# How the Eurosystem's Treatment of Collateral in its Open Market Operations Weakens Fiscal Discipline in the Eurozone (and what to do about it)

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# Abstract

Interest rates are very similar on the euro-denominated sovereign debt instruments of the 12 Eurozone central governments, even for remaining maturities of 10 year and over. This is surprising because by 'fundamental' criteria (such as public debt burdens and capacity to generate primary surpluses) different Eurozone governments appear to represent significantly different degrees of default risk.

The paper offers a contribution to an explanation of this anomaly, based on the way the Eurosystem (the ECB and the 12 national central banks of the Eurozone) treats the sovereign debt instruments of the Eurozone central governments when these are offered as collateral for Repurchase Agreements (Repos) and other collateral financing trades. The Eurosystem is supposed to follow the rule of marking to market all financial instruments offered as collateral. Its representatives believe and insist that this is indeed what it does in practice. We assert that, in practice, those implementing the open market operations of the Eurosystem send, through two operational practices, signals to the market that cause the market prices of the Repo-eligible debt instruments issued by Eurozone central governments to incorporate negligible and excessively small credit risk differentials. In practice these credit risk differentials are zero for the short maturity collateral that is characteristic of most Repos. This represents a subsidy to the use of inferior (higher credit risk) sovereign collateral.

The guilty operational practices are, first, the assignment of all eligible euro-denominated sovereign debt instruments issued by the 12 Eurozone central governments to the same (highest) liquidity category as the euro-denominated debt instruments of the Eurosystem itself. This assignment also means that these financial instruments will be subject to the lowest valuation haircut (discount on market value) imposed by the Eurosystem. The second dysfunctional operational practice is the excessive increase in the valuation haircut when the remaining maturity of the collateral increases. This discourages the use of long-maturity collateral, for which differences in fundamental sovereign default risk would be more difficult to ignore.

Our remedy is simple. Only the euro-denominated liabilities of the Eurosystem are automatically and axiomatically free of default risk. These Eurosystem liabilities (and only these) should be in the highest liquidity category. They should be subject to a zero valuation haircut at all maturities. As regards all other Repo-eligible instruments, the AAA-rated securities (sovereign, non-sovereign, public or private) would be in one liquidity category. At the moment this would include 8 Eurozone sovereigns. All AA-rated eligible securities would be in a common lower liquidity category (and subject to a higher valuation discount). At the moment this would include Belgium, Italy and Portugal. All A-rated eligible securities would be in the next lowest liquidity category (and subject to a yet higher valuation discount). At the moment this would include Greece.

The valuation haircut on Repos would either be independent of remaining maturity or would follow private market practice. Either way there would be no artificial discouragement of the use of long-maturity instruments as collateral for short-maturity Repos.

If the size of the haircut were to increase sufficiently sharply as the credit rating declined, our proposal would be equivalent to the Eurosystem refusing to accept the euro-denominated sovereign debt of governments with a low credit rating as collateral in its Repo operations.

On November 9, 2005, the ECB issued a 'clarification' of its collateral policy and practices[3]. It would only accept securities (sovereign or non-sovereign) with a credit rating of at least A- as collateral in Repos and other collateralised lending operations.

Instead of, or in addition to, declaring sovereign debt with low credit ratings to be ineligible as collateral in Repos, the Eurosystem could refuse to accept as collateral the debt of Eurozone governments deemed to have excessive deficits, by the standards of the Excessive Deficits Procedure of the Stability and Growth Pact.

The Eurosystem should set the zero default risk benchmarks for euro-denominated debt instruments at all maturities through the issuance on a sufficient scale of its own debt instruments at all maturities.

Penalising the securities issued by private and public issuers with a low credit rating by applying a larger haircut to lower-rated securities or even by declaring all securities rated below some minimal cut-off point to be ineligible as collateral in Repos and other secured lending operations would not create a risk of there being too few collateralisable securities available in the Repo and money markets. The reason is that (appropriate) Asset-Backed Securities (ABS), including Collateralised Bond Obligations (CBO) are eligible as collateral for lending by the Eurosystem. The highest tranche of a CBO backed by BBB or even BB-rated bonds can easily be rated AA or even AAA.

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[3] Financial Times, Wednesday November 9, 2005, page 1, 'ECB targets its problem nations'.

## 1. Why are sovereign default risk premia in the Eurozone so uniform and low?

A key argument used by proponents of the European Union's Stability and Growth Pact (both before and after the reforms of the Pact agreed in March 2005) was that capital markets do not adequately discipline governments inclined to excessive debt and deficits.[4] We agree that, since the inception of EMU on January 1, 1999, market interest rates have not adequately reflected the different degrees of default or credit risk associated with the sovereign debt issued by the twelve Eurozone central governments. We argue that this 'market failure' is at least in part a result of 'policy failure' or 'policy implementation failure': through inappropriate operational practices towards the collateral used in its open-market operations, the Eurosystem (the European Central Bank (ECB) and the 12 national central banks (NCBs) of the Eurozone) ends up suppressing, probably unintentionally, national sovereign default-risk differences

There is surprisingly little difference in the risk premia on the euro-denominated central government debt of Eurosystem members despite end-2004 general government-debt-to-annual GDP ratios ranging from 7.5 percent in Luxembourg and 29.9 percent in Ireland to a whopping 105.8 percent in Italy and 110.5 percent in Greece (see Table 1). Germany (at 66.0 percent) and France (at 65.6 percent) are located about half-way between the two extremes, just on the wrong side of the 'Maastricht' ceiling of 60.0 percent.

**TABLE 1 here**

The robust fiscal positions of Luxembourg and Ireland are further emphasized by Luxembourg's small primary (non-interest) general government financial deficit (0.9 percent of GDP in 2004) and Ireland's primary surplus (2.5 percent of GDP in 2004). The cyclically

[4] There is a large literature on the determinants of sovereign and sub-sovereign default risk premia. Alesina et. al. (1992) studied OECD sovereign risk premia, Bayoumi, Goldstein and Woglom studies risk premia on the debt issued by US states. Lonning (2000) considers Pre-EMU default premia on European government debt, Codogno, Favero and Missale study yield spreads on EMU government bonds and Bernoth, Schuknecht and von Hagen (2004) compare the pre-EMU and EMU-period risk premia in the European Bond market.

corrected primary surplus of Ireland was around 2.8 percent of GDP in 2004.[5] The official EU data reported in Table 1 put the primary deficit of Greece at 0.4 percent of GDP in 2004, while Italy is reported to have generated a primary surplus of 2.0 percent of GDP for that year.

We doubt the accuracy of both the Greek and the Italian general government deficit data for the years 1997 till 2004. For a number of years now, creative accounting (violations of the spirit of European financial accounting rules and conventions) and outright fiddling of the data (violations of the letter of these rules and conventions) have resulted in official figures for the Stability and Growth Pact deficits of theses two countries that systematically and significantly understate the nominal value of the change in the net financial liabilities of their general government sectors. The magnitude of these understatements is not yet known, however. The dire fiscal predicaments of Greece and Italy stand in sharp contrast to the situation in another country with a highly indebted government, Belgium, where a serious fiscal adjustment effort has been underway for many years, as is evident from the sizeable primary surpluses and the sharp decline in the debt-GDP ratio during recent years.

Government solvency requires that the present value of current and anticipated future primary surpluses of the government be at least equal to the notional value of the outstanding stock of government debt.[6] The combination of a high debt-to-GDP ratio and a history of, at best, small primary surpluses is only consistent with government solvency if one is confident that future primary surpluses will, on average, be significantly larger, as a share of GDP, than past and present ones. Conversions on the road to Damascus are certainly possible. However, the longer actual and potential holders of sovereign bonds have to rely on faith rather than on tangible evidence of the willingness and capacity of the fiscal authorities to

[5] We apply the same cyclical correction to the primary surplus as to the actual surplus (given in Table 1), since the government's net interest bill is unlikely to exhibit much cyclical variation.
[6] Notional value here means market value in the absence of default risk discounts. The general government does not include the national central bank (or the ECB).

generate adequate primary surpluses, the greater the likelihood that default risk will play a role in the market's valuation of the public debt.

Given the significant differences among the fiscal positions of the 12 EMU member governments, it is surprising that the markets do not impose larger default risk premium differentials. At the short end of the spectrum, interest-rate differentials on 3-month Treasury bills are effectively zero (see Table 2).[7] Even at longer maturities the spreads are surprisingly small, with 10-year Irish government bonds paying only 19 basis points less than 10-year German government bonds and 10-year Greek government bonds paying only 27 basis points more (see Table 2 and Chart 1).[8] [9]

**TABLE 2 here**

One interpretation of the small differences in interest rates is that market participants believe that risk of sovereign default is indeed negligible *throughout* the Eurozone and thus that it is effectively the same for Luxembourg as for Greece. One possible justification for such beliefs could be that each of the twelve EMU members is deemed to be of unquestioned fiscal probity and that consequently sovereign default risk and the associated sovereign default risk premia are (very close to) zero for each of them. We do not consider this plausible. The euro-denominated sovereign debt of the 12 Eurozone nations includes debt instruments issued by sovereigns with markedly different credit ratings, as is apparent from Table 3.

**Table 3 here**

[7] The comparability of the 3 month T-Bills needs further work. The corresponding column of Table 2 should therefore be taken as illustrative only.

[8] Wednesday 8 June 2005, from the Financial Times. Note that this is *after* the French 'non' and the Dutch 'nee' in the referenda on the Treaty Establishing a Constitution for the EU.

[9] Portugal's dramatic fall from fiscal grace, with a general government deficit likely to reach 7 percent of GDP in 2005, is not anticipated in Table 1 (nor priced into the spreads of Table 2). It is, however, reflected in the August 2005 sovereign credit ratings reported in Table 3.

