increased from 0.8% of total debt in 2007 to 1.9% of total debt by the end of 2011.

In addition to changes in the funding strategy, the majority of debt management agencies in the euro area responded to the sovereign debt crisis with increased flexibility in the issuance calendar and, to some extent, also in the range of instruments and issuance techniques. In various member states, sovereign debt managers used specific techniques to improve the liquidity of the secondary market. Primary dealers were granted concessions, which took the form of second-stage non-competitive auctions and/or exclusive rights or preferences in concluding individual transactions.<sup>24</sup> As to market making, minimum bid sizes and active participation on the secondary market became requirements.

Throughout the euro area syndicated bond issuances became more popular

<sup>23</sup> We do not consider the case of Ireland, which also shows very low shares of short-term debt, since this development is solely due to the recent debt restructuring.

<sup>24</sup> For a detailed description of changes in the primary dealer requirements during the crisis see Blommestein (2009) and OECD (2012).

from 2007 to 2009, as these eased the issuance of large debt tranches and tended to reduce government dependency on highly volatile markets. In 2009, syndicated issuances stood at about 16% of total bond issuance across the euro area.

### Risk Dynamics

The new focus of sovereign debt management on short-term financing and the increased importance of foreign currency debt implied substantially increased market risk. The share of debt with residual maturity up to one year increased further from 22% of total debt in 2007 to 25% of total debt in 2008 and stabilized at these new highs. Moreover, as can be seen in Table 1, the average residual maturity of debt decreased slightly from 6.9 years in 2007 to 6.7 years in 2011. Both figures indicate increased rollover risk.

Macroeconomic risk implied in the debt portfolio also reacted to the shift toward more short-term financing. Our stylized demand shock scenario implies that the issuance of debt with shorter maturities increased the insurance of the government budget and decreased budgetary risk. This is of course only true if we again assume that refinancing cost react procyclically. If the demand shock led to soaring country risk premiums and increasing refinancing costs, the shift toward shorter maturities would imply an increase of budgetary risk.

In the case of our stylized cost-push supply shock, similar to the case of countercyclical refinancing costs, the stronger focus on short-term issuance decreased the level of insurance offered by the debt portfolio and increased budgetary risk.

## 5 Conclusions

Sovereign debt management funding strategies imply various forms of risk. At the same time appropriate strategies can (partly) insure government budgets against certain macroeconomic shocks. The latter point is typically not considered by sovereign debt management agencies, which tend to focus on micro portfolio optimization aspects.

This paper analyzed the different forms of risk implied by the composition of the sovereign debt portfolio and discussed methods for their evaluation. By determining the risk properties of existing debt management instruments we underlined the potential of certain debt management instruments to insure the budget against stylized demand and supply shocks. We conclude that, from an overall macroeconomic perspective, debt management agencies should use a broader definition of risk to guide their portfolio choices.

Debt management strategies in euro area countries were substantially influenced by the creation of the euro. Increasing market liquidity and the focus on cost minimization, which exploited the relative cost advantages in issuing long-term debt instruments, led to an increase in average residual maturity and, in general, to a convergence of national debt portfolio structures. Furthermore, inflation-indexed bonds became part of some member states' debt portfolios, while the role of variable-rate long-term debt decreased.

By contrast, in the wake of the financial crisis, the loss of the risk-free status for euro area sovereign assets and the substantial relative cost advantages due to a steepening of the yield curve led to an increasing importance of short-term debt in euro area funding strategies. This caused an increase in rollover risk and market risk of the euro area debt portfolio.

