Sovereign debt management and fiscal vulnerabilities

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Abstract

A wide consensus has emerged on the role of debt management in reducing fiscal vulnerability by providing insurance against macroeconomic shocks to the government budget. Whether this goal is better accomplished by nominal or inflation-indexed debt, by a short or a long maturity structure, remains however controversial. In this paper we review the issues of indexation and debt maturity, discussing in particular the role of the maturity structure in light of integrated financial markets and the risk of default. We argue that the role of inflation-indexed debt as a hedge against demand and inflation shocks is less important when price stability is ensured by a Ricardian fiscal policy and an independent central bank. A strong case can instead be made for a long maturity structure to reduce interest-rate risk and, more importantly, the risk of default. The maturity of the debt is a key variable to assess the vulnerability of the government fiscal position and should deserve greater attention in debt sustainability analysis. Finally, we compare the theory of fiscal insurance to the debt managers' practice of minimizing the cost and risk of the interest expenditure. A concern for the cost of debt service is justified only if expected return differentials between debt instruments are determined by mispricing, market imperfections or liquidity, but not if higher risk premia reflect a fair price for insurance. Our analysis points to the danger of minimizing the interest expenditure over a short horizon as may happen in times of crisis, when the government strives to achieve budget balance. More generally, fiscal insurance cannot be evaluated using national accounts figures, such as the interest expenditure and the book value of the debt. The lack of a more theory-based accounting framework is indeed a major obstacle to optimal debt management.

Keywords: Debt management, default risk, inflation-indexed debt, maturity structure, interest-rate risk, optimal taxation

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1. Introduction

How should the debt be managed? Twenty years ago, the literature on debt management was small, made of few, important but unrelated contributions.[2] Certainly, there was no unique answer to what the objectives of debt management should be.

A wide consensus has now emerged on the role of debt management in reducing fiscal vulnerability by providing insurance against macroeconomic shocks to the government budget. The debt should be managed to make the fiscal position resilient to shocks and thus avoid the risk of having to adjust tax rates or cut government programmes (Bohn 1988, 1990, Missale 1997, 1999).

Faraglia, Marcet and Scott (2008) have named this approach "the fiscal insurance theory" of debt management. While this approach is not new, as it is rooted in the optimal taxation theory, fiscal insurance is a better term to encompass the potential goals of debt management. Indeed, as called for by optimal taxation, a debt structure that provides a hedge against shocks to the budget allows policy makers to minimize variations in tax rates and thus the welfare losses of tax distortions. But, the insurance that the debt structure can offer is not only valuable for tax smoothing; it helps achieve other important objectives of fiscal policy. For instance, by stabilizing the debt-to-GDP ratio, fiscal insurance enhances debt sustainability (Lloyd-Ellis and Zhu 2001, Borenzstein and Mauro 2004, Giavazzi and Missale 2005). The immunizing debt structure also works as an automatic stabilizer: it avoids higher tax rates in bad times, thus preventing taxation from being pro-cyclical, consistent with the Keynesian view of fiscal policy. Finally, as insurance is provided by debt holders to taxpayers, the debt-tax scheme implements an allocation of risk that appears desirable in that debt holders are in a better position to withstand risk, if anything because taxes are compulsory while debt holdings are voluntary (Missale 1999).

It is then clear that debt management is crucial for fiscal policy to attain important macroeconomic objectives and thus cannot be confined to portfolio optimization, which is often the focus of Debt Management Offices. Indeed, according to the theory of fiscal insurance, debt management is inseparable from fiscal policy in that the debt structure affects the distribution of tax rates over time and across states of nature.

Although the optimal taxation literature has increasingly focused on the role of debt maturity in real economies where governments are able to commit to a sustainable path of future taxes, earlier studies dealing with the time inconsistency of taxation also addressed the interaction between debt management and monetary policy. In a closed economy without capital, Lucas and Stokey (1983) showed that – without a proper maturity structure – intertemporal tax changes, by altering the equilibrium allocation of consumption, could affect real interest rates and thus the value of the debt. They also showed that, in a monetary economy, the inability to commit to a future tax plan even prevents the government from issuing nominal debt because of the incentive to wipe out its real value with a price level jump so as to dispose of distortionary taxation. The sustainability of fiscal policy, ie the government's ability to commit to a credible path of future surpluses, is indeed crucial for monetary policy to control inflation and nominal interest rates. As emphasized by the "fiscal theory of the price level", if fiscal policy is Non-Ricardian, the price level and nominal interest rates are determined by the expected primary surpluses, the level of nominal debt (Leeper 1991, Woodford 1994, 1995) and its maturity structure (Cochrane 2001).

The denomination and maturity of public debt may also alter the incentives faced by the monetary authority. Because of inflationary temptations, domestic currency -nominal- debt

[2] Earlier contributions include Tobin (1963), Fischer (1983), Lucas and Stokey (1983), Bohn (1988) and are surveyed in Missale (1997).

may lead to inflationary expectations and thus higher nominal interest rates as first shown by Calvo (1988). Then, foreign currency debt or short maturities are needed to restore the credibility of the anti-inflationary policy (Missale and Blanchard 1994).

The time-consistency literature has provided the theoretical underpinning for the decision to delegate monetary policy to independent central banks with a clear mandate for price stability since the mid-1980s in advanced economies and, more recently, in emerging countries. The effective independence of monetary policy was then supported by pledges of fiscal responsibility, as witnessed by the adoption of fiscal rules in many countries. In turn, central bank independence was instrumental in shifting the debt composition to domestic currency fixed-rate debt and lengthening its maturity structure as shown by Falcetti and Missale (2002).

The separation of debt management from monetary policy was also favoured by the removal of capital controls and financial liberalization. As interest rates had been determined in internationally integrated financial markets with no role, if any before, for changes in the relative supply of domestic securities, the coordination of debt management and monetary policy was considered not an issue anymore.

The separation of debt management from monetary policy worked well and remained undisputed until the global financial crisis, when we entered a new era of fiscal dominance as argued by Turner (2011) and Blommestein and Turner (2012).

