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Liability Management with Inflation-linked Products: The case of Sweden, France and Italy

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In the Swedish case, Lars Hörngren and Erik Zetterström show that seen in retrospect, the government has recorded substantial savings from the issuance of inflation-linked debt. The primary reason is that average inflation has been below the level expected when large parts of the stock were issued. However, as for the UK, they note that over the recent period the diversification benefits of inflation-linked debt are more emphasised than their impact on the expected borrowing costs. They also explain that, although the arguments for issuing inflation-linked bonds were largely qualitative in nature, the decision in 2005 to set a target share of 20% for inflation-linked debt had also been preceded by formal analyses of the appropriate composition of the debt portfolio, including a set of stochastic simulation models. Hörngren and Zetterström review these models and, specifically, how they were set up to integrate inflation-linked debt in the analysis of the overall portfolio.

In the French case, Jean-Paul Renne and Nicolas Sagnes presents the quantitative methodology aimed at assessing the cost and risk

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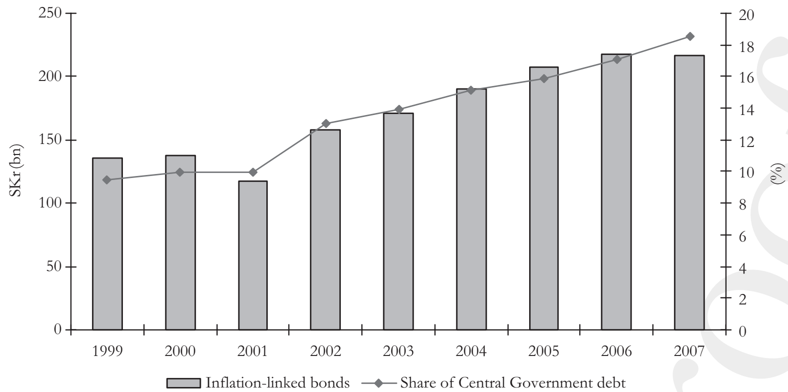
impact of a change in the share of inflation-indexed debt. They consider both interest cost and budget balance and use a wide range of econometric tools to model the French economy and the dynamics of budget balance. Based on this quantitative analysis, they come up with the following results: by saving the inflation risk premium, the government can lower the average debt service when increasing the share of indexed debt, but if the increase is strong, it also makes the debt service more variable. However, the conclusion is also that, starting from 0%, increasing indexed debt up to a moderate level (around 20%) would lead to a decrease in expected interest payments without significantly increasing the variability of the budget balance.

In the Italian case, Davide Iacovoni describes the process behind the Italian Treasury's decision to start issuing inflation-linked bonds in 2003. It emerges that the decision was based on a comprehensive evaluation, which took into account both pure debt management considerations and market aspects. Iacovoni recounts the Treasury's experience in placing these bonds; the evolution of the secondary market since 2003, in terms of both type of trades and investors involved, and the linkers' building programme. The second part of the section is devoted to the models adopted by the Treasury to assess the optimal issuance policy on linkers in quantitative terms. Iacovoni highlights the pros and cons of the different models as well as their internal consistency and capacity to fit actual market data, thereby enabling the reader to understand the reasons underlying the Treasury's actions to improve the analytical framework adopted to support issuance and debt management decisions on linkers.

LIABILITY MANAGEMENT WITH INFLATION-LINKED PRODUCTS: THE CASE OF SWEDEN

The Swedish central government started issuing inflation-linked bonds in 1994. The justification at the time included the fact that the issuer should be able to borrow more cheaply by avoiding the inflation premium in nominal bonds and that the government could signal its commitment to low inflation by assuming long-term inflation risk. Since this was a period with very high borrowing needs, a broadening of the investor base and reduced reliance on nominal instruments were seen as additional advantages from adding a new type of debt to the portfolio.

Figure 22.1 Inflation-linked debt



The figure uses the conventional measure of debt. Based on the measure used in the government's guidelines, the share reached the target of 25% at the end of 2007[1]

The programme started slowly, but from 1996 and onwards the issuance of inflation-linked debt took off. Since its introduction, the share of inflation-linked debt has grown consistently; cf, Figure 22.1. Neither the introduction nor the expansion was preceded by much formal analysis. When comprehensive annual guidelines for government debt management were introduced in Sweden in 1998, the issue of the appropriate share for inflation-linked debt was left open, pending further analysis. However, the government instructed the Swedish National Debt Office (SNDO) to gradually increase the share, based on the presumption that the analysis would show that the share ought to be higher than the level at the time.

The guidelines were formulated in the same way until 2005 when the government set a percentage target of 20%. By then, the justification for inflation-linked debt had been modified. The guidelines now emphasised the value of having an additional debt class in the portfolio, ie, diversification rather than lower expected borrowing costs.[2]

Seen in retrospect, the Swedish government has recorded substantial savings from the issuance of inflation-linked debt. The primary reason is that average inflation has been below the level expected when large parts of the stock were issued, partly because there was a period in the 1990s when the official inflation target was not seen as credible. In recent years, the breakeven inflation rate has hovered at or even below the official inflation target.[3] There is scant evidence for an inflation risk premium. If there is one, it tends to be offset by a liquidity premium. All in all, it is reasonable to assume that the expected cost of inflation-linked debt is similar to that of nominal debt. It is when something unexpected happens that inflation-linked debt will make a difference. To this end, you need models that can help you understand and illustrate the effects of uncertainty.