For instance, only 8 of the 12 Eurozone sovereigns have an AAA or Aaa rating. The weaker credits are Belgium (AA+, Aa1), Italy (AA-, Aa2), Portugal (AA-, Aa2) and Greece (A, A1). Of course, the members of the Eurosystem (both the ECB and the NCBs of the Eurozone countries) all have AAA ratings.

Another reason for a common default risk premium throughout the EMU could be that the political arrangement called EMU implies that the government of any EMU member country threatened with default would be bailed out by the collective called the EMU – the 11 other EMU governments. In that case, the debt instruments of all EMU member governments should bear the same risk of default - the risk of the collective not being able to meet its collective debt obligations.[10] If the implicit bail-out commitment is credible, the market will treat all instruments as being of equivalent default risk. The same conclusion would follow if there was an implicit bailout guarantee not from the EMU member governments, but from the ECB itself.[11]

We reject the *implicit and intentional* bail-out guarantee explanation of the uniform (low) sovereign default risk premia in the Eurozone. Clearly, there is no *explicit* bailout guarantee from the 12 EMU governments or from the ECB. And it is not easy to think of good reasons why there should be a hidden *implicit and intentional* one. It is self-evident that the existence of the political arrangement called USA does not, despite its common currency, imply that a US state or municipality in default would be bailed out by the collective called USA. That is why the debt of the state of California has carried an above-average risk premium for a number of years now, and that is why the good people of the city of New

[10] This common default risk premium on the euro-denominated debt of the 12 national sovereigns could, of course, be positive. Euro-denominated Eurosystem debt should, however, be free of default risk.
[11] For a discussion of bail-out guarantees and other forms of fiscal free-riding in a monetary union with many independent fiscal authorities see e.g. Uhlig (2002).

Haven, Connecticut, USA did not sleep with their wallets under their pillows when, 16 miles up the road, the city of Bridgeport, Connecticut went bust in 1988.[12]

The Treaties establishing the EU go even further in that they explicitly forbid member states from bailing each other out.[13] [14] They also forbid the ECB from bailing out any member state. [15] There is not one iota of evidence that the sovereign debt of all 12 Eurozone countries (let alone the debt of the 25 EU countries) is, or is perceived by anyone in a position of fiscal responsibility and authority in the EMU, to be a collective responsibility of the Eurozone (or of the 25 EU countries). Nor is there any evidence to support the view that the ECB has *intentionally* made an *implicit* commitment to bail out insolvent EMU member governments.

We recognise that, despite the Treaty ban on direct financing by the Eurosystem of member governments (no direct loans from the Eurosystem and no direct purchases of government debt by the Eurosystem in the primary issue market are permitted), the Eurosystem could, if it wished to do so, bail out member governments by outright purchases of their debt in the secondary markets. This would not violate the letter of the Treaties and the Protocols, but it would certainly violate their spirit. Again, there is no evidence to suggest that the ECB would, under any conceivable circumstances, knowingly choose to bail

[12] In June 2004, just before the state passed the budget, State of California GOs (General Obligation bonds) were yielding 70 to 80 basis points more than the national average.

[13] Article 103 of the Consolidated Version of the Treaty Establishing the European Community states: *"1.The Community shall not be liable for or assume the commitments of central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of any Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project. A Member State shall not be liable for or assume the commitments of central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of another Member State, without prejudice to mutual financial guarantees for the joint execution of a specific project."* (European Union (2002)).

[14] How one can forbid a sovereign member state from giving 'aid' to another member state is another matter.

[15] Article 101 of the Consolidated Version of the Treaty Establishing the European Community states: *"1. Overdraft facilities or any other type of credit facility with the ECB or with the central banks of the Member States (hereinafter referred to as "national central banks") in favour of Community institutions or bodies, central governments, regional, local or other public authorities, other bodies governed by public law, or public undertakings of Member States shall be prohibited, as shall the purchase directly from them by the ECB or national central banks of debt instruments."* European Union (2002).

out fiscally challenged Eurozone governments through outright purchases of their debt instruments or through equivalent ways of monetising the debt of the fiscally incontinent.

From the early days of the EMI (Lamfalussy (1997)), through the Presidency of Wim Duisenberg and now during the Presidency of Jean-Claude Trichet, all those who matter for a bail-out decision have clearly and publicly stated that a bail-out of the fiscally improvident by the Eurosystem is not an option. We take them at their word: there will be no bail-outs by the Eurosystem. Yet the market appears to believe otherwise, as is evident from the puny differentials between the sovereign risk premia of the nations in the Eurozone.

## 2. How does the Eurosystem suppress differential default risk premia warranted by fundamentals when collateral is 'marked to market'?

Our explanation of the paradox of very small differences among sovereign risk premia despite significant differences in fundamental creditworthiness is that while the ECB/Eurosystem does not intentionally, consciously or deliberately violate the letter or spirit of the Treaty's prohibition of sovereign and other public sector bail outs, it does send confusing and misleading signals to the market through the practical, technical modalities of how the Eurosystem implements its open market operations. This creates the unintended (by the Eurosystem) presumption of an implicit bail-out guarantee among the private participants in the market.

The Eurosystem's main monetary policy instruments are collateralised loans and repurchase agreements (Repos). In the first of these transactions, the ECB (or, in practice, one of the NCBs) lends money to its counterparty and receives securities as collateral. In the second, the counterparty sells securities to the Eurosystem and commits to buying the securities back from the Eurosystem at an agreed - upon price at a specific future date. In either case, if the counterparty defaults on the agreement, the Eurosystem has title to the

securities and can sell them on the secondary market or do with them as they see fit. In what follows we use the terms collateralised loan and Repo interchangeably.

The duration of a typical repurchase agreement (Repo) is short. It can be as short as overnight, most commonly has a two week duration and generally lasts less than three months (see European Central Bank (2005b)).[16]

It is our contention that the operational practices of the Eurosystem in its operations encourage and support a distorted market equilibrium in which differences among default risk premia on sovereign debt instruments issued by the 12 Eurozone central governments are compressed and effectively suppressed. Despite significant fundamental differences among the default risks associated with the euro-denominated debt issued by the 12 national governments of the Eurozone, all these euro-denominated sovereign debt instruments can *de-facto* be used as collateral in Eurosystem Repos on the same terms as the default risk-free debt certificates issued by the Eurosystem itself.

Our assertion that, through its operational practices, the Eurosystem does not permit significant differences to emerge between the market valuations of otherwise identical Repo-eligible euro-denominated sovereign debt instruments issued by the 12 EMU zone members, contradicts statements made by Mr. Jean-Claude Trichet (President of the ECB), by Dr. Otmar Issing (Chief Economist of the ECB and member of its Executive Board), and by staff members of one of the NCBs, the Nederlandsche Bank. On May 23rd, 2005, President Trichet said the following in reply to a question addressed to him during the periodic 'monetary dialogue' between the Committee on Economic and Monetary Affairs of the

[16] European Central Bank (2005b, pp. 18-20) reports on the maturity structure of its Repo operations in 2004. *"For the sample of 94 banks that reported data in the second quarter of 2004, overnight transactions accounted for 11% of overall secured activity (reverse repos and repos), the maturity band "tomorrow/next to one month" for 79% and maturities over one month for 10%."* (p.18). This statement refers to flows of secured lending and borrowing and initial maturities. Considering stocks outstanding and remaining maturities, the picture is somewhat different. While the maturity band " tomorrow/next to one month" remains the most traded, the share of (one-day) overnight business is smaller in the study based on stock data than in the study based on flow data. Between 2000 and 2004, just over 6 percent of business was at maturities of between 3 months and one year and a very small amount of activity was at maturities over one year.

European Parliament and the President of the ECB (pursuant to Article 113(3) of the EC Treaty).

> *"We have devoted much thought to the re-financing operations of the Central Bank. Our conclusion was that we should not change the current arrangement. If a country behaves improperly, then the basis points that are the difference between the benchmark signature and others would augment and that would automatically call for us to ask for more collateral because the level of our collateral is based upon the value of the collateral, which itself depends on the judgement of the market."* (European Parliament (2005, p. 10)).

On May 20th, 2005 Dr. Issing stated:

> *"All financial assets offered as collateral, including government bonds, are valued daily at market prices. In its collateral policy, the ECB therefore relies on the judgment of the market to distinguish among government bonds and, implicitly, the fiscal behaviour of member states. Moreover, the ECB sets credit standards for the eligibility of assets as collateral and is bound by the Treaty not to distinguish between government and private issuers in the implementation of these standards."* (Issing (2005)).

From the Nederlandsche Bank, van Herpt and Lamers (2005; translation by Willem Buiter), reinforce Issing's message with the statement that:

> *"All financial claims, therefore also the sovereign debt of Eurozone countries offered as collateral to the national central banks of the Eurosystem ….. are marked-to-market daily. Reductions in the market value of sovereign debt instruments lead therefore directly to a reduction in the valuation of the collateral and require either supply of additional collateral or a reduction in the amount of credit that is available. Variations in creditworthiness are therefore most definitely allowed for in the collateral policy of the Eurosystem."*

They go on to suggest that

> *"The authors may have confused the valuation of the collateral with the valuation haircuts for the control of liquidity risk."*

We disagree with the preceding quotes and will deal in the subsections that follow both with the 'valuation haircut' issue and with the general issue of whether the sovereign debt instruments of EMU member states are marked-to-market when valued as collateral in

Repos.[17] We develop the point that the observation that all sovereign debt instruments are marked-to-market does not imply that the resulting market-determined sovereign risk premia properly reflect fundamentals. Since the Eurosystem is the dominant player in the euro Repo markets, its behaviour and the market's interpretation of its motivation, objectives, practices and actions will be the single most important determinant of the risk-spreads established by these markets.

**The problem with haircuts: (1) equal haircuts for all 'Tier One, Category 1' assets in a given maturity bucket.**

Eligible assets (that is, financial instruments that can be offered as collateral in Repos) are classified or grouped by the Eurosystem into a number of different classes (see e.g. European Central Bank (2000, 2002, 2004, 2005a,b) and Pfeiffer (2004)). Tier One consists of marketable debt instruments fulfilling euro area-wide eligibility criteria specified by the ECB. Tier two consists of marketable and non-marketable assets of particular importance to national financial markets and banking systems. Tier Two does not concern us here; in any case the ECB Governing Council has already taken the decision to merge the two Tiers into a single list of eligible assets.