## References

- Alesina, A., M. De Broeck, A. Prati and G. Tabellini. 1992.** Default Risk on Government Debt in OECD Countries. In: *Economic Policy* 15. 427–463.
- Alesina, A., A. Prati and G. Tabellini. 1990.** Public Confidence and Debt Management: A Model and a Case Study of Italy. In: R. Dornbusch and M. Draghi (eds.), *Public Debt Management: Theory and History* (94–124). Cambridge: Cambridge University Press.
- Angeletos, G. 2002.** Fiscal policy with noncontingent debt and the optimal maturity structure. In: *Quarterly Journal of Economics* 117. 1105–1131.
- Bacchiocchi, E. and A. Missale. 2005.** Managing Debt Stability. CESifo Working Paper Series 1388.
- Balibek, E. and M. Köksalan. 2010.** A multi-objective multi-period stochastic programming model for public debt management. In: *European Journal of Operational Research* 2010. 205–217.
- Barro, R. 1979.** On the Determination of Public Debt. In: *Journal of Political Economy*, 87(5). 940–971.
- Barro, R. 1995.** Optimal Debt Management. NBER Working Paper 5327.
- Barro, R. 1999.** Notes on optimal debt management. In: *Journal of Applied Economics* 2. 281–289.
- Barro, R. 2002.** Optimal management of indexed and nominal debt. In: Lefort F. and K. Schmidt-Hebbel (eds.), *Indexation, Inflation, and Monetary Policy* (135–50). Central Bank of Chile.
- Barro, R. 2003.** Optimal management of indexed and nominal debt. In: *Annals of Economics and Finance* 4. 1–15.
- Bergström, P., A. Holmlund and S. Lindberg. 2002.** The SNDOs Simulation Model of Government Debt. Swedish National Debt Office.
- Bernanke, B., M. Gertler and M. Watson. 1997.** Systemic Monetary Policy and the Effects of Oil Price Shocks. In: *Brookings Papers on Economic Activity* 1. 91–157.
- Bernaschi, M., A. Missale and D. Vergni. 2009.** Should governments minimize debt service cost and risk? A closer look at the debt strategy. Simulation approach. Department of Economics, Business and Statistics at Università degli Studi di Milano. Departmental Working Papers 2009-53.
- Blommestein, H. 2009.** Responding to the Crisis: Changes in OECD Primary Market Procedures and Portfolio Risk Management. In: *OECD Journal: Financial Market Trends* 2009/2.
- Blommestein, H., V. Guzzo, A. Halland and Y. Mu. 2010.** Debt Markets: Policy Challenges in the Post-Crisis Landscape. In: *OECD Journal: Financial Market Trends* 2010/1.
- Bohn, H. 1988.** Why Do We Have Nominal Government Debt? In: *Journal of Monetary Economics* 2(1). 127–140.
- Bohn, H. 1990.** Tax Smoothing with Financial Instruments. In: *American Economic Review* 80(5). 1217–1230.
- Bolder, D. 2003.** A Stochastic Simulation Framework for the government of Canada's debt Strategy. Bank of Canada Discussion Paper 03-10.
- Bolder, D. J. and T. Rubin. 2007.** Optimization in a Simulation Setting: Use of Function Approximation in Debt Strategy Analysis. Bank of Canada Working Papers 07-13.
- Borensztein, E. and P. Mauro. 2004.** The Case for GDP-indexed Bonds. In: *Economic Policy* 19(38). 166–216.
- Broeck, M. and A. Guscina. 2011.** Government Debt Issuance in the Euro Area: The Impact of the Financial Crisis. IMF Working Paper WP/11/21.
- Brown, S. and M. Yücel. 1998.** Oil Prices and U.S. Aggregate Economic Activity: A Question of Neutrality. In: *Economic and Financial Review*. Federal Reserve Bank of Dallas, Q2 1989.
- Buera, F. and J. Nicolini. 2004.** Optimal maturity of government debt without state contingent bonds. In: *Journal of Monetary Economics* 51. 531–554.