Although the arguments for issuing inflation-linked bonds were largely qualitative in nature, the decision to set a target share of 20% had also been preceded by formal analyses of the appropriate composition of the debt portfolio, including a set of stochastic simulation models. The purpose of this section is to review these models and, specifically, how they were set up to integrate inflation-linked debt in the analysis of the overall portfolio. The final subsection summarises the lessons we have learnt and points to some important outstanding issues.

Quantitative modelling of inflation-linked bonds

A stochastic macro-based simulation model

The SNDO's first attempt to model inflation-linked bonds in a consistent quantitative manner is presented in Bergström *et al* (2002). The model has two parts. The first is a stochastic simulation model capable of generating paths for key macroeconomic and financial variables, including GDP, inflation, exchange rates and real and nominal interest rates. The second part is a debt strategy simulation model. This uses the simulated paths for the macro and financial variables as inputs to calculate the costs and risks of given portfolio strategies. The resulting cost and risk measures can be used for quantitative assessments of the characteristics of various portfolio strategies.

The macro model is intended to be simple and intuitive, since a non-intuitive model typically will fail to inform (or impress) policy makers. At the technical level the model has two key features. First, variables are assumed to follow stationary autoregressive processes. Second, the autoregressive processes of some variables

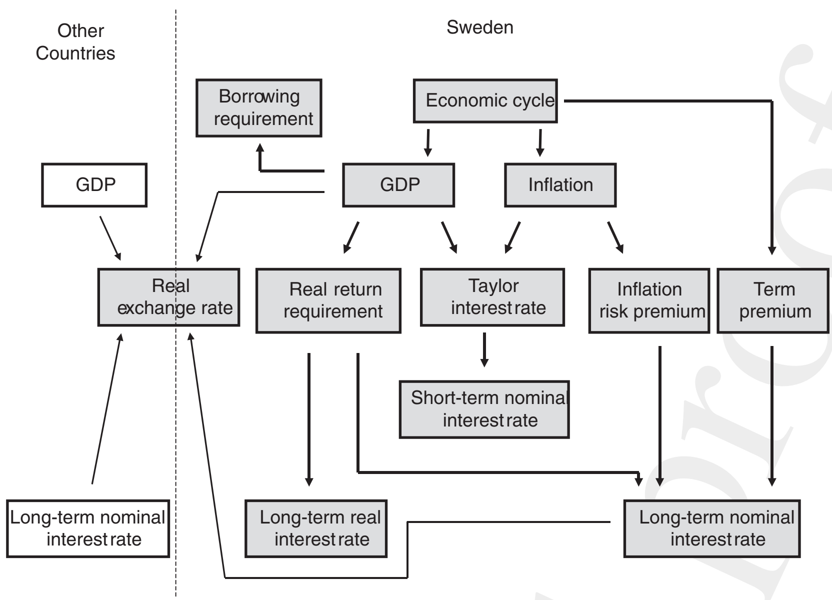


Figure 22.2 The macro simulation model

are allowed to vary over the business cycle, ie, they are state-dependent in the sense that they follow different processes depending on whether the economy is in boom or recession. The latter state variable is in turn governed by a stochastic transition process, known as a two-state Markov chain.

The linkages in the model are depicted in Figure 22.2. Without going into the details of the specification, the picture illustrates that even a simplified macro model tends to become quite complex.

The strategy simulation model tracks and controls the portfolio in a fairly detailed manner. It determines, in each step of the simulation, how much should be issued in each debt category, as well as the maturity distribution in each category, for the financing requirement to be met and the portfolio to satisfy the criteria for the given portfolio strategy. It also computes the cost of the chosen portfolio in each period, given the interest rates, etc, generated by the macro model.

In the version presented in the 2002 guideline proposal, we used the model to generate 1,000 simulated paths over 30-year periods.

We analysed nine portfolio strategies, with distinct differences in portfolio shares and time to maturity.

At the technical level, inflation-linked debt is modelled in the same way as foreign currency debt in that the price level functions analogously to the exchange rate when computing the realised cost in (nominal) domestic currency terms. A key feature of the model is that the inflation rate is endogenous. It goes without saying that the way in which inflation is modelled is crucial for the simulation results. In this case, it is assumed that the domestic central bank meets its inflation target on average.

This reflects a more general characteristic of a simulation model of this type: it is necessary to assure that the key variables in the macro model are stationary. If not, paths that are both economically and politically unsustainable would arise. In the real world, such severe strains on the economy often result in drastic policy measures, including fundamental regime changes. However, it is hard to include such reactions in a quantitative model since they will tend to affect the structural relationships between key variables.[4] Hence, the economy described by the model is inherently well-behaved.

This has several implications for the simulation results. First, portfolio strategies are not tested in extreme circumstances, eg, when the borrowing requirement explodes and debt grows along an unsustainable path for an extended period. Second, and related to inflation-linked debt, it means that, although there is some variability over time in inflation, and thus in the cost of inflation-linked relative to nominal debt, the differences are small. As a result, and despite attempts to measure variability (risk) both across states and along simulated paths, the model is not able to yield quantitatively significant differences between nominal and inflation-linked debt.

To summarise, the stochastic macro-based model gave several useful insights overall, but, as regards the role of inflation-linked debt, it did not help to determine the appropriate share of inflation-linked debt in the Swedish government debt portfolio.

A stochastic simulation model of inflation, interest rates and exchange rates

The second attempt to coax something useful out of a simulation model was launched in 2006 when the Swedish government asked the SNDO to analyse, and propose, a comprehensive maturity benchmark for the whole of the central government debt (earlier only the nominal debt and the foreign currency debt were included in the maturity benchmark).[5] A benchmark for the maturity of the whole debt was seen as desirable since it would increase the possibilities to consider refinancing and refixing risks in nominal and inflation-linked debt jointly.

