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Debt and Interest Rates: The U.S. and the Euro Area

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Abstract:

We find that real interest rates paid on government debt depend significantly upon current and expected future levels of debt, in Europe as in the US. But this result only emerges when we condition on foreign interest rates, illustrating financial international integration. The previously strong effect of debt on US interest rates has been diluted by the addition of 2004-2006 data to the sample, perhaps reflecting the effect of massive purchases of US securities by foreign central banks. Another finding is that the asymmetry in the effect of US interest rates on European interest rates has not disappeared with the coming of European Economic and Monetary Union in 1999, as one might have thought.

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1. Introduction

How has European monetary integration affected the determination of interest rates both within and without the euro area? This question comprises a number of empirical and policy debates. To the extent that the dismantling of the legal and regulatory impediments to capital controls, accompanied by decreases in transactions costs, has resulted in an essentially integrated pool of financial capital, one might think that there is but a single world interest rate.

In taking up this question, we also address two other issues. The first has to do with the achievement of European Economic and Monetary Union in 1999. In the past, US interest rates have had a greater influence on rates in Europe than the influence of European interest rates on the United States, even though the European economies in the aggregate are roughly as large as the United States – larger, if one includes the non-euro members of the European Union.[1] One explanation has been that the asymmetry arose from strategic interaction between one central bank in the United States versus 15 central banks in Europe. The US has had a first-mover advantage (which game theory could model as a Stackleberg equilibrium), and the European monetary authorities have been left with "take it or leave it." A second, not inconsistent, explanation for the asymmetry arose from the fact that European policy-makers were more sensitive to their exchange rates, because their countries were more open to international trade as a share of their GDPs (which in turn is primarily because they are smaller, and secondarily because they are close together, while the US has fewer natural trading partners).

[1] Furthermore, US interest rates have had a greater influence on third countries – especially those in the Western Hemisphere and East Asia – than have European interest rates. E.g., Chinn and Frankel (1994) and Frankel and Wei (1995).

Each of these two explanations should have disappeared since 1999. That the ECB now speaks for all 12 euro countries should have obviated the first explanation. That the euro area as a whole is no longer substantially more open to trade than the United States should have obviated the second explanation. Thus the year 2007, when we have the benefit of seven years of experience with EMU, is a good time to see if the asymmetry of US dominance remains, or if Europe is taking on a more central role in world financial markets.[2]

The other topical issue concerns the role of fiscal policy. One might have thought that the debate over whether fiscal policy affects interest rates would have been settled by now. But the issue has taken on renewed controversy in the light of a current domestic debate in the United States regarding the 2001 and 2003 tax cuts and the associated budget deficits. Gale and Orszag (2003) review the literature regarding effects of current and expected future budget deficits on interest rates,[3] and conclude:

> "…studies that (properly) incorporate deficit expectations in addition to current deficits tend to find economically and statistically significant connections between anticipated deficits and current long-term interest rates." (p. 20)

But others strongly disagree with many of these studies, and with Gale and Orszag's overall characterization of the state of empirical evidence. Looking at additional European data may shed additional light on this unsettled debate. Perhaps the major incremental contribution of this paper is to make a first attempt at measuring the effect of

[2] That the United States has gone deeply into net international debtor position is another reason to ask if its dominance over international financial markets may have diminished over time.

[3] To some observers, the tax cuts enacted by the Bush Administration seem unusually designed to lose tax revenue in the long run, relative to the fiscal stimulus delivered in the short run. Thus the distinction

expected future euro-area budget deficits on European interest rates, in the manner that others have done for the United States. Furthermore, it is not just the long-run fiscal outlook in the United States that is deteriorating; many European countries face even larger future fiscal demands from the next generation of retirees. Meanwhile, the Stability and Growth Pact that was supposed to limit European fiscal deficits appears to be coming unravelled. Thus the up-to-date international evidence on interest rate determination should be equally useful on both sides of the Atlantic.

These two issues – trans-Atlantic monetary transmission and the effects of deficits on interest rates – are conveniently addressed in the same study. That is because interest rates are determined by multiple factors. Indeed it will turn out in our results that conditioning on foreign interest rates is essential for uncovering the effects of domestic debt.

The importance of taking into account multiple factors seems obvious. But perhaps it needs to be stated explicitly, in that the official response of the Bush White House to critiques of its fiscal policy was that "interest rates do not move in lockstep with budget deficits."[4] This proposition is of course true: because interest rates are influenced by a number of factors, including most plausibly the cyclical position of the economy, monetary policy, and international influences, interest rates can often be observed to change at times when fiscal policy has not changed, even under the

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between current deficits and expected future deficits may be more relevant now than in the past.

[4] This was the sentence crafted by Glenn Hubbard, as Chairman of the Council of Economic Advisers, to be used for media consumption, presumably because to the public it would appear to be consistent with the Reaganite claim that deficits would have no effect on interest rates and thus would not lead to crowding out of investment. At the same time, he designed a response for a professional readership to the effect that the quantitative effect of budget deficits on interest rates, though positive, is small, because that is all it takes to crowd out the capital stock in a standard economic framework: "the $1.3 trillion in tax relief included in EGTRRA [the Economic Growth and Tax Relief and Reconciliation Act of 2001] would raise interest rates by only about 19 basis points." Hubbard (2002) and Council of Economic Advisers (2003).

hypothesis that government borrowing causes interest rates to be higher than they otherwise would. Our regression analysis of long-term interest rates will include a variety of factors, including expected future deficits, cyclical position, and cross-Atlantic influences.

In each case -- the nature and extent of international macroeconomic spillovers and the transmission mechanism for monetary and fiscal policy -- the ultimate motivation concerns effects on real economic activity. Long term interest rates are thought to matter for economic activity more than short rates. Indeed, expected future budget deficits should in theory matter for long-term interest rates, not short. But most statistical studies that emphasize international linkages deal only with short-term interest rates. This paper concentrates primarily on long-term rates. Of course it is long-term *real* rates that should matter, more than nominal rates. Accordingly [and notwithstanding that inflation has been more stable in recent years than in the 1970s and 1980s], our analysis will account for the role of inflation.