- Brandner, P., H. Grech and K. Kazemzadeh. 2007.** Yield Differences in Euro Area Government Bond Markets – A View from the Market. BMF WP 7.
- Calvo, G. 1988.** Servicing the Public Debt: The Role of Expectations. In: *American Economic Review* 78(4), 647–661.
- Calvo, G. and C. Reinhart. 2002.** Fear of Floating. In: *The Quarterly Journal of Economics* 117(2), 379–408.
- Connor, G., L. Goldberg and R. Korajczyk. 2010.** *Portfolio Risk Analysis*. Princeton University Press.
- Cruzes, J. and C. Trebesch. 2013.** Sovereign Defaults: The Price of Haircuts, forthcoming in *American Economic Journal: Macroeconomics*.
- Das, U., Y. Lu, M. Papaioannou and I. Petrova. 2012.** Sovereign Risk and Asset and Liability Management – Conceptual Issues. IMF Working Paper WP/12/241.
- ECB. 2007.** The euro bonds and derivatives markets.
- Eichengreen, B. and R. Hausmann. 1999.** Exchange Rates and Financial Fragility. NBER Working Papers 7418.
- Ejsing, J. and J. Sihvonen. 2009.** Liquidity premia in German government bonds. ECB Working Paper 1081.
- European Council. 2012.** Towards a Genuine Economic and Monetary Union. [www.consilium.europa.eu/uedocs/cms\\_data/docs/pressdata/en/ec/131201.pdf](http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/131201.pdf) (retrieved on February 19, 2013).
- Fabozzi, F. and V. Mann. 2005.** *The Handbook of Fixed Income Securities*. McGraw-Hill.
- Faraglia, E., A. Marcet and A. Scott. 2008.** Fiscal insurance and debt management in OECD economies. In: *Economic Journal* 118, 353–376.
- Hendricks, D. 1996.** Evaluation of Value-at-Risk Models Using Historical Data. Federal Reserve Bank of New York. In: *Economic Policy Review*. April.
- Hoogduin, L., B. Öztürk and P. Wierts. 2010.** Public Debt Managers Behaviour: Interactions with Macro Policies. De Nederlandsche Bank Working Paper 273.
- Hooker, M. 2002.** Are Oil Shocks Inflationary? Asymmetric and Nonlinear Specifications versus Changes in Regime. In: *Journal of Money Credit and Banking* 34(2), 540–561.
- IMF and the World Bank. 2001.** *Guidelines for Public Debt Management*. Washington D.C.
- IMF Forum. 2010.** Stockholm Principles: Guiding Principles for Managing Sovereign Risk and High Levels of Public Debt. [www.imf.org/external/np/mcm/stockholm/principles.htm](http://www.imf.org/external/np/mcm/stockholm/principles.htm) (retrieved on February 19, 2013).
- Leong, D. 1999.** *Debt Management: Theory and Practice*. HM Treasury Occasional Paper.
- Lucas, R. and N. Stokey. 1983.** Optimal fiscal and monetary policy in an economy without capital. In: *Journal of Monetary Economics* 12, 55–93.
- Mansini, R., W. Ogryczak and M. G. Speranza. 2007.** Conditional Value at Risk and Related Linear Programming Models for Portfolio Optimization. In: *Annals of Operation Research* 152, 227–256.
- Missale, A. 1997a.** Tax Smoothing with Price Indexed Bonds: A Case Study of Italy and the United Kingdom. In: De Cecco M., L. Pecchi and G. Piga (eds.), *Managing Public Debt: Index-Linked Bonds in Theory and Practice*. Cheltenham: Edward Elgar. 50–92.
- Missale, A. 1997b.** Managing the Public Debt: The Optimal Taxation Approach. In: *Journal of Economic Surveys* 11(3), 235–265.
- Missale, A. 1999.** *Public Debt Management*. Oxford: Oxford University Press.
- Missale, A. and O. J. Blanchard. 1994.** The Debt Burden and Debt Maturity. In: *American Economic Review* 84(1), 309–319.
- Missale, A. 2011.** *Sovereign Debt Management and Fiscal Vulnerabilities*. BIS Papers number 65.

- Montiel, P. 2005.** Public Debt Management and Macroeconomic Stability: An Overview. In: World Bank Research Observer 20(2). 259–281.
- Mundell, R. 1971.** Money, Debt and the Rate of Interest. In: R. A. Mundell. Monetary Theory. Pacific Palisades, California.
- Nosbusch, Y. 2008.** Interest costs and the optimal maturity structure of government debt. In: Economic Journal 118. 477–498.
- Obstfeld, M. 1990.** Discussion to: Confidence Crises and Public Debt Management. In: Dornbusch R. and M. Draghi (eds.). In: Public Debt Management: Theory and History. Cambridge: Cambridge University Press. 94–124.
- OECD. 2005.** Advances in Risk Management of Government Debt.
- OECD. 2012.** Sovereign Borrowing Outlook.
- Piga, G. 2001.** Derivatives and Public Debt Management. International Securities Market Association: Zurich.
- Sandleris, G., H. Sapriza and F. Taddei. 2011.** Indexed Sovereign Debt: An Applied Framework. The Carlo Alberto Notebooks 104.
- Shiller, R. 1993.** Macro Markets, Creating Institutions for Managing Society's Largest Economic Risks. Oxford: Clarendon Press.
- Stiglitz, J. 1983.** On the Relevance or Irrelevance of Public Financial Policy: Indexation, Price Rigidities and Optimal Monetary Policies. In: Dornbusch R. and M. H. Simonsen (eds.). Inflation Debt and Indexation. Cambridge MA: MIT Press. 183–22.
- Tobin, J. 1969.** A General Equilibrium Approach to Monetary Theory. In: Journal of Money, Credit and Banking 1(1). 15–29.
- Woodford, M. 1990.** Public Debt as Private Liquidity. In: American Economic Review, AEA Papers and Proceedings 80(2). 382–388.