Having realised that it is tricky to get answers out of full-fledged macro-based stochastic models where everything depends on everything else in a (somewhat) realistic manner, the SNDO decided to take a step back and skip the structural macro part of the model. The second model therefore focuses on possible future paths for inflation and financial variables, ie, interest rates and exchange rates, without explicit links to a model economy. The interaction between variables is also kept on a more tractable level. Instead of modelling the interplay between variables within a macroeconomic model, we introduce covariance between inflation, interest rates and exchange rates via the disturbance terms in the stochastic processes.

Aside from having a cruder macro setup, the 2006 model retains the two-part structure of the earlier model. That is, it consists of one part that generates paths for variables affecting costs and another part where we try a number of debt strategies. The focus on debt maturity (more specifically the risk associated with different maturity targets) in this application led us to parameterise the model in a way that makes it – on average – as expensive to use inflation-linked debt as domestic or foreign currency debt.[6]

Following the example of the earlier model, variables follow stationary autoregressive processes.[7] However, the two-state Markov chain specification is dropped in an attempt to further simplify the model. Instead, extra attention compared with the earlier model is paid to the modelling of the yield curves.

Yield curves, both domestic and foreign, are estimated with a method put forward by Diebold and Li (2006). They model the entire yield curve as a three-dimensional parameter evolving dynamically. Furthermore, they assume that the three dimensions, interpreted as the level, slope and curvature of a yield curve, can be estimated with autoregressive models.

The costs of inflation-linked debt and foreign currency debt are modelled in the spirit of the 2002 model. That is, simulated paths of inflation and exchange rates are used to calculate costs in nominal domestic currency terms. However, variations on the theme are adopted.

In the 2002 model, gains and losses stemming from innovations in inflation and exchange rates are – aside from their effect on coupon payments – only considered for loans that mature or are repurchased during the period. That is, we employ a cashflow-based measure of cost.

The 2006 model uses two different cost measures: one where the effects of exchange rate and inflation innovations are used to revalue coupon payments and the total stock of outstanding debt, and one where such innovations are considered to affect coupon payments only. These measures can be seen as two extremes. In the first measure, value changes (ie, gains and losses) are registered on the day they occur. In the second measure, we skip revaluation effects on the outstanding – and maturing – debt altogether since innovations will even out in the long run and hence do not affect long-run costs (remember that mean reversion characterises the relevant variables).

Since the risk inherent in a given strategy is defined as the variability in costs stemming from that strategy, it should come as no surprise that the results to a large extent depend on which measure we use.

To be more precise, the risk measure (the risk of a strategy) in the model is defined as the difference between the 95th and the 50th percentile in the simulated cost distributions, of which there is one for each debt category and time step.

In the simulations we generate 20,000 paths for the state variables; the simulation horizon was kept at 30 years. At each time step – one year – we calculate the cost and risk that is associated with a debt of a certain maturity.

Plenty of interesting, and directly useful, conclusions could be drawn from the exercises. We find – with one exception – that risk decreases with time to maturity and increases the longer into the future we look. More importantly, we find that the marginal risk reduction decreases rapidly as maturity is extended, indicating that there is no reason to go very long.

It is also readily evident that what one believes to be the relevant cost measure is vital for perceived riskiness of a debt strategy. If we include the effect on outstanding volumes (stock effects) of innovations in inflation and exchange rates, the foreign currency debt is considerably more risky than inflation-linked debt, which in turn is riskier than nominal domestic currency debt. This risk ranking changes markedly if we assume that stock revaluation effects are unimportant; in this case, foreign currency debt (if it is split between several currencies) and inflation-linked debt are instead less risky than domestic currency debt. One key conclusion (the exception mentioned above) from the simulation exercise – and one that was directly transferred to actual policy – was that a maturity-risk trade-off is not apparent in the foreign currency debt if one also considers the stock effect. Since exchange rate innovations swamped the refixing risk, we found foreign currency debt to be (essentially) equally risky regardless of time to maturity. This finding led the SNDO to shorten the maturity of the foreign currency debt considerably.

Conclusions

Stochastic simulation models are a useful tool for government debt portfolio analyses. However, they do not provide all the answers. In particular, it is difficult to use such models to test how a debt strategy fares in a deep crisis. This is a significant limitation, since it is in crises that debt policy may matter the most. Moreover, in a benign environment, nominal or inflation-linked debt makes little difference, whereas debt costs will behave quite differently in a crisis involving high inflation or deflation depending on whether the portfolio has a significant share of inflation-linked debt.

To capture such effects, stochastic simulation models should be complemented by scenario-based models. The SNDO has also developed such a model.[8] It is designed for stress testing, ie, to see how severe but relatively short-term events that radically alter financial variables or the borrowing needs affect debt costs. By comparing the steady-state costs and the costs during the crisis event, one also gets a measure of the cost of using a particular portfolio as a means to insure against the harmful effects of the shock.

The SNDO's modelling work and other attempts to provide a coherent basis for government debt management have also pointed to limitations in our understanding of the meaning of "cost" and "risk", the key concepts on which the objective of debt management is based.