Research on debt management over the last decade has been influenced by monetary policy independence (and its ability to control inflation) in that the optimal debt composition for fiscal insurance has been investigated within real economies (with no distinction between real and nominal bonds) under sustainable debt paths guaranteed by the assumption of debt limits or expected primary surpluses satisfying the No-Ponzi game condition. On the other hand, financial integration and the increasing importance of global factors in determining long-term interest rates have not been accounted for by models that remained focused on closed economies. Another serious obstacle for the implementation of fiscal insurance is that economic theory and practical policy refer to different concepts. Indeed, theory and policy speak different languages: while the former focuses on the market value of the debt and rates of return, policy makers are concerned with national accounting figures; the book value of the debt and the interest payments (Hall and Sargent 2011).

It is then not surprising that the fiscal insurance approach still offers a limited guidance to policy makers. Based on sound economic principles, fiscal insurance provides general prescriptions but offers no precise indication regarding the type of bonds to be issued and their maturity. While the benefits of fiscal insurance are undisputed, whether this goal is better accomplished by nominal or inflation-indexed debt, by a short or a long maturity structure, remains controversial.

In the first part of this paper we review the issues of price indexation and debt maturity, discussing in particular the choice of the maturity structure in light of integrated financial markets and the risk of default. We argue that the role of inflation-indexed debt as a hedge against demand shocks or inflation shocks loses much of its importance if price stability is ensured by a Ricardian fiscal policy and an independent central bank. A strong case for long maturity debt can instead be made to reduce interest-rate risk and, more importantly, the risk of default when a Non-Ricardian policy regime is entered into due to a sudden shift in expectations driven by market sentiment.

In the second part of the paper, we relate the fiscal insurance theory to policy practice, discuss their different objectives and examine whether they can be reconciled. In particular, we compare the policy implications from fiscal insurance with the debt managers' practice of minimizing the cost and risk of the interest expenditure. We find that a trade-off between cost and risk emerges only if expected return differentials are determined by mispricing, market imperfections and liquidity, but not when higher risk premia reflect a fair price for insurance. Our analysis points to the danger of minimizing the costs and risks of the interest expenditure

over a short time horizon. The excessive role played by current deficits in the evaluation of fiscal performance and in fiscal rules may lead to suboptimal debt strategies in times of crisis, when the government strives to achieve budget balance. Fiscal insurance cannot be evaluated on the basis of national accounts figures, such as the interest expenditure and the book value of the debt. The lack of a more theory-based accounting framework is indeed a major obstacle to optimal debt management.

The paper is organized as follows. After this Introduction, Section 2 deals with the absence of explicitly contingent debt. Section 3 reviews the main arguments for and against inflation-indexed debt. Section 4 investigates the role of debt maturity in providing insurance against macroeconomic shocks and the risk of default. Section 5 examines how the debt is managed in practice and whether it is managed in a way consistent with fiscal insurance. Section 6 concludes.

2. The fiscal insurance theory of debt management

A wide consensus has emerged on the role of debt management in reducing fiscal vulnerability by providing insurance against macroeconomic shocks affecting the government budget. The idea of fiscal insurance is innate in the theory of optimal taxation, in that a debt structure that provides a hedge against macroeconomic shocks to the budget can support a relatively constant tax rate over time and across states of nature. "Tax smoothing" is desirable because it allows policy makers to reduce the welfare losses from tax distortions under realistic assumptions about the elasticity of labour supply and other tax bases (Chari, Christiano and Kehoe 1994).

To reduce fiscal vulnerability, and thus the risk of having to adjust tax rates or cut spending programmes, the government should issue debt instruments with returns that covary negatively with government consumption and positively with the tax base, say, output and aggregate consumption. As first shown by Lucas and Stokey (1983), with complete markets this can be accomplished by issuing debt instruments that are explicitly contingent on the shocks affecting the government budget, for instance by issuing debt negatively indexed to expenditure shocks and/or positively indexed to output (Shiller 1993, Barro 1995, Borenzstein and Mauro 2004).

2.1 Explicitly contingent debt: why does it not exist?

Economic recessions and government spending shocks due, for example, to natural disasters are main sources of fiscal vulnerability. The lack of insurance against such events is, at first glance, puzzling. Why do governments not issue bonds explicitly contingent on their spending or GDP? Moral hazard is the obvious answer for the absence of spending indexation (Bohn 1990, Calvo and Guidotti 1990). The lack of GDP-indexed bonds cannot instead be explained by adverse incentive effects, and deserves further discussion.[3]

Issuance of GDP-indexed bonds runs into various difficulties. A first problem is the delay with which estimates of GDP become available and their later, sometimes substantial, revisions. A second problem regards the complexity of the instrument that makes its pricing a difficult business. When liquidity is added to the list, it becomes immediately evident why governments have not even considered the introduction of such bonds. In fact, the cost of innovating might be substantial. Among the few experiments with GDP indexation it is worth

[3] GDP-indexed bonds have been advocated, among others, by Shiller (1993), Borenzstein and Mauro (2004), Griffith-Jones and Sharma (2006), Kamstra and Shiller (2010).

recalling the offer of GDP warrants on the restructured Argentine debt in 2005. Since the warrant was barely valued at the time of issuance, while GDP growth turned out strong in the following years, sizeable losses were experienced by the Argentine government. However, illiquidity and unconventionality (on which pricing problems depend) could just be an equilibrium phenomenon that a strong move toward real indexation could possibly overcome. This suggests that GDP indexation should attract more attention from researchers and debt managers.

3. Fiscal insurance: nominal versus inflation-indexed debt

A main result in the literature on debt management is that explicitly contingent securities are not needed for fiscal insurance (Bohn 1988, 1990). When markets are incomplete and the government has only conventional debt at its disposal, tax adjustments can be averted by issuing securities that offer low returns in bad states of nature, when output is lower and government consumption higher than expected.

Nominal bonds, being implicitly contingent on the realization of the price level, can provide insurance against shocks that lead to a negative correlation between unexpected inflation and output or to a positive correlation between unexpected inflation and government consumption; that is, when inflation covaries positively with government financing needs.

Whether inflation-indexed or conventional debt provides the best hedge against budget risk thus depends on the types of shocks hitting the economy, in particular on whether supply or demand shocks are expected to prevail. For instance, inflation-indexed bonds provide insurance against negative demand shocks but amplify the budget costs of negative supply shocks.[4] Unfortunately, empirical research may offer limited guidance as to the choice of nominal versus inflation-indexed debt as the optimal mix appears to depend on the countries and time periods considered.[5] More important, nothing guarantees that the same shocks that occurred in the past will repeat in the future.