We arrive at the following conclusions:

- Countries' real and nominal rates appear to have substantial idiosyncratic components, rather than being solely affected by global factors.
- Interestingly, while U.S. interest rates appear important for determining European rates, the reverse is not true, suggesting that the United States, up to this point, still dominates world capital markets.

- For the US, current and expected future debt to GDP ratios appear to influence real long term interest rates over the 1988-2002 period. Expected changes in the debt to GDP ratio are not statistically significant when the sample is extended to include 2006. The significance of expected debt changes rises when one econometrically accounts for the large purchases of US Treasury bills, primarily undertaken by East Asian central banks beginning in 2003.

- A measure of expected future European deficits does have an effect on European long-term interest rates. This is one more piece of evidence that government borrowing has an effect on interest rates, and presumably crowds out components of private demand.

2. Review of the Literature

We take tackle the issue of the medium-run determinants of real interest rates. The central issue will be the relative importance of *identifiable* global versus national factors. The question of whether interest rates are determined in national or global markets has been a source of debate over the past few years. On one side are those who view the capital market as a single pool of funds for the OECD countries (Ford and Laxton, 1999). Sometimes, in fact, the complete integration of the capital markets is taken as given, as in Barro and Sala-i-Martin (1990). On the other side are those who aver that, while global factors are important, national factors retain a key importance (Christiansen and Pigott, 1997; Breedon et al., 1999).

The methodology underlying the tests for national versus global factors is quite straightforward. The government bond rate is related to own-country variables, after controlling for either the inflation rate or the short rate. This relation is augmented by either a proxy for global variables, foreign interest rates, or both. Hence, the regressions take the form of:

$$r_t = \beta_0 + \beta_1 X_t + \beta_2 Z_t + u_t \qquad (1)$$

where r is the national real interest rate, X includes domestic factors and Z includes global factors.

Ford and Laxton (1999) examine one year off-shore real (ex post) interest rates for eight OECD countries over the period December 1977 to December 1997. Essentially, they place own country debt to GDP ratio in X, OECD-wide debt to GDP ratio, and OECD-wide government consumption to GDP ratio (and change therein) in Z. They find that the OECD-wide variables explain a large proportion of variance in national real rates, with adjusted R-squared ranging from 25 to 60 percent (Denmark and Germany respectively). OECD-wide debt is always statistically significant, as are the changes in aggregate consumption (the levels are significant about half the time). The statistically significant coefficient estimates on OECD debt range from 0.23 to 0.45 (Germany and the UK, respectively). Their panel estimate of the effect is 0.23 for all eight countries in the sample, and 0.18 for the European countries of Belgium, Denmark, Germany, Netherlands and Switzerland.

The inclusion of own country debt should yield statistically significant positive coefficients under the "national factors matter" view. In fact they do occasionally

(Belgium); but more often the significant coefficients have a negative sign, which is surely counterintuitive.

Their finding that aggregate debt and consumption matter is robust to the addition of other OECD-wide variables including the *growth rates* of the labor force, employment, GDP, labor productivity, net public debt and GDP inflation.

Breedon et al. (1999) find, in contrast, a substantial role for domestic factors. Examining the G-3 economies over the 1975q2-1988q4 period,[5] they estimate the regression:

$$r_t^{\ell} = \gamma_0 + \gamma_1 d_t + \gamma_2 d_t^{w} + \gamma_3 r_t^{s} + \gamma_4 r_t^{\ell,w} + u_t \qquad (2)$$

where r^{ℓ} ($r^{\ell,w}$)is the national (global) real interest rate, d (d^{w}) is the national (global) debt to GDP ratio, and r^{s} is the short term national real interest rate.

They find that own-country debt to GDP matters, while OECD-wide debt matters as well, although the effect on Japan's real interest rate is perverse. That is a rise in OECD-wide debt to GDP induces a decline in Japanese real interest rates. In all cases, either one or two of the other country long term real interest rates are also found to be a statistically significant determinant of local interest rates.

To an extent, the results of this study are more relevant for our purposes as the authors examine long term real rates, rather than short term rates. However, there are two caveats to keep in mind here. First, in that Breedon et al. examine the three largest economies in the world, one would expect local factors to be important. Second, because of the limitations imposed by using ex post real rates, the sample encompasses a period

[5] The sample is truncated at 1988 because the authors use ex post 10 year real interest rates.

(1975-88) of capital account regulation and liberalization, and omits the most recent period when it is believed that capital has become increasingly mobile.

Most recently, Ardagna et al. (2004) have examined a similar question to ours – namely the effects of public debt and deficits on long term interest rates in a panel of 16 OECD countries. They find that a one percentage point increase in the primary deficit leads to a 10 basis point increase in the long term rate, while public debt has a nonlinear effect. At low levels of debt, increasing debt ratios cause a decrease in long term interest rates, while at higher levels, debt causes elevated interest rates.

One factor that is omitted from all previous cross-country studies of the interest rate-debt nexus, including the Ardagna et al. study, is the role of expectations regarding deficits and debt. We cited the Gale-Orszag survey at the outset. Among the many relevant studies, two examples are particularly recent and relevant. Canzoneri, Cumby and Diba (2002) find that changes in the 5 year and 10 year ahead forecasted budget deficits result in a statistically significant increase in the spread between short term and long term interest rates (which they interpret in light of the fiscal theory of the price level). Laubach (2003) finds robust evidence of a relationship between 5 year and 10 year ahead projected deficits and debts and the level of long term real interest rates in the United States.

3. Cross-Country Evidence

We compile data on the Euro area economies of the Germany, France, Italy and Spain. Taken together, these countries comprise 80% of Euro area GDP (in 2003q1). We

also examine data for the US, UK, and Japan. The variables of interest are the net debt to GDP ratio, long term interest and inflation rates.

