Does the ECB React to the State of Fiscal Policy in Europe? A Real Time Analysis

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Abstract

In the standard Taylor rule, fiscal variables are absent and the central bank is assumed to respond in the same way to a given inflation-output gap outlook whatever the stance of fiscal policy; or whatever the state of public finances and their likely impact on the economy and financial markets. This paper puts this assumption to the test. Estimating Taylor rules for the ECB using real time data, we find that there is no direct response to the fiscal policymakers' instrument, the cyclical adjusted primary balance. But there is a clear response to the level of debt. Monetary policy tightens by 25 basis points for every 2.5pp rise in the debt to GDP ratio. In the ex-post data however, reflecting actual outcomes rather than what was intended to happen, we find that the ECB appears to support expansionary fiscal policies when there is a perceived need to reflate the economy. But it reacted more aggressively to correct past excesses that had already led to high debt ratios.

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E61 (Policy Designs and Consistency, Policy Coordination)

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1. Introduction

The behaviour of monetary policymakers is often characterised in terms of a simple Taylor rule, expressing interest rate decisions as a function of the rate of inflation and the output gap. In the standard specification, there is no direct response to what fiscal policymakers are doing. Any reaction to fiscal policy takes place via its effects on the output gap and inflation, and hence fiscal variables do not enter the Taylor rule in their own right.

Such an approach effectively assumes that the central bank will always respond identically to a given output gap and inflation outlook regardless of the fiscal stance or level of public debt, and recalls the debate over whether asset prices should be included in the monetary control rules (Bernanke and Gertler, 2001). In view of the recent financial crisis, macroprudential policies that respond to the asset markets in general, and the accumulation of fiscal debt in particular, could be an important and useful component in monetary policy decisions.

In this paper we put this assumption to the test. We estimate a Taylor rule for the ECB with fiscal variables included, and test for any policy response. The key finding is that interest rate setting is independent of the cyclically adjusted primary balance, but it does react to the stock of government debt outstanding (a stock variable instead of a flow, implying integral rather than proportional control to remove past "excesses").

Why might we include fiscal variables in the ECB's hypothesised policy reaction function? Up to now there has been rather little empirical work on monetary and fiscal interactions within EMU. This is strange since the architecture of EMU has been profoundly influenced by concerns about the interplay between fiscal and monetary policy. The ECB's strict independence, its focus on price stability, the Stability and Growth Pact and the adoption of fiscal entry criteria for EMU can all be at least partly explained by concern about, and fear of the potentially destructive effects of fiscal-monetary interactions on economic performance[1]. These issues have been given renewed prominence in the light of the current financial crisis which has seen a sharp deterioration in the public finances of many eurozone countries. So there are good practical and institutional reasons for including some fiscal terms; and the reality is that the ECB talks frequently of the importance fiscal policy, and puts considerable effort into monitoring the eurozone's fiscal position.

There are also at least four good theoretical reasons for including fiscal variables:

One argument is based on the idea that higher levels of government debt may create pressure to reduce the real debt burden via inflation- particularly in the context of a monetary union (Chari & Kehoe, 2007; Beetsma & Uhlig, 2000; Dixit & Lambertini, 2003; Eusepei and Preston, 2007). If

[1] For an ECB view on the role of these issues in shaping the architecture of EMU: see Bini Smaghi (2007), Duisenburg (2001), Issing (2004). For a review of the roots of the fiscal criteria, see De Grauwe (1996).

monetary policy did accommodate loose fiscal policy, then debt would enter the Taylor rule with a negative coefficient. On the other hand, if the ECB was able to assert its independence and maintain the primacy of price stability, the reaction to debt would be insignificant or positive (positive if the ECB was trying to offset the effects of excessive fiscal expansions/contractions).