The lack of knowledge about the type of shocks affecting the economy suggests portfolio diversification as an argument for issuing "some" inflation-indexed debt. On the other hand, cost considerations may favour conventional debt. In fact, the positive differential between expected and "break-even inflation" that is often observed especially at the start of indexation programmes suggests that indexed bonds pay a sizeable premium over nominal bonds.[6] Sack and Elsasser (2004) find that the US Treasury paid interest on TIPs of about 20 basis points higher than on conventional bonds.[7] According to TBAC (2008), the estimated cumulative losses on inflation-indexed debt reached 30 billion dollars over the first ten years of the programme.

If a premium is required to compensate investors for the lower liquidity of indexed bonds (and illiquidity is not just a temporary phenomenon due to the low volume of bonds outstanding),

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[4] Furthermore, inflation-indexed debt immunizes the government budget from inflation shocks unrelated to fiscal variables (Barro 2003), whereas nominal debt provides insurance against government consumption shocks that lead to higher inflation (Siu 2004, Lustig, Sleet and Yeltekin 2008).

[5] See eg Bohn (1990), Missale (1997b, 1999), Bacchiocchi and Missale (2005), Giavazzi and Missale (2005), Berndt, Lustig and Yeltekin (2010).

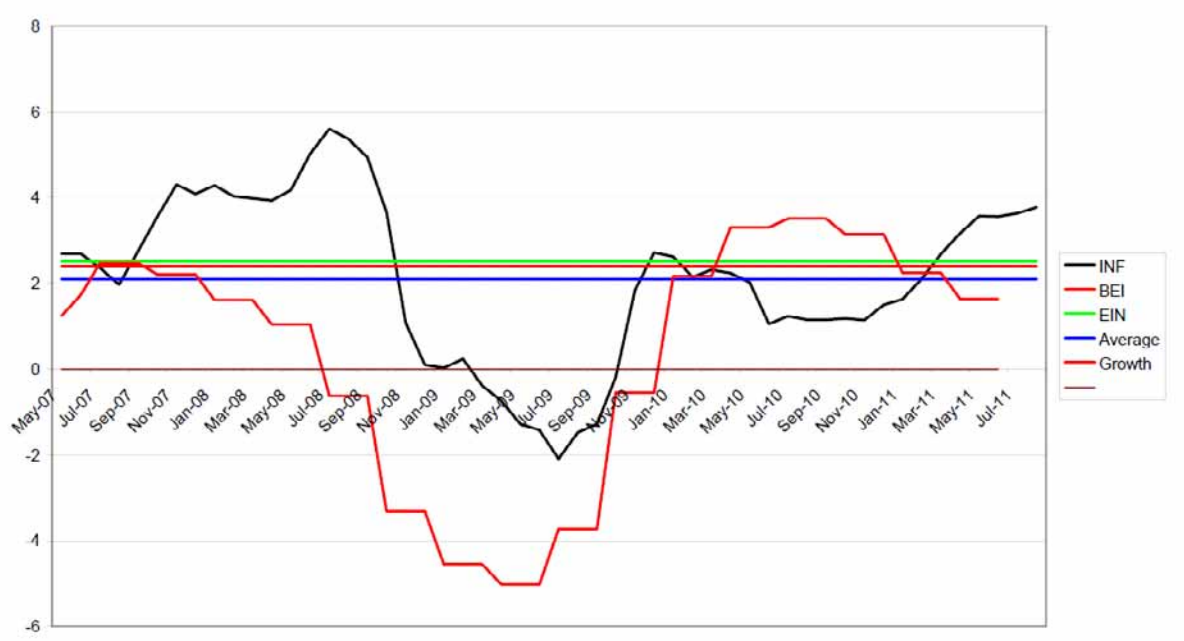
[6] See eg Shen and Corning (2001), Sack and Elsasser (2004), Sagnes and Coeuré (2005), Campbell, Shiller and Viceira (2009).

[7] On the opposite side, Garcia and van Rixtel (2007) estimate that interest savings in the UK and France on inflation-indexed bonds were about 45 basis points in the period 2004–06.

then expected cost minimization can play a role as relevant as fiscal insurance for the choice of indexation (see Section 5.1). It is however clear that the case for conventional debt cannot be made by simply looking at the ex-post interest costs of indexation programmes because ex-post gains and losses could be temporary and, when taken alone, have little to say about insurance effects (Dudley, Roush and Steinberg 2009). For instance, higher payments on inflation-indexed bonds would be perfectly consistent with fiscal insurance if they occurred at times of sustained output growth. In fact, in the wake of the global financial crisis and the ensuing deflation, indexed bonds have proved to be a valuable hedge against output contraction (TBAC 2009). Figure 1 shows the gains obtained by the US Treasury on the 5-year TIP note issued in April 2007. Not only realized inflation over the period turned out to be lower than break-even inflation, but price indexation also provided a useful hedge against output fluctuations, as made clear by the positive correlation between inflation and real GDP growth.

Figure 1

US 5-year TIP maturing Apr 2012



Whether governments should issue nominal or inflation-indexed bonds remains controversial. While there are no compelling arguments against indexed bonds, there are no strong arguments for issuing them either. No doubt, the advent of independent central banks able to control inflation has reduced the importance of inflation-indexed bonds as a hedge against unexpected inflation and demand shocks. In particular, the classical argument for inflation-indexed bonds as an instrument for protecting the real value of the debt against inflation shocks unrelated to other variables (Barro 2003) has lost much of its appeal in stable inflation environments where fiscal policy is Ricardian and price stability is ensured by the central bank.

Then, one may wonder why inflation-indexed bonds have been issued in countries like France, Greece, Germany and Italy only after they delegated their monetary policy to the ECB, and, less recently, in countries with inflation targeting regimes like Canada, the UK and Sweden. Among possible explanations, two are worth considering. The first is that governments care about the risk of inflation; they want to avoid the additional burden of indexation at times of high inflation and may issue nominal debt to build a constituency

against inflation and prevent indexation from spreading to wages, pensions, etc. (Pecchi and Piga 1999). Then, an independent central bank solves these problems. The second explanation is that nominal debt offers an implicit insurance against the realization of extremely bad events: it can be inflated away in emergencies like wars (Fischer 1983) or its real value may adjust as the price level rises to equilibrate the intertemporal budget constraint (Cochrane 2001 and references therein). When fiscal policy is Ricardian and the central bank controls inflation this option is lost and so is the benefit of nominal debt.