One key constraint is the difficulty in estimating expected future deficits and debt. For the United States, future deficits are projected in official bi-annual government forecasts. But other OECD countries do not appear to have produced a consistent series on projected deficits. The EU countries currently report short-horizon budget deficit projections, but these appear to be a relatively new innovation. Hence, we use the two-year ahead OECD projections of budget deficits and net government debt reported in issues of the OECD's semi-annual publication *Economic Outlook*. Various studies have evaluated the time series properties of these forecasts for GDP and inflation, and have generally concluded that they are unbiased predictors.[6] On the specific issue of fiscal forecasts, Artis and Marcellino (1998) find that the OECD projections are relatively accurate.

To be more specific, we use the December forecasts for each calendar year. For instance, the December 1998 forecast for two years ahead pertains to the year-2000 budget deficit and net debt. To retain comparability with some theory, and especially with previous cross-country studies, we focus on net government debt, rather than budget surpluses.[7]

The regressions we implement are of the form:

$$i_t^{\ell} = \gamma_0 + \gamma_1 \pi_t + \gamma_2 d_t + \gamma_3 E_t(d_{t+2} - d_t) + \gamma_4 \hat{y} + \gamma_5 i_t^{\ell,W} + u_t \qquad (3)$$

[6] See Koutsogeorgopoulou (2000) for an assessment of forecast biases and precision of the OECD projections for GDP growth, inflation and current account balance. The debate over the relative performance of OECD and private sector projections was sparked by Blix et al. (2001) and Batchelor (2000).

[7] Kitchen (2002), as cited by Gale and Orszag (2002), argues that the current full-employment budget surplus is highly correlated with the projected full-employment budget surplus, so little is gained by

where i^{ℓ} denotes a long term interest rate, π an inflation rate, $\hat{y}$ the output gap, and E_t (.) a subjective expectations operator. In the baseline specification, we use the lagged one year inflation rate as a proxy measure for expected long term inflation.

The nominal long term interest rates are depicted in Figure 1. The clear convergence in rates would seem to obviate the need for further analysis. Two points are important. First, annual averages of data obscure the differentials that still exist. Second, and perhaps more important, real rates have not converged by similar amounts, as displayed in Figures 2 and 3.

The logic underlying this specification is straightforward. Expected inflation becomes built into the long term nominal interest rate. The effect is one-for-one under the Fisherian model. But this need not be right. On the one hand, many models imply incomplete adjustment, at least in the short run (e.g., due to sticky prices or a sticky capital stock), while, on the other hand, some models imply that the effect of expected inflation on the interest rate is *more* than one-for-one (the Feldstein-Darby-Tanzi effect, which results from the income tax). For this reason, we do not always constrain the inflation coefficient to be one in our equations.

With risk aversion, it is possible that there is an additional premium as well. Government debt-to-GDP, in the absence of complete Ricardian equivalence, has an impact to the extent that government financing crowds out private spending. The same argument applies to expected future debt. The output gap enters in as a summary measure of private sector demand for savings. Finally, the "world" interest rate enters to capture

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including expected variables in addition to the contemporaneous value.

international factors. For the non-US economies, we use the US long term interest rate; for the US, we use the German interest rate.

One limitation imposed by the use of expectations data is that we can estimate the regressions only over the 1988 to 2004 period. Prior to 1988, the OECD did not report two-year ahead debt projections; furthermore only one year-ahead budget surpluses were publicly available.

Another key issue pertains to the appropriate modeling of expected inflation. Sack (2001) observes that the implied long term inflation rate derived from the spread between inflation-indexed instruments and nominal counterparts covaries strongly with the one-year inflation rate. Hence we believe the adoption of one-year lagged inflation as a proxy measure for future expected inflation is as plausible as other alternatives.

The basic set of regressions implemented in Table 1 include only domestic variables, as if we were had not entered a financially interdependent world. It is clear that omitting foreign interest rates yields dismal results, except for the United States, and to a lesser extent, the United Kingdom. In the case of Germany, for instance, the inflation coefficient is near zero, while the current debt-to-GDP ratio coefficient is significantly negative. The expected change in the debt-to-GDP ratio does have the correct sign, as does the output gap. However, the change in debt variable performs less well for France (although better for Italy and Spain). Constraining the inflation coefficient to unity – i.e., assuming that the Fisherian relationship holds – results in equally poor results for the German and French economies (these results not reported). For Italy and Spain, the coefficient estimates on the projected change in the two year debt-to-GDP ratio are large.

It is statistically significant for Spain. Nonetheless, the equation estimates for these countries cannot be judged successful or complete.

For the United States, the results are mixed, regardless of whether the inflation coefficient is freely estimated or constrained to unity. While the output gap and the current debt-to-GDP are statistically significant, expected changes in the debt ratio are not (Column US (1) in Table 1). If one constrains the slope coefficient on current and the expected change in the debt ratio to be the same (Column US (2)), then the debt variable is significant, and indeed more statistically significant than if the current debt variable were entered alone.

It is also noteworthy that the lack of significance is sample-specific. When the sample extends only up to 2002, the expected change in the debt ratio does enter with significance (results not reported). This finding suggests that special factors prevailing in 2003 through 2006 are at work. An obvious candidate is the large purchases of US Treasury securities by East Asian central banks over the past couple of years. The correlation between the mis-prediction of the US ten year yields and intervention defined as gross purchases of Treasury securities, divided by US GDP, is depicted in Figure 10. In Column US (3), the regression is augmented by a proxy for this factor. Now the coefficient on the expected debt ratio is positive – although not significantly so – and the proxy for intervention enters in negatively as expected.[8]

Another way to evaluate this hypothesis is to estimate the equation in Column US (1) over the 1988-2002 period, and then compare the out-of-sample prediction for 2003-04 against the actual value. The prediction series is depicted in Figure 4 as the "fitted

[8] The US balance of payments data do not completely align with IMF reported statistics on the change in the quantity of holdings of US dollars. We conjecture that appealing to IMF data might provide better

yield". The estimated equation over-predicts the actual 2006 value of 4.81 percent by 2.13 percentage points.[9]

In Table 2, the constrained regressions are augmented with world factors – in this case the US interest rate for non-US countries, and the German rate for the US. Interestingly, the results are now much more in accord with the maintained hypothesis – that both global factors and domestic factors matter. In all non-US cases but two, the coefficients are correctly signed.[10] (The results do not differ substantially depending upon whether the inflation coefficient is restricted, so we only report the constrained regression results).

