MANAGING THE PUBLIC DEBT IN FISCAL STABILIZATIONS: THE EVIDENCE

Alessandro Missale
Francesco Giavazzi
Pierpaolo Benigno

Working Paper **6311**

NBER WORKING PAPER SERIES

MANAGING THE PUBLIC DEBT IN FISCAL STABILIZATIONS: THE EVIDENCE

Alessandro Missale
Francesco Giavazzi
Pierpaolo Benigno

Working Paper 6311
http://www.nber.org/papers/w6311

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
December 1997

We thank all the people in Treasuries and Central Banks who helped us to build a database on the composition and maturity of public debt. We thank Prescott Miller for insightful discussion, Pierpaolo Battigalli, Olivier Blanchard, Francesco Daveri, Rudi Dornbusch, Carlo Favero, Ilan Goldfajn, Gustavo Piga and participants in the MIT macro-workshop and in the 1996 Banco de Portugal-CEPR Conference for comments. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

Managing the Public Debt in Fiscal Stabilizations:
The Evidence
Alessandro Missale, Francesco Giavazzi
and Pierpaolo Benigno
NBER Working Paper No. 6311
December 1997
JEL Nos. E31, E41, E43, G12

ABSTRACT

This paper provides evidence on the behavior of public debt managers during fiscal stabilizations in OECD countries over the last two decades. We find that debt maturity tends to lengthen the more credible the program, the lower the long-term interest rate and the higher the volatility of short-term interest rates. We show that this debt issuing strategy is consistent with optimal debt management if information between the government and private investors is asymmetric, as is usually the case at the outset of a stabilization attempt when private investors may lack full confidence in the announced budget cuts.

Alessandro Missale
IGIER
via Salasco 5
Milan 20136
ITALY
alessandro.missale@uni-bocconi.it

Francesco Giavazzi
IGIER
via Salasco 5
Milan 20136
ITALY
and NBER
francesco.giavazzi@uni-bocconi.it

Pierpaolo Benigno
Department of Economics
Princeton University
Princeton, NJ 08544
pierpa@phoenix.princeton.edu

1. Introduction

This paper presents evidence on how governments manage their public debt during a fiscal stabilization. We study 62 episodes of fiscal correction occurred in OECD countries between 1975 and 1995, and analyze the government issuing strategy during the first two years of each program. The empirical evidence shows that governments, at the start of a stabilization, increase the share of fixed-rate long-term debt denominated in the domestic currency the more credible is the program, the lower are long-term interest rates, and the higher is the risk associated with rolling over short-term debt. This evidence points to a trade-off between roll-over risk and the cost of debt servicing that is well known to debt managers (see e.g. H.M. Treasury and Bank of England, 1995).

Issuing short-term debt to be rolled over in the future exposes the government budget to the effects of interest rate shocks. Optimal taxation suggests issuing long-dated securities in order to insulate the budget from such shocks, thus allowing for smoother tax rates (see Barro, 1995). Although this policy may be costly, it is always optimal for the government to insure against interest-rate risk (when this is the only source of uncertainty) provided long-term interest rates reflect properly called term premia and not time consistency problems or market imperfections. However, when the government and private investors do not share the same information, high interest rates on long-term bonds may reflect credibility problems other than term premia, which provides a theoretical justification for a policy aimed at reducing the cost of debt servicing. Asymmetric information plays a crucial role at the outset of a stabilization: as the government's resolution to carry out the program is not known to the private sector, long interest rates may remain high until the time when the uncertainty as to the outcome of the stabilization is resolved. In this situation, as noted by Campbell (1995), a committed government may reduce the cost of debt servicing by issuing short-term debt. This policy can yield additional benefits to the extent that the decison to issue short, or indexed or foreign currency debt, signals to the market the government's intentions: by shortening debt maturity committed governments may distinguish themselves from less determined ones. Episodes of fiscal stabilizations can thus provide valuable information on the determinants of government debt issuing policy.

The evidence presented in Section 2 shows that the credibility of a program, as measured by the change in long-term interest rates at the start of the stabilization, and the roll-over risk, as measured by the conditional volatility of short-term interest rates, are important determinants of the choice of debt instruments in fiscal stabilizations. Credibility and interest-rate risk tend to increase the share of fixed-rate long-term debt, while a higher level of the long-term interest rate reduces it.

These stylized facts motivate the models presented in the next two sections. The model of Section 3 describes the choice of debt maturity —when the authorities and the private sector share the same information— by a government which is attempting to stabilize the debt-to-GDP ratio through tax levies and spending cuts. We show that a government which expects to be successful will always issue long-term bonds to protect itself against the possibility that the stabilization may fail as a result of an exogenous interest rate shock; such a protection can be obtained by predetermining the cost of borrowing through the issue of long-term bonds. Under full information, only a government which expects to fail will issue short-term debt: as it is unable to cut spending, its only hope is to be "saved" by a favourable shock to future interest rates.

Asymmetric information is introduced in Section 4. If the government's resolution to carry out the stabilization is not fully credible, interest rates on long-term debt will be high reflecting investors' lack of confidence. In this case the government may want to issue short-term debt and wait until the uncertainty about the outcome of the stabilization is resolved. By issuing short-term debt the government may also signal its resolution. We formalize this intuition (Campbell, 1995) considering a reputation game between two governments which are both expected to succeed but, being characterized by different spending cuts, would face different interest rates under full information. Because spending cuts require time to be implemented, the private sector must form expectations about future interest rates, and look at the government issuing policy as a signal of its resolve in implementing the cuts. We show that a separating equilibrium exists where the "tough" government shortens debt maturity to signal its determination. The separating maturity is decreasing in the level of the long-term interest rate, and increasing in the variability of interest rates, consistently with our empirical findings.

2. Debt maturity and fiscal stabilizations: the evidence

We consider the fiscal stabilization episodes which took place in OECD countries between 1975 and 1995. Fiscal stabilizations can provide valuable information on the determinants of debt management decisions because, during such episodes, the authorities' assessments of the probability of success are likely to differ from those of the private sector, and so will the expectations of interest rates. Thus, long-term interest rates will reflect credibility problems other than term premia which makes it possible for the government to reduce the cost of debt servicing by issuing short maturity, or foreign currency, or variable-rate debt.

We identify stabilization episodes from the OECD estimates of the general government's primary structural budget surplus —that is, the cyclically adjusted budget surplus net of interest payments. An episode of fiscal stabilization is defined as a period, lasting one or more years, during which the structural primary surplus has improved by at least 1 percent of GDP. This definition is intended to capture relatively important changes in the discretionary component of the budget. By excluding small improvements —that is those between 0 and 1 percent of GDP, there are 7 of such episodes in our sample— we may lose evidence from unsuccesful attempts, but we avoid the risk of including improvements in the budget surplus which occur by chance or, even worse, because of the exhaustion of temporary expansionary fiscal measures.

There have been 68 of such episodes from 1975 to 1995 in the following OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, UK and USA. Our sample reduces to 62 episodes because of the lack of information regarding the debt composition of Greece and Norway and because of the unavailability of data on interest rates for the Spanish episode of 1975.

These episodes are listed in Table 1. The sample includes well-known examples of fiscal consolidations, such as Denmark in 1983-86, Ireland in 1982-83, and then again in 1986-89, Sweden in 1986-87, and so on. Some of these consolidations turned out to be successful, in the sense that the debt-to-GDP ratio was stabilized (such as in Ireland, in 1986-89); others instead failed (such as in Ireland again in 1982-83).

For each episode we look at the two-year change in the share of long-term debt, between the end of the year preceding the stabilization and the end of the second year of the stabilization (we have this information only once-a-year, on December 31st). Long-term debt is defined as the sum of fixed-rate government bonds and loans denominated in the domestic currency with an initial maturity longer than two years. We thus consider debt denominated in foreign currency and bonds whose coupon is indexed to market interest rates or to the price level as short-term debt (See Data Appendix). The composition of the public debt in various countries was obtained from national sources. Public debt includes the holdings of debt by the monetary authorities because we have information on the composition of such holdings only for a subset of countries. Experimenting with different definitions of long-term debt, in particular excluding loans and savings certificates, or limiting the attention to debt held by the private sector, where possible, or shows that our results are robust to alternative definitions.

