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Dissecting the evidence for Germany and the United States

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Abstract

This paper investigates why the slope of the yield curve predicts future economic activity in Germany and the United States. A structural VAR is used to identify aggregate supply, aggregate demand, monetary policy and inflation scare shocks and to analyse their effects on the real, nominal and term premium components of the term spread and on output. In both countries demand and monetary policy shocks contribute to the covariance between output growth and the lagged term spread, while inflation scares do not. As the latter are more important in the United States, they reduce the predictive content of the term spread in that country. The main reason for the stronger leading indicator property in Germany is, however, the positive contribution of supply shocks, which owing to a different monetary policy response explain about half of the positive covariance at lag four in Germany and almost nothing in the United States.

JEL: E43-E44-E58.

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Introduction

Following the findings of Harvey (1988) and Estrella and Hardouvelis (1991), a large empirical literature has documented the excellent leading indicator properties of the slope of the yield curve, defined as the difference between long and short-term interest rates, for future economic activity.[1, 2] While one might have expected a link between the real interest rate and future economic activity, what gives rise to the strong correlation between the nominal interest rate spread and output is of obvious interest to the macroeconomist. A structural interpretation of this correlation is also of interest from a monetary policy perspective, as the appropriate policy response to changes in the slope of the yield curve depends on the nature of the shocks that drive these changes and their implications for future economic activity.[3] Moreover, it is of crucial importance whether the predictive content of the term spread for economic activity is primarily derived from fundamental or policy-driven shocks as only in the former case can central banks hope to use the information embedded in the term structure for the purpose of stabilising output.

While the leading indicator property of the term spread for economic activity has been well documented, there are relatively few studies that investigate its structural foundations. One strand of this literature, typified by Harvey (1988) and Hu (1993), uses the consumption CAPM model to attribute the correlation between the term spread and future economic growth to inter-temporal consumption smoothing. More concretely, consumers who rationally forecast a recession will increase current savings in order to boost future income (i.e. substitute future for present consumption), thus pushing short rates up and depressing longer rates ahead of the slowdown in activity. In this setting the correlation between the *real* term spread and future activity is independent of the nature of the shocks to the economy and the monetary policy regime. As such, it fails to explain the strong predictive content of the *nominal* term spread for real activity and why variations in the information content of the spread are correlated with nominal factors such as the historical inflation performance and the prevailing exchange rate regime.[4]

A second strand in the literature focuses more on the nominal term structure and, assuming short-run nominal rigidities, assigns a significant role to monetary policy actions. Monetary policy can contribute to the positive correlation between the current term spread and future output in

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1 This difference is also referred to as the term spread. The two terms will be used interchangeably throughout the paper.

2 Recent examples are Bernard and Gerlach (1996), Estrella and Mishkin (1997), Davis and Henry (1994), Dueker (1997), Funke (1997), Harvey (1991a,b and 1997), Haubrich and Dombrosky (1996), Hu (1993), Plosser and Rouwenhorst (1994) and Stock and Watson (1989).

3 The need for a structural interpretation when using information on asset prices has been forcefully argued by Woodford (1992). See also Bernanke and Woodford (1996) and Smets (1997).

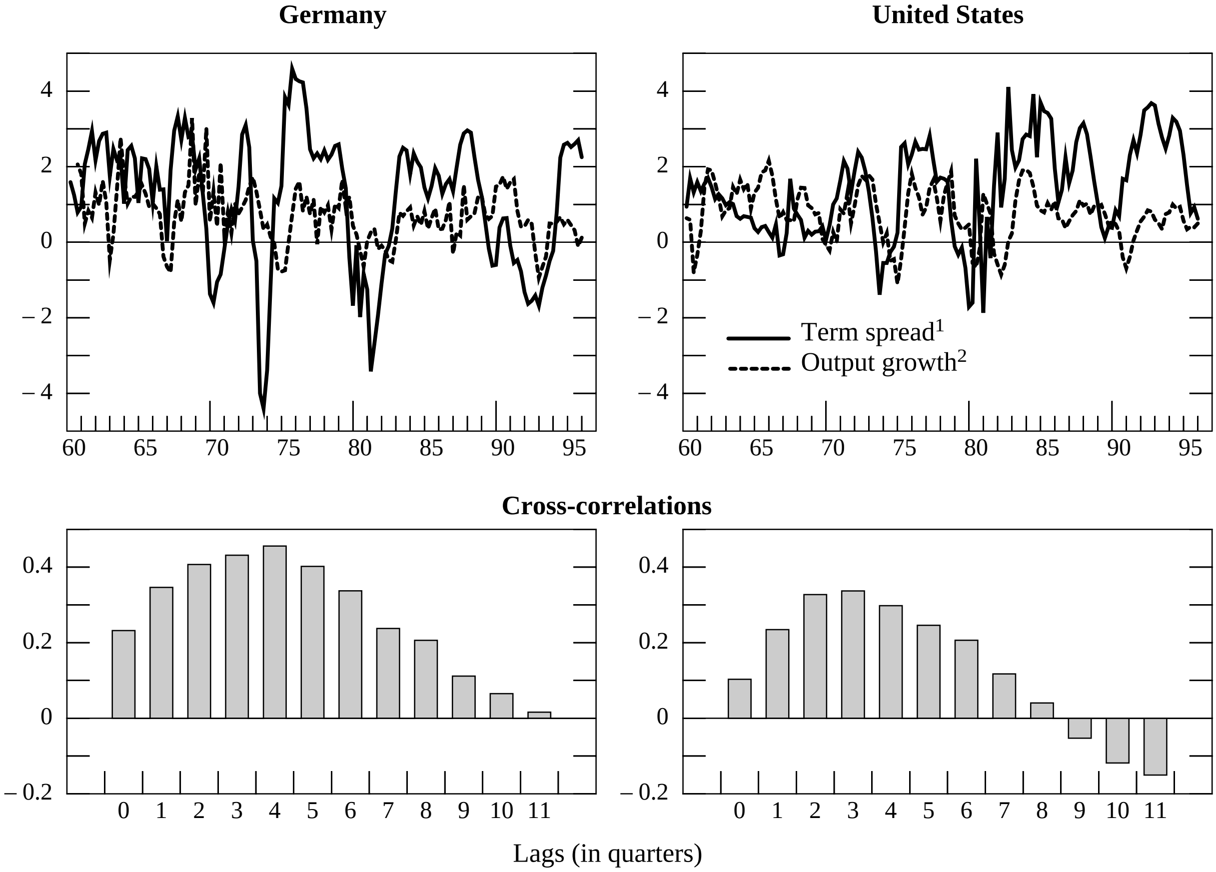
4 For example, Plosser and Rouwenhorst (1994) find that the predictive content of the term structure for real growth is higher in countries with lower and more stable inflation rates. Bernard and Gerlach (1996) find that the information content of the slope is limited in countries with pegged exchange rates.

two ways. First, a credible tightening would drive the short end of the yield curve up (both in nominal and real terms) while having little effect on longer rates. The increase in short-term real rates curtails spending and brings about a slowdown in economic activity, thus creating a negative link between a flattening of the term structure and future growth. Bernanke and Blinder (1992) claim that monetary policy accounts for most of the correlation between interest rates and growth, while Estrella and Hardouvelis (1991) and Plosser and Rouwenhorst (1994) show that, although monetary policy actions are certainly a contributing factor, they cannot account for all of the predictive content of the term spread. Secondly, in the presence of nominal rigidities expected policy may also play a role. A correctly anticipated future easing of monetary policy would drive up long-term interest rates by raising inflationary expectations causing the term structure to steepen, while at the same time leading to a temporary rise in future output. Alternatively, anticipations of higher inflation could have little connection with actual future shifts in the monetary policy stance. For example, Goodfriend (1995) documents the occurrence of what he labels "inflation scares" in US bond markets and discusses the Federal Reserve's response to these episodes. In this case investors' apprehensions about the inflation outlook may lead to a steepening of the term structure without necessarily predicting any change in output. Hence, the more important such shocks are, the less informative the term spread will be for future economic activity.

This paper belongs to the second strand of the literature. Based on a theoretical model which assumes a vertical long-run aggregate supply curve, but allows for real effects of monetary policy in the short run, it investigates the structural foundations of the predictive content of the term spread in Germany and the United States. Our contribution to the literature is threefold. First, in contrast to the papers mentioned above, which rely mostly on single-equation forecasting models, we employ an identified VAR to model the joint movements of output, inflation and the nominal term structure as the combined effect of four fundamental shocks: an aggregate demand, an aggregate supply, a monetary policy and a long-term interest rate shock which following Goodfriend (1995) is labelled "inflation scare". The identified VAR allows us to analyse the economic determinants of the slope of the term structure. In particular, we are able to address questions such as: why does the slope of the term structure change in a given period? How important are various shocks in determining the slope? And importantly: which shocks explain the predictive content of the term spread for economic activity?

Our second contribution is to exploit the ability of VARs to easily generate model-consistent forecasts for future realisations of the endogenous variables in order to decompose the response of the term spread to the various shocks into a real, inflation and term premium component. Such a decomposition helps us to interpret the term structure response to the various shocks and how they contribute to its predictive content for real economic activity. For example, if movements in the term spread are mostly driven by current and expected changes in the real short-term rate (the real component), then a stronger correlation with future output may be expected. Moreover, on the basis of the significance of the response of the term premium component, we can test the expectations hypothesis (EH) conditional on the type of shock that influences the economy. While acceptance of the general coefficient restrictions implied by the EH implies acceptance of the conditional tests, the rejection of the general test does not automatically mean the rejection of each and all conditional tests.[5] For example, a failure to accept the EH may be due to the yield curve response to a particular shock while the reaction of long-term rates to other shocks may be consistent with the future expected path of short-term rates in response to the same innovations. These conditional tests can potentially contribute to our understanding of why the EH is rejected in certain countries.[6]

Graph 1
The term spread and output growth



[1] Lagged four quarters. [2] Current annualised GDP growth.

A third and final contribution is that we employ the same methodology to compare the predictive content of the term spread in Germany and the United States. This comparison is of interest

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5 The use of VARs to test the over-identifying restrictions implied by the expectations hypothesis of the term structure was pioneered by Sargent (1979) and later popularised by Campbell and Shiller (1987). The notion of testing a conditional rational expectations hypothesis in a VAR framework was used in Eichenbaum and Evans (1995) to test uncovered interest rate parity in response to a monetary policy shock. It has been applied to the term structure by Edelberg and Marshall (1996).

6 Recent applications of the Campbell-Shiller framework to the analysis of the term structure in countries other than the United States include those of Hardouvelis (1994) and Gerlach (1996).

because, while in both countries almost every major recession since 1960 has been preceded by a fall in the term spread, the correlation between annual output growth and the lagged term spread is higher in Germany than it is in the United States (Graph 1). Our methodology is able to shed light on why this is the case.

This paper complements two recent papers by Fuhrer and Moore (1995) and Estrella (1996) which both use a similar theoretical framework. Estrella (1996) examines analytically the term spread's predictive content under different policy rules, but does not apply his model to the data. In contrast, Fuhrer and Moore (1995) estimate a small-scale structural model of the US economy to investigate the correlation between the nominal short-term interest rate and output growth under various monetary policy rules. Our analysis differs from Fuhrer and Moore (1995) in two ways. First, by including the long-term interest rate into the empirical model, we can focus on the empirically even stronger correlation between the nominal term spread and output growth and we can test the EH which is assumed to hold in Fuhrer and Moore (1995). Secondly, although the VAR-methodology cannot be employed to run counterfactual monetary policy scenarios, our cross-country comparison does provide some historical evidence of the effect of different monetary policy reaction functions on the strength of this correlation.

The rest of the paper is organised in five sections. The first describes the empirical model and the decomposition of the long-term interest rate into a real, an inflation and a term premium component. It also discusses the implications of the EH for the dynamic responses of each component to the structural innovations.