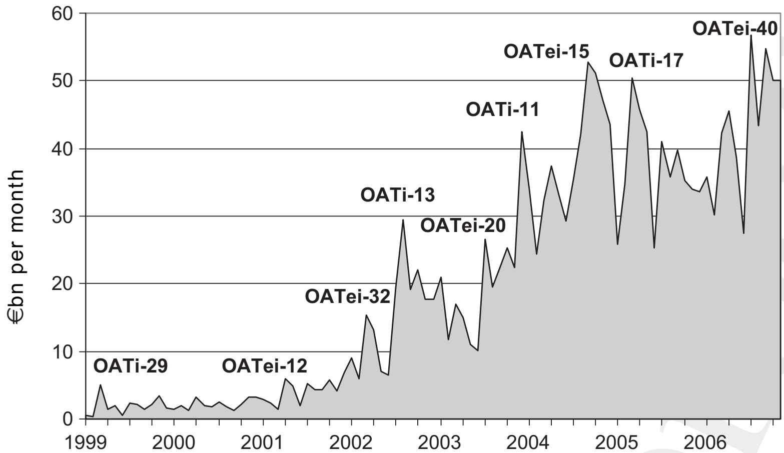
First, financial risk is ultimately related to the interplay between liabilities and assets. The inclusion of GDP as an endogenous state variable in the macro-based simulation is a step in the direction of capturing the key asset of a sovereign borrower, namely, the right to tax income and production. However, it is obvious that GDP is but a crude proxy for the true assets of a sovereign. It is also noteworthy that even this rough specification of the links between the macroeconomy and the state of government finances makes the model quite complex. It appears that a solid approach to sovereign asset and liability management remains an illusive goal.

Second, there are questions outstanding regarding the proper measures of cost. Inevitably, this also affects the perception of risk, since risk must be linked to (unexpected) variability in a relevant measure of cost. Possibly, the lack of clarity is related to the previous point. In the absence of a truly consistent overall framework, it is hard to be very precise about cost measures. In some circumstances it may be correct to ignore revaluation effects; in others it may be necessary to include full mark-to-market costs. Given this uncertainty, it may be necessary to pay attention to several different measures of cost and risk. This complicates the analysis and the decision process, but it would be misleading to pretend that government debt policy is an uncomplicated area.

LIABILITY MANAGEMENT WITH INFLATION-LINKED PRODUCTS: THE FRENCH APPROACH

In December 1997, the Ministry of the Economy, Finance and Industry announced plans to issue in 1998 an inflation-indexed bond. The Act of July 2, 1998 authorised indexation of financial products to inflation, enabling France to launch on September 15, 1998 the first inflation-indexed bond in the Euro area (the 3% January 2009 OATi). In 2001, the Minister decided to issue the first OAT indexed on the euro area harmonised index of consumer prices (HICP) (excluding tobacco). This decision was intended to forward the development of

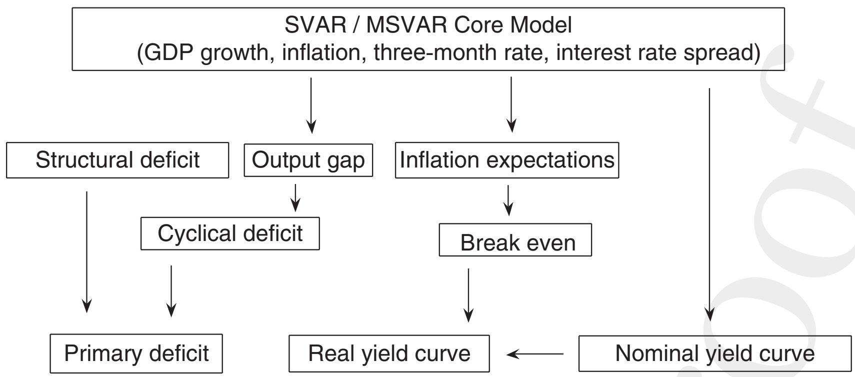
Figure 22.3 Market turnover in French government inflation-linked bonds



the European market for inflation-indexed bonds. Since then, OATi-€i have become an integral part of government issuing policy. At the end of 2007, around 14% of total debt outstanding was indexed. Supported by a significant demand, liquidity in inflation-indexed bonds has experienced a strong increase since the early 2000s (see Figure 22.3).[9]

In 2005, Agence France Trésor developed a methodology, based on the so-called dynamic financial analysis (eg, Bolder (2002, 2003) or Black and Telmer (1999)), aimed at assessing the cost and risk impact of a change in the share of inflation-indexed debt (Renne and Sagnes 2006). Although the following results are broadly based on the same approach, the model has been slightly modified since then and it has also been re-estimated using the latest available data. The macro-finance model is further used to stochastically simulate future economic scenarios. The application of the strategies under the scenarios results in probability distribution for debt service series from which cost and risk measures are derived, for each strategy. This methodology is applied to compare strategies involving different shares of indexed debt. The main results are the following: by saving the inflation risk premium, the government can lower the average debt service when increasing the share of indexed debt, but, if the increase is strong, it also makes the debt service more variable. However, our simulations tend to show

Figure 22.4 Model structure



that, starting from 0%, increasing indexed debt up to a moderate level (around 20%) would lead to a decrease in expected interest payments without significantly increasing the variability of the budget balance.

The stochastic simulation framework

The model is composed of several blocks, the organisation of which is presented on Figure 22.4. The "core" block depicts the dynamics of key macroeconomic and financial variables: GDP growth, inflation, the three-month interest rate and the interest rate spread (10 years to three months).[10] There are two additional blocks, dealing respectively with the yield curve and the primary deficit dynamics. The model includes six nominal bonds with maturities of three months, one year, two years, five years, 10 years and 30 years and two inflation-linked bonds with maturities of 10 and 30 years.

Two alternative econometric modelling approaches are used for the main block (referred to as the core model below): a simple vector auto regression (VAR) and a Markov-switching VAR (MSVAR). Both models are estimated using quarterly data spanning the period 1986Q1–2007Q1.[11]

Introduced by Sims (1980), VARs have been extensively used in macroeconomics. For Stock and Watson (2001), the VAR remains a useful tool for analysing and forecasting time series. It is common knowledge that VARs replicate more satisfyingly the dynamics of time series in comparison with calibrated dynamic general stochastic equilibrium (DSGE) models.