The debt-to-GDP ratio coefficient for Germany is -0.03 (not significant), while that on the change in the ratio is -0.10. The French results are more in line with priors, with both the current debt ratio and the expected change in the debt ratio coming in as significantly positive. Although the Spanish debt ratio coefficient is not significant, at 0.06, the estimate for the future change is quite large (0.31) and highly significant. However, overall there is a large degree of imprecision in all the estimates. In the case of the UK, only the US interest rate comes in significantly.

The small size of our data sample argues that we should exploit the information in the cross section as well as that in the time series dimension. Consequently, we present in

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results, but reserve investigation of this point for future research.

[9] The interest rate the OECD estimated rate as of November. Note that the standard error of the regression is 0.00639, or 0.64 percentage points. A two standard error bound implies that the fitted value is significantly different from the actual. In addition, a Chow forecast test rejects the no-break hypothesis for 2003 at the 5% level. The behavior of the long term bond market is also considered aberrant by industry observers; see for instance Dudley et al. (2004). Wilson and Fiotakis (2004) attribute the deviation more to the effect of intervention on the expected depreciation of the dollar as opposed to the direct effect on the stock of debt.

[10] Inclusion of the German interest rate makes no material change to the results for the US; the German interest rate has a small coefficient estimate, which is not statistically significant. This result confirms the irrelevance of non-US factors over this sample period.

Table 3 panel estimates of equation (3), using pooled data for France, Germany, Italy and Spain. The regressions include fixed effects, and significance levels are calculated using heteroskedasticity consistent standard errors. Scatterplots of the real interest rate against the debt-to-GDP ratio, the change in the 2 year ahead expected debt-to-GDP ratio, and the output gap are presented in Figures 5-7.

In the column 1, the results from a specification allowing free estimation of the inflation coefficient, and no world effects, is reported. [11] The point estimate on the inflation variable is within two standard errors of unity. However, we obtain insignificant coefficients on the debt, expected debt and the output gap variables. Inclusion of the US long term interest rate (column 2) yields much more encouraging results. The inflation coefficient is now closer to its posited value, while both the debt-to-GDP ratio and projected change are significant. The US interest rate is strongly related to the national long term rate with a near unit coefficient.

The output gap variable does not appear to be statistically significant (and as we know in the time series regressions has inconstant behavior). Omitting the gap variable (column 3) does not yield appreciably different results. Constraining the inflation rate coefficient to unity, while including the US rate, also produces plausible coefficient and statistically significant estimates on both debt variables. Current debt has a coefficient of 0.05, while the projected change in the debt ratio obtains a coefficient estimate of 0.11 (column 4). All coefficients are statistically significant.

[11] We have sidestepped the issue of nonstationary time series. In general, most of the annual series fail to reject the unit root null using the standard ADF statistic, an unsurprising result given the brevity of the sample. Cointegration tests are similarly uninformative. If we estimate the first difference counterparts to these regressions, one finds that the general outlines remain the same, although the significance level drops for the debt variables, and increases for the output gap. Reassuringly, the panel regressions estimated in first differences yields results similar to those in Table 3.

Even though there is no direct translation of the two-year ahead forecasts to five-year ahead for these countries, one can make a guess at the relationship using the US data. The slope coefficient of the regression of the 5-year-ahead change in the debt-to-GDP ratio forecasted by the US Congressional Budget Office (CBO) on the OECD's 2 year ahead change yields a coefficient of approximately 2.27.[12] Now, the point estimate on the quasi-5 year ahead debt-to-GDP ratio is 0.058. For the sake of contrast, Laubach estimates the corresponding relationship for the US (over 1985-2002) of 0.053. Extending this relationship between 2 year and 5 year ahead estimates to the other four countries, one obtains point estimates on the quasi-5 year ahead debt-to-GDP ratio of between 0.047 and 0.049 (standard errors of 0.13 and 0.14, respectively).

Returning to the use of our 2 year ahead projections, we now test for whether the US interest rate is merely proxying for an aggregated measure of debt, as suggested by Ford and Laxton (1999), who used G-7 debt. In column (5), we re-estimate the panel for the four countries, replacing the US interest rate with the OECD debt ratio. In this sample (which differs from that studied by Ford and Laxton and Breedon et al.), the OECD debt ratio has a perverse sign. Then, the only variable with statistical significance is the inflation rate.

In sum, it appears that real interest rates depend upon domestic government debt and expected future debt. While international factors do matter, the finding that OECD debt does not enter robustly suggests that the role of world debt is more complicated than that assumed in our specification. The relevant international factor appears to be the US capital market, as represented by the US rate.

[12] Thomas Laubach kindly provided the data used in his paper. Estimate from an OLS regression with no constant. The point estimate is 2.27 (standard error of 0.50), with R^2 of 0.49, SER of 0.060, and DW of

These findings are striking, especially when placed in the context of the existing literature. However, it is important to observe that the evidence pertains to a long period of 16 years, of which only four years of post-EMU data are encompassed. In the most recent period, these country-specific effects must surely have shrunk for euro area countries. So while Hartmann et al. (2003) claims that "the integration of government bond market has advanced less than is the case for money market", the yield spreads are now quite small relative to pre-EMU – on the order of 10 to 30 basis points, as opposed to multiple percentage points in 1988.[13] This observation suggests that Euro area wide debt might now be more important post-EMU. Unfortunately, this effect cannot yet be discerned empirically.

We have examined how debt and expected debt affect the level of the interest rate. There is a literature that focuses on the determinants of the spread between the long term and short term rate (see Canzoneri, et al., 2003). In the current context, there is some reason to believe that the spread is related to the expected change in debt; Figure 8 depicts the time series for these two variables for the US.