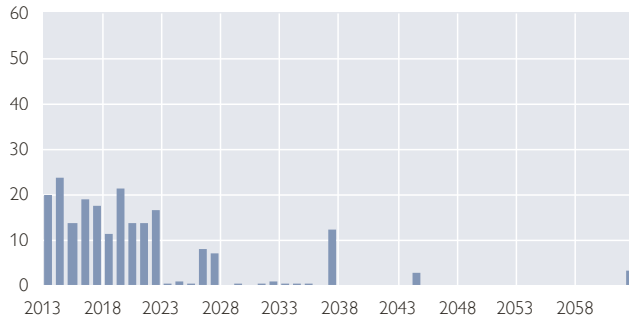
## Appendix

Chart A1

### Sovereign Debt Redemption Profile of Selected Euro Area Countries

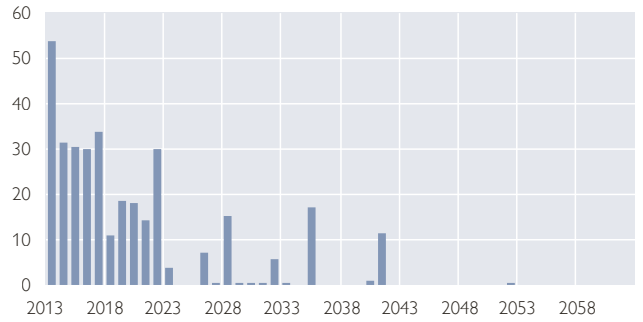
#### Austria

EUR billion



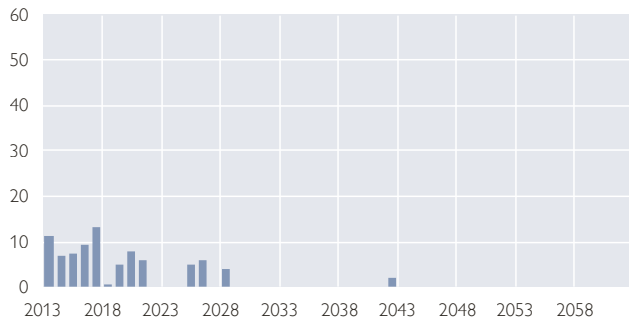
#### Belgium

EUR billion



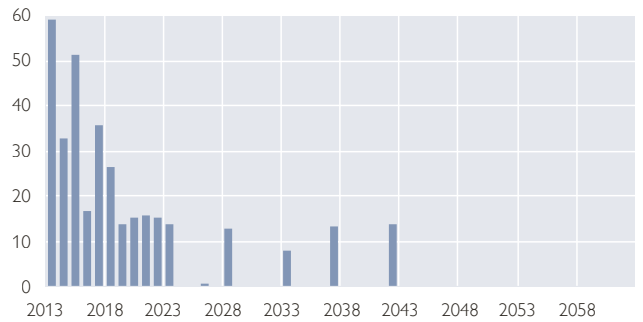
#### Finland

EUR billion



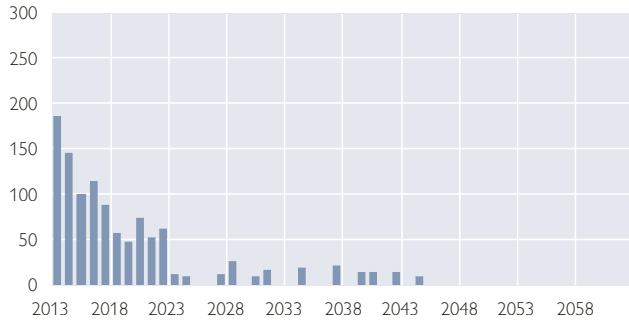
#### Netherlands

EUR billion



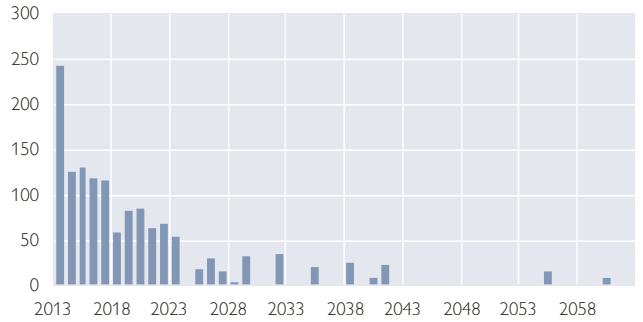
#### Germany

EUR billion