In both countries the estimated dynamic response of the endogenous variables (presented in Section 2) conforms broadly with that implied by the theoretical model presented in Appendix A.2. The responses of the term spread – with the exception of those corresponding to inflation scare shocks – are also qualitatively similar to the predictions of the EH, although the hypothesis is rejected in a strict statistical sense. In both countries aggregate demand and supply shocks account for the lion's share of the variability of output and inflation. The yield curve dynamics, however, are driven by a different mix of factors: while in both countries about half of the medium-term variability in the term spread is accounted for by demand and monetary policy shocks, the other half is driven by supply shocks in the German case and by apprehensions about the long-run inflation outlook (inflation scares) in the US case. These results, combined with the relatively more subdued response of the US real short rates to inflationary demand and supply shocks, lead us to interpret the evidence as being a manifestation of the greater credibility enjoyed by the Bundesbank owing to its established inflation-fighting track record.

Section 3 presents the decomposition of the term spread and output growth covariance at various lags in the four identified fundamental factors. The main reason for the stronger leading indicator property in Germany is the positive contribution of supply shocks, which owing to a different monetary policy response explain about half of the positive convariance at lag four in

Germany and almost nothing in the United States. Moreover, the fact that nominal shocks to the long-term rate account for such a large share in the variability of the US term spread while having no significant influence on economic activity dampens the information content of the yield curve.

Section 4 offers an interpretation of the recent experience in the two countries based on the empirical results of the previous sections. In the United States the analysis suggests that a favourable nominal shock accounted for most of the fall in the term spread in 1995, perhaps indicating that fears of an incipient economic downturn were overstated. In Germany, on the other hand, the rise in the term spread could be attributed to positive supply and demand shocks which were consistent with an anticipated upturn in economic activity.

In the last section we review the main conclusions and point out their policy implications.

1. Econometric methodology

1.1 The identified VAR model

The basis for the empirical work is a fourth-order VAR model estimated for Germany and the United States using quarterly data from 1960:1 to 1995:4. The vector x_t of endogenous variables comprises quarterly GDP growth, a three-month money market rate, the quarterly inflation rate and the term spread defined as the difference between the ten-year government bond yield and the three-month rate.[7] The vector ε_t of mutually uncorrelated structural innovations includes an aggregate supply, an aggregate demand, a monetary policy and an inflation scare shock. The model can be written in autoregressive form as:

$$(1) \qquad x_t = \hat{B}(L)x_{t-1} + \hat{u}_t \qquad \text{with } \hat{u}_t = \hat{A}(0)\hat{\varepsilon}_t$$

where $B(L)$ is a matrix of lag polynomials, u_t is the vector of VAR residuals and ^ denotes estimated variables. The matrix $A(0)$ embodies the identification scheme in the sense that it is constructed to perform the mapping of the estimated reduced-form residuals onto the underlying structural disturbances. Following Bernanke and Mihov (1996), we performed stability tests for the coefficients of system (1) using the methods described in Andrews (1993). The LM tests, reported in the Appendix, fail to detect major structural breaks throughout the sample.

The identification scheme is motivated by a standard aggregate supply demand model augmented by a term structure equation which links the long-term interest rate to expected short-term rates and a Fisher equation which includes an inflation scare innovation. Appendix A.2 contains an

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[7] The data sources, as well as the unit root tests that underlie the specification in equation (1), are reported in Appendix A.1.

example of such a model, based on Fuhrer and Moore (1996), Svensson (1997) and Estrella (1997), and derives the theoretical impulse responses to the four structural shocks.

The identification suggested by the model calls for a mixture of short and long-run zero restrictions as in Galí (1992) and Gerlach and Smets (1995).[8] The assumption of a vertical long-run Phillips curve implies that demand and nominal shocks (which include monetary policy and inflation scare shocks) have no long-run impact on the level of real output. Supply innovations are thus the source of all permanent shocks to output. Demand shocks are distinguished from nominal shocks by the assumption that the latter do not contemporaneously affect real output. The notion that there are lags in the monetary transmission mechanism to output is not very controversial and has been used extensively in the VAR literature to identify monetary policy shocks.[9]

Finally, we need one additional assumption to distinguish monetary policy from inflation scare shocks: we assume that monetary authorities do not respond contemporaneously (i.e. within the quarter) to inflation scares. This assumption may be more controversial. If the monetary authorities fear that a rise in long-term interest rates, due to lower credibility, may feed through into inflation expectations in the goods and labour markets, then it may be optimal for them to respond with a pre-emptive tightening. This reaction would create a contemporaneous "causal" link between inflation scare shocks and short-term interest rates. The basic model maintains the zero contemporaneous restriction because we believe it is a good approximation of the actual behaviour of the central banks in the United States and Germany. Robustness checks reported in Appendix A.3 demonstrate that allowing for some response of the short-term rate to bond yield innovations does not significantly affect the estimated impulse responses. In any case, it would not affect the determination of the supply and demand shocks.[10]

Combined with the standard assumptions that the structural shocks are mutually uncorrelated and have a standardised unit variance, the restrictions discussed above deliver a just identified model. The identification scheme is implemented by applying the common trends methodology of King, Plosser, Stock and Watson (1991) as extended by Warne (1993).[11]

1.2 The decomposition of the term spread

The decomposition of the term spread into a real, nominal and term premium component

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8 The original contributions on using long-run restrictions to separate demand from supply shocks were Blanchard and Quah (1989), Shapiro and Watson (1988) and King, Plosser, Stock and Watson (1991).

9 See, for example, Bernanke and Blinder (1989) and Christiano, Eichenbaum and Evans (1991).

10 In VAR papers that use a triangular identification scheme it is quite common to put asset prices such as other interest rates and the exchange rate after the monetary policy instrument. This boils down to a similar assumption that monetary authorities do not contemporaneously respond to shocks to these asset prices. See, for example, Friedman and Kuttner (1992) or Eichenbaum and Evans (1995).

11 For details, see the technical appendix in Smets (1996).

is derived in two steps. First, the yield to maturity of an N-period bond, R_t, can be decomposed into a weighted average of expected future one-period interest rates and a term premium ϕ_t:

$$(2) \qquad R_t = \sum_{i=0}^{N-1} w_i \mathrm{E}_t r_{t+i} + \phi_t \quad \text{where } w_i = g^i (1-g)/(1-g^N)$$

The weights, w_i, are derived as part of the linearisation explained in Shiller, Campbell and Schoenholz (1983) and account for the duration effects of coupons on longer-term bonds.[12] Equation (2) is an identity and does not impose any restrictions on the estimated model. The EH of the term structure holds if the risk premium is constant, $\phi_t = \bar{\phi}$.

The second step combines expression (2) with the Fisher equation to write the level of the nominal long-term rate as the sum of three components: a *real* component which captures the expected future path of real short-term interest rates, ρ_{t+i}; an *inflation* component which corresponds to the weighted sum of expected future inflation, $E_t\pi_{t+i+1}$; and a *term premium* component which captures all remaining factors that may influence the level of the long rate:

$$(3) \qquad R_t = \phi_t + \sum_{i=0}^{N-1} w_i \mathrm{E}_t \rho_{t+i} + \sum_{i=0}^{N-1} w_i \mathrm{E}_t \pi_{t+i+1}$$

One of the appealing aspects of the VAR methodology is that the estimated dynamic model can generate forecasts of both short-term interest rates and inflation. The j-step ahead forecast of the k^{th} element of the variable vector x_t; is given by the formula:

$$(4) \qquad e_k^T \mathrm{E}_t x_{t+j} = e_k^T \hat{B}^j x_t$$

where e_k^T is a 1×4 row vector with the k^{th} element equal to unity and zeroes elsewhere.[13] Substituting the model-generated expectations in equation (3), one can calculate the term premium as the difference between the long rate and the real and inflation component.

This decomposition of the long rate depends on the estimated coefficients of the VAR but not on the identification scheme. In order to better understand the term structure effects of each of the structural shocks, it is informative to examine the response of each of these components to the structural innovations of the system. Analogous to (3), the 4-tuple of the j-step impulse responses of the long rate to the structural innovations, $\hat{\rho}_R(j)$, can be decomposed into a real, an inflation and a term premium component as follows:

$$(5) \qquad \rho_R(j) \equiv e_R^T \hat{B}^j \hat{A}(0) = \sum_{i=0}^{N-1} w_i (e_r^T - e_\pi^T \hat{B}) \hat{B}^{i+j} \hat{A}(0) + \sum_{i=0}^{N-1} w_i e_\pi^T \hat{B}^{i+j+1} \hat{A}(0) + \rho_\phi(j)$$

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12 The constant g is equal to 1/(1+*Rbar*), where *Rbar* is the mean long rate over the sample.

13 For simplicity we consider a first-order VAR. The results carry through in a straightforward manner for any order system once this is written in companion form. In addition, the fact that our system is specified in terms of the term spread and not the level of the long rate poses no major complications since the latter can be easily obtained as the sum of the former and the short rate.

As the l.h.s. and the first two terms of the r.h.s. are all known (estimated) quantities, equation (5) can be viewed as a definition of the impulse responses of the term premium to the structural shocks (the vector $\rho_{\phi}(j)$).

1.3 The expectations hypothesis and the term premium component

As mentioned above, the EH posits that the term premium in equation (2) is constant. In terms of our VAR system, and assuming for simplicity that the premium is equal to zero, the hypothesis can be stated as:

$$(6) \qquad R_t \equiv e_R^T x_t = \sum_{i=0}^{N-1} w_i e_r^T \hat{B}^i x_t \quad \text{or equivalently,} \quad R^{EH}(B):\ e_R^T - \sum_{i=0}^{N-1} w_i e_r^T \hat{B}^i = 0$$

Equation (6) represents a set of highly non-linear cross-equation restrictions on the coefficients of the VAR.[14] The test of a linear version of these restrictions using the particular VAR specification described above, rejected the EH.[15] The Wald statistic for the 16 restrictions was equal to 59.4 for the German and 42.4 for the US model, indicating a sound rejection of the restrictions at conventional significance levels.

If the EH is valid – i.e. if $R^{EH}(B)$ holds – the impulse responses of the term premium to all four shocks should be equal to zero. To see this more formally, note that by rearranging (5) and consolidating the terms that relate to the Fisher relationship, one obtains:

$$(7) \qquad \rho_{\phi}(j) = \left(e_R^T - \sum_{i=0}^{N-1} w_i e_r^T \hat{B}^i \right) \hat{B}^j \hat{A}(0)$$

According to the EH, the term in parentheses should be statistically indistinguishable from zero.[16] We call this an *unconditional* statement of the EH.

While the EH restrictions were rejected in our case, it is important to recognise that a rejection of the unconditional EH does not rule out the possibility that the term premium might indeed be invariant with respect to certain innovations. For example, it could be that the response of the long rate to a monetary policy shock is consistent with the model-implied future path of the short rate, whereas the same might not be true for the other three shocks. In this case we say that the EH holds *conditional* on the monetary policy shock, but it does not hold *conditional* on the other shocks. The relative contribution of each structural innovation in explaining the dynamics of the yield curve will

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[14] As we estimate a four-variable, fourth-order system, equation (6) represents 16 zero restrictions in our case.

[15] The linear restrictions are derived by assuming that the long rate is approximately equivalent to a perpetuity, and in our notation are expressed as: $e_R^T(I - gB) = (1 - g)e_r^T gB$. Campbell and Shiller (1987) tested the EH in this way, albeit within a differently specified VAR.

[16] It should be noted that this result does not depend on the earlier simplifying assumption of a zero term premium. The impulse responses represent deviations from a baseline projection that accounts for a constant.

thus be an important factor behind the relative success or failure of the EH to describe the determination of the term structure of interest rates.