As discussed in the introduction, theory points to three factors influencing the government's choice of debt maturity at the start of a stabilization: the roll-over risk, the level of the interest rates and the credibility of the government. The roll-over risk is related to the conditional volatility of short-term interest rates: we measure this variability by the coefficient of variation (standard error divided by the mean) of short-term interest rates in the seven-year period preceding the stabilization attempt. The standard error is estimated from the auxilliary regression (on quarterly data) of the short-term interest rate on its first lag and the first lag of the long rate. Data on interest rates are taken from the OECD whenever available, otherwise from IMF-IFS.

Measuring the credibility of a stabilization program is difficult. Ideally, one would like to know how credible is the program from the start, say, at the time it is announced and before the maturity is chosen. Realistically, we have to rely on an ex-post measure of credibility. We measure the credibility of the stabilization attempt by the fall in the spread between the yield on long-term government bonds in the country considered and German bonds. Thus, we identify as credible an attempt which leads to a fall in the long interest rate relative to the German rate. (We assume German policies to be fully credible). The change in the long spread that we consider is that occurring in the first year of the stabilization.

The literature on debt management also suggests the debt-to-GDP ratio as a factor influencing the decision about the type of debt instruments a government issues: Missale-Blanchard (1994) provide evidence of a negative relation between the debt level and debt maturity. We have thus also looked at the debt-GDP ratio at the start of the stabilization.

No clear pattern in the choice of debt maturity emerges from Table 1. While on average debt maturity lengthens, the number of episodes where the opposite happens appear to be equally important. One way to summarize this evidence is to split the sample between those episodes which have been accompanied by a lengthening of debt maturity, and those where the opposite has happened. This is shown in the first two columns of Table 2 which report simple means (of the different variables) for the two sub-samples.

The average increase in the share of fixed rate long-term debt has been 4.9 percent in the 36 episodes where this has happened, while a comparable 5.1 percent fall is observed in the 26 episodes where maturity has shortened. Interestingly, the two sub-samples show the same conditional volatility in short-term interest rates and an average initial long-term interest rate which differs by only 7 basis points. Episodes in which the maturity lengthened differ from episodes in which it shortened because of a higher debt-to-GDP ratio and a lower initial share of long-term debt. More importantly, the former episodes appear to have enjoyed a greater initial credibility as shown by the 1.11 percent fall in the long spread on German rate relative to the episodes in which the maturity shortened, where, on average, the long rate rose in the first year of the stabilization attempt. To further investigate the possibility that credible stabilization attempts are associated with issuance of long instead of short-term debt, we have also divided our sample in two parts, depending on whether the long rate has fallen or increased vis-à-vis the German rate. As shown in the last two columns of Table 2, the number of episodes in each group is about the same. In the 30 cases of a falling long rate —which we tentatively call credible stabilizations— the share of long-term debt has increased while the opposite has happened in episodes of rising interest rates. "Credible" stabilizations show a 4.9 percent higher mean change of the share of long debt in spite of their worse initial conditions in terms of interest rates, debt levels, and debt maturity.

The evidence provided so far has been descriptive. In order to examine whether credibility, i.e. the change in the long spread, the initial level of interest rates and the roll-over risk have a significant impact on the choice of debt maturity, we have run a simple OLS regression. The dependent variable is the 2 year change in the share of fixed-rate long-term debt. On the right-hand-side we have a constant, the standard error (divided by the mean) of short-term interest rates, the long interest rate the year before the stabilization, the change in the spread of long rates vis-à-vis long German bonds, and the debt-to-GDP ratio. We also include the share of long-term debt at the start of the stabilization, since it can make a big difference if the government starts off with, say, 80 percent of long debt, or only 5 percent.

The results reported in Table 3 show that credible fiscal stabilizations are accompanied by a lengthening of debt maturity. When the full sample is considered, in column 1, the coefficient of the change in the long rate spread is positive and significant at the 5% level. The level of long interest rates is also an important factor in the choice of debt maturity. High long rates lead governments to issue short-term (or variable rate or foreign-currency) debt to avoid being locked into costly debt contracts. The coefficient of the standard error of short rates, though positive as theory suggests, is not precisely estimated; it is not significant at the 10% level. While the level of debt appears not to affect the choice of the debt to issue, there is clear evidence that lengthening maturity is easier when maturity is short at the beginning of the stabilization.

In column 2 we show the results obtained including a dummy for the 1990s. This should capture the lengthening in debt maturity that occurred in many countries after the liberalization of financial markets and the emergence of liquid markets for long-term government bonds denominated in the domestic currency. Although the dummy variable is not significant, in this regression the coefficient of the standard error of short-term rates is significant at the 10% level. Finally, in all regressions a standard Jarque-Bera test does not reject the hypothesis that the residuals are normally distributed.

Both the long interest rate and the change in spread are strongly significant: as argued in the introduction, and shown more formally in the following sections, a government will only issue short-term debt if it faces a high term premium on long rates, reflecting investors' lack of confidence in the stabilization. When a stabilization gains credibility from the outset, as reflected in a fall of the spread, the government will issue long.

In the last two columns of Table 3 we ask whether or not the effects detected so far are equally present in all the stabilization episodes, independently of the magnitude of the fiscal adjustment. To this end we divide episodes in two sub-samples. We examine in column 3 episodes in which the fiscal adjustment has been relatively small, and, in column 4, episodes in which the magnitude of the adjustment has been larger. The median adjustment used to divide the sample happens to be 2.5% of GDP. The outcome of this simple characterization is interesting: except for the initial maturity, none of the coefficients in the sample of minor stabilization episodes is significant at the 5% level, and only the coefficient on the long-term interest rate is significant at the 10% level. Credibility and long rates appear to play a significant role in the choice of debt maturity only in episodes of relatively large fiscal adjustment.

In Tables 4 and 5 we also present evidence for stabilizations with a total fiscal adjustment greater or equal to 2% of GDP. We have no good excuse for choosing the 2% cut-off point, except that any such choice would be arbitrary, and lowering the cut-off point to 2% allows us to consider twelve more episodes. The only result that changes in the new sample is the coefficient on the conditional volatility of short rates, which is now significant at the 5% level (seee Table 4, column 1).

In Column 2 of Table 4 we examine the implications of making our definition of stabilization more restrictive along the time dimension. We consider only episodes which last no less than 2 years, as we may want to capture fiscal consolidation which are significant because of the consistent change in the discretionary component of the budget deficit, in addition to their overall magnitude. This experiment leads to the same results obtained on the broader sample including 1-year episodes but excluding fiscal corrections lower than 2% of GDP.[1]

In the last two columns of Table 4 we provide evidence on an alternative specification for the choice of debt maturity. Conventional wisdom suggests that the spread between long and short-term rates —the slope of the yield curve— not only conveys useful information about the path for future interest rates but also captures term premia or "unjustified" inflation expectations to which debt managers may want to react. The slope of the yield curve and its change could thus better explain the behavior of debt maturity during stabilization attempts than the level and the change (relative to German rates) in the long interest rate. We have explored this idea by adding to the regressors the spread between the long and the short interest rate in the year preceding the stabilization and (the negative of) its change in the first year of the stabilization. Results are shown in columns 3 and 4 of Table 4 for the full sample and the restricted sample, respectively, and are surprising. Not only do the long interest rate and its change (relative to the German rate) outperform the yield slope and its change as explanatory variable, but their coefficient are unaffected by the inclusion of the new regressors. Contrary to what could be expected, a high spread between long and short interest rates —once one controls for the level of the long interest rate— is associated with an increase in the share of long-term debt. A fall in the long-short spread also leads to a shortening of debt maturity. In the full-sample regression such effects are statistically significant at the 5% and 10% levels. This evidence could be explained by the inability of yearly data to capture movements in the yield curve, or even by the non homogeneity of short interest rate in the OECD data-base. An

[1]When attention is restricted to consolidations longer than 1 year, the volatility of short interest rates is significant also for episodes exhibiting a correction greater than 2.5% of GDP.

alternative explanation is that stabilization episodes are often accompanied by a tightening of monetary policy which raises short rates above long-term rates. In such instances the yield slope becomes negative, and the credibility of the stabilization attempt can only be inferred from the behavior of the long interest rate. Only the fall of such rate below its pre-stabilization level, rather than the twist in the yield curve, is a sign that the stabilization is credible.