The use of Markov-switching models in macroeconomics has been widely developed following Hamilton (1989), who uses Markov chains to introduce latent variables indicating growth and recession periods. Krolzig (1997) applies such models in a multivariate context. In our case, this method is expected to efficiently capture – and further to enable the simulation of – two regimes. While one of them corresponds to periods with stronger nominal rate of interest and growth, the other corresponds to periods with lower means for these variables. In this context, some of the changes that were attributed to strong and persistent shocks in the simple VAR case then appear to result from regime switches (eg, Garcia and Perron (1996)). Besides, the yield curve appears to be more volatile in the first regime than in the second one, as is suggested by the variances of the short rate and the slope of the yield curve.

The primary deficit is split into a cyclical and a structural component. In an attempt to estimate the part of public deficit accounted for by cyclical fluctuations, Van den Noord (2000) assesses the elasticities of public income and expenses to the economic cycle.[12] A report dealing with public finances in the Eurozone (European Commission 2002) underlines the consensus about the 0.5 value for the elasticity of the cyclical deficit to the cycle, as measured by the output gap. Therefore, the cyclical primary deficit (in percentage of GDP) is simply taken to be equal to half the output gap. For its part, the primary structural deficit is finally modelled by a basic AR(1).

While the simulation approach requires the derivation of the whole yield curve in order to satisfyingly depict debt managing tools, only two points are provided by the core model (three months and 10 years). An extrapolation procedure has therefore to be implemented. Using a parametric form inspired by the Nelson and Siegel (1987) model, the par yield for a maturity m bond is given by a Laguerre polynomial:

$$y_t^m = \beta_{0,t} + (\beta_{1,t} + \beta_2)\frac{\tau}{m}(1 - e^{-m/\tau}) - \beta_2 e^{-m/\tau}$$

This model can be seen as a two-factor model ($\beta_{0,t}$ and $\beta_{1,t}$). Since the yields are linear combinations of these two factors, each yield of the curve is a linear combination of any two other distinct yields.

This is an attractive feature of the model since it allows you to get the whole yield curve by knowing the two yields modelled by the core model.[13] This method is very basic compared with the two popular approaches to term structure modelling, namely the no-arbitrage models and the equilibrium models. Nevertheless, it still appears to be relevant in view of the good fit it provides and since our objective is more to build a model able to reproduce closely the dynamics of the series rather than to develop a general equilibrium macro-finance model.

The real yield curve computation is based on the standard equation (eg, Barr and Pesaran (2000)) $r_t^m = y_t^m - be_t^m$ where be_t^m is the breakeven inflation of maturity $t + m$, equal to the sum of the expected average annual inflation between periods t and $t + m$ and of a term resulting from differences existing between nominal and indexed bonds among which stands out the inflation risk premium.[14]

Faced with the absence of consensus regarding the estimation/modelling of the inflation risk premium, and also for parsimonious purposes, the model assumes that the risk premium is equal to 20 basis points (bp) and is constant over the simulation period.[15]

The financing strategies can be seen as reaction functions of the debt manager. Knowing the information available at time t, the debt manager has to choose how to spread the government financing requirements over the different available securities. The simplest conceivable strategy consists in issuing in each period the same proportion of each bond (defined by a vector α), but there is a problem of convergence for the debt composition. As illustrated in Bolder (2003), the previous strategy does not reach a stable debt composition as defined by α. Bolder (2003) shows that the trick is to systematically replace the maturing bonds by ones having the same maturities. Moreover, the presence of inflation-indexed bonds also requires a specific treatment, as, when inflation-linked debt matures, the capital to be replaced is higher than for an equivalent nominal bond, because of inflation accrual.[16]

The model replicates the use of interest rate swaps in order to reach the targeted structure of the debt portfolio as soon as the first simulation period. Using combinations of swaps (mixing plain vanilla swaps with inflation-indexed swap in the present case), the issuer can indeed synthetically modify the debt structure so as to instantaneously match the α target. The structure is then kept constant over time by renewing these swaps at maturity.

AN APPLICATION TO OPTIMAL SHARE OF INFLATION-LINKED DEBT

This simulation framework is used to analyse the effects – in terms of cost and risk – of changes in the share of inflation-linked debt. The considered strategies differ along two directions: the share of inflation-indexed debt (between 0% and 40%) and the average maturity of the debt portfolio (between 5.5 and 7.5 years).[17] Insofar as the aim of the paper is to analyse the impact in terms of cost and risk of the share of inflation-indexed debt, the second direction may appear superfluous. Yet, it is interesting to the extent that it gives an idea of the room for cost minimisation offered by inflation-indexed debt compared with the more "classical" one stemming from decreases in duration.