2. The economic determinants of the term spread

This section analyses the impact of the structural shocks on the endogenous variables in our system and, in particular, on the term spread and its three components. Graphs 2-5 present the main results. The graphs have identical structure and each depicts the effects of a specific structural innovation in both countries. The two left-hand columns compare the effects of the shock in question on output (first row), inflation (second row), the nominal three-month interest rate (third row), the ten-year bond yield (fourth row) and the real short-term interest rate (fifth row). The real short rate is defined as the nominal interest rate minus the *ex ante* expected inflation predicted by the VAR. The two right-hand columns concentrate on the effects of the shock on the term spread (first row) and its real (second row), inflation (third row) and term premium (fourth row) components as defined in Section 2.2. In each of these graphs we also plot the bootstrapped 90% confidence intervals. The last row of the right-hand panel compares directly the estimated impulse response of the term spread (i.e. the same line plotted in the first row) together with the response of the term spread that would be consistent with the expectations hypothesis (the latter being the sum of the real and inflation components presented in rows two and three respectively). The discrepancy between the two curves is equal to the term premium (fourth row).

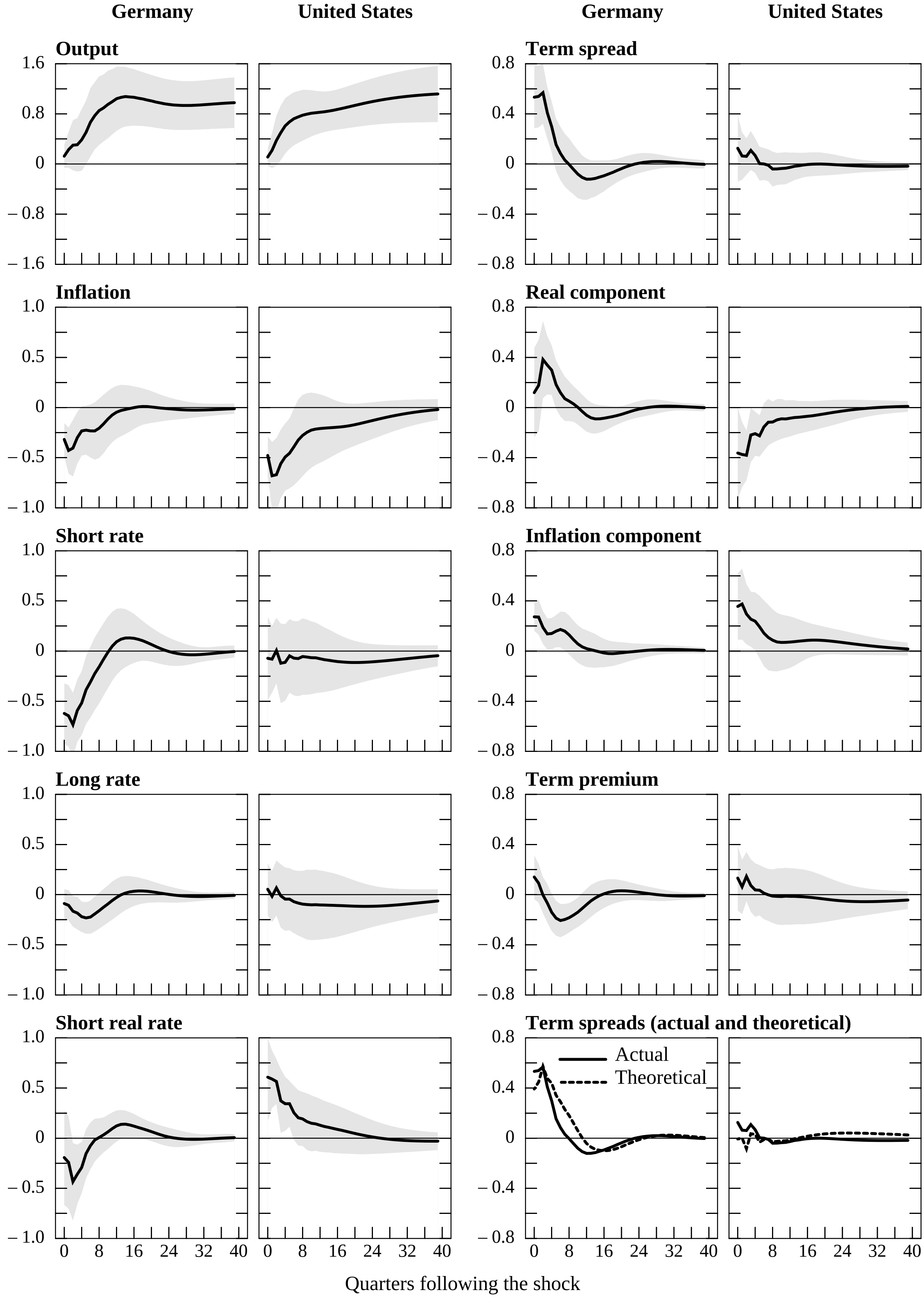
2.1 Supply shocks

As shown in Graph 2, and consistent with the predictions of the theoretical model discussed in the Appendix, in both countries a favourable supply shock raises output permanently by about 1 percentage point and leads to an immediate fall in inflation. The response of interest rates is, however, quite different across the two countries. In Germany short-term rates fall immediately, in nominal as well as in real terms. In the United States nominal rates do not show a significant response and, as a result, the real short rate actually increases. One possible interpretation of this cross-country difference is that the German monetary authorities respond more vigorously to the inflation effects of a supply shock, while the US authorities are more concerned with output stabilisation. This apparent difference in the central banks' preferences with respect to the output inflation trade-off is consistent with the stronger and more significant inflation effects in the United States.

The timid response of the short-term US interest rates is mirrored by the long end of the yield curve with the result that the term spread remains unaffected. By contrast, the German yield curve steepens as the long-term rate response is significantly more subdued than that of the three-month rate. As is shown in the right-hand panel of Graph 2, this response is qualitatively very similar

Graph 2

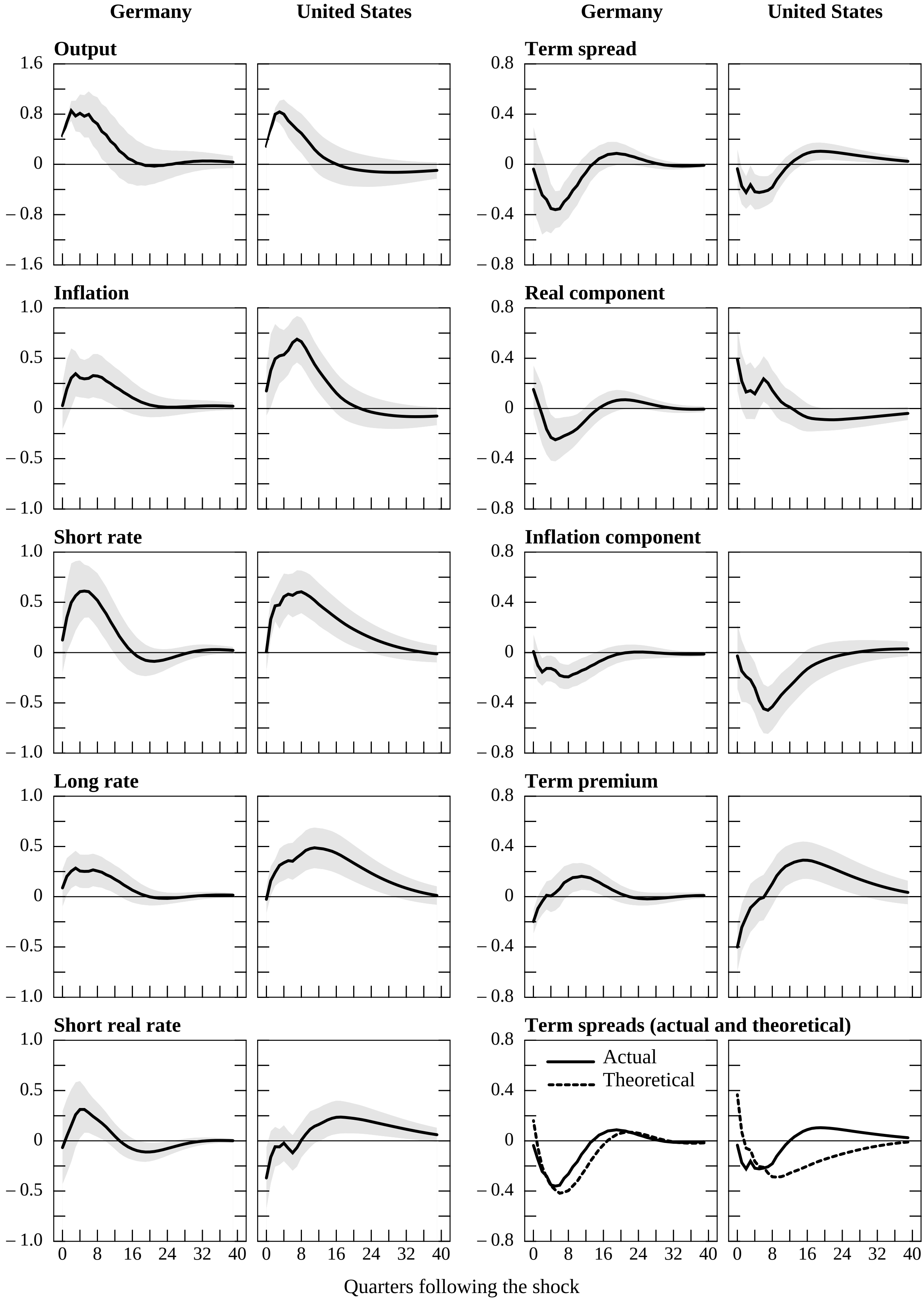
The effects of a supply shock



Note: The shaded areas represent bootstrapped 90% confidence bands. See the first paragraph of Section 2 for a description of the various panels.

Graph 3

The effects of a demand shock



Note: The shaded areas represent bootstrapped 90% confidence bands. See the first paragraph of Section 2 for a description of the various panels.

to what one would expect on the basis of the EH, although there is some evidence that the actual response of long rates is somewhat less persistent than warranted.

2.2 Demand shocks

The effects of aggregate demand shocks (shown in Graph 3) are very similar in the two countries. A typical shock has a larger short-term impact on output than supply shocks and is hump-shaped. Qualitatively consistent with the theoretical model in the Appendix, expansionary demand shocks lead to a rise in inflation and nominal interest rates, which peak after about two years. Again, the interest rate response is more immediate and stronger, and the inflation response is smaller, in Germany than in the United States. And as was the case with the supply shock, this is reflected in a qualitatively different response of the real rate: while the German real rate becomes significantly positive after three quarters, US real rates remain below baseline for eight quarters.