What matters for the choice of debt maturity is thus the level of the long rate, rather than its position relative to the short rate. A government facing high short and long interest rates, with short rates higher than long rates, may well prefer to borrow short if it is confident that high long rates are only temporary and will fall as the program is carried out and credibility is gained. The model we present in Section 4 develops this intuition.

Finally, we ask whether our estimates could suffer from an endogeneity problem. As we measure the credibility of the stabilization by the fall in the interest rate during the first year of the program, there is a potential for this variable to be affected by the choice of type of debt that the government issues at the outset of the stabilization. The choice of a particular debt instrument may convey private information about the prospects of the stabilization attempt, and may thus affect private investors' expectations and thus interest rates. To take care of the possible endogeneity of the change in long interest rates vis-à-vis German rates, we use, as an instrument, the change in such variable occurring in the six month preceding the first year of the stabilization, and thus the choice of debt maturity. Instrumental variable estimates are shown in Table 5 for both the full and the restricted samples and for both the specifications excluding and including the slope of the yield curve and its change. This latter variable has also been instrumented with its value in the six months preceding the stabilization attempt.

The instrumental variable regressions confirm earlier results. Although, the coefficient for the change in the long interest rate spread is greater than the corresponding OLS coefficient, a formal Hausman test does not reject the hypothesis that such variable is exogenous to the choice of debt maturity at the 10% and 5% significance levels for the full sample and the restricted sample respectively.[2]

3. The choice of debt maturity: likely and unlikely stabilizers

A main finding of the preceding analysis is that stabilizations which are credible from the outset are accompanied by a lengthening of debt maturity. In this section we provide a tentative explanation of this fact based on the idea that a government

[2]When we focus, pherhaps less arbitrarily, on stabilizations with a fiscal correction greater than the median of 2.5% of GDP, the same results are obtained except for the fact that the volatility of short rates is no longer significant.

with favorable stabilization prospects will issue long-term debt to protect its efforts from being jeopardized by an adverse shock to interest rates.

We describe the choice of debt maturity in a situation where the government and the private sector share the same information. Within this framework, credibility refers to the probability of success of the stabilization itself, as opposed to the credibility of the policymaker (Dornbusch 1991, Drazen-Masson 1994). We shall compare the choice of debt maturity by a government which is credible in the sense that it is expected to succeed —the "likely" stabilizer— with one which is expected to fail —the "unlikely" stabilizer.

The aim of both governments is to halt the rising debt-to-GDP ratio by cutting public spending and levying taxes. The relevant time-horizon extends over two periods: period 0 and period 1. The sequence of events, summarized in Figure 1, is as follows. At the beginning of period 0, the government rolls over the stock of public debt and has two options: it can either issue two-period bonds, or one-period bonds maturing at the beginning of period 1. We describe this choice through the parameter m: the share of long-term debt. When $m = 1$, the government issues only two-period bonds; when $m = 0$, only one-period bonds. At the beginning of period 0, the one-period interest rate during period 0 is known. For the ease of notation we assume such interest rate equal to zero. The one-period interest rate, i, which will prevail in period 1, is instead uncertain; it depends on external circumstances. We denote the expectation of i at the beginning of period 0 as $E_0 i$, —i.e. $E_0 i$ is the forward rate—. Government spending, G, is observed by private investors at the end of period 0 before the debt is rolled over (an assumption which will play a relevant role only in the next section under asymmetric information). The uncertainty about the period-1 interest rate is resolved at the beginning of period 1 before the one-period bonds are rolled over. When taxes are set the only remaining source of uncertainty arises from an exogenous shock, X, which hits the government budget at the end of period 1. We assume that the distribution of the shock X is triangular with mean zero and a support ranging between $-a$ and a.[3]

The government sets taxes at the beginning of period 1, after observing i but before X realizes. Raising taxes is increasingly costly, say, because taxes are distortionary. Their level is chosen so as to minimize the loss, L, from tax costs and the expected costs of failure

$$L = \frac{1}{2}T^2 + pK$$

where T denotes taxes, p is the probability that the stabilization fails, and K is the fixed cost of failure relative to the cost of tax distortions.[4] The probability that the

[3]As it will become clear later on, only the algebra, but not the substance, of our results changes if the distribution of X were not truncated, for example if X were normally distributed.

[4]For a similar specification of the government problem in the context of exchange rate stabilization see Dornbusch (1991).

stabilization fails, i.e. that the debt, B, increases, $\Delta B = X + G + I - T > 0$, is the probability that an adverse shock to the budget, X, exceeds the planned surplus

$$p = Prob[X > T - G - I]$$

where G is the level of public spending, and I, the cost of debt service, is

$$I \equiv (1-m)i + mE_0 i$$

where the stock of debt inherited at the beginning of period 0 is normalized to 1. Thus, $(1-m)$ is the share of debt financed, at the beginning of period 0, by one-period bonds which need to be rolled-over at the interest rate, i, prevailing in period 1. m is the share of two-period bonds issued at the beginning of period 0, which bear a long-term interest rate, $E_0 i$ (equal to the forward rate).

Consider first the choice of taxes and debt maturity by a government whose determination at cutting spending is publicly known and whose program is expected to succeed. A "likely" stabilizer can be thought as being characterized either by a high cost of failure, K, relative to a^2 or by a low level of public spending in period 1: we call this level G^L. Such a government is expected to succeed in the sense that for $X = E_0 X = 0$ (and for its choice of taxes, T^*) the overall budget shows a surplus: $T^* - G^L - I > 0$ —it could fail only if hit by a "very large" realization of X.[5]

Since the planned surplus $\zeta \equiv T^* - G^L - I$ is positive, as in Figure 1, the probability of failure is lower than one half and is derived using the right-hand side of the triangular distribution of X, as

$$p = Prob[X > T - G^L - I] = \frac{1}{2a^2}(a + G^L + I - T)^2$$

Replacing p in the government loss function yields the loss that the government expects before knowing the realization of X, but after having observed period-1 interest rates and thus I:

$$L = \frac{K}{2a^2}(a + G^L + I - T)^2 + \frac{1}{2}T^2$$

Deriving L with respect to T, we obtain the optimal value of taxes:

$$T^* = \delta(a + G^L + I) \qquad where \quad 0 < \delta \equiv \frac{K}{a^2 + K} < 1$$

which is increasing in public spending and in the cost of debt service.

[5]We shall indicate in a moment the conditions on the values of the parameters K, a and G which ensure a positive planned surplus. The support of the distribution of i must also be bounded from above to rule out the possibility that the surplus turns out to be negative because of a large realization of I.