Eligible Tier One assets are allocated to one of four categories of decreasing liquidity. The "Tier One, Category 1" class of assets contains the assets with the highest liquidity. It contains the euro-denominated securities issued by the 12 Eurozone central government and the euro-denominated financial instruments issued by the Eurosystem, plus small amounts of euro-denominated securities issued by other parties.[18] [19] For the purpose of this paper, all that

[17] In confidential correspondence, Francesco Papadia and Ulrich Bindseil have elaborated on and reinforced the points made by Issing and by van Herpt and Lamers.

[18] Debt certificates issued by the ECB and national central banks prior to the adoption of the euro in their respective Member State were classified in liquidity category I (highest liquidity) together with central government securities.

[19] Paraphrasing a helpful private communication from Mr. Ulrich Bindseil of the ECB, the exact composition of the Tier One Category 1 class of assets is as follows. The "central government" issuer group consists of the

matters is that Tier One Category 1 includes the euro-denominated debt instruments of the Eurosystem *and* of the 12 Eurozone central governments, and not much else. The division of the Repo-eligible securities into categories and the assignment of the euro-denominated debt of the 12 Eurozone sovereigns to the highest liquidity category matter for two reasons. First, because it is a highly visible signal of the Eurosystem's perception of the financial standing of the Eurozone sovereign debtors; and, second, because a specific 'valuation haircut' is assigned to each category, with less liquid categories receiving a larger valuation haircut. A haircut is a discount applied to the market value of a financial instrument. The discount is meant to compensate the lender in a Repo operation for the imperfect liquidity of the collateral he is offered. It is expressed as a percentage discount on the market price. Table 4 shows how the haircut varies across categories and with the residual maturity of the instrument.[20]

**Table 4 here**

Consider first the rows of Table 4, which show how the haircut varies, for a given remaining maturity, with the degree of illiquidity attributed to an asset, as reflected in the Category to which it has been assigned by the Eurosystem. For instance, the haircut applied to debt instruments in the zero-to-one-year maturity 'bucket' of fixed coupon instruments in the liquidity category Tier One, Category 1 is 0.5 percent of the market value. The corresponding Category 4 instrument would be subject to a 2.0 percent haircut.

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Treasuries of all EU Member States. Standard eligibility criteria have to be fulfilled, such as denomination in euro, sufficient credit quality, etc. The outstanding euro denominated debt of non-euro area Treasuries is very small in comparison to the debt of euro area Treasuries. Also the euro denominated bonds issued by Norway, Iceland and Liechtenstein, the other central governments of the European Economic Area (EEA, whose members and contracting parties are the EU, the 25 EU member states and Norway, Iceland and Liechtenstein). and euro bonds of non-EEA G10 Governments (e.g. Canada) have been assigned to this category. Outstanding amounts of these types of instruments are even smaller. Regarding central bank debt instruments, in principle the same rules described above for Government paper apply. However, no EU central bank from outside the euro area has ever issued euro denominated debt instruments, and the debt instruments issued by today's euro area central banks before 1999 have all matured, and there are currently no assets falling under this category.

[20] Table 4 considers only fixed coupon and zero coupon instruments. Larger valuation haircuts apply to eligible Tier One inverse floating rate instruments.

The lowest haircut (for a given type of instrument and remaining maturity) is given to the assets in Tier One, Category 1 – containing the euro-denominated debt instruments of the Eurosystem and of the 12 Eurozone central governments. A Greek central government bond therefore is subject to the same proportional discount on its market value as an Irish government bond. Nowhere in the publications of the Eurosystem can any information be found about the *economic* and *financial* criteria used for including or excluding euro-denominated sovereign debt instruments from the highest liquidity, "Tier One, Category 1" class of assets.

Is it obvious that Greek and Irish central government debt is of comparable liquidity? An asset is liquid if it can be turned into cash at short notice, with low transaction costs and without the transaction significantly affecting the market price of the asset. Liquidity is characterised by a fundamental 'network'-type externality: I am more willing to purchase and hold an asset (making it more liquid for others) if I deem the asset to be liquid. The Eurosystem is the most important player in the euromarkets. A security will be liquid when the Eurosystem, by including it in its highest liquidity category of eligible assets and awarding it the lowest possible haircut, 'certifies' it as liquid. It is doubtful whether Greek, Portuguese or even Italian sovereign debt would be highly liquid today without this 'certification' by the Eurosystem

By lumping together the euro-denominated sovereign debt instruments of the 12 Eurozone member states and those issued by the Eurosystem in the highest liquidity Category I, the Eurosystem underlines and emphasizes the similarity of these securities. By putting the 12 Eurozone national sovereigns in one liquidity Category with the Eurosystem - the only issuer of euro-denominated debt instruments certain to be free of default risk - some of the Eurosystem's the aura of guaranteed solvency rubs off on every debt instrument in Category I, however poor the fiscal fundamentals of the national government that issued it. Few

market participants are likely to entertain the possibility that a financial instrument may be highly liquid yet also subject to non-trivial default risk.

Does this artificial liquidity enhancement of the debt instruments issued by the fiscally challenged Eurozone sovereigns matter for the valuation of these securities? What would happen to the market valuation of the debt of the non-triple A - rated Eurozone governments (Belgium, Portugal, Italy and Greece) if they were moved from Category I into Category II? What would happen to their market values if Categories I and II (or the first three or all four Categories) were merged and a common proportional haircut were to be applied to the market value of every asset in the new merged category? There is no way to perform a controlled experiment to evaluate these counterfactuals, but there must be a strong presumption that the market prices of the non-triple A – rated Eurozone sovereign debt instruments would fall. When there are significant fundamental differences among the creditworthiness of the 12 EMU member governments, bestowing liquidity on the debt instruments issued by the 12 governments without regard to these default risk differences may artificially boost the demand for the debt instruments with higher default risk.

**2b. The problem with haircuts: (2) penalising long maturities.**

There is a second feature of the Eurosystem's 'haircut schedules' that makes it more likely that the operational practice of the Eurosystem in the markets suppresses differential sovereign default risk premia. As is clear from Table 4, these 'liquidity insurance adjustments' (which appear to be completely *ad-hoc* and arbitrary) penalise financial instruments with a long remaining maturity and thereby discourage their use as collateral for Repos. The haircut in the highest liquidity class (Tier One, Category I) is 0.5 percent for securities with a residual maturity of up to one year, 4.0 percent for fixed coupon financial instruments with a residual maturity of 7 to 10 years and 5.5 percent for zero coupon financial instruments with a residual maturity of more than 10 years. For zero coupon

securities the haircuts are 4.5 percent for maturities of 7 to 10 years and 8.5 percent for maturities in excess of 10 years.

We noted earlier that Repos tend to be of short duration. In and of itself, the short duration of Repos ought not to discourage the use as collateral of long-maturity securities, as long as there is a liquid secondary market for the longer-maturity instruments. However, the fact that the proportional haircut increases sharply with remaining maturity amounts to a severe tax on the use as collateral in Repos of financial instruments whose remaining maturity significantly exceeds the term of the Repo, no matter how low their default risk or how high their liquidity outside the Repo markets. There is no obvious economic rationale for such savage penalisation of duration.

Default risk is higher on financial instruments with longer remaining maturities. If a short-term loan (or Repo) were collateralised with a Greek government bond with a 10-year remaining maturity, it would be all but impossible not to be aware of the non-negligible risk of sovereign default during that 10-year period. It is therefore likely that some reasonable approximation to the fundamental default risk premium would be reflected in the market price of a 10-year security offered as collateral. Because only debt with a short remaining maturity tends to be offered as collateral, it is easier for the Eurosystem in its operational practice to ignore differential default risk that is warranted, even for short-maturity debt instruments, by fundamentals. Even a few basis points over short maturities, can have macroeconomic significance: a (constant) one basis point probability of default over a one-month horizon accumulates into a 1.21 percent probability of default over ten years.

In summary, we base our contention that the operational Repo market practices of the Eurosystem suppress the expression in market valuation differentials of fundamental differences between the sovereign default risks of the 12 EMU member states, on three kinds of evidence.

Exhibit one consists of the two directly verifiable anomalies in the formal rules and practices governing 'haircuts' imposed on the market value of Eurozone sovereign debt instruments offered as collateral in Repos: first, the lumping together in the highest liquidity class (Tier One, Category I) of the euro-denominated debt of the Eurosystem and that of all 12 Eurozone sovereigns; second the excessive penalties on the use of longer-maturity debt instruments as collateral for Repos. Exhibit two is the minuscule size of the sovereign risk premium differentials observed among the nations of the Eurozone despite the, in our view, convincing evidence that there exists material fundamental default risk for at least three Eurozone sovereigns.

The third kind of evidence in support of our view consists of statements and writings of practitioners trading in or economists working close to the Eurozone sovereign debt markets. Fels (2005a, b) has written extensively on one of the building blocks of our argument: the effect of the Eurosystem's formulation and implementation of its 'haircut' policy on the pricing of the debt instruments of the 12 Eurozone sovereigns. Charles Wyplosz (2005), in evidence to the European Parliament, independently noted many of the same anomalies uncovered by us and offered as a remedy essentially the same proposal as the one offered by us in Section 4.

## 3. How the Eurosystem subsidises the use of sovereign collateral subject to default risk by counterparties subject to default risk

In the simple algebraic examples of this Section, the valuation haircuts are ignored. They are part of the reason why the Eurosystem ends up subsidising the use of low-quality (higher default risk) securities as collateral in Repos, but do not affect the calculation of the implicit subsidy.[21]

[21]No valuation haircuts are applied in liquidity-absorbing reverse open-market operations.