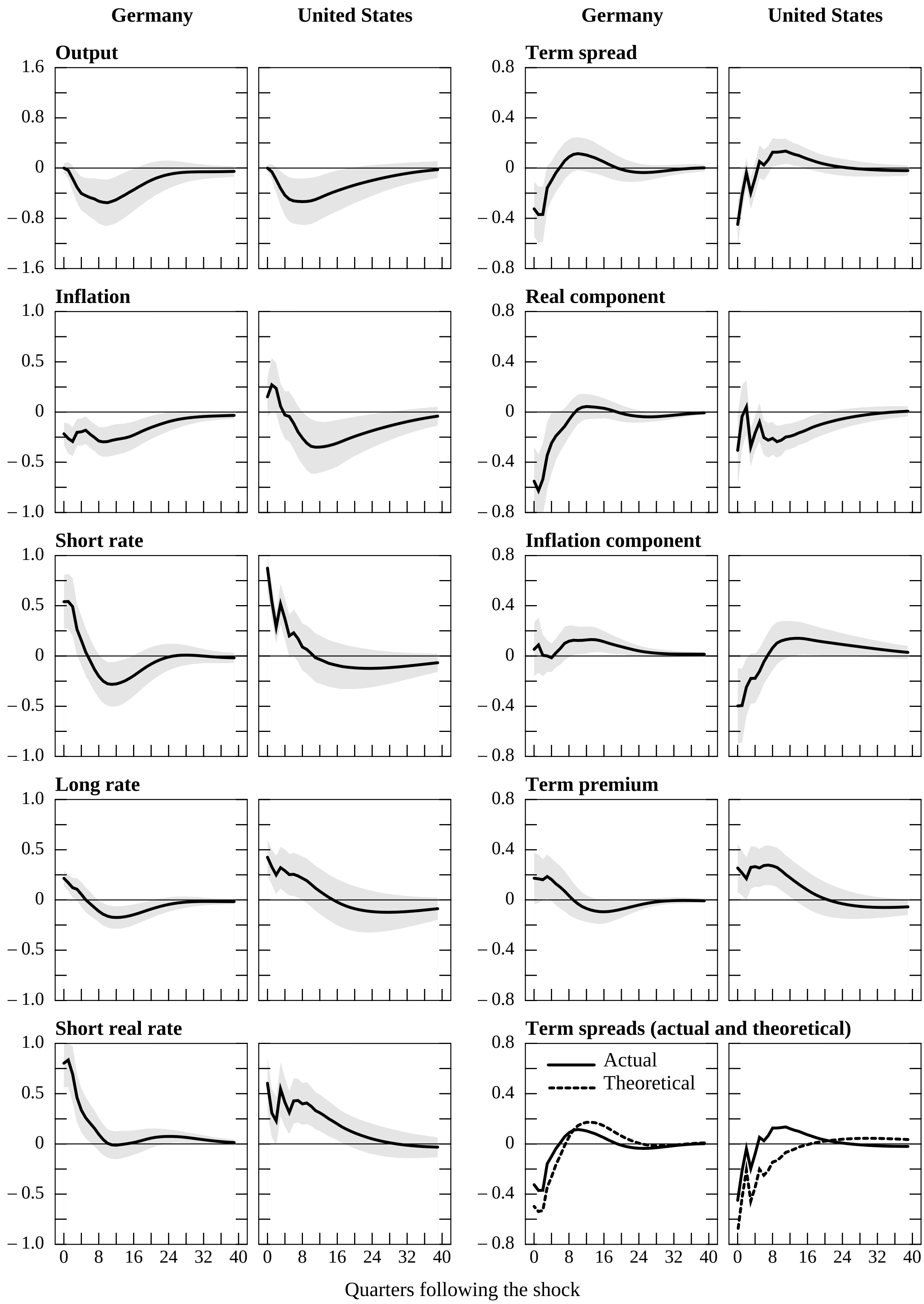
Long rates in both countries correctly anticipate the temporary nature of the short rate response and, as a result, the yield curve flattens following an expansionary demand shock. However, the response of the term premium component suggests that in both countries there are significant deviations from the predictions of the EH. In particular, the initial undershooting of long rates compared with the EH-consistent response is followed by a significant overshooting eight quarters later. The violation of the EH is much clearer and statistically more significant in the United States than in Germany. One interpretation of this pattern may be the existence of a strong backward-looking element in the financial markets' inflation forecast which leads them to systematically underestimate the initial inflationary effects of an unanticipated expansionary demand shock, and subsequently overestimate the persistence of inflation after a prolonged period of higher-than-expected price growth. Alternatively, the overshooting can be interpreted as the appearance of an inflation risk premium following a persistent upward trend in prices. It is interesting to note at this point that the higher significance of such an inflation risk premium in the United States is consistent with the historically more muted policy response to inflationary demand shocks in that country.

2.3 Monetary policy shocks

As shown in Graph 4, a one-standard deviation monetary policy shock is in both countries associated with a pronounced rise in the nominal and real short-term interest rate. Output falls quickly in response to a policy tightening, while a significant reduction in inflation takes longer to materialise. Consistent with the temporary nature of the tightening, the long-term rate rises less than the short-term rate, resulting in a significant flattening of the yield curve. This fall in the spread is mainly driven by the behaviour of its real component, although for the US term structure the inflation component is initially also significantly negative. In both countries we observe an increase in the term premium, which is rather insignificant in Germany but quite pronounced in the United States, probably signalling an increased uncertainty concerning the inflation outlook.

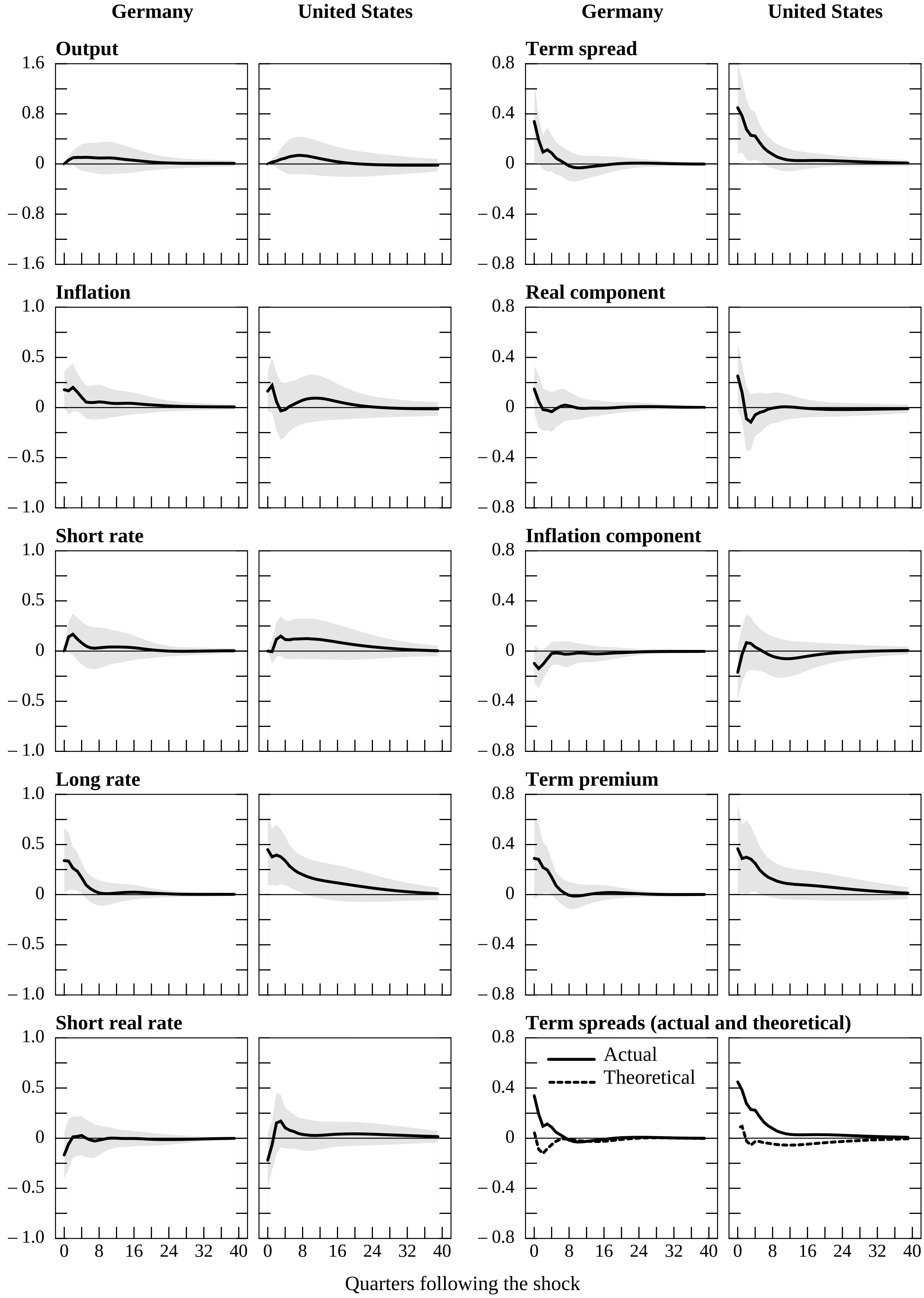
Graph 4

The effects of a policy shock



Note: The shaded areas represent bootstrapped 90% confidence bands. See the first paragraph of Section 2 for a description of the various panels.

Graph 5
The effects of an inflation scare shock



Note: The shaded areas represent bootstrapped 90% confidence bands. See the first paragraph of Section 2 for a description of the various panels.

In the light of our earlier findings regarding the different effects of aggregate supply and demand shocks on the real short-term rates, a possible interpretation of this differential response of the term premium may be that financial markets incorrectly read the rise in the US short-term interest rates as a signal of future inflationary pressures.

2.4 Inflation scares

The nominal long-term interest rate increases strongly (by about 35 basis points in Germany and close to 50 basis points in the United States) in response to the fourth innovation in our system. As this increase in long rates is associated with only a temporary and not very significant rise in inflation and is not followed by an increase in the short-term rate, it appears reasonable to interpret these innovations as inflation scares, episodes of heightened fear of an acceleration in inflation which induce investors to demand higher nominal yields but have no firm grounding in current macroeconomic conditions. Further evidence of this fact is provided by the very wide confidence bands around the response of the long-term interest rate and the spread, signifying the high level of noise surrounding these signals. Inflation scare shocks do not typically lead to a significant response from output and thus are likely to cloud the message of the term spread for future activity. The right-hand panel of Graph 5 confirms that true to the interpretation of these innovations as largely unjustified inflationary apprehensions, the main driving force behind the steepening of the yield curve is the rise in the term premium component.

2.5 Variance decomposition

The forecast error variance decomposition shown in Table 1 gives an idea of the relative importance of each of the estimated structural shocks in explaining the movements of the endogenous variables. Focusing first on economic activity, and in accordance with many other studies, we find that at business cycle frequencies (i.e. a horizon of two to three years) demand and supply shocks are about equally important in explaining the dynamics of output growth, although demand shocks clearly dominate at shorter horizons. In both countries monetary policy shocks play only a secondary role and inflation scare shocks are entirely uninformative.[17] Supply and demand shocks are also the most important driving forces behind changes in inflation, but in this case their relative ranking with respect to their contribution at the shorter horizons is reversed.

The more striking differences across the two countries concern the relative importance of the various shocks in explaining movements in the term spread. Demand shocks play a similar role in both countries; they account for about one-quarter of the variance in the term spread at a two-year

[17] The fact that monetary policy shocks do not play a very important role should not come as a surprise as these shocks only reflect non-systematic shifts in monetary policy. However, this does not imply that systematic monetary policy is not important. Systematic monetary policy is captured by the real interest rate response to the other shocks.