A second argument is that central banks reaction functions should include variables which are absent from their loss function. Svensson (2003) makes the point that a pure-inflation targeter should nevertheless react to any variable which contains information about future inflation. Put differently, different time horizons are important - current inflation captures inflation pressures now or anticipated in the near future, but may miss longer term threats to price stability. In the context of asset prices for example, some have advocated central banks "leaning against the wind" because uncorrected asset price imbalances may store up future problems for output and inflation (Cechetti et al, 2003; Bordo & Jeanne, 2003). In the same way, a loose fiscal stance may be interpreted as a sign of inflationary pressure further down the line.[2] In that case, the central bank would raise interest rates in response to a looser fiscal policy.

Thirdly, the debt ratio is an indicator of the potential for financial instability when public finances become unsustainable (Hughes Hallett et al, 2009). So the central bank watches that and takes action to head off any further build up of debt that might go unsustainable. Specifically the fiscal theory of the price level suggests that once debt is too high, prices will start to jump. But by then it is too late. So central bank acts now as a defensive measure.

Fourth, even if central bank is not concerned with unsustainability as such, it has to act before the bond market collapses because otherwise it has lost its only real policy instrument. Both Goodfriend (2009) and Cochrane (2009) argue that monetary policy has fiscal consequences and may actually merge in cases of deflation. In order not to undermine their own policy actions, monetary policymakers have to adjust their monetary instruments to eliminate those fiscal effects. In short, if central banks need to coordinate with fiscal policy, they will have to take the stance of the other instrument into account.

The Literature: These four rationales are all *normative* - in that they relate to what the ECB "should" do under given circumstances. The focus of this paper, however, is on the *positive*: how has the ECB actually behaved, or tried to behave in reality? In recent years, there has been a growing appreciation that analyses of policymakers behaviour need to consider the data the policymaker had at the time (*real time data*), as opposed to the revised data available many

[2] This tallies with remarks by Wim Duisenburg (2001) about the role of fiscal policy in ECB thinking: "The ECB closely monitors fiscal policy since this is one of the main areas where significant shocks to price stability…can originate". He also spoke of the ECB's attention to "all economic, financial and monetary factors which could threaten the maintenance of price stability over the medium term.

years hence (*ex post data)*. As Orphanides (2001) points out, any policy rule based on ex post data cannot be said to be a description of what the policymaker intended to happen since it relies on information that the policymaker did not have at the time. At best it can reveal what actually ended up happening. By the same token, empirical estimates of policymakers' reaction functions need to be formulated in terms of the real time data that the policymaker could have reacted to. We respect this principle by including real time data for all variables, including fiscal variables, which earlier work has shown to be subject to sizeable revisions over time (Hughes Hallett et al, 2007).

A number of papers have attempted to estimate reaction functions for the ECB[3], several of which follow Orphanides's recommendation of using real time data (Gerdesmeier and Roffia, 2004; Sauer and Sturm, 2007; Gerlach, 2007; Gorter et al 2007: Castelnuovo, 2006). On the other hand, only two papers implement real time data methods in the context of forward looking behaviour, and neither of those uses real time data for both output gap and inflation. Gorter et al (2007) use consensus forecasts for inflation, but departs from the canonical Taylor rule by using forecasts of economic growth rather than the output gap. Castelnuovo (2006) uses the same consensus forecasts for inflation, but then uses ex post data for the output gap.

There are no empirical papers evaluating the response of the ECB to fiscal variables. But there are two important papers which analysed similar interactions prior to EMU. Mélitz (2000) estimates reaction functions for monetary and fiscal authorities which include a term in the other policymaker's instrument for a panel of OECD countries. He finds monetary policymakers do respond to fiscal policy - they tighten when fiscal policy is looser; and the fiscal policymakers have a similar counter-reaction[4]. Hence the central banks of that time appear to have been in conflict with the fiscal policymakers. Is this true for the ECB? And is it still true in real time? That is in terms of what the policymakers intended to happen, as opposed to what actually happened after the shocks, control errors and implementation problems are accounted for?

This paper therefore makes several contributions to the literature. First, it tests for a monetary policy reaction to fiscal variables; and hence checks whether results elsewhere in the literature are robust to inclusion of the fiscal variables. Second, in contrast to the existing literature on ECB Taylor Rules, it uses forward looking real time data for both inflation and the output gap. Third, it updates the older literature on pre-EMU fiscal monetary interactions by looking at what has happened *after* EMU.