Assume the ECB sets the interest rate for Repo operations at 100$i$% per annum.[22] Assume, for simplicity, that Repo operations, loans and bonds all have the same one year maturity. All loans (bonds) are identical in all respects, except for the identity of the issuer and therefore the default risk associated with the loans (bonds). Eurosystem debt instruments (bonds) are free of default risk. A Eurosystem bond promising to pay €1 one year from now therefore has a price today equal to $\frac{€1}{1+i}$.

Ponziland is an EMU member whose government issues one-year sovereign bonds denominated in euro that are subject to default risk. Let $F(\bar{s})$, be the probability that the Ponziland government defaults on its debt. If Ponziland defaults on its debt, the owners of the debt get nothing. The market price today of a Ponziland sovereign bond promising to pay €1 one year from now (but subject to default risk) can be written as $\frac{€1}{[1+\delta(\bar{s})](1+i)}$, where $\delta(\bar{s})$ is the (proportional) default risk premium on Ponziland debt. If Ponziland debt is subject to default risk, that is, if $F(\bar{s})>0$, any reasonable asset pricing model will generate a positive value for $\delta(\bar{s})$. Any positive value for $\delta(\bar{s})$ will do for the purpose of this note. For expositional simplicity we assume that all parties in the market are concerned with maximising expected euro returns.[23]

Arbitrage Bank, an eligible counterparty for the Eurosystem, is subject to default risk also. The probability that Arbitrage Bank will honour all its contractual commitments is $1-F(\bar{a})$; the probability that it will default and pay nothing is $F(\bar{a})$. The probability that both Arbitrage Bank and Ponziland will default at the same time is denoted $F(\bar{a},\bar{s})$, and the

[22] At the time of writing (October 2005) $i=0.02$. The rate used in the Eurosystem's main refining operations has been at this 2 percent per annum level since June 6, 2003.
[23] The assumption that they are risk neutral towards euro returns is a convenient simplification. The Appendix considers the more general case of risk aversion when period utility is a function of real consumption..

conditional probability of Ponziland defaulting given that Arbitrage Bank defaults by $F(\bar{s}\,|\,\bar{a})$. By Bayes' rule, $F(\bar{s}\,|\,\bar{a}) = F(\bar{a},\bar{s})/F(\bar{a})$.

With risk-neutrality, market equilibrium requires that the default risk premium equals the default probability:

$$\frac{\delta(\bar{s})}{1+\delta(\bar{s})} = F(\bar{s}). \tag{1}$$

Now consider the pricing of a collateralised loan. Arbitrage Bank obtains a collateralised loan from the Eurosystem.[24] Arbitrage Bank can borrow from the Eurosystem by selling an eligible asset to the Eurosystem today and entering into a contractual commitment to repurchase that asset a year from today at a price agreed today. The interest factor implied by this is given by the ratio of the repurchase price agreed today for a year from now and the sale price paid today. Either Arbitrage Bank honours the agreement, pays the agreed repurchase price to the Eurosystem a year from now and receives back the asset it sold a year earlier, or it defaults on the agreement and pays nothing. In that case the Eurosystem keeps the asset it bought from Arbitrage Bank a year earlier and can sell it in the secondary market or do with it as it sees fit.

For any collateralised loan (including Repos), the expected payment next year from Arbitrage Bank to the Eurosystem is equal to: {[the contractual payment due under the loan agreement multiplied by the probability that Arbitrage Bank does not default] plus [the contractual value of the collateral multiplied by the probability that the collateral will not be in default when Arbitrage Bank is in default]}.

Consider first the case where Arbitrage Bank borrows €1 from the Eurosystem collateralised with (safe) Eurosystem bonds owned by Arbitrage Bank. The interest factor on the secured loan can be written as $(1+i)\left[1+\delta(\bar{a},e)\right]$, where $\delta(\bar{a},e)$ is the default risk

[24] See BIS (1999) for a useful discussion of the institutional, legal and practical aspects of Repos and Repo markets.

premium for a €1 loan to Arbitrage Bank collateralised with €1 worth of Eurosystem bonds. Assume it also lends €1 to the Eurosystem at the risk-free rate (say through a purchase and resale of default-risk-free Eurosystem bonds). From its lending to the Eurosystem, Arbitrage Bank will, with complete certainty, earn € $1+i$ one year from now. Unsurprisingly, the default risk premium on a loan to Arbitrage Bank that is fully collateralised with safe Eurosystem debt is zero:

$$\delta(\bar{a}, e) = 0 \tag{2}$$

Now consider the case where the Arbitrage Bank again borrows €1 from the Eurosystem, but this time collateralises the loan with €1 worth of Ponziland bonds (*at market prices reflecting fundamentals*) rather than with Eurosystem bonds. Note that the collateral is risky but, in this example, is priced or 'marked to market' properly.

The probability of Arbitrage Bank defaulting *but* Ponziland debt not defaulting is the probability of Arbitrage Bank defaulting, $F(\bar{a})$, minus the probability of both Arbitrage Bank and Ponziland defaulting $F(\bar{a}, \bar{s})$. Using Bayes' rule, the probability of Arbitrage Bank defaulting but Ponziland not defaulting is $F(\bar{a})[1-F(\bar{s}\,|\,\bar{a})]$. The expected repayment at the end of the year to the Eurosystem by Arbitrage Bank is

$€(1+i)\left\{\left[1+\delta(\bar{a}, \bar{s})\right][1-F(\bar{a})]+\left[1+\delta(\bar{s})\right]F(\bar{a})[1-F(\bar{s}\,|\,\bar{a})]\right\}$, where $\delta(\bar{a}, \bar{s})$ is the default risk premium on a loan to Arbitrage Bank fully collateralised with Ponziland bonds, and $\delta(\bar{s})$ is, as before, the default risk premium on Ponziland debt. Assume that in addition to its collateralized borrowing from the Eurosystem, Arbitrage Bank also lends 1€ risk-free (say by doing a reverse Repo using Eurosystem debt as collateral). The expected discounted profit of the combined lending and borrowing operation is $€\left\{1-\left[1+\delta(\bar{a}, \bar{s})\right][1-F(\bar{a})]-\left[1+\delta(\bar{s})\right]F(\bar{a})[1-F(\bar{s}\,|\,\bar{a})]\right\}$. The collateralised loan risk premium that ensures zero expected profits is:

$$\delta(\bar{a},\bar{s}) = \frac{F(\bar{a})[1+\delta(\bar{s})]}{1-F(\bar{a})}\left(F(\bar{s}\,|\,\bar{a}) - \frac{\delta(\bar{s})}{1+\delta(\bar{s})}\right) \qquad (3)^{25}$$
$$= 0 \quad \text{if } F(\bar{s}\,|\,\bar{a}) = F(\bar{s})$$

When the two default events are independent, the probability of Ponziland defaulting given that Arbitrage Bank has defaulted, $F(\bar{s}\,|\,\bar{a})$, equals the unconditional probability of Ponziland defaulting, $F(\bar{s})$. In that case the market default risk premium on the Ponziland bond used as collateral $\frac{\delta(\bar{s})}{1+\delta(\bar{s})}$ (which under risk neutrality equals the unconditional probability of default on the Ponziland bond, $F(\bar{s})$, compensates exactly for the default risk on the Ponziland bond, and there is a zero default risk premium on the collateralised loan.

We now come to the crucial case where, as in the previous example, Arbitrage Bank lends €1 to the Eurosystem using a reverse Repo of Eurosystem bonds and borrows €1 from the Eurosystem collateralised with Ponziland bonds. However, as explained in the previous Section, the Ponziland collateral is valued as free of default risk by the market because of the confusing signals sent by the Eurosystem through its liquidity categorization and its 'haircut' policy. How should the Eurosystem, if it allowed for the fact that Ponziland debt is in fact subject to default risk, price this under-collateralised loan to Arbitrage Bank?

Instead of having to offer $(1+i)[1+\delta(\bar{s})]$ units of the Ponziland bond as collateral per euro borrowed, Arbitrage Bank is allowed to offer only $1+i$ units of the bond as collateral per euro borrowed. What default risk-premium on such an under-collateralised loan, $\hat{\delta}(\bar{a},\bar{s})$, say, would just equate the expected profit from the combined lending and collateralised borrowing activities of Arbitrage Bank to zero? The expected payment to the Eurosystem per euro borrowed is

[25] The second equality follows from the assumption of risk neutrality, which implies that $F(\bar{s}) = \delta(\bar{s})[1+\delta(\bar{s})]^{-1}$.

$(1+i)\left\{[1+\hat{\delta}(\overline{a},\overline{s})][1-F(\overline{a})]+F(\overline{a})[1-F(\overline{s}\,|\,\overline{a})]\right\}$. The default risk premium that reduces the expected profit to zero is given by:

$$\hat{\delta}(\overline{a},\overline{s})=\frac{F(\overline{a})F(\overline{s}\,|\,\overline{a})}{1-F(\overline{a})}=\frac{F(\overline{s})F(\overline{a}\,|\,\overline{s})}{1-F(\overline{a})}=\frac{F(\overline{s},\overline{a})}{1-F(\overline{a})} \tag{4}$$

Not surprisingly, under risk neutrality, the appropriate loan risk-premium for the under-collateralised loan is the joint probability of both the borrower and the collateral defaulting.

If the default events of Ponziland and Arbitrage Bank were perfectly positively correlated (Ponziland debt defaults whenever Arbitrage Bank defaults), the default risk premium would be given by $\hat{\delta}(\overline{a},\overline{s})=\frac{F(\overline{a})}{1-F(\overline{a})}$. If the default events of Ponziland and Arbitrage Bank were perfectly negatively correlated (Ponziland debt never defaults when Arbitrage Bank defaults), the default risk premium on the collateralised loan would be zero: $\hat{\delta}(\overline{a},\overline{s})=0$. When the two default events are independent, the default risk premium would be $\hat{\delta}(\overline{a},\overline{s})=\frac{F(\overline{s})F(\overline{a})}{1-F(\overline{a})}$.