Table 1a

Forecast error variance decomposition

Germany

Variable		Percentage contribution of shocks to variance			
Quarters	**Std. error**	**Supply**	**Demand**	**Policy**	**Scare**
Output					
0	0.4	6.3	93.6	0.0	0.0
4	1.8	11.2	80.4	7.3	1.0
8	2.8	27.8	58.0	13.0	1.0
12	3.7	43.5	39.9	15.5	0.9
16	4.3	55.1	29.3	14.7	0.7
20	4.8	62.5	23.7	13.0	0.6
Inflation					
0	0.4	56.2	0.3	27.9	15.4
4	1.1	44.9	25.3	20.9	8.6
8	1.4	38.2	33.1	22.6	5.9
12	1.6	31.6	35.3	28.1	4.8
16	1.7	28.3	34.4	32.5	4.6
20	1.7	27.0	33.3	35.0	4.5
Short rate					
0	0.8	57.3	2.1	40.4	0.0
4	2.0	49.7	26.1	22.4	1.6
8	2.4	41.4	40.6	16.5	1.3
12	2.5	36.9	43.3	18.4	1.3
16	2.6	36.0	42.0	20.5	1.3
20	2.6	35.8	41.5	21.2	1.3
Term spread					
0	0.7	56.2	0.2	20.5	22.9
4	1.4	56.6	13.7	20.9	8.7
8	1.5	48.1	26.9	17.5	7.2
12	1.6	46.4	28.5	17.9	7.0
16	1.6	46.7	28.0	18.2	6.9
20	1.6	46.6	28.4	18.1	6.8

Table 1b

Forecast error variance decomposition

United States

Variable		**Percentage contribution of shocks to variance**			
Quarters	**Std. error**	**Supply**	**Demand**	**Policy**	**Scare**
Output					
0	0.3	14.9	85.0	0.0	0.0
4	1.8	26.4	64.5	8.6	0.4
8	2.8	39.8	43.2	16.0	0.8
12	3.4	49.3	31.3	18.4	0.8
16	3.9	57.0	24.3	18.0	0.6
20	4.3	63.4	19.8	16.2	0.5
Inflation					
0	0.5	72.1	11.5	6.4	9.9
4	1.6	54.9	37.1	4.7	3.2
8	2.2	39.9	52.9	5.0	2.0
12	2.5	33.4	54.1	10.4	1.9
16	2.7	32.0	51.1	14.8	1.9
20	2.7	31.8	48.6	17.5	1.8
Short rate					
0	0.8	0.9	0.0	98.9	0.0
4	1.5	1.4	35.3	61.1	2.1
8	2.0	1.0	55.4	40.6	2.8
12	2.2	1.0	63.9	31.7	3.2
16	2.4	1.3	66.5	28.5	3.4
20	2.4	1.9	66.8	27.6	3.5
Term spread					
0	0.6	4.9	0.4	47.1	47.4
4	1.0	4.4	16.6	28.1	50.7
8	1.1	3.7	26.4	24.3	45.4
12	1.1	3.9	25.8	27.1	43.0
16	1.1	3.7	26.3	28.2	41.5
20	1.2	3.6	28.3	27.7	39.9

horizon. Monetary policy shocks are a more important source of variation (especially in the short run) in the United States, where they explain a stable share in excess of one-quarter of the total variance at all horizons. The main difference across the two countries concerns supply and inflation scare shocks. In Germany about half of the variance in the term spread is accounted for by supply shocks, a reflection of the significant tightening of policy in response to the inflationary effects of unfavourable supply developments. In contrast, the estimated supply shocks do not contribute at all to movements in the slope of the yield curve in the United States. The reverse holds for the inflation scare shocks: in the United States they account for between 40 and 50% of the movements in the term spread, whereas their contribution is negligible in Germany.

2.6 Summary

The analysis of the impulse response functions suggests that, with a few exceptions, the qualitative effects of the structural shocks are similar in Germany and the United States, and that they conform with the predictions of the standard aggregate supply demand model discussed in the Appendix.

With the exception of the effect of an inflation scare shock, we also find that the EH offers a reasonable explanation of the term structure dynamics, as the term spread's response to supply, demand and policy shocks is qualitatively consistent with the future expected path of the short rate. This does not mean that the implications of the EH are being accepted in a strict statistical sense. On the contrary, we produce evidence that the impulse responses of the term spread deviate systematically from the EH-consistent path. These deviations are particularly strong in the United States in response to aggregate demand and monetary policy shocks. In view of the importance of these shocks in determining the dynamics of the term spread and in combination with the significant role of inflation uncertainties in shaping the long end of the yield curve, our analysis can offer an explanation of the frequent finding in the literature that the EH is rejected most strongly by US data.[18]

Overall, the differences in the behaviour of the term spread and its components are suggestive of historically different attitudes towards the output inflation trade-off of the two central banks. The apparent readiness of the Bundesbank to respond vigorously to supply and demand shocks in a systematic fashion over the sample period as manifested by the response of the real short term rates and its solid record in combating inflation seem to have enhanced its credibility with investors. The more pronounced overshooting of the US long rates following demand and monetary policy shocks and the negligible effects of inflation scares on the German term structure can be interpreted as evidence consistent with this assertion.

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[18] See, for example, Hardouvelis (1994).

3. Dissecting the predictive content of the term spread for economic activity

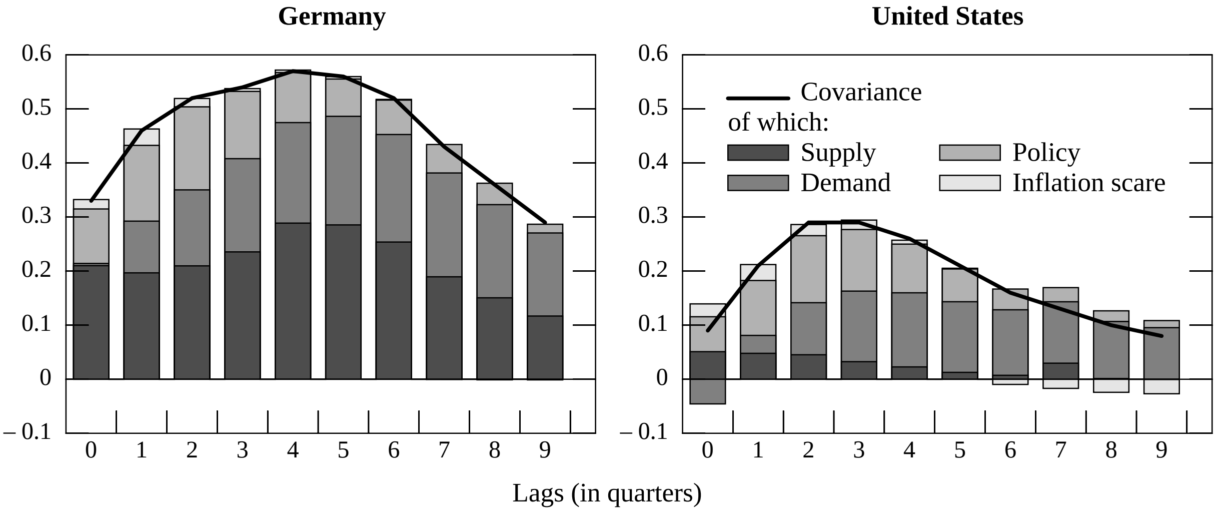
The preceding discussion of the determinants of the output and term spread movements in the two countries provides the basis for the structural investigation of the leading indicator property of the term spread for economic activity. Graph 6 plots the results of the analytical decomposition of the covariance between the term spread and current and future output growth to the four structural shocks. This decomposition is derived using the moving average representation of the VAR system in (1) and calculating the unconditional variance of the current term spread and *k*-period ahead output growth. Using the notation from Section 1, the decomposition is based on the following formula:

$$(8) \qquad Cov\left(spd_t\,,\,dy_{t+k}\right) \;=\; \mathrm{E}\left[\left(e_{spd}^T \sum_{j=0}^{\infty} \hat{B}^j \hat{A}(0)\varepsilon_{t-j}\right)\left(e_{dy}^T \sum_{j=0}^{\infty} \hat{B}^j \hat{A}(0)\hat{\varepsilon}_{t+k-j}\right)^T\right]$$

$$= \; e_{spd}^T \left(\sum_{j=0}^{\infty} \hat{B}^{j+k} \hat{A}(0)\,\hat{A}(0)^T\,(\hat{B}^j)^T\right) e_{dy}$$

where spd_t and dy_t denote the term spread and output growth at time *t* respectively. By analogy to the variance decomposition, the covariance in (8) is the sum of four components, each corresponding to one of the structural innovations. The only minor conceptual difference between this decomposition and the one in Table 1 is that since we decompose a covariance, as opposed to a variance, some of the components (or the total) may be negative.

Graph 6
The decomposition of term spread/output growth covariance



Note: The unconditional covariance between the current output growth and lagged term spread (solid line) is decomposed to the contributions of the four structural shocks identified in the VAR.

In both countries monetary policy and demand shocks contribute significantly to the positive covariance between output growth and the lagged term spread. The contribution of monetary policy shocks is comparable in the two countries and peaks at lag two reflecting the quite immediate impact of a policy tightening on output. However, at longer horizons (three to six quarters) the contribution of the demand shocks dominates, reflecting the more delayed impact of a policy tightening following an expansionary demand shock. Demand shocks play a more important role in Germany where their contribution peaks at lag five, one quarter later than in the United States.

However, the main reason for the greater predictive content of the term spread for economic activity in Germany can be traced to the contribution of the supply shocks. These innovations contribute hardly anything to the US covariance while explaining about half of the maximum cross-covariance observed at lag four in Germany. The different responses of the two yield curves to a supply shock is the key to explaining this contrast. As discussed in Section 3, in Germany a favourable supply shock leads to an immediate steepening of the yield curve and positive output growth rates for at least the following eight quarters. This is in contrast to the reaction of the US interest rates, which is insignificant.

As expected, inflation scare shocks do not contribute in either country to the forecasting power of changes in the term spread for economic growth. However, the fact that about half of the variation in the US term spread can be accounted for by such shocks implies that their presence weakens significantly the predictive content of the term spread for economic activity, which is mainly due to the other shocks.

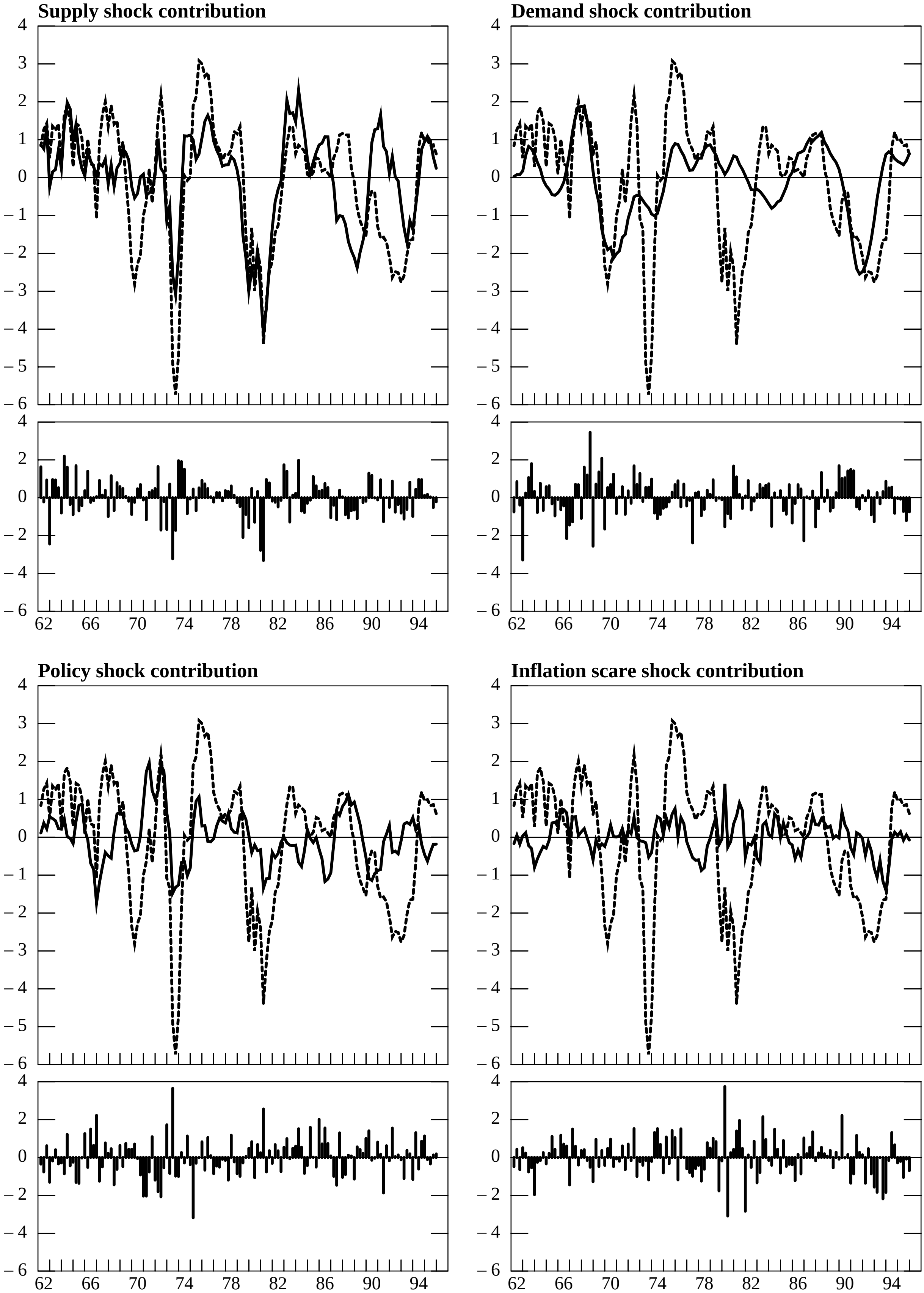
4. The term slope in the 1990s

The question of how to respond to changes in the slope of the yield curve received quite some attention in Germany and the United States at the end of 1995, as the term spread gave clear but opposite signs in both countries. In the United States the yield curve became very flat in 1995, which in the past signalled a higher likelihood of recession. However, whereas previously this was often associated with a deliberate tightening of monetary policy reflected in rising short-term rates, the low term spread in 1995 was mainly the result of falling long-term rates. The policy question was whether in that situation short-term interest rates should be reduced to avoid a downturn. In Germany the opposite phenomenon took place, with the yield curve steepening considerably until the summer, after which it more or less stabilised. The traditional interpretation that monetary policy was too loose was challenged by the argument that unusual circumstances had driven up long-term rates. In particular, it was argued that the uncertainty relating to the creation of a future European central bank had led to an uncharacteristic steepening of the yield curve which should not warrant a policy response.