We investigate how the spread between the 10 year yield and short term rate responds to our debt measures in this sample of countries. The results are reported in Table 4. Simple OLS regression results are reported for the US and UK, and a fixed effects panel for the continental European countries of France, Germany, Italy and Spain. The results indicate that the current debt matters for the four continental European countries in our sample, and for the UK, although not for the US. Expected debt changes matter for the US and UK. Consequently, while the American relationship between

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1.07. Sample period 1988-2002.

[13] See Figure 8 in Hartmann et al. (2003), p. 22 for a depiction of all Euro area interest rates.

expected debt and the *level* of the interest rate has been obscured in the last few years, the link to the term spread has remained in place.

4. Conclusion

Government bond markets returned to the fore in 2003 and 2006. We expect that attention will remain fixed upon yields in these markets for some time. In the United States, the policy-induced change in the cyclically-adjusted budget balance from surplus to deficit is likely to collide with additional financing demands from the private sector. The vast purchases of US Treasury securities by East Asian central banks have perhaps only delayed that day of reckoning.[14] In the Euro area, the impending increases in public expenditures associated with populations that are aging even more rapidly than in the US will also put upward pressure on debt stocks and hence interest rates.[15]

Our analysis indicates that over the past three decades, short and long term interest rates have been driven more from the US side than the European side. However, since European Monetary Union went into effect, long term real rates in both the United States and the Euro area have tended to move in such a manner as to close any gaps that open up between them. This is suggestive of two-way influences, although a structural economic model is necessary to make a stronger conclusion.

Conditioning on foreign interest rates enables us to discern more sharply the domestic influences as well. One key contribution of our study is the finding of a role for actual levels and expected changes in national stocks of government debt over the past 17 years, thereby extending to Europe a result that others have found for the United States.

[14] Here we are in disagreement with the thesis forwarded by Dooley et al. (2003), and their succeeding

The fact that global debt stocks do not explain particularly well the evolution of country-by-country real interest rates indicates that long term government debt is not perfectly substitutable. Unfortunately, we are unable to determine whether this characterization has changed since monetary union. For example, aggregate Euro area debt might now better explain the real interest rates for the long term government debt of Euro area governments. But, for now, we have too few observations to address this conjecture.

papers.

[15] See EEAG (2003) and European Commission (2001).

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Appendix 1: Data Sources, Description and Calculation

Raw Data

Interest rates. Money market rates are collected from IMF, *International Financial Statistics*. Quarterly series are end-of-period interest rates. With the exception of the Euro area and Spanish rates (drawn from *IFS*), the long term benchmark bond rates were provided by Marjorie Santos of Data Bank Services, Monetary and Economic Department, the Bank for International Settlements, July 29, 2003. They update earlier series drawn from the BIS database from the Federal Reserve System (see Chinn and Meredith, 2004). (The 2003q2-2006q3 data are drawn from *IFS* long term bond series). The specific series are as follows:

Euro area: Monthly average of daily data, yield calculated using harmonized 10 year government bond yields, weighted by GDP. Source: ECB.
France: Monthly average of daily data, secondary market yields on 10 year (benchmark) government bonds. Source: Bank of France.
Germany: End of month data, secondary market yields on 10 year public bonds. Source: Bundesbank.
Italy: Monthly average of daily data, gross yields on 10 year (benchmark) government bonds. Source: Bank of Italy.
Japan: End of month data, bond yields on 10 year (benchmark) government bonds released by the Japan Bond Trading Co. Source: Bank of Japan.
Spain: Simple monthly average of daily yields on bonds with over two years maturity. Source: Bank of Spain.
UK: End of month data, gross (before tax) calculated redemption yields. Source: Bank of England.
US: End of month data, interest rate expressed on a bond equivalent basis, constant 10 year yield to maturity. Source: Federal Reserve Board.

In the annual regressions, the interest rates are averages of the quarterly series.

Prices. Prices are measured as CPI's, obtained from IFS, accessed January 2007. In the case of the Eurozone, the CPI is a harmonized CPI over the 1998q1-2006q3 period. For the earlier period, the CPI is a GDP-weighted CPI series provided by Bernd Schnatz.

Debt and deficit series. The actual net government debt-to-GDP series and budget surplus-to-GDP series (observed and full employment) are collected from the December 2006 *OECD Economic Outlook*. Projected one-year and two-year ahead series are collected from December issues of *Economic Outlook*, 1987-2006. Net government debt (net government liabilities from 1994 onward) differs from gross debt as the government's financial assets are taken into account. Net government debt and projected net government debt for the OECD are drawn from the December 2006 issue for the 1995-2006 period; from the December 2005 issue for earlier years. The current and 5 year ahead debt-to-GDP ratios reported by the CBO were provided by Thomas Laubach of the Federal Reserve.

Output gap. The output gap series is drawn from the December 2006 *OECD Economic Outlook.*

Derived Series

Inflation rate. The quarterly inflation rates are calculated from 4-quarter changes in the national CPIs. In the annual regressions, the inflation rates are the average of the quarterly rates.

Real interest rate. In the baseline specification, the quarterly real rates are calculated as nominal interest rate minus corresponding inflation rate. In the annual regressions, the interest rates (both nominal and real) are the average of the corresponding quarterly rates.

Table 1
Determinants of long term interest rates: inflation, debt and output gap, 1988-2006

	US (1)	US (2)	US (3)1/	Germany	France	Italy	Spain 2/	UK
Constant	-0.021	-0.000	-0.005	0.086***	0.105***	-0.005	-0.082***	0.084***
	(0.01)	(0.009)	(0.011)	(0.006)	(0.012)	(0.102)	(0.023)	(0.024)
Inflation	0.915***	0.917***	0.894***	-0.060	0.430	2.236***	2.208***	0.627**
	(0.179)	(0.227)	(0.125)	(0.072)	(0.291)	(0.095	(0.337)	(0.237)
debt ratio	0.119***		0.098	-0.083**	-0.164***	-0.009	0.185**	-0.117**
	(0.028)	0.076***	(0.022)	(0.015)	(0.026)	(0.109)	(0.044)	(0.049)
		(0.031)						
expected change in debt ratio	-0.121		-0.028	-0.011	0.078	-0.392**	0.216**	-0.124
	(0.111)		(0.084)	(0.026)	(0.081)	(0.148)	(0.097)	(0.110)
Output gap	0.091	0.260**	0.090	0.308***	-0.111	-0.876*	0.364**	-0.604
	(0.263)	(0.259)	(0.176)	(0.100)	(0.278)	(0.403)	(0.157)	(0.375)
Intervention			-0.708***					
			0.175					
N	19	19	19	19	19	19	19	19
Adj.R^2	0.64	0.48	0.71	0.90	0.81	0.92	0.94	0.72
DW	1.44	0.71	1.67	1.98	1.20	3.15	0.97	0.71