We now turn to the choice of m. Substituting T^* in the loss function and taking expectations conditional on the information at time 0, yields the expected value of the loss function, L^*, as of the beginning of period 0:

$$E_0 L^* = E_0 \frac{\delta}{2}[a + G^L + I]^2 = E_0 \frac{\delta}{2}[a + G^L + (1-m)i + mE_0 i]^2$$

Since L^* is a convex function of total spending, its expected value is minimized by setting $m = 1$: the government only issues two-period bonds. This choice mimimizes the variance of total spending by eliminating all the uncertainty related to the cost of debt servicing. In other words, the government —because on average it is successful— is unwilling to take bets on interest rates. For a given variance of period-1 interest rates, the smaller the value of m (the larger the amount of debt to be rolled over), the higher is the probability that the stabilization will fail, because a negative interest rate shock increases the probability of failure by a larger amount than a positive shock reduces it.[6]

The idea that long maturity debt helps to avoid refinancing risk and thus allows to smooth tax rates is a well established result in the literature on debt management (Barro 1995). By reducing the exposure of the government budget to interest-rate risk, long-term debt also prevents the emergence of self-fulfilling crises or speculative attacks (Calvo 1988, Alesina-Prati-Tabellini 1990 and Giavazzi-Pagano 1990). Within the present framework, the optimality of long-term debt also arises quite naturally, but for a different reason: long-term debt is optimal not only because it reduces tax distortions but because it increases the probability of success. This effect adds to the traditional argument in the stabilization literature that long-term nominal debt enlarges the inflation-tax base and thus leads to a lower equilibrium inflation in the event that the stabilization fails (Calvo-Guidotti 1990, Guidotti-Kumar 1991).

However, for our explanation to be complete, we must also show that governments with little chances to succeed find it optimal to issue short-term debt. In what follows we show that a government which expects to fail issues short-term debt: as it is unable to cut spending, its only hope is to be "saved" by a favourable shock to interest rates. We refer to such a government as the "unlikely" stabilizer and, accordingly, denote its level of spending in period 1 by G^U. The unlikely stabilizer carries out minor spending cuts; its planned surplus (its surplus in the absence of shocks) is negative, $T^* - G^U - I < 0$, so that it will not stabilize the debt except for unusually favorable realizations of X.

Why such a government would not aim at a higher level of taxes so as improve its chances of success? Within our model this happens if both the cost of failure is low relative to budget uncertainty (to the variance of X) and if the level of spending is

[6] This is because, in the region we are considering, the probability density function is downward sloping.

high. Formally, the government finds it optimal to choose a level of taxes, T^*, such that $T^* - G^U - I < 0$ if (and only if) $K < a^2$ and $G^U + I > K/a$.[7]

As in Figure 3, the critical value of X now lies to the left of the origin, i.e. $\zeta \equiv T^* - G^U - I < 0$. It follows that the probability of failure is

$$p = 1 - \frac{1}{2a^a}(a + T - G^U - I)^2$$

and that the optimal value of taxes is equal to

$$T^* = \lambda[a - G^U - I] \qquad where \quad \lambda \equiv \frac{K}{a^2 - K} > 0$$

and is decreasing in total spending. The reason why taxes fall as G^U increases is that, when the variance of the shock is large, i.e. when $a^2 > K$, the marginal benefit from an increase in taxes is relatively small, because it raises the probability of success by a relatively small amount while its marginal cost is high relative the cost of failure.

Consider now the choice of debt maturity. The loss as expected at the beginning of period 0, when the government chooses the maturity of the debt, is

$$E_0 L^* = K - \frac{\lambda}{2} E_0[a - G^U - I]^2 = K - \frac{\lambda}{2} E_0[a - G^U - (1-m)i - mE_0 i]^2$$

Since the loss function, L^*, is concave in interest payments, the expected loss is minimized by the maturity $m = 0$, which maximizes the variability of debt service. The problem has a corner solution: at the beginning of period 0 the unlikely stabilizer only issues one-period bonds.[8] Indeed, issuing short, and hoping for a favourable realization of i, is the optimal strategy for a government with little chances to succeed and low cost of failing.[9] It is "as if" the unlikely government were risk-lover; its only hope is to be saved by a large fall in interest rates.

We have suggested an explanation for why credible stabilizations are accompanied by a lengthening of debt maturity. In Section 2 we also reported evidence that the maturity of the debt tends to increase with the conditional variability of interest rates but there is nothing in our model which predicts such a behavior: maturity

---

[7]The proof of such claim is straightforward but lengthy; it requires to compare local minima obtained for alternative intervals of T; those for which the left-hand side and those for which the right-hand side of the triangular distribution of X applies. A possible complication is that interior minima may not exist because of the concavity of the loss function. Finally, to ensure that the surplus is negative for all realization of i, the support of its distribution must have a lower bound $\underline{i}$ which satisfies $G^U + \underline{i} > K/a$. (Simmetrically, the condition $G^L + \bar{i} < K/a$ on the upper bound of the distribution of i ensures that a government plans for a positive surplus even when $K < a^2$.)

[8]We do not consider the unrealistic case of $m < 0$ (and $m > 2$) where the government issues short-term bonds and invests the proceeds in private assets.

[9]This is because of the positive slope of the probability density function: a favorable shock to the budget increases the probability of success by a larger amount than a negative shock of the same magnitude reduces it.

lengthens if the stabilization is credible and shortens if it is unlikely, independently of the variance of interest rates. We also observed a significant decrease of debt maturity asssociated with high long-term interest rate. While high interest rates may reflect investors' lack of confidence in the stabilization attempt, this fact also needs to be explained. Moreover, the concept of credibility, that we referred to, can be disputed: a program may not be credible because the government resolution to carry out the announced fiscal correction is not known to private investors. In the next section we extend the analysis to allow for these effects. We present a standard reputation game whose implications for the choice of debt maturity are consistent with the empirical finding of Section 2.

4. Shortening maturity to signal the government's resolve

If private investors did not believe that the government will carry out the announced spending cuts, the interest rate on long-term bonds would be too high relative to the government's expectations of future interest rates. As stressed by Campbell (1995), in such a situation a committed government may issue short maturities in order to reduce the cost of debt servicing and, by so doing, it may signal its resolution. Since short-term debt exposes the budget to roll-over risk, the lower the variance of short-term rates and the higher the level of long-term rates, the greater the decrease in debt maturity. Only when the uncertainty as to the outcome of the stabilization is resolved and credibility is gained, the government will issue long maturity debt.

We introduce asymmetric information by assuming that the amount of spending cuts and thus the level of spending in period 1 are not known to private investors. The government can be of two types —dry or wet— depending on the level of spending in period 1. A dry government (carries out larger cuts and) has a level of spending in period 1, G^L, which is lower than the level of spending, G^H, of a wet government.

We assume that the mean of the period-1 interest rate, i, depends on the level of spending; it is low, if the level of spending will be relatively low, or high if spending will be relatively high. The model thus captures the relationship between government spending and the rate of interest implicit, for example, in a closed economy where agents have finite planning horizons. The higher interest rate faced by the wet government in period 1 may also reflect the expectation that the inability to stabilize the debt may result in inflation, or debt default. We define by $-s-$ the difference between the expected period-1 interest rate of a government recognized as wet compared with that expected by a government known to be dry. In principle, the informational spread, s, is a function of the difference in the probabilities of success of the two governments. Making s endogenous, i.e. depend on the probabilities, p's, of the two governments, would certainly desirable. However, this would prevent us from deriving analytical solutions while adding very little to the understanding of the problem. We prefer to keep the analysis simple.

The random interest rate faced by the wet government is distributed as:

$$i^W \sim (E_0 i^W;\ \sigma^2)$$

while the dry government faces

$$i^D = i^W - s \sim (E_0 i^W - s;\ \sigma^2)$$

More precisely, we assume that, except for the mean, the distributions of the interest rates are identical across governments. We also assume that $E_0 i^W - s > 0$.

The interest rate on long-term debt, $E_0 i$, reflects the investors' assessment of the government ability to cut spending. As investors are uncertain about the type of government and thus about the mean of i, the relatively tougher government will pay a premium on long maturities. A dry government may thus want to issue short-term debt since such debt is refinanced in period 1, after spending cuts are observed and thus at a lower interest rate. For such a government it is worth borrowing short and wait for period 1 when uncertainty is resolved and its type is revealed.

If high interest rates reflect expected inflation (and exchange rate devaluation), price-indexed debt and foreign currency debt can play the same role as short-term debt in avoiding the costs of asymmetric information. Such types of debt appear to provide the ideal solution to credibility problems, since –if long-term– they also limit the risk of refinancing. However, foreign currency debt exposes the government budget to exchange rate risk which may arise, say, because of foreign monetary disturbances (Bohn 1990a) and be undesirable for tax-smoothing purposes (Goldfajn 1995, Missale 1997). Price-indexed debt may also have undesirable effects on taxation (Bohn 1988,1990b) and, more importantly, it can be costly to issue until a thick and efficient market for such debt develops. The consideration of such costs, though not explicitly modelled, has motivated our treatment of price-indexed debt and foreign currency debt as short-term debt in the empirical analysis. In what follows we will accordingly refer to them as short-term debt.