It is interesting at this point to revisit this period and analyse the picture given by the term spread through the lens of our model. Graphs 7a and 7b plot each of the four estimated structural shocks and their contribution to the historical movements of the term spread in each country. The most striking aspect of the most recent term spread cycle in the two countries is the atypical asynchronicity. While in Germany the slope of the yield curve flattened considerably from 1987 until

Graph 7a

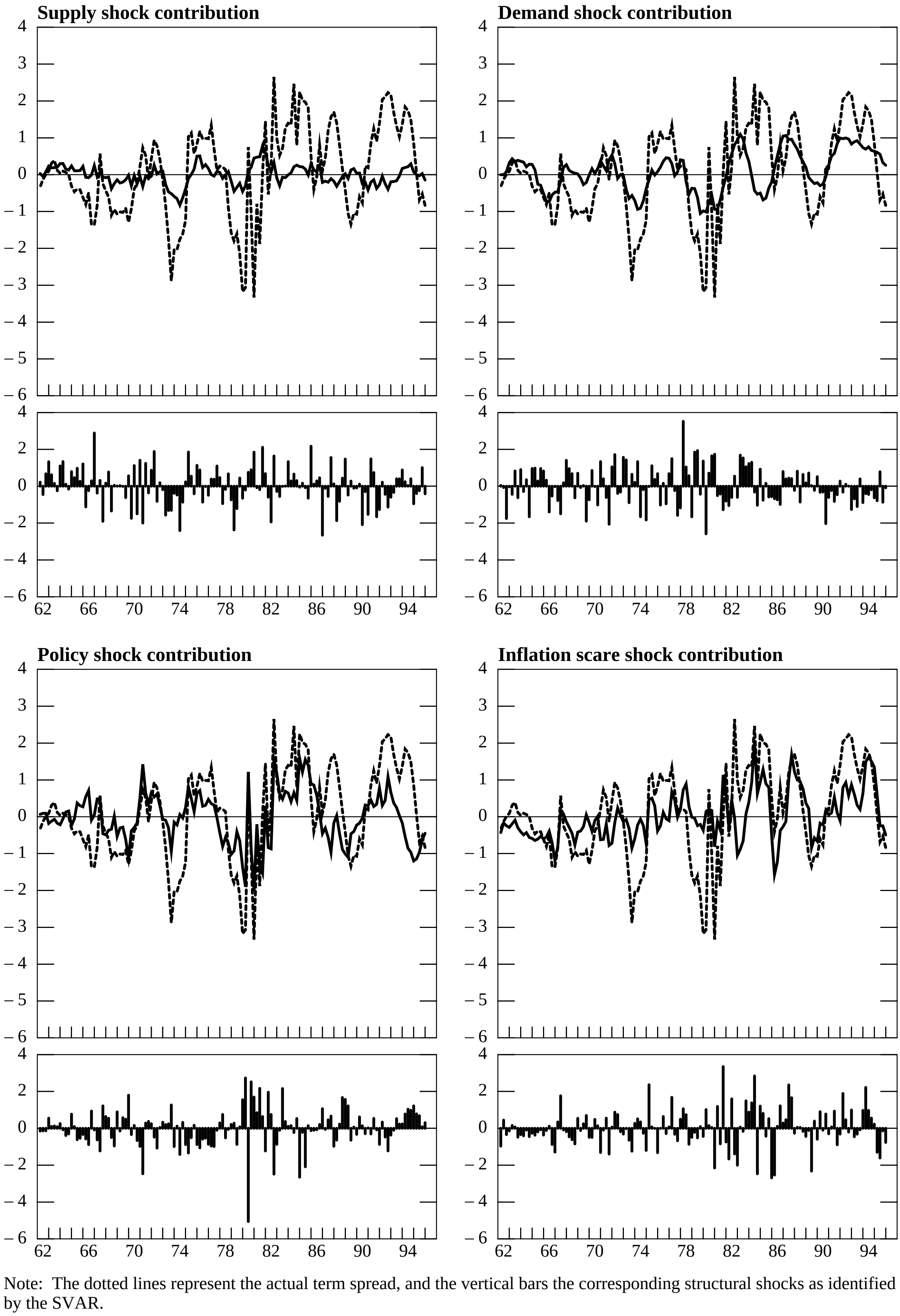
Historical decomposition of the term spread – Germany



Note: The dotted lines represent the actual term spread, and the vertical bars the corresponding structural shocks as identified by the SVAR.

Graph 7b

Historical decomposition of the term spread – United States



Note: The dotted lines represent the actual term spread, and the vertical bars the corresponding structural shocks as identified by the SVAR.

the end of 1992, only to reverse its course even more abruptly in 1993, the yield curve in the United States first steepened and then flattened over roughly the same period. This contrasts with the experience of the 1970s and 1980s, when movements in the slope of the term structure were much more synchronised.

In Germany most of the fall and subsequent rise in the term spread can be accounted for by demand-related shocks. However, demand shocks do not necessarily explain the timing of the steepening of the yield curve, which primarily took place at the beginning of 1994. The VAR model for Germany attributes this particular episode to both an expansionary supply shock and, to a lesser extent, an increase in the term premium. As the former shocks represent positive developments in terms of higher output and lower inflation, and the latter historically have not had significant effects on either of these variables, this particular episode appears not to present problems for the monetary authorities.

In the United States most of the cyclical movement in the term spread in the 1990s can be accounted for by a combination of demand and monetary policy shocks. The most striking recent episode was the flattening of the yield curve in 1994-95 to a point where the probability of an incipient recession based on the historical relationship between economic activity and the slope of the yield curve became significantly positive.[19] Our VAR model for the United States associates the decreasing term spread mostly with a smaller term premium as a result of reduced inflationary expectations in the US bond market. Interestingly enough, this fall in the term premium coincides with the pre-emptive tightening by the Federal Reserve in the same period, as shown in the third panel of Graph 7b which illustrates the effects of monetary policy shocks on the US term spread. By implication, the particularly flat yield curve should not have been interpreted as signalling an economic downturn, as inflation scare shocks have only nominal effects.

Conclusions and policy implications

In this paper we have investigated the economic determinants of the slope of the yield curve and economic activity in Germany and the United States with the main objective of identifying the sources of the strong leading indicator property of the term spread for future output growth. Our main finding is that monetary policy plays a central role in determining the intensity of the relationship between the term structure and output growth; we thus reject the view that "real" underlying shocks are the only source of this link. The role of monetary policy is both direct and indirect. Monetary policy has a direct impact in the sense that a systematic strategy of "leaning against the wind" gives rise to a positive correlation between the term spread and future output growth. However, as the comparison between the two countries' experience demonstrates, monetary policy

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[19] See, for example, Estrella and Mishkin (1997).

credibility can also influence the strength of the correlation between the two variables. A strong anti-inflationary track record helps to minimise the bond market's uncertainty about the inflation outlook and thus reduces the importance of nominal shocks to the long-term rate that tends to cloud the predictive content of the term spread for future output growth.

There are two features of our results with direct policy implications. First, the predictive content of the term spread is not time-invariant. It depends on the constellation of the underlying factors that determine economic conditions at any particular moment. The policy implication is that monetary authorities need to give a structural interpretation to observed movements in the term spread before this indicator is incorporated in monetary policy formulation. For example, we find that in contrast to demand and monetary policy shocks, inflation scare shocks, while an important source of variation in the term spread in the United States, do not contribute to the ability of the slope to forecast future economic activity. The central bank must, therefore, be able to distinguish between these types of innovation in the spread before deciding on the required policy response.

A second feature of the results is that, as highlighted in Estrella (1996), the predictive content of the term spread is not policy-independent. This raises the problems of circularity that may arise when monetary authorities attempt to systematically respond to asset prices which themselves are based on the market's anticipation of current and future policy actions.[20] This "endogeneity" does not invalidate the potential usefulness of the information incorporated in asset prices, but suggests that the central bank needs to use this information in a way complementary to its own independent conjunctural assessment. The key issue in evaluating the usefulness of the information derived from asset prices in guiding monetary policy is whether financial markets incorporate information not readily available to the central bank through other channels. This is an empirical question.

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[20] See Woodford (1994) and Bernanke and Woodford (1996).

Appendix

A.1 Data, unit root and stability tests

We estimate the model described in equation (1) for Germany and the United States using quarterly data from 1960:1 to 1995:4. Real output is measured by real GDP and prices by the consumer price index.[21] Both are seasonally adjusted. In addition, we filtered out the short-term quarter-to-quarter noise present in the original series by running both the real GDP and CPI series through a centred three-quarter moving-average filter. Graph A.1 plots the data series used in our analysis. The short-term interest rate is a three-month interest rate, while the long-term interest rates is a 10-year bond yield. [22]

The following table presents the results of stationarity tests performed on the data series used in the paper.

Table A.1

Phillips-Perron tests for a unit root

Quarterly data: 1960:1-1995:4

Variable	**Germany**	**United States**
Real GDP growth	-13.86**	-8.70**
CPI inflation	-5.59**	-3.94**
Nominal short interest rate	-3.01**	-2.37
Nominal long interest rate	-2.71*	-1.81
Term spread	-3.57**	-3.92**