Notes: OLS regression using annual data, in levels (Newey-West robust standard errors in parentheses). Percentage variables defined in decimal form. N is the number of observations, Adj.R^2 is the adjusted R-squared, and DW is the Durbin-Watson statistic. *(**)[***] denotes significance at the 10%(5%)[1%] level.
1/ Intervention is defined as official sector purchases of Treasury securities.

2/ Sample is 1990-2004.

Table 2
Determinants of long term real interest rates: debt, output gap and foreign interest rate, 1988-2006

	US	US1/	Germany	France	Italy	Spain 1/	UK
Constant	-0.013	-0.004	0.018	-0.054**	-0.087	-0.043***	-0.042
	(0.010)	(0.009)	(0.032)	(0.022)	(0.136)	(0.010)	(0.033)
Inflation	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Debt ratio	0.059	0.061*	-0.025*	0.063*	0.018	0.061	0.055
	(0.038)	(0.034)	(0.044)	(0.031)	(0.139)	(0.039)	(0.048)
expected change in debt ratio	-0.104	-0.045	-0.104**	0.198***	0.217	0.312***	0.076
	(0.078)	(0.083)	(0.048)	(0.050)	(0.353)	(0.042)	(0.093)
output gap	-0.038	-0.023	0.055	0.460**	0.242	0.368*	-0.333
	(0.183)	(0.170)	(0.187)	(0.159)	(0.598)	(0.170)	(0.232)
Foreign interest rate	0.286	0.85	0.489	1.238***	2.040**	1.002***	0.947***
	(0.173)	(0.188)	(0.320)	(0.193)	(0.653)	(0.239)	(0.311)
Intervention		-0.518*					
		(0.258)					
N	19	19	19	19	19	17	19
Adj.R^2	0.43	0.47	0.53	0.89	0.71	0.91	0.60
DW	1.71	1.76	1.84	1.49	1.16	2.14	1.30

Notes: OLS regression using annual data, in levels (Newey-West robust standard errors in parentheses). Percentage variables defined in decimal form. N is the number of observations, Adj.R^2 is the adjusted R-squared. *(**)[***] denotes significance at the 10%(5%)[1%] level.
1/ Intervention is defined as official sector purchases of Treasury securities.

2/ Sample is 1990-2006.

Table 3
Determinants of European long term interest rates: inflation, debt and G-7 debt, output gap and foreign interest rate, 1988-2006

	(1)	(2)	(3)	(4)	(5)
Inflation	1.519***	1.043***	1.088***	1.00	1.624***
	(0.323)	(0.224)	(0.196)		(0.315)
debt ratio	-0.019	0.060***	0.051***	0.048***	-0.024
	(0.034)	(0.016)	(0.018)	(0.016)	(0.028)
expected change	0.082	0.111**	0.096*	0.106**	0.088
in debt ratio	(0.094)	(0.051)	(0.046)	(0.044)	(0.087)
output gap	0.108	0.090			
	(0.196)	(0.117)			
Foreign interest rate		1.302***	1.304***	1.324***	
		(0.103)	(0.105)	(0.103)	
oecd debt ratio					-0.038**
					(0.018)
N	67	67	67	67	66
Adj.R^2	0.55	0.86	0.86	0.75	0.60

Notes: Fixed effects regression using annual data, in levels (White robust standard errors in parentheses). Percentage variables defined in decimal form. N is the number of observations, and Adj.R^2 is the adjusted R-squared,. *(**)[***] denotes significance at the 10%(5%)[1%] level.

Table 4
Determinants of long term – short term spread: debt and expected change in debt, 1988-2004

	US	GY,FR, IT, SP	UK
	(1)	(2)	(3)
Constant	0.001		-0.024**
	(0.024)		(0.010)
Debt ratio	0.026	0.041***	0.078**
	(0.050)	(0.013)	(0.032)
expected change	0.249***	-0.075*	0.133***
in debt ratio	(0.069)	(0.043)	(0.035)
intervention			
N	19	67	19
Adj.R^2	0.35	0.16	0.32
DW	1.13	1.24	1.45

Notes: Columns (1) and (3): OLS regression using annual data, in levels (Newey-West robust standard errors in parentheses). Column (2), Fixed Effects SURE, White standard errors. Percentage variables defined in decimal form. N is the number of observations, Adj.R^2 is the adjusted R-squared. *(**)[***] denotes significance at the 10%(5%)[1%] level.