However, instead of charging a loan default risk premium $\hat{\delta}(\overline{a},\overline{s})$ on loans collateralised with Ponziland bonds that are not marked to market according to the fundamentals but instead are valued as if they were free of default risk, the premium actually charged by the Eurosystem for such a loan is zero. Thus lending at the risk-free rate and borrowing from the Eurosystem with the loans under-collateralised with Ponziland bonds is an activity with positive expected profit. As long as there is a positive probability of default by both the eligible borrower (Arbitrage Bank) *and* the issuer of the collateral (the government of Ponziland), there will be an incentive to buy Ponziland debt cheaply in the market (at a price of €$\frac{1}{[1+\delta(\overline{s})](1+i)}$ per euro worth of contractual value a year from now)

and to use it as expensive collateral (at a price of $€\frac{1}{1+i}$ per euro worth of contractual value a year from now. Arbitrage Bank and all other eligible counterparties with positive default risk ($F(\bar{a})>0$) have a 'money machine'. The resulting excess demand for Ponziland debt drives down $\delta(\bar{s})$, the sovereign risk premium on Ponziland debt.

We believe that this is a stylized but accurate representation of what the Eurosystem does. From (4) it is clear that if indeed Ponziland debt were to be free of default risk ($F(\bar{s})=\delta(\bar{s})=0$), the appropriate default risk premium on the collateralised loan would indeed be zero, regardless of the default risk of Arbitrage Bank. However, as long as there exist both Eurozone governments whose debt is subject to default risk and eligible counterparties that are subject to default risk, the Eurosystem is subsidising the use of such debt as collateral by these counterparties. This boosts the demand for Ponziland sovereign debt for use as collateral and thus depresses the market default risk spreads below the levels warranted by fundamentals.

It is true that the subsidy per euro borrowed is small. When the two default events are independent, it is the product of the two unconditional default probabilities, which will be a small number in most cases.[26] However, no matter how small the subsidy per euro borrowed that is on offer, by increasing the scale of the borrowing, the resulting pure profit can become commercially interesting. If it were possible to increase the scale of borrowing without bound, the only equilibrium would be one in which the default risk premium on Ponziland debt goes down to zero. The reason this does not happen is that the Eurosystem is not a pure price setter and quantity taker in its Repo operations. In sets both price and an upper bound to quantity. With rationing by the Eurosystem, the market default risk premium on Ponziland debt will be too low, but greater than zero.

[26] It seems likely, however, that the correlation between the two default events is positive, rather than zero.

It might be argued that the Eurosystem's procedures suppress default risk only for the duration of the repurchase agreement, which is typically short (with the modal contract length a week or so). However, if these Eurosystem procedures and practices are thought by market participants likely to remain in effect into the distant future, then, in forward-looking bond markets even long-term euro-denominated sovereign risk premia (and interest rates) will tend to converge.

This sovereign-risk-suppressing collateral policy of the Eurosystem may become even more important in the future. As soon as the eight new EU members from Eastern and Central Europe become part of the Eurozone, they too will become "beneficiaries" of the Eurosystem's sovereign default risk subsidy. The anticipation of this may already affect the spreads on the sovereign debt of the new EU members and would-be Eurozone participants.

**How large is the implicit subsidy to the counterparties and does it matter if it is small?**[27]

The magnitude of the implicit subsidy to the counterparties is given by the product of the average value of the risk premium forgone by private counterparties, $\hat{\delta}(\bar{a},\bar{s})$, and the amount of 'low-quality' collateral (collateral with a significant fundamental probability of default) held by the Eurosystem as a result of its Repos and other collateralised loans. We do not know the share of each of the 12 Eurozone sovereigns' debt instruments in the aggregate euro-denominated collateral held by the Eurosystem, but we can establish an upper bound on the amount of low-quality sovereign debt instruments held by the Eurosystem. The size of the total balance sheet of the Eurosystem is just under one trillion euros (on September 30, 2005, total assets stood at just over €996 billion).[28] Of this amount, just under € 400 billion constitutes lending to euro area credit institutions in euro. This is an upper bound on the total

[27] We would like to thank Giuseppe Bertola for suggesting this calculation of an upper bound to the magnitude of the implicit subsidy.
[28] ECB Monthly Bulletin, July 2005, Table 1.1, page S6.

amount of 'Ponziland' debt instruments held as collateral by the Eurosystem. An upper bound on $\frac{\hat{\delta}(\bar{a},\bar{s})}{1+\hat{\delta}(\bar{a},\bar{s})}$ is given by the (average) probability of default of the counterparties (the real-world Arbitrage Banks), $F(\bar{a})$. This is bound to be an overestimate, as it assumes that whenever the counterparty defaults, the issuer of the collateral also defaults. The spread between the yield on debt issued by AAA commercial banks and the highest quality sovereign (Ireland in the euro area) provides a rough estimate of the default risk of the counterparties. Such spreads are currently (August 2005) extremely low, as little as 10bps to 20bps for instruments with a one-year maturity and even smaller for the shorter maturities representative of most real-word Repos. A 10bps subsidy rate (at an annual rate) on €400 bn yields a €400mn annual subsidy - small beer indeed, by the standards of global financial markets, and the size of the actual subsidy is certain to be much smaller than this generous upper bound.

The modest magnitude of the subsidy actually paid out does not, however, undermine our argument about the seriousness of the distortion introduced by the Eurosystem's operational practices. We contend that the equilibrium subsidy rate is as small as it its because of the market's response to the operational practice of the Eurosystem. This is but a specific example of the general point that the magnitude of the distortion and efficiency loss introduced by inappropriate taxes or subsidies is not measured by the revenue cost of the subsidy or the revenue raised by the tax.[29] If (counterfactually) access to the implicit subsidy to poor quality collateral were not rationed by the Eurosystem, counterparties with a positive default risk would have an infinite excess demand for poor quality Ponziland debt and a matching excess supply of high quality Eurosystem debt. As was already pointed out, the only possible equilibrium would be one where the price of Ponziland debt is pushed up to the

[29]For instance although a constant tax rate of 100 percent on labour income would be highly distortionary, it would yield no revenue because no-one would supply labour.

point that the market default risk premium vanishes. In such an equilibrium the amount of the implicit subsidy that is paid is of course zero, but the efficiency losses associated with the under-pricing of Ponziland sovereign risk can be significant.

If our characterisation of the operational practice of the Eurosystem is correct, the Eurosystem would end up holding a disproportionately large amount of low-quality, high default risk sovereign euro debt instruments in its balance sheet. A form of *Gresham's Law* would be at work, with lower quality sovereign debt 'driving out' good quality sovereign debt. 'Driving out' here means private counterparties passing the low quality sovereign debt on to the Eurosystem. This is a testable implication, and it would be interesting to know the composition, across the twelve sovereign issuers in the Eurozone, of the sovereign euro-denominated debt held by the Eurosystem. Such information on the 'nationality distribution' of the Eurozone sovereign debt held by the Eurosystem is, however, not publicly available.

## 4. Recommendation and Conclusion

We believe that the statements by President Trichet and by Dr. Issing and the response of van Herpt and Lamers (2005) to earlier versions of this paper and/or to articles in the financial press (see e.g. Buiter and Sibert (2005a)) do not undermine our argument. They all assert that all financial instruments offered and accepted as collateral for Repo transactions are 'marked to market', that is, valued at market prices. We agree. However, these market prices are distorted by the message conveyed through the Eurosystem's operational practices in its Repo operations, that the debt instruments of the 12 Eurozone sovereign are equivalent to each other and to the debt instruments issued by the Eurosystem itself, that they are therefore effectively free of default risk.

We agree that, since the Eurosystem started functioning officially on January 1, 1999, the *fundamental* default risk attached to *short-maturity* sovereign debt instruments of the 12

EMU member states has been low, even for Italy and (since January 1 2001) for Greece.[30] We emphasize two related points. First, although the fundamental short-term default risk attached to the euro-denominated debt of the non-triple A-rated Eurozone sovereigns has been low in the past, it has always been positive, not zero. Second, the short-term fundamental default risk has never been uniform across the 12 Eurozone sovereigns.

Rather than undertaking the politically sensitive task of assessing the differential default risks of the 12 EMU member states, those conducting Repo operations on behalf of the Eurosystem have chosen to price all Tier One, Category I short-maturity debt instruments offered as collateral as if they were all free of default risk. Those trading for the Eurosystem have the initiative in these valuations, because open market operations are always initiated by the Eurosystem. This practice by the Eurosystem of suppressing short-term differential sovereign default risk premia for the EMU-zone governments has been recognised by the counterparties of the Eurosystem and has been incorporated into their expectations of future Eurosystem behaviour. In this way differential sovereign default risk premia have been suppressed also for longer-maturity sovereign debt instruments.