4. Fiscal insurance: the role of debt maturity

When markets are incomplete and the government has only conventional debt at its disposal, it can choose the maturity of the debt to make its value contingent on the term structure of interest rates. Angeletos (2002) and Buera and Nicolini (2004) show that, in a real economy without capital where government consumption is uncertain, a sufficiently rich maturity structure of real bonds can support the same distribution of tax rates as that obtained in a complete market economy. Although, as shown by Faraglia, Marcet and Scott (2010), these results cannot be generalized to more complex stochastic structures, they are nevertheless suggestive of the insurance that conventional debt can provide.

The idea is that the value of a bond (and thus its return), being implicitly contingent on the realization of the interest rate of the corresponding maturity, can provide insurance against budget risk. In particular, shocks that adversely affect the budget and raise long-term interest rates can be hedged by a fall in the market value of long maturity debt. If instead the same shocks led to a fall in long-term rates, they could be hedged by a long position in long-term debt funded with short-term debt.

To gain further insight into the fiscal insurance role of the maturity structure it is useful to look at the government's intertemporal budget constraint. Let us restrict our attention to the case where the government issues only inflation-indexed bonds with different maturities; that is, claims on future consumption. Then, defining with $B_{t-1}(t+j)$ the obligations (principal redemptions and coupons) implied by the bonds outstanding at the end of time $t-1$ to be paid at maturity time $t+j$ $(\text{with } j=0,...,M-1)$, the intertemporal budget constraint (in real terms) can be written as:

$$B_{t-1}(t)+\sum_{j=1}^{M-1} q_t(t+j)B_{t-1}(t+j)=S_t+\sum_{j=1}^{\infty}E_t\left[m_t(t+j)S_{t+j}\right] \qquad (1)$$

where E_t denotes expectations conditional on information at time t, S_t is the primary surplus and $m_t(t+j)\equiv \beta^j u'(c_{t+j})/u'(c_t)$ is the marginal rate of substitution between consumption in period t and $t+j$.[8] Finally, $q_t(t+j)$ are the prices, at time t, of real zero-coupon bonds maturing in period $t+j$; ie they are the prices associated with the term structure of real spot interest rates.

Using the Euler equation $q_t(t+j)=E_t m_t(t+j)$, from consumer maximization, the intertemporal budget constraint can be written as:

[8] See Angeletos (2002) for a derivation. To save on notation the dependence of primary surpluses and consumption on the history of events is not made explicit.

$$B_{t-1}(t)+\sum_{j=1}^{M-1} q_t(t+j)B_{t-1}(t+j)=S_t+\sum_{j=1}^{\infty} q_t(t+j)E_tS_{t+j}+\sum_{s=1}^{\infty} Cov_t\left[m_t(t+j);S_{t+j}\right] \quad (2)$$

where Cov_t denotes the covariance conditional on information at time t.

Equation (2) shows that a long maturity structure makes the market value of the debt sensitive to interest-rate changes. If negative shocks to current and future primary surpluses lead to higher interest rates, the value of long maturity debt falls and this reduces the need for fiscal adjustment.

4.1 Government consumption shocks

A long maturity debt structure provides fiscal insurance against macroeconomic shocks that induce a positive covariance between interest rates and government financing needs. For instance, government consumption shocks that lead to an upward shift in the term structure of interest rates can be hedged by a fall in the market value of long-term debt (Angeletos 2002, Barro 2003, Buera and Nicolini 2004, Lustig, Sleet and Yeltekin 2008).

This does not mean that the increase in interest rates is beneficial. Higher rates do worsen the fiscal position, as they reduce the present value of future surpluses above the direct effect of government consumption, but a long maturity structure minimizes their impact; the longer the maturity, the lower the deterioration in the fiscal position and thus the necessary correction. The government's holding of a short maturity asset, ie $B_{t-1}(t)<0$, can further improve the hedging performance of the government portfolio, as in the example of Angeletos (2002). Furthermore, insurance is enhanced by long-term nominal debt to the extent that fiscal shocks lead to contemporaneous or expected future inflation (and thus higher long-term interest rates) as in Lustig, Sleet and Yeltekin (2008).

How relevant is this argument for long maturity debt? Empirical evidence on the impact of government spending, and more generally of budget deficits, on interest rates casts serious doubts on the importance of this channel. Indeed, the evidence is mixed and, even when the effect of spending on interest rates appears significant, such effect is estimated to be small, around a few basis points (Ardagna, Caselli and Lane 2007, Laubach 2009). As suggested by their strong international comovements, long-term interest rates appear to be mainly driven by international risk factors (Codogno, Favero and Missale 2003) and/or global fiscal trends (Dell'Erba and Sola 2011).

4.2 Output shocks

The maturity structure can also provide insurance against shocks that affect output and tax revenues to the extent that such shocks lead to changes in interest rates. Finding the maturity structure that provides the best hedge against such shocks is however a difficult task because the covariance between output and interest rates may vary with the source of output fluctuations.

For instance, productivity shocks are best hedged by short maturity debt because negative shocks that reduce output and revenues also decrease interest rates and thus lead to higher returns on long-term debt (Faraglia, Marcet and Scott 2010).[9] The same is true for prolonged recessions that are accompanied by an easing of monetary policy. On the other hand, supply shocks due to rising wages or energy prices are best hedged by long maturity debt especially

[9] Put another way, when productivity and output are lower than expected, a short maturity structure allows policy makers to roll over the debt at low interest rates thus reducing the need for tax adjustments.

if the resulting inflation is countered by higher real interest rates. In fact, the impact of monetary policy rates on output is another argument for a long maturity structure. Bacchiocchi and Missale (2005) show that long maturity debt is optimal in a model where the central bank is able to fully stabilize demand shocks but has to induce an output contraction to counter inflation from supply shocks.

As the covariance between output and interest rates depends on the source of variations, on whether supply or demand shocks prevail, and on the monetary policy reaction to such shocks, little can be said on whether a long or a short maturity debt structure should be in place.