We limit our analysis to the case in which both governments are, on average, successful, but (as shown in Figure 4) the sizes of the shocks which could cause them to fail, ζ^W and ζ^D, differ. Both governments are better off the smaller is the variance of interest payments, and thus prefer long maturities. However, if a dry government is not credible, it will pay a premium on long maturities. It thus has an incentive to distinguish itself from the wet type by shortening debt maturity.

We consider a class of separating equilibria whereby beliefs have the following form: for maturities shorter than or equal to m^S, the separating maturity, investors expect the government to be dry; for maturities longer than m^S they expect the government to be wet.

The wet government will reveal itself if the expected loss, when it chooses to issue only two-period bonds and is therefore identified as wet, is smaller than the expected loss when it chooses a maturity equal to (or shorter than) m^S, and is thus believed to be dry, that is, if

$$E_0 L^W(W, m=1) \leq E_0 L^W(D, m \leq m^S)$$

where the superscript indicates the government type, while the first term between parenthesis denotes investors' beliefs. This inequality reduces to

$$(1-m)^2\sigma^2 - ms[2(a + G^H + E_0 i^W) - ms] \geq 0$$

and is satisfied for

$$m \leq m^S \equiv \frac{\sigma^2 + sx - \sqrt{s^2x^2 + \sigma^2 s(2x - s)}}{\sigma^2 + s^2}$$

where $x = a + G^H + E_0 i^W$. The incentive compatibility constraint of the wet government is satisfied for maturities shorter or equal to m^S which lies in the interval $[0; 1]$ for any choice of the parameter values. The intuition for this result is as follows. A short maturity brings no benefit to a wet government, except for allowing this government to disguise itself as dry. Since by mimicking a dry government interest payments are saved only on long-term debt, such a gain disappears as the maturity shortens. By contrast, the roll-over risk increases as the maturity shortens. It follows there is always a short enough, but positive, maturity, $0 < m^S < 1$, which leads the wet government to reveal itself. Consistently with the evidence presented in Section 2, the candidate separating maturity is increasing in the variance of interest rates and decreasing in the level of the long-term interest rate. What is crucial for a separating equilibrium to exist is thus the willingness of the dry government to shorten the maturity down to m^S.

What are the options for the dry government? By choosing m^S, it signals itself as dry; otherwise it is undistinguishable from a wet type. In the latter case it chooses, in the interval $m^S < m \leq 1$, the maturity which minimizes its loss, given that it is expected to be wet. This maturity can be shorter than $m = 1$: a dry government believed to be wet issues some short-term bonds since, by doing so, it can reduce interest payments.

The dry government thus shortens the maturity to m^S, and signals its type, if the loss from doing so is smaller than the loss it experiences when it chooses a longer maturity and is therefore believed wet:

$$E_0 L^D(D, m^S) \leq E_0 L^D(W, m^S < \bar{m} \leq 1)$$

where $\bar{m}$ is the maturity which minimizes the expected loss of the dry government when it is believed wet; i.e. for maturities in the interval $m^S < \bar{m} \leq 1$. The incentive compatibility constraint of the dry government is satisfied if

$$(1-m^S)^2\sigma^2 \leq (1-\bar{m})^2\sigma^2 + \bar{m}^2 s^2 + 2\bar{m}s(z-s)$$

where $z = a + G^L + E_0 i^W$. This condition shows that the dry government shortens the maturity of the debt to signal its type if the cost of being perceived as wet —i.e. the informational spread s— is high relative to the roll-over risk, σ^2. If this were not the case, the dry government would prefer to issue long-maturity debt and pay the higher interest rate.

An intuitive sufficient condition for a separating equilibrium is[10]

$$\sigma^2 \leq s(a + G^L + E_0 i^W - s)\left(1 + \frac{a + G^L + E_0 i^W}{2(a + G^H + E_0 i^W) - s}\right)$$

where the right-hand-side is increasing in s.[11]

Necessary conditions on the values of σ^2 and s for a separating equilibrium to exist, have been found by the help of numerical simulations, but are not reported for reason of space. Results confirm that σ^2 cannot be too large relative to s —otherwise the dry government would prefer not to reveal itself, and limit the roll-over risk by issuing a larger amount of long-term debt.

In cases where separating equilibria do not exist, i.e. when the roll-over risk is high relative to the informational spread, pooling equilibria, where both governments choose the same maturity, may exist. In the next Section we show that in a pooling equilibrium debt maturity is always longer than in a separating equilibrium. Although the problem of multiple equilibria cannot be avoided, we can still show that the pooling maturity, as the separating one, is increasing in the variance of interest-rate shocks and decreasing in the informational spread.

4.1 High risk and low spread: pooling equilibria

We have shown that a committed government may issue short-term debt to reduce the expected cost of debt servicing and to signal its resolution to carry out the stabilization program. Consistently with the evidence presented in Section 2, the separating maturity is increasing in the variance of interest rates and decreasing in the

[10]The math is as follows. Since for any given maturity the expected loss is lower when the government is believed dry than when it is believed wet, the above inequality is satisfied for $m = m^S$. Then, noting that the loss from being believed dry is decreasing in maturity, a sufficient condition, for such inequality to be satisfied, is that the loss from being believed wet is increasing in m for maturities longer than m^S (i.e. that $(1-m)^2(\sigma^2+s^2) - (1-m)2sz$ be increasing over the interval $[m^S; 1]$). Since such a loss is a second order polinomial in m, this is always the case if the unconstrained minimum, m^M is lower than m^S. The unconstrained minimum is $m^M = (\sigma^2 - s(z-s))/(\sigma^2+s^2)$

[11]Provided that $a + G^L + E_0 i^W > 2s$, that we can safely assume.

long-term interest rate. However, separating equilibria do not exist when the informational spread is small relative to the roll-over risk. In this section we ask if, under these circumstances, pooling equilibria exist, in which both governments choose the same maturity.

We assume that agents have prior beliefs on the government they face: they expect it to be dry with probability q, and wet with probability $(1-q)$, so that, in a pooling equilibrium, the forward rate is equal to

$$E_0 i^P = q(E_0 i^W - s) + (1-q)E_0 i^W = E_0 i^W - qs$$

where $E_0 i^P$ is decreasing in the government reputation q, and in the informational spread s.

Consider first the maturities which minimize the loss functions of the two governments given pooling expectations —more precisely, given that interest rates on long-term debt are as in a pooling equilibrium: $E_0 i^W - qs$. Clearly, the wet government prefers the longest possible maturity, $m = 1$, since with short-term debt it would pay a higher interest rate when such debt is refinanced and would be exposed to roll-over risk. More generally, the loss of the wet government is decreasing in debt maturity. On the contrary, the dry government finds it optimal to issue some short-term debt, even in the absence of signalling effects, since such debt is refinanced after spending cuts are observed and, thus, at a lower interest rate. The maturity, m^D, which minimizes its loss function, given that interest rate on long-term debt are as in a pooling equilibrium, is equal to

$$m^D = \frac{\sigma^2 - s(1-q)(z-s)}{\sigma^2 + s^2(1-q)^2}$$

It is then clear that a pooling equilibrium cannot be supported by pooling expectations for maturities longer than m^D. If this were not the case, the wet government would choose a longer maturity than the dry government, and a pooling equilibrium would not exist.