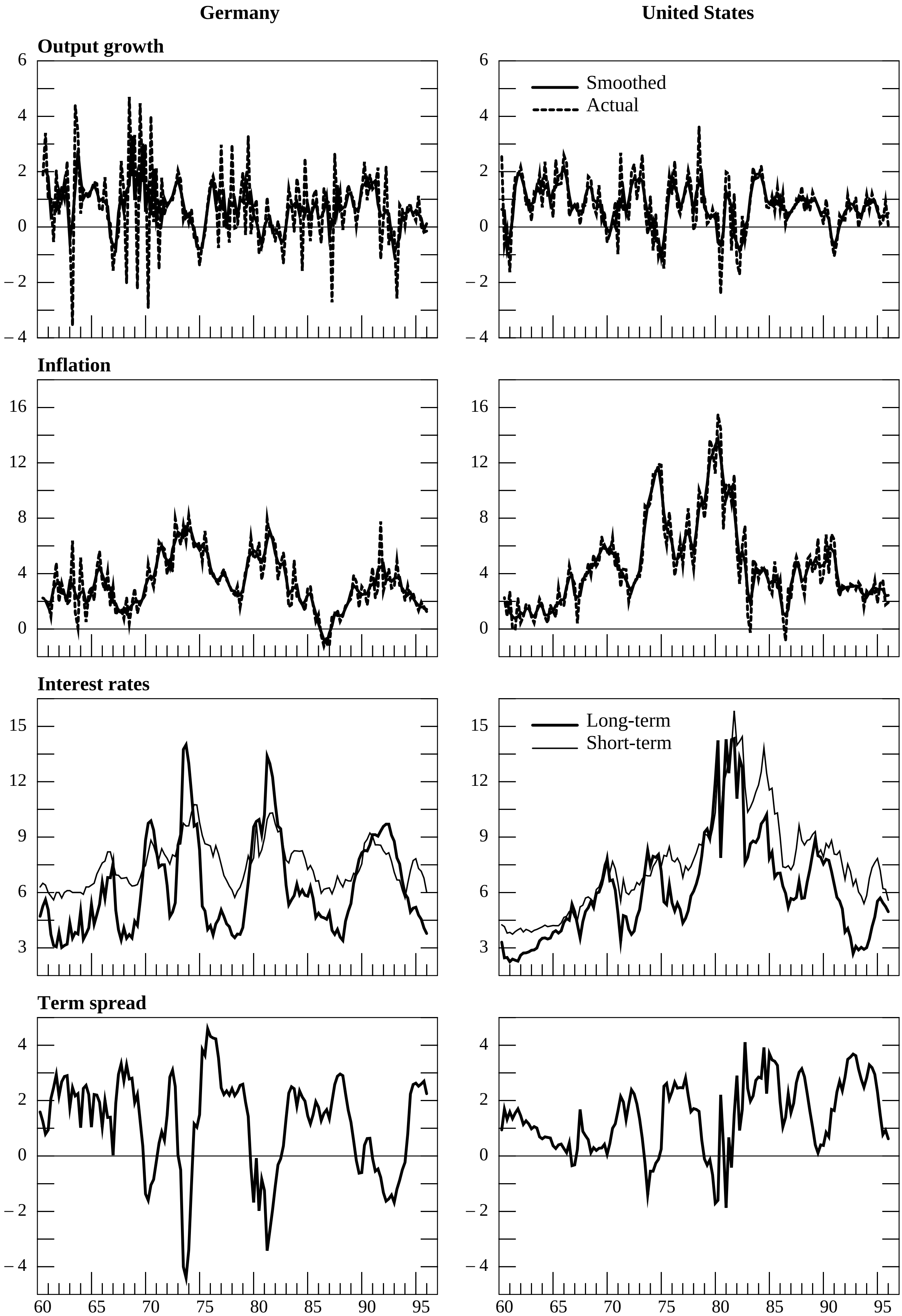
** (*) significant at the 5% (10%) level.

Whereas the reported statistical evidence is mixed, we assume that for both countries inflation and the two interest rates are stationary. The only series for which we fail to reject the unit root hypothesis at the 10% confidence level using Phillips-Perron tests are the US interest rates. Although we could easily allow for a unit root in interest rates in our analysis, we chose to maintain

[21] The data refer to output in western Germany and prices both before and after German reunification.

[22] For Germany, the three-month rate is the end-of-quarter interbank rate for 1970-96 and last-month's average for 1960-69; the long-term rate is the end-of-quarter yield on federal public bonds with a maturity of ten years for 1967-96 and all maturities for 1960-66. For the United States, the three-month rate is the end-of-quarter rate on Treasury bills for 1978-96 and last-month's average for 1960-77; the long-term rate is the end-of-quarter yield on ten-year Treasury bonds for 1962-96 and last-month's average for 1960-61.

Graph A.1
The data



the assumption of stationarity for three reasons. First, conventional unit root tests are known to have low power. For example, Lai (1997) rejects non-stationarity in US real interest rates using a new modified Dickey-Fuller test, which has greater power than standard tests. Secondly, on a priori and theoretical grounds we find it unlikely that interest rates in the United States would have a true unit root component. As discussed by Rose (1988), according to standard consumption asset pricing models this would imply that real consumption or output growth has a unit root component, for which there is no evidence at all. Finally, having a similar specification as in Germany allows an easier comparison of the results across the two countries.

Finally, following Bernanke and Mihov (1996) we have evaluated the stability of the VAR specification by conducting a series of sup Lagrange Multiplier test following the methodology of Andrews (1993).[23] For each equation we have tested for the constancy of the coefficients corresponding to each of the four variables separately. The results are tabulated below.

Table A.2

Andrews coefficient stability tests

Equation	**Variable**			
	Output	Short rate	Inflation	Term spread
Germany				
Output	8.33	11.77	12.12	16.39*
Short rate	5.58	8.99	6.78	6.05
Inflation	8.27	9.81	8.64	6.25
Term spread	10.63	9.24	7.27	7.04
United States				
Output	9.44	8.34	5.27	5.89
Short rate	9.61	5.39	5.98	4.01
Inflation	7.72	11.61	9.41	8.61
Term spread	8.99	6.07	8.76	6.35

** (*) significant at the 5% (10%) level.

The 10%, 5% and 1% critical values, tabulated in Andrews (1993) for stability tests with a sample truncation parameter of 15% and four lags, are, respectively, 14.31, 16.45 and 20.71.

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[23] We would like to thank Ilian Mihov for making this code available.

It appears that the VAR system is stable as no breaks can be detected. The single case in which the test rejects the hypothesis of no break corresponds to the lagged values of the term spread in the German system's output equation where the LM test statistic is significant at the 10% level (but not at 5%), indicating a potential discontinuity in 1974. Since the rejection of stability is not very strong at all, we decided to treat the system as stable.

A.2 Theoretical model

The empirical identified VAR model that underlies the analysis in this paper is based on a standard aggregate supply demand model. This section presents a simple version of such a model based on Fuhrer and Moore (1995), Svensson (1996) and Estrella (1997) and plots the impulse responses of the endogenous variables to each of four structural shocks. The model is described in structural form as follows:

$$\bar{y}_t = \bar{y}_{t-1} + \eta_t^s \quad \textit{Aggregate supply}$$

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + (1 - \beta_1 - \beta_2)\bar{y}_{t-1} - \beta_4 \rho_{t-1} + \eta_t^d \quad \textit{IS curve}$$

$$i_t - \pi_t = \gamma_1 (i_{t-1} - \pi_{t-1}) + \gamma_2 \pi_t + \gamma_3 (y_t - \bar{y}_t) + \eta_t^p \quad \textit{Monetary policy reaction function}$$

$$R_t = \rho_t + \frac{1}{N}\sum_{i=0}^{N-1} \mathrm{E}_t \pi_{t+i+1} + \xi_t \quad \textit{Fisher equation}$$

$$\pi_t = \alpha_1 \pi_{t-1} + (1 - \alpha_1)\mathrm{E}_t \pi_{t+1} + \alpha_2 (y_{t-1} - \bar{y}_{t-1}) \quad \textit{Phillips curve}$$

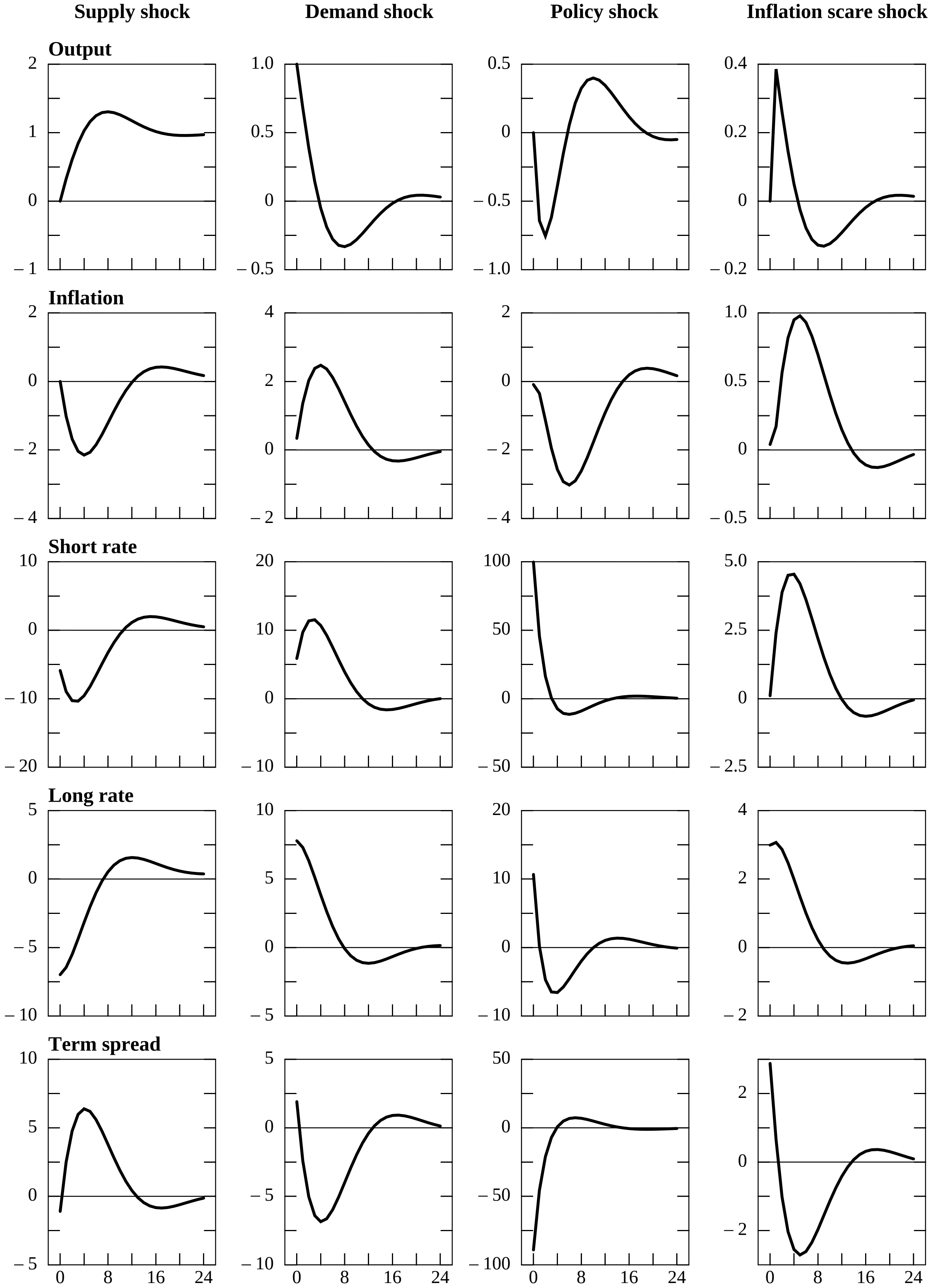
$$R_t = \frac{1}{N}\sum_{i=0}^{N-1} \{\mathrm{E}_t i_{t+i}\} \quad \textit{Expectations hypothesis}$$

The first equation is a random walk specification for potential output subject to a supply shock. The second equation corresponds to a dynamic IS curve where current output depends positively on past values of the output gap and negatively on the real long-term interest rate, and it is subject to a random demand shock. The reason why two lags of output are included in the specification is to capture the "hump" of the output dynamics observed in many studies and is the result of a positive β_1 and a negative β_2 which satisfy the constraint $\beta_1 + \beta_1 \leq 1$. In the monetary policy reaction function the short-term real rate of interest depends on inflation and the output gap with relative weights γ_2 and γ_3, and the central bank has a preference for smooth short-term interest rates expressed by γ_1. The real long-term interest rate is defined as the nominal rate of ten-period maturity minus the expected inflation rate over the same period and is influenced by a random inflation scare shock. The nominal long rate is defined as the average expected short rate over ten periods.

Because the system contains forward-looking expectation terms, it is very complicated to solve analytically. Its reduced form can be found numerically for a particular parameter configuration

Graph A.2

Impulse responses of the theoretical model



Quarters following the shock

Note: The coefficients used were: $\alpha_0 = 0.25$, $\alpha_1 = 0.60$, $\beta_1 = 0.97$, $\beta_2 = -0.01$, $\beta_4 = 0.05$, $\gamma_1 = 0.50$, $\gamma_2 = 1.60$, $\gamma_3 = 5.00$.

by using the solution method described in Sims (1996).