One can appreciate how the Eurosystem painted itself into this awkward corner. Most central banks other than the Eurosystem belong to a single sovereign national entity. Such a conventional central bank is a key state institution of that national entity and it has that national entity's government as its budgetary counterpart. The Federal Reserve Board, the Bank of Japan and the Bank of England all fit this conventional model. By convention, these central banks tend to treat the domestic-currency-denominated debt issued by their (unique) national sovereign as risk-free. For example, in its operations, the Fed values dollar-denominated US Treasury debt at par with its own comparable debt instruments when it is

[30] The Eurosystem led a 'Shadowlands' existence between June 1, 1998, when the ECB was created and the appointments of the six Executive Board members became effective, and January 1, 1999 when the third and final phase of EMU began for the 11 original members.

used as collateral in Repos.[31] Market prices, even for default-risk free financial instruments, are variable and uncertain whenever the maturity of the instrument exceeds one period. Most central banks (including the Eurosystem) mark collateral to market daily and require their counterparties to post additional collateral if the market valuation of the collateral declines.[32]

Even in a conventional nation state with a single sovereign, it is by no means obvious that, when the central bank has operational and target independence (both *de jure* and *de facto*), the domestic currency debt of the sovereign government should automatically be treated as free of default risk. This would require *either* that the sovereign is known to be always solvent – even without discretionary recourse to seigniorage, *or* that the government can compel the central bank to monetise its debt and/or deficits, *or* that the government can itself issue 'currency' (irredeemable, negotiable bearer bonds) that it can declare to be legal tender and that would be a perfect substitute for central bank money.[33]

The Eurosystem faces not one but twelve national sovereigns. The ECB is the world's first true 'multilateral' or supranational central bank. The national central banks are its shareholders. Through their ownership of the NCBs, the governments of the member states are indirectly the shareholders of the ECB.[34] Like other multilateral institutions, the ECB finds it difficult not to treat its shareholders as formally equal. In the case of the IMF, the World Bank and the EBRD, treating the shareholders as formally equal has been interpreted to mean that each of these institutions charges the same interest rate to all its sovereign shareholders when they borrow from the institution, regardless of the actual differences in creditworthiness among the shareholders.[35] The inevitable result has been that

[31] Comparable debt instruments means debt instruments identical in all respects except for the identity of the issuer.
[32] Such margin requirements are familiar from futures markets.
[33] The US Treasury could in principle decide to issue new 'Treasury Notes', which were issued until 1971. They are part of the stock of US currency.
[34] There are some strange exceptions to this rule, as in the case of the Banca d'Italia, which is owned by the Italian banks and therefore not publicly owned. These quirks do not affect the argument.
[35] For instance, the European Bank for Reconstruction and Development has a uniform sovereign lending rate of 100bps over Libor. In exceptional circumstances, a sovereign project can be granted a derogation from the

these international financial institutions no longer lend to the better credit risks among their shareholders because their loans are too expensive and the shareholders can obtain better terms in the market, that the institutions ration their lending to the worst credit risks. The Eurosystem's operational collateral policy as applied to the sovereign debt of the EMU area member states, appears to be driven by the same imperative towards inappropriate equal treatment of unequals that gave birth to the uniform sovereign risk pricing policies of the Bretton Woods institutions and the regional development banks.

The solution to the problem created by the Eurosystem's subsidy to the use of poor quality Eurozone sovereign debt as collateral in Repos with eligible counterparties subject to default risk is simple: eliminate the subsidy by ending the practice. To make this operational, the Eurosystem and the other Repo market participants must first recognise that only the euro-denominated debt instruments issued by the Eurosystem itself are naturally free of default risk.[36]

The Eurosystem has a monopoly on printing money (the issuance of base money with legal tender status) in the Eurozone. It is therefore clear that euro-denominated debt instruments issued by the Eurosystem should be automatically considered free of default-risk and, hence, should set the benchmark for valuing default-risk free debt instruments for all purposes, including their use as collateral in Repos. As national governments cannot print additional euros, they must obtain the euros needed to service their euro-denominated debt through taxation or through lower present and future public spending. Both higher taxes and lower public spending are painful for some subjects of the polity and therefore politically unpopular and difficult. There are conceivable contingencies under which the cost of default

sovereign pricing policy, but such derogations are few and far between and result in but small reduction in the spread, typically to 75 or 50 basis points.

[36] The legacy debt instruments issued before EMU started by the national central banks should now be viewed as euro-denominated debt, expressed in rather awkward non-decimal denominations of the euro.

to the government is less than the cost of generating the increase in present and future primary surpluses necessary to rule out default.

All other Repo-eligible instruments, including the sovereign debt of the 12 Eurozone governments, should be acceptable as collateral by the Eurosystem only at prices reflecting country-specific, market-determined sovereign default risk discounts that are not distorted by misleading signals from the Eurosystem about the equivalence of the euro-denominated debt instruments issued by the 12 Eurozone member states.[37] A simple practical way to eliminate the distortion created by the Eurosystem's assignment of sovereign debt instruments of heterogeneous fundamental creditworthiness and liquidity to a common liquidity class is the following. Assign all (sovereign and non-sovereign, public and private) eligible AAA-rated debt instruments to the liquidity category with the lowest haircut. This would today include eight of the 12 Eurozone central governments. Next assign all eligible AA-rated debt instruments (sovereign and non-sovereign, public and private) to the liquidity category with the second lowest haircut. This would today include the central governments of Belgium, Italy and Portugal. Next assign all eligible A-rated debt instruments to the liquidity category with the third lowest haircut. This would today include the central government of Greece. Continue in this fashion until all eligible securities are exhausted.

The practice of mechanically penalising a longer remaining maturity with a bigger haircut should be abandoned. Instead there should be either a maturity-independent haircut or a maturity-dependent haircut schedule that reflects private market practice. This too would result in a much flatter maturity – haircut profile than the one currently administered by the Eurosystem.

[37] Even undistorted sovereign default risk premia may of course be zero for the most creditworthy Eurozone sovereigns.

The eligible euro-denominated debt instruments of the Eurosystem – the only financial instruments axiomatically free of default risk - would be in a class/category of itself, without any valuation haircuts.

An attractive feature of the proposal is that it would not require the ECB itself to determine what size haircut should be applied to the debt instruments of different Eurozone governments offered as collateral in Repo transactions. The rating agencies would perform this politically delicate function. By not discriminating against the use of long-maturity debt as collateral in Repos, our proposal also makes it more likely that undeniable differences in fundamental long-term default risk would indeed be reflected in the market price of the collateral offered in short-term Repos. Our proposal is also more flexible than the alternative of declaring the debt of a fiscally fallible Eurozone government (say one that is subject to the Excessive Deficit Procedure of the Stability and Growth Pact) to be ineligible as collateral for Repos, or to ration the use of such debt as collateral more tightly than that of Eurozone members compliant with the Stability and Growth Pact. However, if the magnitude of the haircut were to increase sufficiently sharply as the credit rating went down, our proposal amounts to declaring the debt of sufficiently low-rated sovereigns to be ineligible for use as collateral in the Eurosystem's open market operations.

On November 9, 2005, the ECB issued a 'clarification' of its collateral policy and practices[38]. It would only accept securities (sovereign or non-sovereign) with a credit rating of at least A- as collateral in Repos and other collateralised lending operations. It was not made clear whether all three, two or just one of the key rating agencies (Standard & Poor's, Moody's and Fitch) had to rate a security as at least A- to for it be eligible.

The ECB pointed out that it had not in the past ever included securities with a rating less than A minus in its list of Repo-eligible securities. From the amount of surprise created by this

[38] Financial Times, Wednesday November 9, 2005, page 1, 'ECB targets its problem nations'.

'clarification' in the financial markets, and from the fact that both the President of the ECB, Mr. Jean Trichet and the European Commissioner for Economic and Monetary Affairs, Mr Joaquín Almunia misstated the eligibility criterion after it was announced, it is apparent that this clarification was overdue.[39] It will certainly contribute to creating a climate of opinion in which the fiscal sustainability-challenged EMU nations (Greece, rated A, Italy, rated AA minus and Portugal, also rated AA minus) will be under greater market pressure to put their fiscal house in order.

Because only the euro-denominated debt instruments of the Eurosystem are automatically free of default risk, only the Eurosystem can provide the default risk-free benchmarks that are so important for the proper functioning of the money markets and capital markets of the Eurozone. For the Eurosystem to provide credible, liquid benchmarks across the maturity spectrum, that is, from overnight to fifty years and beyond, a significant increase in the volume of Eurosystem debt instruments outstanding at all maturities would be required. This should not pose any technical problems, as the Eurosystem can easily expand the size of its balance sheet (currently about 1 trillion euros) by outright sales (issuance) of its own debt instruments and outright purchases of other eligible debt instruments.[40]

We do not argue that sovereign default risk premia determined without the Eurosystem subsidising the use of low-quality Eurozone sovereign debt used as collateral in Repos, would by themselves be sufficient to discourage unsustainable government deficits. That remains an open question. It is self-evident, however, that the suppression of euro-area sovereign default risk premium differentials inherent in the Eurosystem's current monetary policy operating procedures is a fiscal-financial sustainability own goal that can be avoided

[39] Mr Trichet, on Tuesday November 10 2005 and Mr. Almunia, on November 24, 2005, stated that any security rated less than A would not be eligible. This was later 'clarified' by ECB staff as meaning that any security that did not belong to the A *category* of securities (which includes securities rated A-) would not be eligible. There is a whole lot of clarification going on.

[40] It would be great for research economists if the Eurosystem were to issue a perpetuity or consol. It would also have symbolic value as an expression of faith in the long (indeed never-ending) life of the institution.

through a simple change in operating procedures. The current procedures suggest that all Eurozone sovereign debt instruments are equal. Our proposal ensures that when some are less equal than others, they are priced accordingly.

If, even after the Eurosystem abandons its distortionary collateral practices, the markets were not to price sovereign default risk differentials among the 12 EMU area sovereigns properly, there would be a case for further measures to correct such market failure and make up for the absence of market discipline. One possible measure would be the imposition of an *additional* hair cut on the debt offered as collateral for Repos issued by euro-zone countries violating the Stability and Growth Pact fiscal norms. If this haircut were to be sufficiently large, it would amount to the Eurosystem declaring the sovereign debt of Stability and Growth Pact-violating countries to be ineligible for use as collateral in Eurosystem Repo operations.

Penalising the securities issued by private and public issuers with a low credit rating by applying a larger haircut to lower-rated securities or by declaring ineligible as collateral in Repos and other secured lending operations all securities rated below some minimal cut-off point would not create a risk of there being too few collateralisable securities available in the Repo and money markets. The reason is that among the securities that (subject to standard conditions) are eligible as collateral for lending by the Eurosystem are *'Other securitised assets/ABS/MBS'*.