Therefore, looking for expectations which can sustain a pooling equilibrium, the candidate assumption is that the government is believed to be wet whenever it chooses a maturity longer than m^D. Then, it is easy to show that a pooling equilibrium, where both governments choose the same maturity, m^D, exists and is sustained by such expectations, if m^D satisfies the incentive compatibility constraint of the wet government:

$$E_0 L^W(Pooling,\, m^D) \leq E_0 L^W(W,\, m = 1)$$

which is satisfied if

$$(1-m^D)^2\sigma^2 - m^D qs[2(a + G^H + E_0 i^W) - m^D qs] < 0$$

i.e. for

$$m^D > m^W \equiv \frac{\sigma^2 + sqx - \sqrt{s^2q^2x^2 + \sigma^2 sq(2x - sq)}}{\sigma^2 + s^2q^2}$$

For a wet government the pooling maturity, m^D, must be sufficiently long to insulate the budget from roll-over risk and produce a substantial reduction in interest costs.

The incentive compatibility constraint of the dry government is also verified for $m^D > m^W$. This follows from the fact that m^D minimizes the loss of the dry government given pooling expectations and, for any given maturity, such loss is always smaller than the loss it experiences when is believed to be wet.

Writing the condition $m^D > m^W$ as

$$\frac{\sigma^2 - s(1-q)(z-s)}{\sigma^2 + s^2(1-q)^2} > \frac{\sigma^2 + sqx - \sqrt{s^2q^2x^2 + \sigma^2 sq(2x - sq)}}{\sigma^2 + s^2q^2}$$

shows that for a sufficiently high initial reputation, q, a pooling equilibrium exists in which both governments choose m^D. Intuitively, the maturity, m^D, which represents the optimal trade-off for a dry government between risk and interest costs, increases in reputation, since a better reputation means a lower informational premium. On the other hand, the maturity m^W, which leaves the wet government indifferent, decreases in reputation, since long-term debt becomes relatively cheaper and, hence, a lower share of it is needed to offset the same roll-over risk.

Obviously, other pooling equilibria exist when $m^D > m^W$. Any maturity m^P, such that $m^W < m^P < m^D$ can also be sustained as a pooling equilibrium by the expectation that the government is wet when a maturity longer than m^P is chosen, provided that m^P satisfies the incentive compatibility constraint of the dry government. Formally, the loss from choosing the pooling maturity, m^P, must be is smaller than the loss a dry government obtains by choosing the maturity, m^M, and being believed wet:

$$E_0 L^D(Pooling,\ m^P) < E_0 L^D(W,\ m^M)$$

where m^M is the maturity which minimizes the loss of the dry government when it is believed wet —and which, for the reason explained above, could be smaller than 1.

This condition is verified for

$$(m^P)^2[\sigma^2 + s^2(1-q)^2] - 2m^P[\sigma^2 - s(1-q)(z-s)] + m^M[\sigma^2 - s(z-s)] < 0$$

which requires a sufficiently high initial reputation q.[12]

[12]When $m^D < m^W$, i.e. when reputation is low, a pooling equilibrium, where both governments choose m^W, could also exist, if the incentive compatibility constraints of the dry government were satisfied with $m^P = m^W$. However, such an equilibrium would have to be sustained by the expectations that the government is wet whenever a maturity different from m^W is chosen. This is because a dry government, unlike a wet one, would never choose a maturity longer than m^W (and

Parameter values for which the above conditions hold cannot be obtained analitically. However, two important points can still be made without the need of numerical simulations. First, the maturities m^S, m^W and m^D —and thus any pooling maturity— are all increasing in the variance of period-1 interest rates, σ^2, and decreasing in the informational spread, s. Second, if a pooling equilibrium exists, the corresponding maturity is longer than the maturity m^S which would induce the wet government to reveal itself. This follows by noting that m^S is implicitly defined by $(m^S)^2(\sigma^2 + s^2) - 2ms(\sigma^2 + sx) + \sigma^2 = 0$. Substituting the value of m^S in the loss differential of the wet government yields:

$$E_0 L^W(Pooling,\ m^S) - E_0 L^W(W,\ m = 1) = m^S s(1 - q)[2x - (1 + q)m^S s] > 0$$

which shows that m^S does not satisfies the incentive compatibility constraint of the wet government and therefore that $m^S < m^W$.

Therefore, when the roll-over risk, σ^2, is high relative to the informational spread, s, so that a separating equilibrium does not exist, the dry government prefers to issue long-maturity debt and incur the higher interest rate. In the resulting pooling equilibrium, debt maturity is always longer than in any separating equilibrium arising for lower values of σ^2 relative to s.

5. Conclusions

This paper provides evidence on the behavior of public debt managers at the start of fiscal stabilizations. Such episodes are clear instances in which interest rates on long-term bonds may be uduly high because of the lack of confidence in the stabilization program by private investors. This is a clear case where the informational advantage of the authorities makes it possible to minimize the cost of debt servicing by issuing short maturity or foreign currency or variable-rate debt.

We find that governments, at the start of a stabilization, tend to issue a larger share of short maturity debt the less credible is the program, and the lower is the roll-over risk. Building on earlier ideas in the literature, and integrating optimal taxation and asymmetric information, we develop a model of debt management which highlights the role of the government's credibility and the risk associated with rolling over short maturity debt.

We show that the debt issuing strategy that is observed in reality can be consistent with optimal debt management. While this conclusion hinges upon the hypothesis

it would always choose a maturity shorter than m^W). Since such an equilibrium must be sustained by the expectations that the government is wet except for the choice of a single specific maturity, its relevance is questionable. Under the same conditions other pooling equilibria with maturities longer than m^W may exist but they all are characterized by pooling expectations holding for one single maturity.

of asymmetric information between the government and private investors, we find that the attempt to confront theory with the actual behavior of debt managers is promising. There is certainly a case for extending our work allowing for a more accurate matching between stabilization announcements and debt issuing decisions. We see this as the next step in our research project, which would, however, require moving from a cross-country analysis to case studies of fiscal stabilizations.

References

Alesina, Alberto, Alessandro Prati and Guido Tabellini, "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, 1990.

Barro, Robert J., "Optimal Debt Management", NBER Working Paper No. 5327, October 1995.

Bohn, Henning, "Why Do We Have Nominal Government Debt?," *Journal of Monetary Economics*, 1988, 21, 127-40.

Bohn, Henning, "A Positive Theory of Foreign Currency Debt," *Journal of International Economics*, 1990a, 29, 273-92.

Bohn, Henning, "Tax Smoothing with Financial Instruments," *American Economic Review*, 1990a, 80(5), 1217-30.

Calvo, Guillermo A., "Servicing the Public Debt: the Role of Expectations," *American Economic Review*, 1988, 78(4), 647-61.

Calvo, Guillermo A. and Pablo E. Guidotti, "Indexation and Maturity of Government Bonds: An Exploratory Model," in R. Dornbusch and M. Draghi, eds., *Public Debt Management: Theory and History* (52-93). Cambridge: Cambridge University Press, 1990a.

Calvo, Guillermo A. and Pablo E. Guidotti, "Credibility and Nominal Debt," *IMF Staff Papers* 37, September 1990b, 612-35.

Campbell, John Y., "Some Lessons from the Yield Curve", *Journal of Economic Perspectives*, Summer 1995, 9, 129-152.

Dornbusch, Rudiger, "Credibility and Stabilization", *Quarterly Journal of Economics*, August 1991, Vol. CVI, No.426, 837-850.

Giavazzi, Francesco and Marco Pagano, "Confidence Crises and Public Debt Management," in R. Dornbusch and M. Draghi, eds., *Public Debt Management: Theory and History* (94-124). Cambridge: Cambridge University Press, 1990.

Goldfajn, Ilan, "On Public Debt Indexation and Denomination," Brandeis University Working Paper No.345, 1995.

Guidotti, Pablo E. and Manmohan S. Kumar, "Domestic Public Debt of Externally Indebted Countries," *IMF Occasional Paper* No.80, June 1991.

H.M. Treasury and Bank of England, "Report of the Debt Management Review," London: The Publishing Unit, HM Treasury, July 1995.