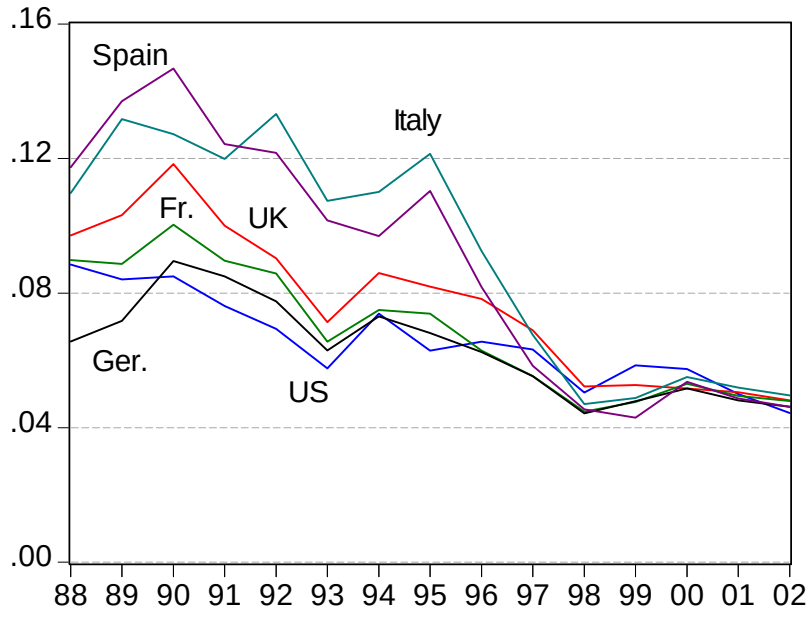

Figure 1: Long term nominal interest rates

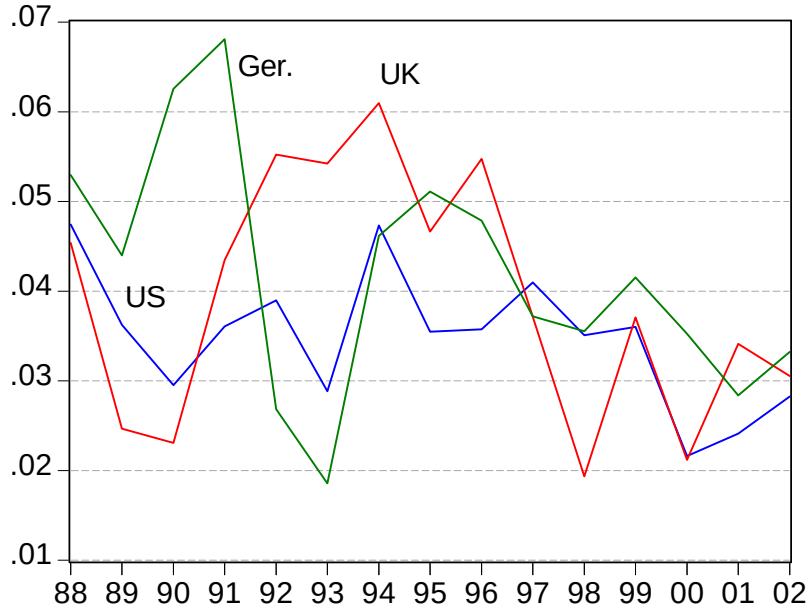

Figure 2: Long term real interest rates for US, UK and Germany

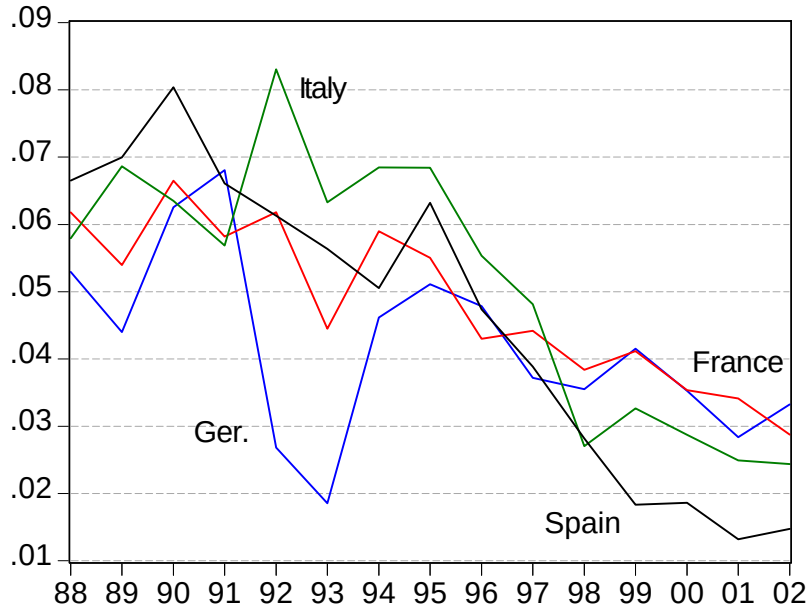

Figure 3: Real long term interest rates for selected Euro Area economies

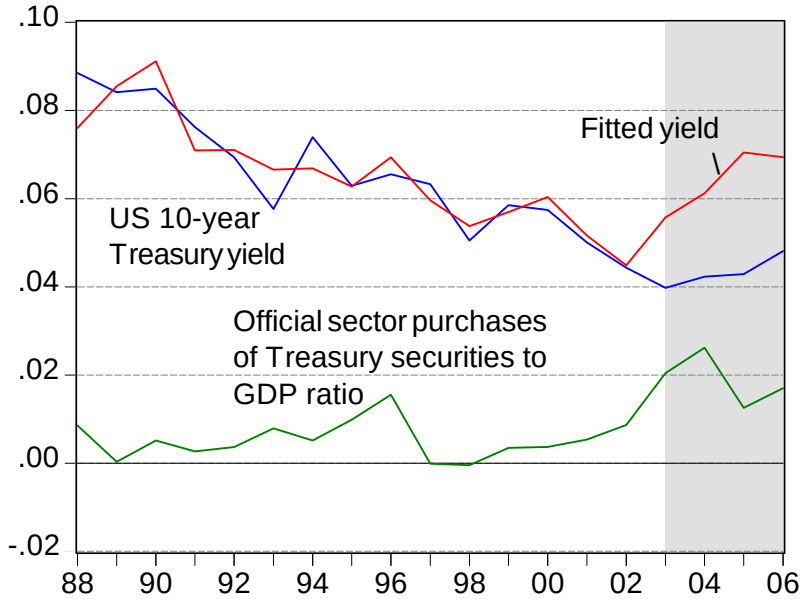

Figure 4: US long term rate and purchases of US Treasury securities. 2006 is first 3 quarters.