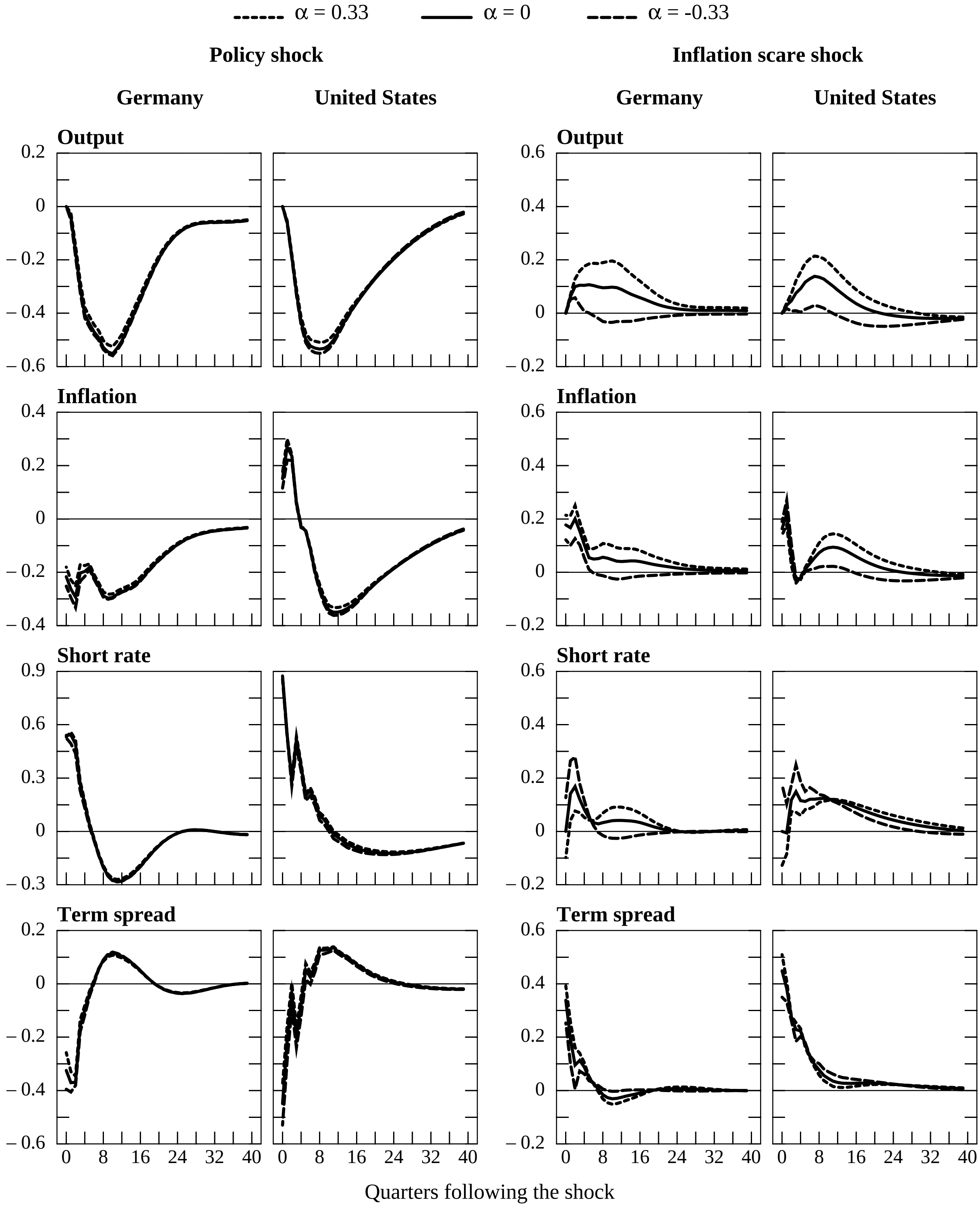
The system, defined as such, satisfies the identification assumptions of the VAR and, as is apparent from Graph A.2, the impulse response functions are qualitatively quite similar to the empirical ones. Note that, since the parameters used were not estimated or calibrated, the size of the responses is not meaningful.

A.3 Sensitivity analysis

As discussed in Section 1.1, the most controversial identifying assumption may be the one that restrains the three-month interest rates from responding within the quarter to inflation scare shocks. As mentioned in the text, the estimation of the supply and demand shocks is not affected by this identifying assumption. However, it may be the case that the estimation of the policy and inflation scare shocks is substantially affected. In Graph A.3 we analyse the sensitivity of the estimated impulse responses of the four endogenous variables to a reasonable range of responses of the short-term rate to an inflation scare shock. The solid line reports the benchmark model which is analysed in the main text. The two other lines are the estimated impulse response parameters when short rates rise by 33 basis points for every 100 basis point inflation scare shock to the long rate and when short rates fall by 33 basis points for every 100 basis point inflation scare shock. As can be seen in the graph, the impulse responses are not much affected.

Graph A.3

Sensitivity analysis



References

Andrews, D. W. K. (1993): "Tests for parameter instability and structural change with unknown change point". *Econometrica*, vol. 61(4), pp. 821-56.

Bernanke, B. and A. Blinder (1992): "The Federal Funds Rate and the channels of monetary transmission". *American Economic Review*, vol. 82(4), pp. 901-21.

Bernanke, B. and I. Mihov (1996): "Measuring monetary policy". NBER *Working Paper* no. 5145.

Bernanke, B. and M. Woodford (1996): "Inflation forecasts and monetary policy". Mimeo.

Bernard, H. and S. Gerlach (1996): "Does the term structure predict recessions? The international evidence". BIS *Working Papers* no. 37, September.

Blanchard, O. and D. Quah (1989): "The dynamic effects of aggregate demand and supply disturbances". *American Economic Review*, vol. 79, pp. 655-73.

Campbell, J. Y. and R. Shiller (1987): "Cointegration and tests of present value models". *Journal of Political Economy,* vol. 95, pp. 1062-88.

Christiano, L. J., M. Eichenbaum and C. Evans (1996): "Identification and the effects of monetary policy shocks", in M. I. Blejer, Z. Eckstein, Z. Hercowitz and L. Leiderman (eds.), *Financial factors in economic stabilisation and growth,* Cambridge University Press, Cambridge, UK.

Davis, E. P. and S. G. B. Henry (1994): "The use of financial spreads as indicator variables: Evidence for the United Kingdom and Germany". International Monetary Fund *Staff Papers*, vol. 41(3), pp.517-25.

Dueker, M. J. (1997): "Strengthening the case for the yield curve as a predictor of US recessions". The Federal Reserve Bank of St. Louis *Review*, vol. 79(2), pp. 41-51.

Edelberg, W. and D. Marshall (1996): "Monetary policy shocks and long-term interest rates". Federal Reserve Bank of Chicago *Economic Perspectives*, vol. XX(2), pp. 2-17.

Eichenbaum, M. and C. Evans (1995): "Some empirical evidence of the effects of monetary policy shocks on exchange rates". *Quarterly Journal of Economics*, vol. 110, pp. 975-1009.

Estrella, A. (1997): "Why do interest rates predict macro outcomes? A unified theory of inflation, output, interest and policy". Federal Reserve Bank of New York, *Research Paper*, no. 9717.

Estrella, A. and G. Hardouvelis (1991): "The term structure as a predictor of real economic activity". *Journal of Finance*, vol. 46(2), pp. 555-76.

Estrella, A. and F. Mishkin (1997): "The predictive power of the term structure of interest rates in Europe and the United States: Implications for the European Central Bank". *European Economic Review*, vol. 41(7), pp. 1375-402.

Friedman, B. and K. Kuttner (1993): "Economic activity and the short-term credit markets: an analysis of prices and quantities". *Brookings Papers on Economic Activity,* 2, pp. 193-283.

Fuhrer, J. C and G. R. Moore (1995): "Monetary policy trade-offs and the correlation between nominal interest rates and real output". *American Economic Review*, vol. 85(1), pp. 219-39.

Funke, N. (1997): "Predicting recessions: some evidence for Germany". *Weltwirtschaftliches Archiv*, vol. 133(1), pp.91-102.

Galí, J. (1992): "How well does the IS-LM model fit postwar US data?" *Quarterly Journal of Economics*, pp. 709-38, May.

Gerlach, S. (1996): "Monetary policy and the behaviour of interest rates: are long rates excessively volatile?" BIS *Working Papers*, no. 34.

Gerlach, S. and F. Smets (1995): "The monetary transmission mechanism: evidence from the G7 countries". CEPR *Discussion Paper*, no. 1219.

Goodfriend, M. (1995): "Acquiring and maintaining credibility for low inflation: the US experience", in L. Leiderman and L. E. O. Svensson (eds.), *Inflation targets*, CEPR, London.

Hardouvelis, G. (1994): "The term structure spread and future changes in long and short rates in the G7 countries". *Journal of Monetary Economics*, vol. 33, pp. 255-83.

Harvey, C. R. (1988): "The real term structure and consumption growth". *Journal of Financial Economics*, vol. 22, pp. 305-33.

Harvey, C. R. (1991a): "Les taux d'intérêt et la croissance économique en France". *Analyse financière*, 1991(3), pp. 97-103.

Harvey, C. R. (1991b): "Interest rate based forecasts of German economic growth". *Weltwirtschaftliches Archiv*, vol. 127(4), pp. 701-18.

Harvey, C. R. (1995): "The relation between the term structure of interest rates and Canadian economic growth". Duke University, mimeo.

Haubrich, J. G. and A. M. Dombrosky (1996): "Predicting real growth using the yield curve". Federal Reserve Bank of Cleveland *Economic Review*, vol. 32(1), pp. 26-35.

Hu, Z. (1993): "The yield curve and real activity". International Monetary Fund *Staff Papers*, vol. 40(4), pp. 781-806.

King, R. G., C. I. Plosser, J. H. Stock and M. W. Watson (1991): "Stochastic trends and economic fluctuations". *American Economic Review*, vol. 81, pp. 819-40.

Lai, K. S. (1997): "Is the real interest rate unstable? Some new evidence". *Applied Economics*, vol. 29, pp. 359-64.

Plosser, C. I. and K. G. Rouwenhorst (1994): "International term structures and real economic growth". *Journal of Monetary Economics*, vol. 33, pp. 133-55.

Rose, A. K. (1988): "Is the real interest rate stable?" *Journal of Finance*, vol. 43, pp. 1095-112.

Sargent, T. J. (1979): "A note on maximum likelihood estimation of the rational expectations model of the term structure". *Journal of Monetary Economics*, vol. 5, pp. 133-43.

Shiller, R. J., J. Y. Campbell, and K. L. Schoenholtz (1983): "Forward rates and future policy: interpreting the term structure of interest rates". *Brookings Papers on Economic Activity*, vol. 1, pp. 173-217.

Shapiro, M. D. and M. W. Watson (1988): "Sources of business cycle fluctuations", in S. Fisher (ed.), NBER *Macroeconomic Annual*, pp. 111-56, Cambridge, Mass. MIT Press.

Sims, C. A. (1996): "Solving linear rational expectations models". Yale University, mimeo.

Smets, F. (1996): "Measuring monetary policy in the G7 countries: interest rates versus exchange rates". BIS, mimeo.

Smets, F. (1997): "Financial asset prices and monetary policy: theory and evidence". BIS *Working Papers*, no. 46.

Stock, J. and M. Watson (1989): "New indexes of coincident and leading indicators", in O. Blanchard and S. Fisher (eds.), NBER *Macroeconomic Annual*, Cambridge, Mass: MIT Press.

Svensson, L. E. O. (1997): "Inflation forecast targeting: implementing and monitoring inflation targets". European Economic Review, vol. 41(6), pp. 1111-46.

Warne, A. (1993): "A common-trends model: identification, estimation and inference". Institute for International Economic Studies *Seminar Paper*, no. 555, University of Stockholm.

Woodford, M. (1994): "Nonstandard Indicators for monetary policy: can their usefulness be judged from forecasting regressions", in N. G. Mankiw (ed), *Monetary Policy*, The University of Chicago Press, London.

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