Missale, Alessandro, "Tax Smoothing with Price Indexed Bonds: A Case Study of Italy and the United Kingdom," in M. De Cecco, L. Pecchi and G. Piga, eds., *Managing Public Debt: Index-Linked Bonds in Theory and Practice* (50-92). Cheltenham: Edward Elgar, 1997.

Missale, Alessandro and Olivier J. Blanchard, "The Debt Burden and Debt Maturity", *American Economic Review*, March 1994, 84, 309-19.

Data Sources and Definitions

Data on the composition by instrument of public debts are from national sources. Usually they refer to the Central Government debt, but the rule is amended in a few cases when data were available only for the General Government. Since for some countries the composition of debt holdings of the monetary authorities is not available we use a definition of debt which includes Central Bank holdings, a part from credit lines.

Long-term debt is defined as the sum of fixed-rate bonds and loans denominated in the domestic currency with an initial term to maturity longer than 2 years. Choosing a cut-off maturity of 2 years, instead of 1 year, allows to consider 2-year Treasury Notes issued in Denmark and Germany and 18-months Treasury Bills for Spain as short-term debt. (Austrian Treasury Bills can be extended after the initial 1-year maturity but the interest rate becomes variable.)

Hence, bonds and loans denominated in foreign currency and debt bearing coupons indexed to interest rates, to the price level or to the ECU exchange rate, have been considered as short-term. The only exception to this criterium is Finland where information on the share of variable rate debt (now about 15% of the total) is not available. (Long-term Spanish loans of the 1970s have been considered as short debt, since they were placed with the local banks at below-market interest rates.)

Extendable bonds and bonds with an option for early redemption (such as those issued in Belgium and Italy) have been considered as long-term debt if the period preceding the earliest possible maturity is longer than 2 years. Bonds bearing the option to convert from fixed-rate to variable-rate coupons (as those issued in France in the early 1980s) have been considered as fixed-rate debt since the option is not exercised in case of falling interest rates.

Data on primary structural surpluses as a percentage of actual GDP have been computed by normalizing structural balances (defined in terms of potential GDP) and subtracting interest payments as a percentage of actual GDP. (The latter are obtained as the difference between overall financial surpluses and the corresponding primary surpluses). For the most recent period these data are published in the OECD *Economic Outlook.* Revised series of the above variables starting in 1970s have been kindly provided by Alexandra Bibbe of the OECD Economics Department, Public Economics Division.

Long-term interest rates refer to secondary market yields to maturity of benchmark long-term government bonds, while short-term interest rates refer to 3-month interbank rates since interest rates on Treasury bills are not always available.

Yearly data on short- and long-term interest ratesare from OECD, *Economic Outlook.* Quarterly data on short- and long-term interest rates are from OECD *Main Economic Indicators* and, when the OECD series is not available, from IMF *International Financial Statistics.* The ratio of gross public debt to GDP is from OECD, *Economic Outlook.*

Table 1: Fiscal Stabilizations

Episode	Cumulative change in structural budget	change in share of long debt y(t+1)-y(t-1)	St.Err/Mean short rate y(t-1)	Long interest rate year(t-1)	Decrease in Long Spread y(t-1)-y(t)	Debt-GDP ratio year(t-1)	Share of long-term debt year(t-1)
Finland 75-76	3.7	-10.0	0.03	8.79	-2.59	0.08	57.0
Sweden 75-76	2.7	-1.0	0.21	8.04	-2.76	0.30	90.7
Italy 76-77	4.2	0.6	0.21	10.04	-3.26	0.58	36.8
USA 76-79	2.4	6.0	0.15	7.99	-0.26	0.40	35.1
Germany 76-77	1.7	1.4	0.19	8.68	0.00	0.25	83.3
France 76	1.2	-2.0	0.15	10.31	-0.84	0.30	16.3
Australia 77	2.7	-12.6	0.11	10.18	-1.61	0.25	70.1
Austria 77-78	2.0	2.6	0.02	8.75	-1.49	0.27	53.9
UK 77	1.6	3.7	0.16	13.61	0.07	0.60	73.4
Belgium 77	1.3	-1.2	0.22	9.09	-1.18	0.59	80.2
Netherl. 77	1.0	-1.0	0.33	8.95	-0.66	0.41	89.7
Japan 79-87	7.8	5.7	0.13	6.37	-0.51	0.40	70.0
UK 79-82	5.8	3.1	0.18	12.06	0.57	0.57	77.2
Canada 79-81	3.3	9.3	0.12	9.27	0.51	0.46	39.8
France 79-80	2.5	12.9	0.13	10.61	1.21	0.31	15.2
Spain 79	1.0	6.0	0.43	11.88	0.03	0.14	15.3
Germany 80-85	5.4	4.7	0.22	7.58	0.00	0.31	87.2
Australia 80-82	3.2	1.7	0.07	9.76	-1.02	0.25	56.1
Austria 80-81	2.3	-14.3	0.02	7.96	-0.49	0.36	60.6
Italy 80	1.7	-9.0	0.19	13.02	-1.36	0.61	30.4
Netherl. 81-83	2.7	4.9	0.31	10.18	0.34	0.47	92.8
Finland 81	1.3	-4.6	0.12	10.42	1.11	0.14	42.2
Belgium 82-87	10.0	-6.6	0.20	13.44	-1.17	0.93	55.1
Ireland 82-83	6.5	-5.8	0.16	17.27	-0.97	0.76	44.7
Italy 82-83	3.7	-9.2	0.14	19.36	-2.04	0.60	21.4
Denmark 83-86	12.2	8.4	0.18	21.36	5.42	0.67	58.9
France 83-87	3.4	1.4	0.11	16.00	0.76	0.34	30.1
Sweden 83-84	2.2	-4.4	0.12	13.29	-0.13	0.62	59.2
Spain 83-84	1.3	-13.8	0.18	15.99	-1.79	0.30	24.5
Portugal 84-86	8.5	-2.9	0.14	26.55	-3.29	0.50	7.1
Finland 84	2.4	-1.9	0.09	10.76	-0.46	0.18	43.0
Austria 84	2.2	-1.0	0.02	8.17	0.06	0.47	41.9
Australia 85-89	3.7	-5.9	0.07	13.55	-1.33	0.25	64.5
Netherls 85	1.2	-0.3	0.19	8.10	-0.16	0.67	98.8
Ireland 86-89	8.7	6.9	0.08	12.64	0.71	1.04	40.9
Sweden 86-87	5.6	3.2	0.10	13.24	1.83	0.67	49.8
Canada 86-90	3.2	1.0	0.17	11.11	0.70	0.65	40.2
Spain 86-87	2.0	11.7	0.11	13.37	1.13	0.51	11.7
Italy 86	1.2	3.0	0.05	13.71	1.37	0.82	11.0

Table 1 Cont'd: Fiscal Stabilizations

Episode	Cumulative change in structural budget	change in share of long debt y(t+1)-y(t-1)	St.Err/Mean short rate y(t-1)	Long interest rate year(t-1)	Decrease in Long Spread y(t-1)-y(t)	Debt-GDP ratio year(t-1)	Share of long-term debt year(t-1)
Netherl. 87-88	1.6	0.1	0.14	6.32	0.00	0.74	93.5
USA 87-89	1.1	-0.2	0.16	7.68	-0.63	0.51	53.6
Finland 88-89	2.4	10.6	0.08	7.91	-2.15	0.20	45.8
UK 88-90	2.4	-10.6	0.11	9.59	0.15	0.56	68.6
Italy 88-89	1.1	5.5	0.07	10.64	-0.01	0.91	14.0
Germany 89	1.7	-2.2	0.10	6.48	0.00	0.44	93.8
Sweden 89	1.1	-6.3	0.11	11.35	0.71	0.53	51.6
Spain 91-96	5.8	7.7	0.10	14.59	1.45	0.50	28.9
Netherl. 91	2.8	0.7	0.11	8.92	-0.14	0.79	98.7
Ireland 91-94	2.7	1.5	0.15	10.08	0.60	0.97	40.7
Italy 91	1.5	4.7	0.09	13.54	0.08	1.06	18.5
Belgium 92-96	4.2	2.7	0.09	9.31	0.05	1.30	59.4
Germany 92-94	2.9	-3.6	0.09	8.51	0.00	0.41	92.4
Portugal 92	2.8	8.0	0.08	21.28	0.05	0.70	7.9
Austria 92	1.4	2.5	0.06	8.61	-0.25	0.59	48.7
Canada 93-96	5.0	4.0	0.12	8.76	-0.54	0.88	46.1
Italy 93	3.8	12.1	0.11	13.71	0.98	1.17	24.5
USA 93-96	2.8	0.8	0.08	7.01	-0.29	0.60	49.9
Netherl. 93	2.0	-1.3	0.08	8.10	0.32	0.80	99.5
Finland 93-94	1.8	3.5	0.11	12.07	2.42	0.46	30.9
Sweden 94-96	8.4	8.1	0.12	8.54	-0.50	0.76	43.9
UK 94-96	2.8	-1.4	0.11	7.47	-0.24	0.57	61.0
Portugal 94-96	2.0	5.0	0.07	17.70	0.87	0.68	15.9