ABS, Asset-Backed Securities, are bonds or notes backed by financial assets. Typically these assets consist of receivables other than mortgage loans, such as credit card receivables, auto loans, manufactured-housing contracts and home-equity loans.[41] ABS differ from most other kinds of bonds in that their creditworthiness (which is at the triple-A level

[41] Securities backed by first mortgages, although the most common ABS, are considered a separate investment category, Mortgage Based Securities or MBS.

for more than 90% of outstanding issues) derives from sources other than the paying ability of the originator of the underlying assets.

Bonds issued by Gritapor, a mythical EMU member state whose credit rating falls below the A category (a rating below A-), say to BBB or even BB, can still be used in part and indirectly as collateral in Eurosystem Repos and other collateralised lending operations. This can be achieved through Special Purpose Vehicles (SPVs) or suitable existing financial intermediaries issuing a particular kind of ABS, collateralised bond obligations or CBOs, backed by Gritapor (and similarly-rated) bonds. Through the form of internal credit enhancement known as 'subordination' (technically 'overcollateralisation'), the Gritapor bonds could back CBOs with a Repo-eligible credit rating, for some fraction of the market value of the Gritapor bonds.

For instance, BBB-rated Gritapor bonds could back a CBO structure characterised by a senior (or A) class of securities and one or more subordinated (B, C, etc.) classes that function as the protective layers for the A tranche.[42] If Gritapor were to default on the bonds held in the pool, the loss is not shared equally among all securities in the pool, but instead is first absorbed by the subordinated securities, beginning with the lowest tranche. The A tranche is unaffected unless the losses on the Gritapor bonds exceed the amount of the subordinated tranches. The A tranche of an ABS structure backed by BBB rated bonds could easily be AAA-rated.

Thus the enhancement of market discipline through tougher collateral requirements need not impair the liquidity and smooth functioning of Repo and money markets.

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[42] The A, B, C etc. tranches of an ABS structure are logically distinct from the A, B and C ratings of securities.

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Table 1

General Government Debt and Deficits of the 12 EMU Countries, 1999-2004

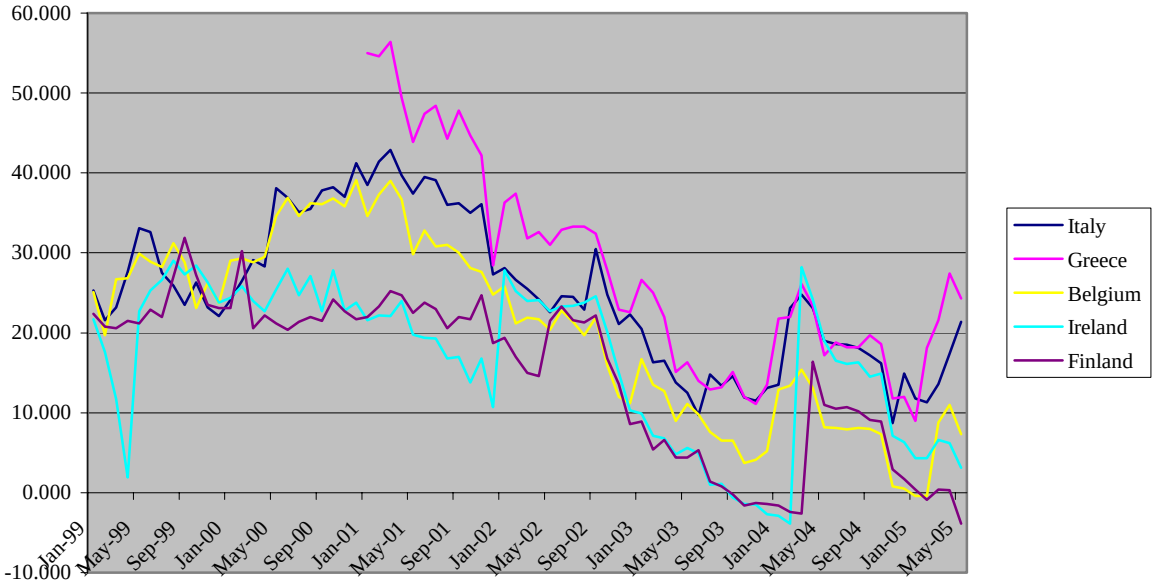
(% of GDP)

| | | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|
| General Government Consolidated Gross Debt | Belgium | 114.9 | 109.1 | 108.0 | 105.4 | 100.0 | 95.6 |
| | Germany | 61.2 | 60.2 | 59.4 | 60.9 | 64.2 | 66.0 |
| | Greece | 112.3 | 114.0 | 114.8 | 112.2 | 109.3 | 110.5 |
| | Spain | 63.1 | 61.1 | 57.8 | 55.0 | 51.4 | 48.9 |
| | France | 58.5 | 56.8 | 57.0 | 59.0 | 63.9 | 65.6 |
| | Ireland | 48.7 | 38.3 | 35.8 | 32.6 | 32.0 | 29.9 |
| | Italy | 115.5 | 111.2 | 110.7 | 108.0 | 106.3 | 105.8 |
| | Luxembourg | 6.0 | 5.5 | 7.2 | 7.5 | 7.1 | 7.5 |
| | Netherlands | 63.1 | 55.9 | 52.9 | 52.6 | 54.3 | 55.7 |
| | Austria | 67.4 | 66.7 | 67.1 | 66.7 | 65.4 | 65.2 |
| | Portugal | 54.3 | 53.3 | 55.9 | 58.5 | 60.1 | 61.9 |
| | Finland | 47.0 | 44.6 | 43.8 | 42.5 | 45.3 | 45.1 |
| General Government Deficit (- is surplus) | Belgium | 0.4 | -0.2 | -0.6 | -0.1 | -0.4 | -0.1 |
| | Germany | 1.5 | -1.3 | 2.8 | 3.7 | 3.8 | 3.7 |
| | Greece | 3.4 | 4.1 | 3.6 | 4.1 | 5.2 | 6.1 |
| | Spain | 1.2 | 0.9 | 0.5 | 0.3 | -0.3 | 0.3 |
| | France | 1.8 | 1.4 | 1.5 | 3.2 | 4.2 | 3.7 |
| | Ireland | -2.5 | -4.4 | -1.0 | 0.3 | -0.2 | -1.3 |
| | Italy | 1.8 | 0.7 | 3.0 | 2.7 | 3.0 | 3.1 |
| | Luxembourg | -3.4 | -6.2 | -6.2 | -2.3 | -0.5 | 1.1 |
| | Netherlands | -0.7 | -2.2 | 0.1 | 1.9 | 3.3 | 2.5 |
| | Austria | 2.4 | 1.7 | -0.1 | 0.4 | 1.3 | 1.4 |
| | Portugal | 2.9 | 2.9 | 4.4 | 2.7 | 3.0 | 3.0 |
| | Finland | -2.2 | -7.1 | -5.2 | -4.3 | -2.3 | -1.9 |
| Cyclically Adjusted General Government Deficit (- is surplus) | Belgium | 0.8 | 1.2 | 0.1 | -0.3 | -1.0 | -0.4 |
| | Germany | 1.6 | 2.0 | 3.4 | 3.7 | 3.2 | 3.3 |
| | Greece | 3.0 | 4.1 | 4.3 | 4.4 | 5.8 | 6.9 |
| | Spain | 1.4 | 1.7 | 1.1 | 0.6 | -0.2 | 0.3 |
| | France | 1.8 | 2.1 | 2.4 | 3.6 | 3.9 | 3.6 |
| | Ireland | -1.3 | -2.5 | 0.6 | 1.8 | 0.3 | -1.0 |
| | Italy | 1.7 | 2.4 | 3.7 | 2.9 | 2.7 | 2.8 |
| | LuxembourgU | -2.4 | -3.0 | -4.6 | -1.8 | -0.7 | 1.1 |
| | Netherlands | 1.0 | 0.8 | 2.0 | 3.0 | 2.7 | 1.7 |
| | Austria | 2.6 | 2.5 | 0.0 | 0.3 | 0.9 | 1.1 |
| | Portugal | 3.6 | 4.3 | 5.4 | 3.3 | 2.6 | 2.4 |
| | Finland | -0.9 | -4.6 | -4.1 | -3.9 | -2.6 | -1.9 |
| General Government Primary Deficit (- is surplus) | Belgium | -6.6 | -6.9 | -7.2 | -6.1 | -5.7 | -4.8 |
| | Germany | -2.0 | -4.7 | -0.4 | 0.5 | 0.7 | 0.6 |
| | Greece | -5.0 | -4.0 | -3.7 | -2.2 | -0.6 | 0.4 |
| | Spain | -2.4 | -2.4 | -2.6 | -2.6 | -2.8 | -1.9 |
| | France | -1.4 | -1.7 | -1.6 | 0.2 | 1.3 | 0.8 |
| | Ireland | -4.9 | -6.4 | -2.4 | -1.0 | -1.5 | -2.5 |
| | Italy | -5.0 | -5.8 | -3.6 | -3.2 | -2.4 | -2.0 |
| | Luxembourg | -3.8 | -6.5 | -6.5 | -2.6 | -0.8 | 0.9 |
| | Netherlands | -5.1 | -6.0 | -3.3 | -1.1 | 0.3 | -0.4 |
| | Austria | -1.2 | -2.1 | -3.8 | -3.1 | -2.0 | -1.7 |
| | Portugal | -0.4 | -0.4 | 1.2 | -0.3 | 0.0 | 0.1 |
| | Finland | -5.3 | -10.0 | -7.9 | -6.5 | -4.5 | -4.0 |

Source: European Commission (2005)

## Chart 1

**Spreads over Bunds on 10-year sovereign Eurozone bonds, 1999.01-2005.09 (bps)**




Source: Bloomberg

| Table 2 | | | |
|---|---|---|---|
| EMU 12 Central Government Spreads vs German Sovereign Debt | | | |
| | Vs. 10-year Bund* | Vs 3-month German T-Bill** | |
| Belgium | + 0.07 | -0.027 | |
| Germany | -- | -- | |
| Greece | + 0.25 | | |
| Spain | -0.02 | -0.019 | |
| France | +0.01 | -0.018 | |
| Ireland | -0.22 | | |
| Italy | +0.22 | +0.003 | |
| Luxembourg | NA | | |
| Netherlands | -0.06 | | |
| Austria | +0.03 | | |
| Portugal | +0.01 | | |
| Finland | -0.04 | | |