4.3 Interest-rate shocks

As the relation between interest rates and fiscal variables is either weak or depends on the types of shocks hitting the economy, characterizing the optimal maturity structure seems a frustrating exercise. However, to the extent that interest rates are mainly driven by international factors, say, global fiscal trends and "risk appetite" or risk awareness (and are thus unrelated to domestic fiscal variables), long maturity debt is optimal. A long maturity structure immunizes the government budget from pure interest-rate risk, ie from interest-rate shocks that are independent of domestic fiscal variables and thus primary surpluses.

If we assume that the covariance term in equation (2) is, to a first approximation, negligible (and debt obligations are honoured with certainty), then it is easy to see that the budget can be insured against interest-rate risk, ie against shocks to the term structure $q_t(t+j)$, by structuring the debt so that maturing liabilities match current and future primary surpluses (Barro 1995, 2003). If perfect matching were possible, no new debt would be expected to be issued, and the government budget would be immune from interest-rate shocks. However, since in the real world the maturity of the debt is typically shorter than the maturity of primary surpluses – ie $B_{t-1}(t) > S_t$ – the government budget is exposed to interest-rate (or refinancing) risk. Any unanticipated increase in interest rates would require an increase in taxes (or a reduction of government spending) to satisfy the intertemporal budget constraint. The necessary revision in tax rates is however lower the longer the maturity of the debt. This is because the fall in the present value of future surpluses due to an increase in interest rates is partially hedged by a fall in the market value of the debt and such insurance effect increases with debt duration. Therefore, a long maturity structure is needed to hedge against interest-rate risk and maintain a stable tax rate.[10]

4.4 The risk of default

A strong case for long maturity debt also emerges when a Non-Ricardian policy regime is entered into either because fiscal policy becomes unsustainable or is perceived as such due to a sudden shift in market sentiment. The consideration of debt crises triggered by a revision in economic growth, fiscal fundamentals or a sudden change in investors' confidence suggests that the risk of default should be a main concern of debt management. Debt crises also provide a clear instance in which the maturity structure of the debt affects expectations and interest rates thus interacting with monetary policy, adding to the cases considered in Turner (2011) and Blommestein and Turner (2012).

[10] A relatively shorter maturity structure would be consistent with budget insurance only if interest-rate shocks led to opposite movements in short- and long-term interest rates producing an inversion of the term structure.

A long maturity structure is the best insurance against the risk of default because debt crisis episodes are characterized by a fall in expected primary surpluses and a sharp increase in interest rates driven by the emergence of sizeable default-risk premia. Long-term debt is then a natural hedge against a sudden change in expectations because its market value falls when default-risk premia rise as a result of weak fiscal fundamentals or a shift in market sentiment.

This is not a new result; it has long been known that a long maturity structure enhances debt sustainability as it minimizes the risk of having to roll over a large share of debt when interest rates are too high or market access is denied (Calvo 1988, Alesina, Prati and Tabellini 1990). However, looking at the intertemporal budget constraint offers new insight into the role of debt maturity.

The maturity structure that reduces the risk of default can be characterized by looking at the government's intertemporal budget constraint (1) modified to consider the possibility that debt obligations may not be repaid:

$$B_{t-1}(t) + \sum_{j=1}^{M-1} q_t^*(t+j) B_{t-1}(t+j) = S_t + \sum_{j=1}^{\infty} E_t\left[m_t(t+j) S_{t+j}\right] \quad (3)$$

where a "star" on bond prices emphasizes that $q_t^*(t+j)$ are lower than the prices of "safe" claims on future consumption, $q_t(t+j)$, as the former discount the possibility that debt commitments will not be honoured in full.

Equation (3) shows that a downward revision in the expected path of future surpluses leads to a fall in the market value of the debt as bond prices, $q_t^*(t+j)$, decline due to the emergence of a default-risk component in interest rates. Since the unconditional probability of a default occurring at any future date increases with the horizon considered, the price of bonds falls more the longer their maturity, j. As the impact of the probability of default on the value of the debt increases with its duration, the longer the maturity of the debt the lower the default-risk premium that is needed to match the fall in the expected value of future primary surpluses.[11] Therefore, a long (and balanced) maturity structure minimizes the risk of default that the market prices in interest rates. As debt maturity is critical for debt sustainability, it should be considered as important as other fiscal fundamentals.

4.5 Nominal versus inflation-indexed debt

The policy implications of fiscal insurance for the maturity structure are usually derived from models where all variables are in real terms and government bonds are claims to future consumption, ie they are indexed to the price level. This raises the issue of whether, and under what conditions, these results extend to the case that the government issues fixed-rate nominal bonds.[12] In fact, nominal bonds are still the predominant financing instrument despite the rapidly increasing market in inflation-indexed bonds and thus the relevant case to consider.

Lustig, Sleet and Yeltekin (2008) show that when the government only issues non-contingent nominal debt, long-term nominal debt provides insurance against fiscal shocks that induce costly contemporaneous or expected future inflation and thus higher long-term interest rates.

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[11] The discussion is purposely informal. See Cochrane (2001) for a similar role of nominal-debt maturity in stabilizing expected inflation in a model where expected inflation plays the same role as the default-risk premium in devaluing long maturity debt following shocks to the present value of primary surpluses.

[12] Cochrane (2001) examines the case of nominal bonds but assumes constant real interest rates.

More generally, Bernaschi, Missale and Vergni (2009) find that a long maturity structure of nominal debt is optimal when the nominal term structure moves in the same direction as the term structure of real rates, as is the case in a stable inflation environment.

Consider the intertemporal budget constraint with nominal debt. While the market value of nominal debt varies with nominal interest rates, the present discounted value of primary surpluses (being naturally indexed to the price level)[13] depends on the marginal rates of substitution between consumption at different dates and thus, to a first approximation, on real interest rates (see equation (2)).[14] Hence, whether long-term nominal debt provides a hedge against variations in the present value of primary surpluses induced by shocks to real interest rates depends on the relation between the term structure of real and nominal interest rates. To the extent that nominal rates covary positively with real interest rates, that is, if the nominal term structure moves in the same direction as the term structure of real rates, then previous results apply, with qualifications, to the maturity structure of nominal debt.[15] In particular, if nominal interest rates change more than one-to-one with shocks to real rates, then the greater market-value sensitivity of nominal debt can provide a substitute for duration in hedging against variations in the present value of primary surpluses. However, the optimal duration of nominal debt should still be very long, as this effect is unlikely to compensate for the observed much longer duration of primary surpluses. More realistically, if nominal interest rates change less than one-to-one with real interest rates, then the argument for a long maturity structure is strengthened because the duration of the nominal debt must be longer than that of primary surpluses to compensate for the lower variations in nominal interest rates.