Table 2

Fiscal Stabilizations and Debt Maturity: The Evidence

Episodes of Lengthening and Shortening Maturity: Simple Means

	Long Mat	Short Mat	Credible	Not Cred.
Observations	36	26	30	32
Change in Share of Fix-rate Long Debt	4.9	-5.1	3.2	-1.7
Standard Error of Short Rates	0.13	0.13	0.13	0.13
Long Interest Rate	11.31	11.24	12.0	10.6
Fall in Long Rate Spread	0.29	-0.82	0.78	-1.06
Fiscal Adjustment	3.61	2.83	3.28	3.28
Debt-to-GDP ratio	0.61	0.46	0.60	0.51
Initial Share of Long Debt	45.7	58.3	48.1	53.8

Table 3

Cross Sections of Stabilization Episodes
t-statistics in parenthesis

	Full Sample	Full Sample	≤ 2.5	> 2.5
Number of Observations	N=62	N=62	N=31	N=31
Adjusted R^2	0.28	0.27	0.10	0.44
Jarque-Bera p-value	1.36 (0.51)	0.81 (0.67)	0.29 (0.84)	3.52 (0.17)
Mean of Dependent Variable Change in share of fix-rate long-term debt	0.69	0.69	0.17	1.21
Constant	6.83* (1.77)	6.36 (1.65)	12.52 (1.68)	10.36* (1.82)
Standard error of short rates	14.80 (1.49)	17.34* (1.71)	14.24 (0.98)	24.49 (1.54)
Long interest rate	-0.46** (-2.17)	-0.42** (-2.01)	-0.97* (-1.72)	-0.52** (-2.25)
Fall in long rate spread	1.99** (3.82)	1.93** (3.68)	1.81 (1.45)	2.31** (4.31)
Debt-GDP ratio	3.89 (1.41)	2.27 (0.73)	4.49 (0.80)	1.81 (0.55)
Initial share of long debt	-0.09** (-2.87)	-0.09** (-2.81)	-0.12** (-2.30)	-0.12** -2.39
Dummy 90		2.12 (1.14)		

Table 4

Specification with Slope of Yield Curve

Sample: Episodes with correction greater or equal to 2.0%
t-statistics in parenthesis

			Yield Curve	
	≥ 2.0	2 years	Full Sample	≥ 2.0
Number of Observations	N=43	N=36	N=62	N=43
Adjusted R^2	0.39	0.40	0.34	0.40
Jarque-Bera p-value	1.35 (0.51)	2.58 (0.27)	0.19 (0.91)	1.34 (0.51)
Mean of Dependent Variable Change in share of fix-rate long-term debt	1.23	1.36	0.69	1.23
Constant	12.95** (2.88)	16.75** (3.48)	8.47** (2.27)	13.53** (3.00)
Standard error of short rates	35.06** (2.31)	41.67** (2.62)	11.91 (1.17)	34.37** (2.26)
Long interest rate	-0.62** (-2.70)	-0.74** (-3.13)	-0.54** (-2.54)	-0.68** -(2.85)
Fall in long rate spread	2.14** (3.75)	2.14** (3.83)	1.95** (3.90)	2.19** (3.75)
Debt-GDP ratio	-0.59 (-0.18)	-3.95 (-1.10)	3.18 (1.19)	-0.22 (-0.70)
Initial share of long debt	-0.16** (-3.90)	-0.18** (-3.77)	-0.09** (-3.01)	-0.15** (-3.57)
Yield Slope			0.71* (1.94)	0.47 (0.97)
Decrease in Yield Slope			-1.11** (-2.45)	-0.90 (-1.52)

Table 5

Instrumental Variable Regressions

Sample: Episodes with correction greater or equal to 2.0%
t-statistics in parenthesis

	Instrumental Variables			
	Full Sample	$\geq$ 2.0	Full Sample	$\geq$ 2.0
Number of Observations	N=62	N=43	N=62	N=43
Adjusted R^2	0.08	0.28	0.12	0.21
Jarque-Bera p-value	1.68 (0.44)	0.23 (0.89)	2.51 (0.28)	0.51 (0.77)
Mean of Dependent Variable Change in share of fix-rate long-term debt	0.69	1.23	0.69	1.23
Constant	9.29** (2.01)	15.68** (2.99)	9.39** (2.08)	15.58** (2.79)
Standard error of short rates	15.72 (1.41)	35.98** (2.19)	18.46 (1.49)	36.39* (2.08)
Long interest rate	-0.52** (-2.17)	-0.69** (-2.72)	-0.58** (-2.36)	-0.69** -(2.51)
Fall in long rate spread	3.99** (2.78)	3.58** (3.00)	3.67** (2.68)	3.60** (2.63)
Debt-GDP ratio	1.37 (0.38)	-1.82 (-0.46)	1.83 (0.54)	-1.64 (-0.38)
Initial share of long-term debt	-0.09** (-2.61)	-0.17** (-3.72)	-0.10** (-2.77)	-0.17** (-3.42)
Yield Slope			0.36 (0.77)	-0.07 (-0.13)
Decrease in Yield Slope			0.02 (0.02)	0.23 (0.20)

Hausman Test for Specification without yield slope
Full Sample: t=1.742 (P.value=0.087) — Restricted Sample t=1.547 (P.value=0.131)

FIGURE 1 TIMING

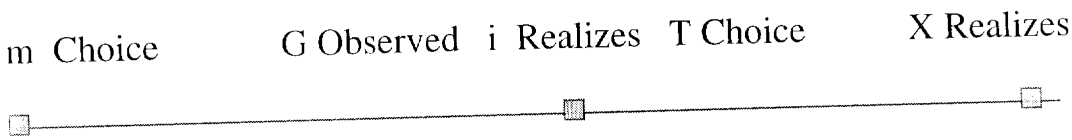

FIGURE 2

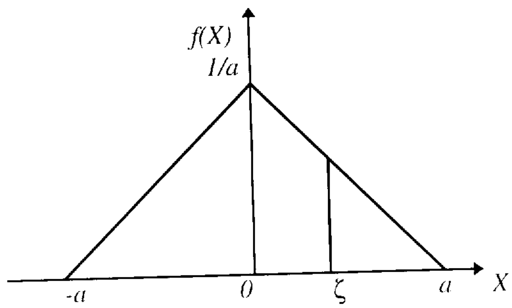

FIGURE 3

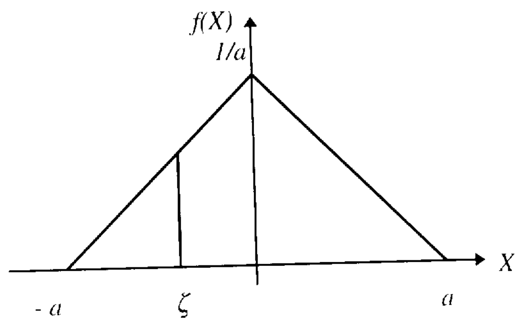

FIGURE 4