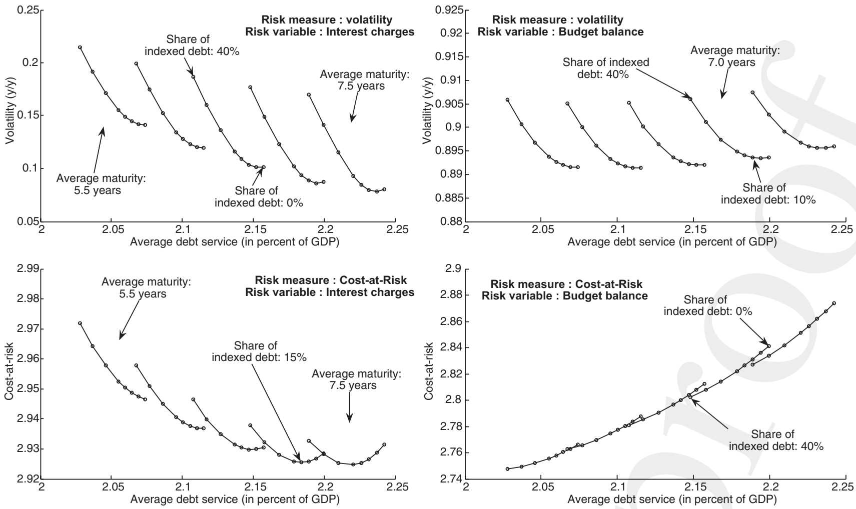
Four risk measures have been considered. Two of them relate to interest payments in percentage of GDP and the other two relate to the budget balance in percentage of GDP (interest payments plus primary deficit). For each of these two variables (interest payments and budget balance), two risk measures, which do not depict the same kind of "variability", are computed. More precisely, while the first – hereinafter referred to as volatility – corresponds to year-to-year variability, the second one – cost-at-risk – refers to lower-frequency variability.[18] Note that some financing strategies can be judged to be risky with respect to one of these measures and not risky with respect to the other one.[19]

After having applied the different strategies under the 10,000 10-year scenarios, these are plotted in cost/risk planes. Figure 22.5 presents the cost/risk planes resulting from MSVAR simulations.

On each cost/risk plane, five curves are plotted. Each curve contains strategies implying the same average debt maturity. On a given curve, the strategies differ according to the share of inflation-indexed debt they result in. The analysis of the shape of these curves suggests that a rise in the share of inflation-linked bonds has the following implications.

(1) A decrease in the average debt interest payments, reflecting the existence of the inflation risk premium: an increase in the share

Figure 22.5 Simulation results: cost/risk planes, MSVAR model



of indexed debt of 40 percentage points yields a decrease in annual interest payments by around 0.05% of GDP. Naturally, this figure depends on the chosen inflation risk premium.[20]

(2) An impact on risk that depends on the chosen cost measure (interest cost or budget balance): we observe a rise in the volatility measure of annual interest payment charges. This risk measure increases more than twofold when the share of inflation-indexed debt passes from 0% to 40% (for both models, VAR and MSVAR). This can be accounted for by the additional volatility introduced in debt charges when more debt is indexed on inflation. However, it turns out that, starting from 0%, an increase in the share of inflation-indexed debt is efficient up to a threshold. Besides, this threshold tends to be higher when the variability of the budget balance is considered: it is close to 10% in this case (for both models) against 5% when the variability of interest payments is considered. Besides, it has to be noted that the rise in volatility is extremely limited – compared with the decrease in average cost – when the share of indexed debt grows but remains below 20% (especially regarding the budget balance variability).[21]

(3) Overall, it appears that a rise in the share of inflation-indexed debt results in a less – if any, depending on the risk measure – harmful impact in terms of budget balance variability than it has on sole interest payment variability: this gives support to the intuition that, to a certain extent, the covariances between payments of indexed bonds and cyclical variations of the primary deficit can be exploited to hedge some shocks affecting public outlays. Besides, these results are fairly robust to the choice of the econometric model (VAR versus MSVAR). By comparing the different curves on each cost/risk plane (one curve stands for one given average debt maturity), one can observe that the previous results only slightly depend on the considered average maturity of debt.[22]

As a result, according to these simulations, if one is more concerned with budget balance variability than with interest payments – consistently with tax smoothing objectives notably (eg, Barro (1979, 1999)) – and is starting from a large average debt maturity and from a low share of inflation-indexed debt, then one should increase the share of inflation-indexed debt (up to at least 10% $\sim$ 20% if the main concern is with budget balance year-on-year change or even more if the main concern is with budget balance cost-at-risk).

THE ITALIAN TREASURY'S EXPERIENCE WITH INFLATION-LINKED BONDS

The Italian Treasury launched its inflation-linked bond program in 2003 after having analysed and prepared this move for quite a long time. The previous experience with linkers was in 1983, 20 years before. It was not really a positive one: the choice of the inflation index, the GDP deflator, as well as its design, with annual coupon, were the main causes for its lukewarm reception by the market.

20 years later a completely different context allowed the Treasury to finally enter this market again as the reasons from a public debt management perspective and a wider economy policy one were all there. Issuing inflation-linked bonds was considered to be a social welfare improving policy as the State is among the few natural inflation receivers in the economy (through taxes) so it is also one of the few who can actually pay inflation. Given the latent

demand for inflation-protected assets in the system, offering them represented a way to provide the economy with a "public good" thereby "completing" markets.

But of course this was a necessary and not a sufficient condition for the Treasury to go ahead. From a pure public debt management perspective these bonds allow the issuer to move its efficient frontier towards the origin in the cost–risk space: by saving the inflation-risk premium components embedded in nominal rates, especially on longer maturities, and by reducing the volatility of the cost of debt in real terms, the diversification effect brought about by this new asset class could have been really significant. There are also additional benefits derived from the possibility of lightening the pressure on nominal bonds in terms of issuance volumes and at least partially contributing to the stabilisation of the debt/GDP ratio, as this ratio heavily depends on the real cost of debt.

Besides the analysis of the demand evolution, aimed at assessing the possibility of launching an actual "program" of inflation-linked securities and not so much a one-shot opportunistic issuance, two additional factors spurred the Treasury to the final decision: (i) the start of European Monetary Union, with its framework clearly aimed at keeping inflation low and stable and (ii) the rise of a significant structural demand for bonds linked to euro-area inflation. By choosing the same linker format – the so-called Canadian model – already chosen other large sovereign issuers such as France, USA and Canada, and by adopting the euro-area harmonized consumer price index (excluding tobacco) as the inflation reference, the Treasury was indeed able to satisfy the demand coming from a very large spectrum of investors and to pursue its goals in terms of issuance activity and the presence of this asset call within the total debt.