The argument for long nominal debt is also valid for shocks to expected inflation to the extent that such shocks induce a positive reaction of real interest rates. This is the case in inflation targeting regimes where, following the Taylor principle, the central bank controls expected inflation by raising the nominal interest rate more than the increase in expected inflation. To conclude, if shocks to nominal interest rates have a real component, the argument in favour of a long maturity structure derived for inflation-indexed debt extends to nominal debt.

5. Debt management in practice

How do policy implications from fiscal insurance compare with practical debt management? Most debt managers focus on aims broadly based around the notion of “minimizing cost subject to an acceptable level of risk”. In practice, they often choose debt portfolio strategies looking at the trade-off between cost and risk minimization of the interest expenditure obtained from stochastic simulations of macro-dynamic models.

The cost-risk management of the interest expenditure apparently shares with the fiscal insurance theory the objective of minimizing budget risk and thus tax adjustments. However, the management of expenditure risk is mainly motivated by the objective of minimizing the cost of debt service. Debt managers worry about expenditure risk because a greater risk may lead, ex-post, to higher interest costs for any given expected expenditure. This raises the issue of whether the objective of cost minimization is economically justified, and especially so

[13] As tax revenues and government consumption increase with inflation, primary surpluses are, to a first approximation, unaffected by inflation.

[14] The real value of the debt also depends on the current price level that we assume to be stable.

[15] See Appendix 1 in Bernaschi, Missale and Vergni (2009) for a formal analysis.

since governments have to pay a risk premium on their debts to reduce fiscal vulnerability to macroeconomic shocks.

5.1 The cost of fiscal insurance

While debt managers aim to minimize the expected cost of debt service independently of its source, the fiscal insurance theory holds that governments should be ready to pay a premium to avoid risk. To the extent that risk premia reflect a fair price for insurance, there should be no trade-off between risk and cost minimization: to avoid risk, the government should incur higher expected costs (Bohn 1995, 1999, Nosbusch 2008). Cost considerations matter only if expected return differentials, ie risk premia, between alternative debt instruments arise because of credibility problems, mispricing, market imperfections and liquidity (Bohn 1999, Missale 1997).

The reason why the government should issue bonds with higher risk premia to hedge against macroeconomic shocks is that it has a comparative disadvantage in providing insurance to the private sector, as explained in Bohn (1995). This is because bonds that have a higher return in bad states of nature (that is when output is lower and the fiscal position weaker than expected) imply higher tax rates on private-sector income. These tax changes undo the insurance offered by high debt returns. Hence, a strategy that relies on debt instruments to insure the private sector is self-defeating.

Optimal taxation models may, however, underestimate the magnitude of risk premia for, at least, three reasons. First, higher risk premia may result from market imperfections, illiquidity, and perhaps mispricing. In fact, as shown by Mehra and Prescott (1985), once we account for the low variance of consumption growth, observed risk premia appear too high to be generated by standard consumption asset-pricing models such as those considered in the optimal taxation literature. If actual risk premia are too high because of high risk aversion, then governments should refrain from policies which minimize the cost of debt service, as the latter impose significant risks on taxpayers. Cost minimization is instead warranted if high risk premia reflect private intermediation costs due, for example, to illiquidity. In this case, Bohn (1999) shows that a government's issuance of a safe asset at low cost is welfare improving. The increasing demand for safe and liquid assets in the wake of the global financial crisis suggests that the argument has some relevance.

The second reason why optimal taxation models may underestimate risk premia is that bond pricing depends on the equilibrium allocation of aggregate consumption because of the assumptions of rational expectations and a representative household. As bond holders differ from taxpayers, say, because taxes fall on future generations, the welfare maximizing distribution of taxes and aggregate consumption may not be relevant for debt holders' decisions and thus for bond pricing.[16] Perhaps more important, by assuming rational expectations, models of optimal taxation give households the ability to correctly perceive the distribution of tax rates and thus the equilibrium allocation of consumption associated with alternative debt-tax schemes.

The third reason is that the optimal debt structure is usually derived from non-monetary models or under the assumption of full commitment. When time-consistency problems are considered, implications for debt management change, as first shown by Lucas and Stokey (1983) in a model of optimal taxation where the government issues (explicitly contingent) real debt. Credibility problems may lead to substantial expected return differentials among alternative debt instruments and imply a trade-off between fiscal insurance and cost

[16] This may however strengthen the argument for risk minimization.

minimization (Calvo and Guidotti 1990). If this were the case, the government would have to buy less insurance to minimize interest costs and tax distortions.

These considerations suggest that our knowledge on the determinants of the cost of insurance is too limited to easily dismiss cost minimization; certainly more research efforts should be devoted to understanding the determinants of risk premia.[17]

5.2 The risk-cost management of the interest expenditure

A second fundamental difference between theory and practice is that fiscal insurance focuses on the intertemporal budget constraint; that is, on the market value of government liabilities *vis-à-vis* the present value of future primary surpluses, whereas debt managers are just concerned with the stochastic sequence of interest-expenditure flows or budget deficits. Hence, the fiscal insurance theory implicitly assumes an asset-liability management framework for the evaluation of debt financing strategies whereas the simulation approach is, at best, an optimal management of expenditure flows.

The debt managers' focus on interest expenditure, as opposed to the market value of the debt, is forced by accounting standards and by the excessive role that budget deficits play in fiscal policy evaluation. How far does this concern take us away from the policy recommendations of the fiscal insurance approach?

Consider first the following simple example. Suppose that the short-term interest rate is expected to increase so that the term structure is upward sloping consistent with the expectations theory. Then, as the long-term interest rate is fully determined by the perfectly foreseen path of the short-term interest rate, the maturity of *new* bond issues is irrelevant for expected cost minimization. Indeed, economic theory holds that – in the absence of a term premium – the type of debt that the government issues does not matter. However, over a short time horizon, the expected interest expenditure is minimized by short maturity debt.