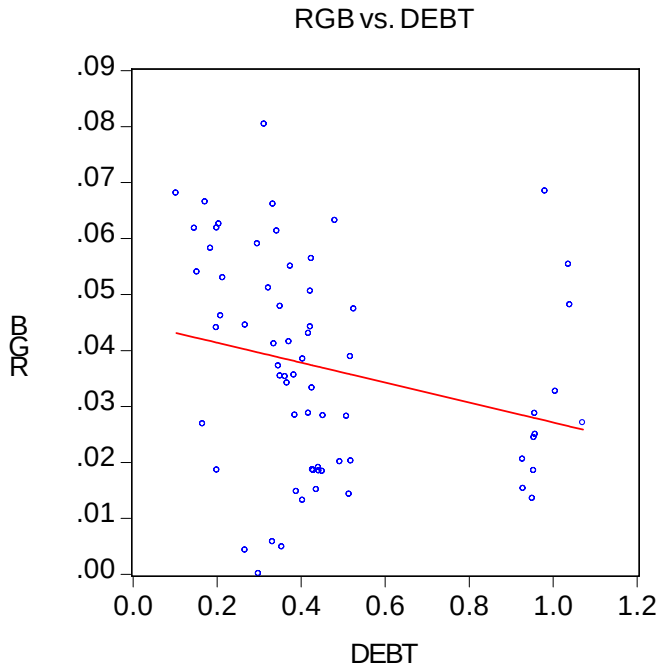

Figure 5: European pooled data on real long term rate against debt to GDP ratio

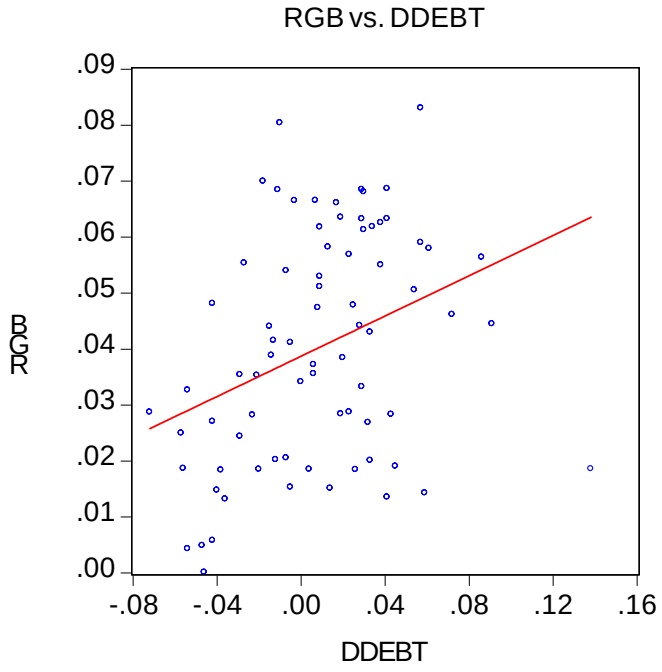

Figure 6: European pooled data on real long term rate against 2 year change in debt to GDP ratio

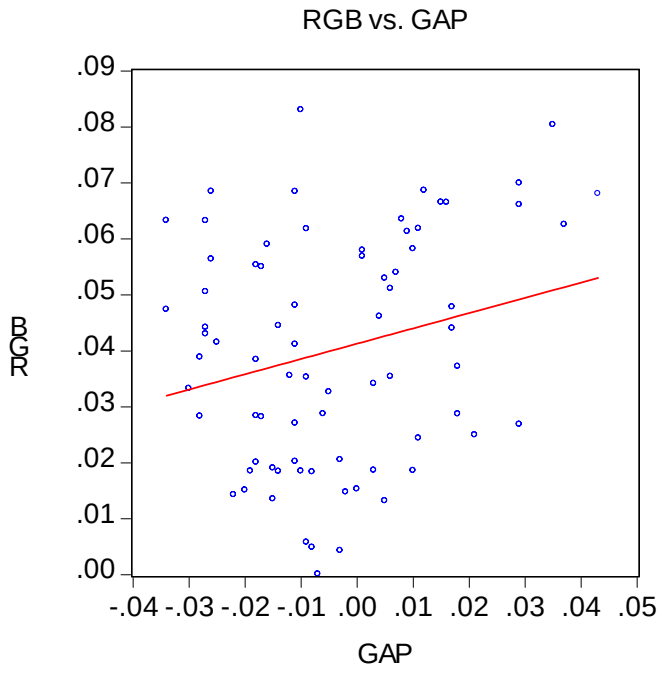

Figure 7: European pooled data on long term real rate against output gap

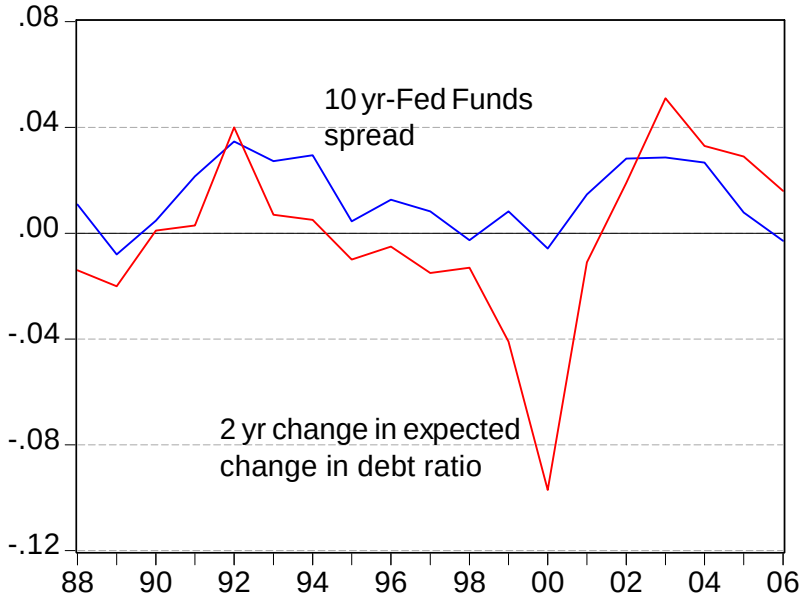

Figure 8: US spread and 2 year expected change in the debt ratio.

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