In almost five years (from September 2003 to June 2008) around 87 billion euros of BTP€is have been placed in the market both through auctions and syndications. Given the commitment clearly shown by the Treasury to keep the pace of issuance more regular and stable, the appeal of these bonds has steadily grown. Not only have most of the outstanding bonds been placed abroad (normally between 70% and 80% of each placement through syndication has been allotted to non-Italian investors, since the first transaction in September 03), but also the base of investors has significantly

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developed over time. Initially demand came mostly from banks and dealers interested in hedging the inflation exposure they had entered into by issuing retail tailored inflation structured products; then insurance companies and pension funds become more active by hedging liabilities linked to inflation. More recently relative value players (hedge funds and other accounts of leveraged type) have become increasingly present in the sector as the liquidity of the bonds has definitively improved and the inflation swap market has taken off significantly.

Trading these bonds versus conventional ones (on a breakeven inflation basis) versus other linkers or against swap has indeed become increasingly feasible at a lesser cost, thereby attracting new and sophisticated players in the market. The Treasury over time has followed these developments by shaping its program accordingly, in order to continue to achieve its goals in terms of cost and risk. In this respect, new maturities have been introduced and an adequate mix of flexibility (in terms of bonds to be offered each time) and regularity (in terms of issuance frequency and final volume to be reached by each bond) has been adopted in an effort to address the spontaneous evolution of the market.

Assessing the optimal issuance strategy on linkers

Even before launching its program the Treasury focused on existing models aimed at implementing a strategy that could maximise the benefits (or a subset of them) of including linkers in the total central government marketable debt.

Since 2002 the Treasury has analytically studied the link between the government budget and the main macroeconomic variables, such as real growth and inflation. As far as inflation is concerned, a positive and statistically significant relation was found between this variable and the strictly automatic component of the budget: a shock to inflation in a given year translates into a higher primary budget in the same year and in the following four years on the base of specific coefficients (so-called semi-elasticities). Therefore, even if obvious and known from a pure theoretical ground, the study (Maggi *et al* 2005) fully validated the status of the government as a natural inflation payer, being an inflation receiver through taxes, and to some extent it provided the Treasury with a very useful insight to quantify the sensitivity of the public budget to inflation.

However, this kind of approach could not be a practical tool to assess the optimal issuance strategy: first of all inflation was found to be steadily and clearly correlated with the part of the primary balance represented by items that by definition tend to automatically move with macroeconomic variables; with respect to the whole primary budget, including those items that are set discretionarily by the government each year, the relation was much less stable and significant. Even if this result was in no way undermining the above conclusion in which the government is actually a natural inflation receiver, assessing how much larger is the natural inflation hedge coming from tax revenues in the medium- to long-term perspective remained an open issue that was difficult to solve. Moreover, deciding on the volumes of linkers to be placed in the market only on the basis of the "inflation capacity" of the budget is considered to be not exhaustive even within a deficit smoothing approach (Missale 2001): according to this approach the optimal share of inflation-indexed paper should be set according to the sign and level of covariances among the main macroeconomic variables affecting the government budget (real interest rates, GDP real growth, inflation and so on). However, this policy recommendation has turned out to be rather difficult to implement because, in particular, these covariances are not stable over time, which is a feature that does not fit with the characteristics of the Italian Government debt, as its size does not allow for rapid and large changes in its composition.

In parallel with the deficit smoothing approach, the issue regarding how to assess the optimal strategy on linkers has also been analysed within the traditional cost–risk portfolio theory approach and more recently within the optimal control approach that the Treasury has also adopted since 2004.[23] This last approach relies on a cost of debt function based on the generation of several interest rate scenarios: since the introduction of inflation-linked bonds for each generated nominal yield curve scenario, the model generates a consistent breakeven inflation curve scenario. In a first period this was achieved through a "backward looking" model whereby European inflation rate and the European Central Bank (ECB) repo rate were linked through a response function: on the basis of historical data, the user could introduce into the model several evolution paths for European inflation and automatically generate as many correspondent (and consistent with the past) ECB rate paths. No particular assumption was made about differences in the evolution of the actual inflation rate and breakeven inflation rate, nor was a term structure for breakeven inflation rates introduced.

The model was then dramatically improved by adopting a value-at-risk approach whereby the term structure of nominal rates and breakeven inflation rates, the short term interest rate and the European inflation rate were generated through a system of structural equations of the economy with some exogenous constraints introduced in order to take into account stylised facts emerging from time series of these variables (such as a lower volatility of real interest rates than nominal and an almost linear shape of the breakeven term structure). However, when the VaR model was calibrated with more recent data (from 2007 onwards) some of its matrices did not fulfill some necessary conditions (mainly to be definite positive): this showed that the fit of the model with actual data was not satisfactory, especially if the abovementioned constraints had to hold.

The current version of the model is quite different from that of the past in the way nominal interest rates and breakeven inflation rate are now generated. The nominal yield curves are now generated through a Nelson and Siegel approach with few stochastic parameters, while breakeven curve paths are derived in such a way that they are correlated with nominal rates on the basis of historical correlations. Breakeven rates at different maturities are related to each other in order to give rise to an almost linear term structure with a given slope. That slope can be changed on the basis of specific assumptions regarding the inflation risk premium at different maturities.

Until mid-2007 this version of the model had brought about very useful results that had helped the Treasury to assess its issuance policy concerning both nominal securities and inflation-indexed bonds.