Bernaschi, Missale and Vergni (2009) show that interest-expenditure minimization may lead to suboptimal debt strategies when carried out over a short time horizon. They evaluate the cost-risk performance of debt portfolios of different maturities by examining the time path of the stochastic distribution of their interest expenditures.[18] They find that a very long, possibly infinite, horizon should be taken as the reference period to obtain implications that are consistent with the fiscal insurance theory of debt management.[19] Intuitively, portfolio strategies can be compared in terms of interest expenditure only if the horizon extends up to the redemption date of the longest maturity bond issued during the simulation period.

The analysis points to the danger of a cost-risk management of the interest expenditure and raises concerns over debt strategies derived from medium-term simulation models such as that provided by the World Bank and IMF (2009).[20] In the example above, by issuing short-term debt a government would move away from the (long maturity) portfolio that minimizes interest-rate risk and expose the budget to the costs of future interest-rate shocks. The risks of short-termism are further investigated in the next section.

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[17] For an analysis of risk premia on inflation-indexed bonds see Campbell, Shiller and Viceira (2009).

[18] The stochastic distribution of the interest expenditure over time is simulated using simple stochastic models of the evolution of the term structure of interest rates.

[19] We also find that the ranking of debt portfolios by expenditure risk may depend on the length of the simulation period.

[20] Although most governments run simulations over a ten-year period, they often focus on cost-risk indicators computed on much shorter horizons (see Risbjerg and Holmlund 2005).

5.3 Fiscal rules and the risk of impatience

Fiscal rules, such as the Stability and Growth Pact or a Budget Balance rule, make the interest expenditure the key variable to be controlled by debt management. Then, the excessive role played by current deficits in the evaluation of fiscal performance together with governments' myopic views may distort debt managers' choices and favour suboptimal debt strategies.

To make a simple example, consider the implications of a Budget Balance rule. In order to ensure a balanced budget the nominal primary surplus, S_t^N, has to match the nominal interest expenditure, I_t, ie the sum of coupons, capital uplifts and the per-year difference between the face values and the issue prices of the outstanding bonds.[21]

Defining the ex-post payment rate on the outstanding debt as $i_t = I_t / B_{t-1}$, the Budget Balance rule, $S_t^N = I_t$, can be written in terms of the surplus-to-GDP ratio, s_t, and the debt-to-GDP ratio, b_{t-1}, as:[22]

$$s_t = \frac{i_t}{1+y_t} b_{t-1} \tag{4}$$

where y_t is the growth rate of nominal GDP.

If the primary surplus is affected by output shocks so that its ratio to GDP increases with unanticipated output growth, $y_t - E_{t-1}y_t$, then a balanced budget requires that the government offset such shocks by controlling the policy component of the primary surplus, for example, the average tax rate. Defining the policy controlled component of the surplus as fiscal adjustment, A_t, the Budget Balance rule implies:

$$A_t = \frac{i_t}{1+y_t} b_{t-1} - \eta\left(y_t - E_{t-1}y_t\right) \tag{5}$$

where η is the elasticity of the surplus ratio to nominal GDP growth; ie we assume, for simplicity, that real growth and inflation elasticities are the same (which is generally not the case).

Equation (5) shows that a decline of GDP growth below its natural rate implies an additional burden to fiscal adjustment on top of interest payments. It also makes clear that GDP-indexed bonds and, to a lesser extent, inflation-indexed bonds help to stabilize the policy component of the surplus by providing an insurance against shocks to nominal growth.

In fact, a sensible objective function for the debt manager would be to minimize the expected quadratic loss of the fiscal adjustment in the current and future periods. Assuming two periods, the present and the future, we have:

$$Min\ L = E_{t-1}A_t^2 + \beta E_{t-1}A_{t+1}^2 \tag{6}$$

Substituting equation (5) for A_t yields:

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[21] According to ESA95 accounting rules, the difference between the face value and the issue price of a bond divided by its life (from issuance to maturity) is considered an interest payment as well as its coupon.

[22] Dividing both the surplus and the interest payments by nominal GDP is justified by the fact that the variable that the government controls is the surplus-to-GDP ratio, for example, by choosing the average tax rate.

$$Min\ L = \left(E_{t-1} \frac{i_t}{1+y_t} b_{t-1} \right)^2 + Var_{t-1}\left[\frac{i_t}{1+y_t} b_{t-1} \right] - 2\eta b_{t-1} Cov_{t-1}\left[y_t; \frac{i_t}{1+y_t} \right] + k + \\ + \beta \left(E_{t-1} \frac{i_{t+1}}{1+y_{t+1}} b_t \right)^2 + \beta Var_{t-1}\left[\frac{i_{t+1}}{1+y_{t+1}} b_t \right] - \beta 2\eta Cov_{t-1}\left[y_{t+1}; \frac{i_{t+1} b_t}{1+y_{t+1}} \right] \quad (7)$$

where Var_{t-1} and Cov_{t-1} denote, respectively, the variance and covariance conditional on the information at time $t-1$ when the debt manager chooses the type of debt to be issued, and k is an unimportant constant.

Equation (7) shows that bonds indexed to nominal GDP would provide a valuable hedge against cyclical variations in the primary surplus that are not controlled by the government. Inflation-indexed bonds could also provide insurance to the extent that inflation and real output growth were not negatively correlated, that is, if supply shocks did not prevail. However, if issuing GDP-indexed bonds is "too costly" because investors require a premium for illiquidity and complexity (see Section 2.1), then the choice is between conventional long maturity bonds and short maturity bonds, say, bonds with a 10-year and 1-year maturity.

A distinctive feature of both types of bonds is that their interest payments at period t are known at the time of issuance, $t-1$, which implies that the conditional variance and covariance terms in the loss function for period t are zero. However, while the interest payments on 10-year bonds will remain fixed for 10 years ahead, 1-year bonds, being rolled over in period t, expose the fiscal adjustment to interest-payment uncertainty. Indeed, short maturity debt implies greater interest-payment variability at $t+1$ (see the variance term in the loss for period $t+1$) and may lead to higher future payments when the interest rate is expected to rise (see the expected term in the loss for period $t+1$). Moreover, short maturity debt may lead to additional losses if interest rates covary negatively with nominal GDP growth. Although we argued in Section 4 that a systematic relation between interest rates and output growth is hard to find, there may be instances when high rates are associated with output contraction, say, as in the case of monetary policy tightening to fight inflation.