Source: Spreads vs. 10-year Bund, Financial Times
: Spreads vs. 3 M German T-Bills, Bloomberg
* : Wednesday, June 8, 2005.
** : Tuesday, 31 May, 2005
-- : zero by definition
NA : not available

| Table 3 | | |
|---|---|---|
| **Credit Ratings for Domestic Currency Debt of Eurozone Sovereigns and Central Banks** | | |
| | Standard & Poor's* | Moody's** |
| Austria | AAA (AAA) | Aaa |
| Belgium | AA+ (NA) | Aa1 |
| Finland | AAA (AAA) | Aaa |
| France | AAA (AAA) | Aaa |
| Germany | AAA (AAA) | Aaa |
| Greece | A (NA) | A1 |
| Ireland | AAA (AAA) | Aaa |
| Italy | AA- (AAA) | Aa2 |
| Luxembourg | AAA (AAA) | Aaa |
| Netherlands | AAA (AAA) | Aaa |
| Portugal | AA- (AAA) | Aa2 |
| Spain | AAA (AAA) | Aaa |
| EC | AAA (NA) | |
| ECB | NA (AAA) | |
| *25 August 2005<br>** 19 August 2005<br>NA: not available/applicable | | |

**Table 4**

LEVEL OF VALUATION HAIRCUTS (%) APPLIED TO ELIGIBLE TIER ONE ASSETS IN RELATION TO FIXED COUPON AND ZERO COUPON INSTRUMENTS

| | Liquidity categories | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Category I | | Category II | | Category III | | Category IV | |
| Residual maturity (years) | fixed coupon | zero coupon | fixed coupon | zero coupon | fixed coupon | zero coupon | fixed coupon | zero coupon |
| 0-1 | 0.5 | 0.5 | 1 | 1 | 1.5 | 1.5 | 2 | 2 |
| 1-3 | 1.5 | 1.5 | 2.5 | 2.5 | 3 | 3 | 3.5 | 3.5 |
| 3-5 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 | 5.5 | 6 |
| 5-7 | 3 | 3.5 | 4.5 | 5 | 5.5 | 6 | 6.5 | 7 |
| 7-10 | 4 | 4.5 | 5.5 | 6.5 | 6.5 | 8 | 8 | 10 |
| >10 | 5.5 | 8.5 | 7.5 | 12 | 9 | 15 | 12 | 18 |

Source: European Central Bank (2005a), Chapter 6, Box 10, p. 47.

## Appendix: The equilibrium default risk premium on an under-collateralised loan.

Let $u(c_t), u' > 0; u'' < 0, \lim_{c\to\infty} u'(c_t) = \lim_{c\to 0}\left(u'(c_t)\right)^{-1} = 0$ be the twice continuously differentiable period utility function of a representative investor. Period *t* consumption is $c_t$ and $p_t$ is the period *t* euro general price level. The investor maximizes expected utility and his subjective discount factor is $\beta, 0 < \beta < 1$. Arbitrage Bank defaults when some random variable *a* defined on the real line is less than $\bar{a}$. Ponziland defaults when some random variable *s* defined on the real line is less than $\bar{s}$. The joint probability density function of consumption, inflation, $\pi_{t+1} \equiv p_{t+1}/p_t$, *a* and *s* is $f(c_{t+1}, \pi_{t+1}, a, s)$ for $c_{t+1} \geq 0, \pi_{t+1} \geq 0, -\infty < a, s < \infty$. For simplicity this joint probability density function is assumed to be continuous. We define the marginal probability density functions $f(c_{t+1}, \pi_{t+1}, a) \equiv \int_{-\infty}^{+\infty} f(c_{t+1}, \pi_{t+1}, a, s)ds$, $f(c_{t+1}, \pi_{t+1}) \equiv \int_{-\infty}^{+\infty} f(c_{t+1}, \pi_{t+1}, a)da$ etc. The joint distribution function of $c_{t+1}, \pi_{t+1}, a$ and $s$ is given by

$F(C, \Pi, A, S) \equiv \int_0^C \int_0^\Pi \int_{-\infty}^A \int_{-\infty}^S f(c_{t+1}, \pi_{t+1}, a, s)dc_{t+1}d\pi_{t+1}dads$ and the associated marginal distribution functions are defined anologously to the marginal probability density functions. $E_t(z_{t+1}|\Omega)$ denotes the expectation, at the beginning of period *t*, of some random variable $z_{t+1}$ conditional on $\Omega$ where $\Omega$ is the set of all possible realisations of $c, \pi, a$ and $s$. The Euler equation for intertemporal consumption choice when the investor lends or borrows through a one-period euro-denominated default risk-free instrument is:

$$\begin{aligned} u'(c_t) &= (1+i)\beta E_t\left(u'(c_{t+1})\pi_{t+1}^{-1} \middle| -\infty < a, s < \infty; c_{t+1}, \pi_{t+1} \geq 0\right) \\ &= (1+i)\beta \int_0^\infty \int_0^\infty u'(c_{t+1})\pi_{t+1}^{-1} f(c_{t+1}, \pi_{t+1})dc_{t+1}d\pi_{t+1} \end{aligned} \tag{A1}$$

The Euler-equation for intertemporal consumption choice when the investor lends to Arbitrage Bank and the loan is collateralised at time *t* with $\frac{1}{1+i}$ €s of Ponziland debt for every € worth of contractual loan repayment in period *t+1* is

$$\begin{aligned} u'(c_t) = (1+i)[1+\hat{\delta}(\bar{a},\bar{s})]\beta\int_0^\infty\int_0^\infty\int_{\bar{a}}^\infty u'(c_{t+1})\pi_{t+1}^{-1} f(c_{t+1},\pi_{t+1},a)dc_{t+1}d\pi_{t+1}da \\ +(1+i)\beta\int_0^\infty\int_0^\infty\int_{-\infty}^{\bar{a}}\int_{\bar{s}}^\infty u'(c_{t+1})\pi_{t+1}^{-1} f(c_{t+1},\pi_{t+1},a,s)dc_{t+1}d\pi_{t+1}dads \end{aligned} \tag{A2}$$

Equations (A1) and (A2) imply that

$$\begin{aligned} \int_0^\infty\int_0^\infty u'(c_{t+1})\pi_{t+1}^{-1} f(c_{t+1},\pi_{t+1})dc_{t+1}d\pi_{t+1} = [1+\hat{\delta}(\bar{a},\bar{s})]\int_0^\infty\int_0^\infty\int_{\bar{a}}^\infty u'(c_{t+1})\pi_{t+1}^{-1} f(c_{t+1},\pi_{t+1},a)dc_{t+1}d\pi_{t+1}da \\ +\int_0^\infty\int_0^\infty\int_{-\infty}^{\bar{a}}\int_{\bar{s}}^\infty u'(c_{t+1})\pi_{t+1}^{-1} f(c_{t+1},\pi_{t+1},a,s)dc_{t+1}d\pi_{t+1}dads \end{aligned} \tag{A3}$$

Making equation (A3) operational requires knowledge of the utility function and of the joint distribution function of consumption, inflation and the two default indicators, *a* and *s* (strictly speaking we need the joint distribution of $u'(c)\pi^{-1}$, *a* and *s*).

Equation (A3) simplifies drastically if $u'(c_{t+1})\pi_{t+1}^{-1}$ is constant. This 'constant marginal utility of a euro' assumption was called (euro-) risk neutrality in the body of the paper. With (euro-) risk neutrality, (A3) becomes

$$\begin{aligned} &\int_0^\infty\int_0^\infty f(c_{t+1},\pi_{t+1})dc_{t+1}d\pi_{t+1} \\ &= [1+\hat{\delta}(\bar{a},\bar{s})]\int_0^\infty\int_0^\infty\int_{\bar{a}}^\infty f(c_{t+1},\pi_{t+1},a)dc_{t+1}d\pi_{t+1}da + \int_0^\infty\int_0^\infty\int_{-\infty}^{\bar{a}}\int_{\bar{s}}^\infty f(c_{t+1},\pi_{t+1},a,s)dc_{t+1}d\pi_{t+1}dads \\ &\text{or} \\ 1 &= [1+\hat{\delta}(\bar{a},\bar{s})]\int_0^\infty\int_0^\infty\left(1-\int_{-\infty}^{\bar{a}} f(c_{t+1},\pi_{t+1},a)da\right)dc_{t+1}d\pi_{t+1} \\ &+\int_{-\infty}^{\bar{a}}\int_0^\infty\int_0^\infty\left(\int_{-\infty}^\infty f(c_{t+1},\pi_{t+1},a,s) - \int_{-\infty}^{\bar{s}} f(c_{t+1},\pi_{t+1},a,s)\right)dc_{t+1}d\pi_{t+1}dads \\ &= [1+\hat{\delta}(\bar{a},\bar{s})][1-F(\bar{a})]+F(\bar{a})-F(\bar{a},\bar{s}) \end{aligned} \tag{A4}$$

Equation (A4) implies that

$$\hat{\delta}(\bar{a},\bar{s}) = \frac{F(\bar{a},\bar{s})}{1-F(\bar{a})} \tag{A5}$$

This is the same as equation (4) in the main paper.

Another simplifying assumption leading to the same expression as (A5) would be that the joint distribution function of the two defaults event indicators, *a* and *s*, is independent of the joint distribution function of $c$ and $\pi^{-1}$. If $f(c_{t+1}, \pi_{t+1}, a, s) = f(c_{t+1}, \pi_{t+1}) f(a, s)$, a little algebra again shows that the equilibrium default premium on a loan to Arbitrage Bank that is under-collateralised with Ponziland sovereign debt is given by (A5).