It is still unclear whether the large financial turmoil that started in August 2007 and the recent new inflationary environment (at a world level) may have weakened the performance of the model. Its calibration with data updated through summer 2008 so far has not given clear results.

Revised Proof Ref: IRaP September 19, 2008

1 The percentage target in the current (2008) guidelines is 25%, but this reflects a modification in the way the debt is measured for guideline purposes, not an intention to increase the exposure to inflation.

2 Sweden maintains a foreign currency debt (with a target share of 15%), also based on the diversification effect of adding more debt classes to the portfolio.

3 In the most recent period (late 2007), breakeven levels have been above the inflation target, probably reflecting to some extent that significant budget surpluses reduce the issuance of inflation-linked debt in Sweden to a very low level.

4 There are reaction functions in the model, but they describe current policy rules regarding inflation and the budget, not how these rules would be modified in the event of a severe shock.

5 The model is presented in an appendix to the SNDO's guideline proposal for 2007; see Swedish National Debt Office (2006).

6 This assumption is also reasonable for a financially highly open economy and is in line with the emphasis on the diversification effects of different debt classes mentioned in the introduction.

7 As it is hard to separate the stochastics in many financial data series from pure random walks, we also tried random walk processes for interest rates and exchange rates as a test of strategy risks in such extreme circumstances. The experiment did not lead to different conclusions compared with the autoregressive specification.

8 The model is presented in an appendix to the SNDO's guideline proposal for 2005; see Swedish National Debt Office (2004).

9 This growing demand can partly be accounted for by some regulatory changes regarding insurance company and pension funds (see Garcia and van Rixtel (2007)).

10 The model assumes that inflation, the primary deficit and yield curves (the nominal and the real curves) are exogenous to the debt manager. That is, the feedback effects from debt management to the macroeconomic environment are not modelled. As long as the differences implied by the different strategies are not too large, such an assumption should not impact the assessed hierarchy of the strategies in terms of cost and risk.

11 The choice of a quarterly frequency is accounted for by at least three reasons. Firstly, the econometric estimation of the model requires long enough series, hence ruling out the annual frequency. Secondly, the cyclical primary deficit is modelled as a function of the output gap. Therefore, and since GDP is a quarterly series, higher frequencies are ruled out. Thirdly, this frequency appears to be consistent with our problem, since the shortest maturity that is considered is a three-month one.

12 When GDP is lower than its potential, a fiscal income deficit and a surplus of public expenses (notably due to a rise in unemployment compensations) occur. On the contrary, when the GDP is larger than its potential, a surplus of fiscal and social receipts, as well as lower expenses are observed. This is known as the automatic stabiliser.

13 The constant parameters entering the last equation, namely τ and β_2, are obtained in order to minimise the squared errors along the yield curve, using monthly data spanning 1991M12–2007M4. This explains 98% (on average) of the variance of 12 benchmarks yields for maturities ranging from three months to 30 years.

14 The inflation expectations are consistent with the core model that is used (VaR or MSVaR).

15 Empirical estimates span quite a wide range, from 10bp (Hördahl and Vestin 2005) to 220bp (Foresi *et al* 1997). Our base scenario involves a constant value of 20bp for the risk premium, which is consistent with the results of Cappiello and Guéné (2005) who studied French long-term bonds over the period 1985–2003.

16 The idea is that when an inflation-linked bond matures, it is replaced by a bond having the same features for an amount equal to the nominal of the bond, and the remaining capital (equal to the inflation accrual) is replaced by a combination of bonds reflecting α.

17 At the end of 2006, the share of inflation indexed debt (in French government negotiable debt outstanding) was around 13% and the average maturity was seven years.

18 More precisely, the cost-at-risk is computed here as the lower bound of the interest payment (or deficit) obtained in the worst 10% scenarios.

19 For instance, consider a financing strategy whose implementation results in smooth but sweeping debt services over time: such a strategy is a safe strategy if one is concerned about year-to-year variability, and a risky strategy if one is concerned about the probability that the debt service reaches a concerning level in a given number of years.

20 The simulations have also been carried out with a 10bp inflation risk premium. The results were qualitatively the same but naturally the (government) saving associated with an increase in inflation-indexed debt is approximately divided by two.

21 There is a very limited effect on the variability of interest payments when variability is measured by the cost-at-risk and a little decrease in cost-at-risk applied to budget balance. In the MSVAR case, for instance, increasing the share of inflation-linked debt from 0% to 40% yields a decrease in the budget balance cost-at-risk of less than 0.04% of GDP (versus 0.05% regarding the budget balance cost-at-risk when the core model is a VaR).

22 Furthermore, it can be noted that a two-year decrease of the average debt maturity (from 7.5 to 5.5 years) reduces average annual interest payments by about 0.15% of GDP but yields a 50% rise in interest payment volatility and an increase in the interest payment cost-at-risk of about 0.10% of GDP in the VAR case and 0.03% of GDP in the MSVAR case. While the decrease in cost obviously comes from the positive average slope of the yield curve, the rise in risk can be accounted for by two phenomena: firstly, the refinancing risk is larger when more short-term bonds – which have to be refinanced more often – are issued and secondly, shorter interest rates are more volatile than longer ones. Meanwhile, the same change in average debt maturity results in slight decreases in budget balance variability measures.

23 For the details of the model please see Amado *et al* (2004). Over time, as mentioned also in text, the model has undergone some major refinements as the generation of yield curves is concerned. Therefore, a new version of the paper will be issued in the near future.

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Q1

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Q1 (page 24):
Amado 2004: Please give volume and page numbers, and also author initials