It is worth saying that debt managers are aware of the risks and potentially higher future costs of short maturity debt and opt for fairly long maturities as shown by the actual maturity structures of sovereign debts in OECD countries. However, in a time of crisis, when the government strives to achieve budget balance and the deficit becomes the focal point of the economic policy debate, the debt manager's horizon may shorten dramatically. Suppose that the 1-year yield to maturity is lower than the 10-year yield either because the yield curve is upward sloping or, more generally, because of the presence of a term premium. Then, an impatient debt manager who discounts the future heavily, ie when $\beta \to 0$, will only issue 1-year bonds to minimize next-period interest payments (and ease fiscal adjustment) as this is the only variable that enters the loss function (7) when $\beta = 0$.

Therefore, in times of crisis, when surviving the present is what matters most, focusing on interest payments, a concept of dubious economic relevance but crucial for fiscal rules binding the overall deficit, may bias the choice of debt managers in favour of short maturity debt. While a forward looking debt manager may try to resist the urge to cut the interest expenditure, she may be forced to deliver a "nice" budget under the pressure of a government striving to meet its commitments. The use of "unconventional" swaps contracts by fiscally weak Member States to satisfy the 3% deficit limit in the run up to EMU is a real-world example of how accounting conventions may set the wrong incentives and distort debt managers' choices.

No doubt, these examples are extreme but still point to the danger of evaluating fiscal sustainability on the basis of national accounts figures that are vaguely related to debt sustainability, such as the current deficit, the interest expenditure, and the book value of the debt. Hall and Sargent (2011) show how different debt returns are from interest payments

and thus how different are the dynamics of the market value of the debt (relative to GDP) compared to official figures. In fact, while economic theory and fiscal insurance evaluate debt strategies for their impact on the intertemporal budget constraint, and thus look at the market value of the debt, real returns, debt maturity, etc., in most countries, data on the market value of the debt do not even exist!

We may feel comfortable with the simple concepts of current deficits, interest expenditure, and debt-to-GDP ratios, but we just abide by conventions: the use of national accounts as the only standard to evaluate fiscal policy is a major obstacle to optimal debt management.

6. Concluding remarks

Debt management should aim at minimizing fiscal vulnerability by providing insurance against macroeconomic shocks affecting the government budget. Indeed, a wide consensus has emerged in the literature on the benefits of fiscal insurance and debt managers have paid greater and greater attention to reducing the exposure of their debts to interest-rate risk and exchange-rate risk. The reliance on domestic currency bonds and the lengthening of the maturity structures that has taken place over the last two decades is clear evidence of the increased awareness of such risks.

However, the fiscal insurance approach does not offer simple policy recommendations for the specific debt instruments to be issued. Whether insurance is better provided by nominal or inflation-indexed bonds, by a short or a long maturity structure depends on the type of shocks hitting the economy. What type of debt should then be issued? In this paper we have re-examined this issue looking at the fiscal insurance that inflation indexation and debt maturity can offer in light of the different shocks affecting the government budget and their relevance.

Whether governments should issue nominal or inflation-indexed bonds is controversial. The lack of knowledge about the type of shocks hitting the economy suggests portfolio diversification as an argument for “some” inflation-indexed debt. On the other hand, the role of inflation-indexed bonds as a hedge against demand shocks or inflation shocks (unrelated to other variables) is less important in a stable inflation environment when fiscal policy is Ricardian and price stability is ensured by the central bank.

By contrast, there is no doubt that indexation to nominal GDP would be ideal to hedge against output fluctuations. Issuing GDP-indexed bonds can be costly because of the premium required for illiquidity and complexity but the time has come to take this opportunity into greater consideration.

We have made a strong case for long maturity debt, either nominal or indexed. Our argument is not based on the relation between interest rates and fiscal variables, which is either weak or conditional on particular shocks, but on the fact that a long maturity structure avoids interest-rate risk and, more importantly, reduces the risk of default if expected future primary surpluses fall as a result of policy or a shift in market sentiment. The euro debt crisis does provide a clear indication for the management of sovereign debt: a long maturity structure is the best insurance against the risk of default. The maturity of the debt is a key variable to assess the vulnerability of the government fiscal position and should thus deserve greater attention in debt sustainability analysis. An excessive focus on the level of debt, on the debt-to-GDP ratio, as well as on current deficits, is misleading in the presence of substantial differences in debt duration. Moreover, as the original duration of the debt is modified by swaps contracts, a correct assessment of fiscal vulnerability calls for a greater transparency of such operations.

Finally, we have compared the policy implications from fiscal insurance with the debt managers’ practice of minimizing the cost and risk of the interest expenditure obtained from

stochastic simulations of macro-dynamic models. The management of expenditure risk is mainly motivated by the objective of minimizing the cost of debt service, taking risk into account. Debt managers worry about expenditure risk because a greater risk may lead, ex-post, to higher interest costs, for any given expected expenditure.

A concern for the cost of debt service is justified if expected return differentials between debt instruments are determined by mispricing, market imperfections and liquidity, but it is not when higher risk premia reflect a fair price for insurance. In the latter case, there is no trade-off between cost and risk minimization. This suggests that more research efforts should be devoted to understanding the determinants of risk premia.

A second fundamental difference is that the fiscal insurance theory focuses on the intertemporal budget constraint, that is, on the market value of government liabilities *vis-à-vis* the present value of future primary surpluses, whereas debt managers are just concerned with the stochastic sequence of interest-expenditure flows. Interest-expenditure minimization may lead to suboptimal debt strategies when carried out over a short horizon. To obtain implications that are consistent with the fiscal insurance theory of debt management, portfolio strategies should be compared over a time horizon that extends up to the redemption date of the longest maturity bond issued during the simulation period.

The debt managers' focus on interest expenditure, as opposed to the market value of the debt, is forced by accounting standards and by the excessive role that budget deficits play in fiscal policy evaluation. Fiscal rules, such as the Stability and Growth Pact or the Budget Balance rule, make the interest expenditure the key variable to be controlled by debt management. In times of crisis, when surviving the present is what matters most, focusing on interest payments, a concept of dubious economic relevance but crucial for fiscal rules binding the overall deficit, may bias debt managers' choices and favour suboptimal debt strategies. Our analysis points to the danger of evaluating debt management on the basis of national accounts figures that are vaguely related to debt sustainability, such as the current deficit, the interest expenditure and the book value of the debt. The lack of a more theory-based accounting framework is a major obstacle to optimal debt management.

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