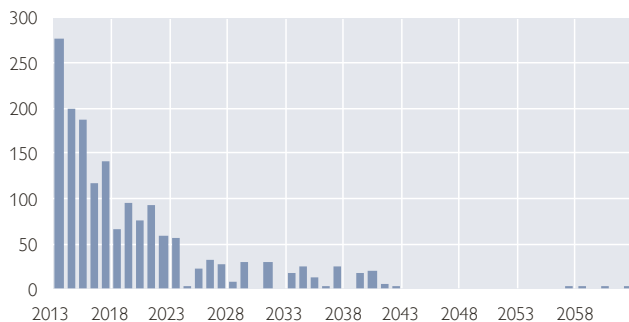
#### France

EUR billion



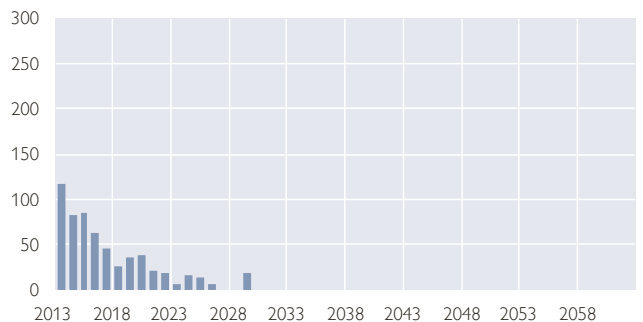
#### Italy

EUR billion



#### Spain

EUR billion

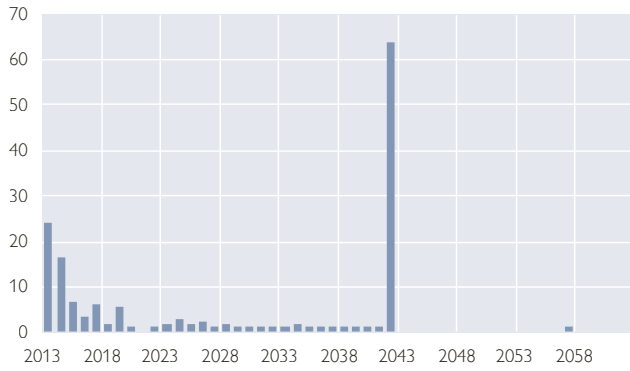


Source: Thomson Reuters.

**Sovereign Debt Redemption Profile of Countries Under Rescue Programs**

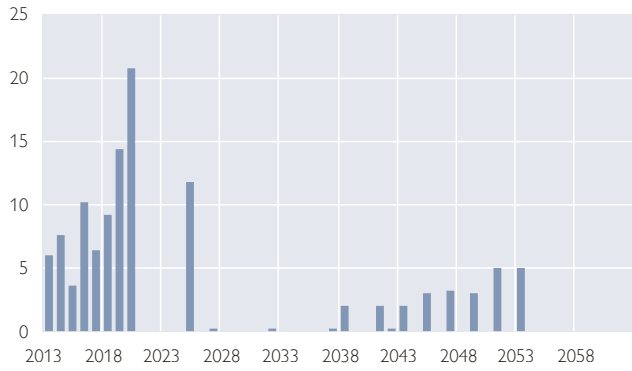
**Greece**

EUR billion



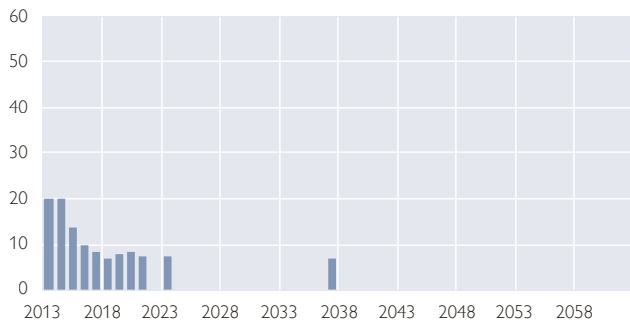
**Ireland**

EUR billion



**Portugal**

EUR billion



Source: Thomson Reuters.