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[3] Studies using only *ex post* data include: Gerlach-Kristen (2003), Surico (2003), Carstensen - Colavecchio (2004), Fourçans and Vranceau (2004)

[4] Similarly, Wyplosz (1999) finds a significant negative coefficient on the primary balance (fiscal surplus) in the monetary policymakers reaction function.

2. Dataset

There is no single eurozone dataset available for all our relevant variables. The Euro Area Real Time Database is the single most complete dataset, but the vintages only begin in 2001 and some only run up to 2006. For that reason, to obtain data for a longer sample period it was necessary to compile our dataset independently, using data from several sources. In all cases our data is at a quarterly frequency.

The fiscal and output gap data are taken from successive issues of the OECD's *Economic Outlook* from December 1994 (No 56) onwards to June 2008. This data is published twice per year- one edition in June and one in edition December. The published values of the variables are all on a yearly basis[5]. To derive quarterly data, we take the latest available vintage at the start of a given quarter and then use the Lisman method[6] to interpolate quarterly values for the whole time series. This procedure supplies our national data.

Economic Outlook does not report eurozone figures for the whole period. We therefore construct our own eurozone data, based on a weighted average of national data. Weights are determined by the nominal GDP share (in millions of euro) of each country[7]. In each case, we use a vintage of GDP which matches the vintage of the variable being measured- e.g. real time budget deficits are weighted according to real time GDP, ex post budget deficits are weighted using ex post GDP and so on. Economic Outlook does not report figures across the whole period for Luxembourg, Slovenia, Malta and Cyprus and therefore, these countries are effectively left out (assigned a weight of zero). However, the bias from excluding these countries from the construction of our eurozone data is extremely small, since they account for less than 1% of Eurozone GDP (and for most of the sample, only Luxembourg was an EMU member).

The interest rate measure used is the 3-month Euribor rate at the end of quarter, taken from Eurostat. In principle there is no distinction between real time and ex post data here, since the observation of the discount rate in real time is not subject to measurement error. However, since the data is an end of quarter figure, policy revisions during the subsequent quarter are possible; and the ECB does make small adjustments to its policy rate between policy meetings to keep the market determined Euribor rate at its intended value. Hence there could be small intra-quarter policy revisions that play the same role. It remains to be seen if those revisions are actually significant numerically.

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[5] The December 2000 and the December 2004 issues of economic outlook (68 and 74 respectively) do not report a figure for the Greek primary balance. In these cases, the missing data was filled in using figures reported in the previous editions (67 and 73 respectively).

[6] See Lisman and Sandee (1967)

[7] Greece is assigned a weight of zero prior to 2001.

Inflation expectations data is taken from Consensus Forecasts. This is a monthly survey of over 200 forecasters, who report inflation expectations for around 20 countries. Participants are asked to forecast year end inflation for the current year and the next year - i.e. in December of each year. To generate a forecast for inflation in the intermediate months, we follow a number of other authors[8] in using linear interpolation. This of course only provides a proxy for the true expectations, but nevertheless respects the "real-time principle" of restricting our information set to information that could have been known to policymakers at the time. The eurozone figure is obtained by taking a weighted average of the national figures using Eurostat's yearly HICP country weights[9]. Consensus Forecasts do not collect data on Luxembourg, Slovenia, Malta and Cyprus, and we exclude them from our analysis. Again, since they have a combined weight of less than 1% in the HICP, our measure is very close to the full euro-area figure.

Data on inflation itself was taken from from Eurostat, using the year on year change in the HICP. Given that initial releases are seldom revised (Coenen et al 2003), the real time data and ex post data for current inflation are largely the same[10], although there is typically a lag of around 2 months in the reporting of inflation figures. In any case, our analysis is forward looking and hence the inflation variable which enters the Taylor rule is a forecast - actual inflation is used only as an instrument.

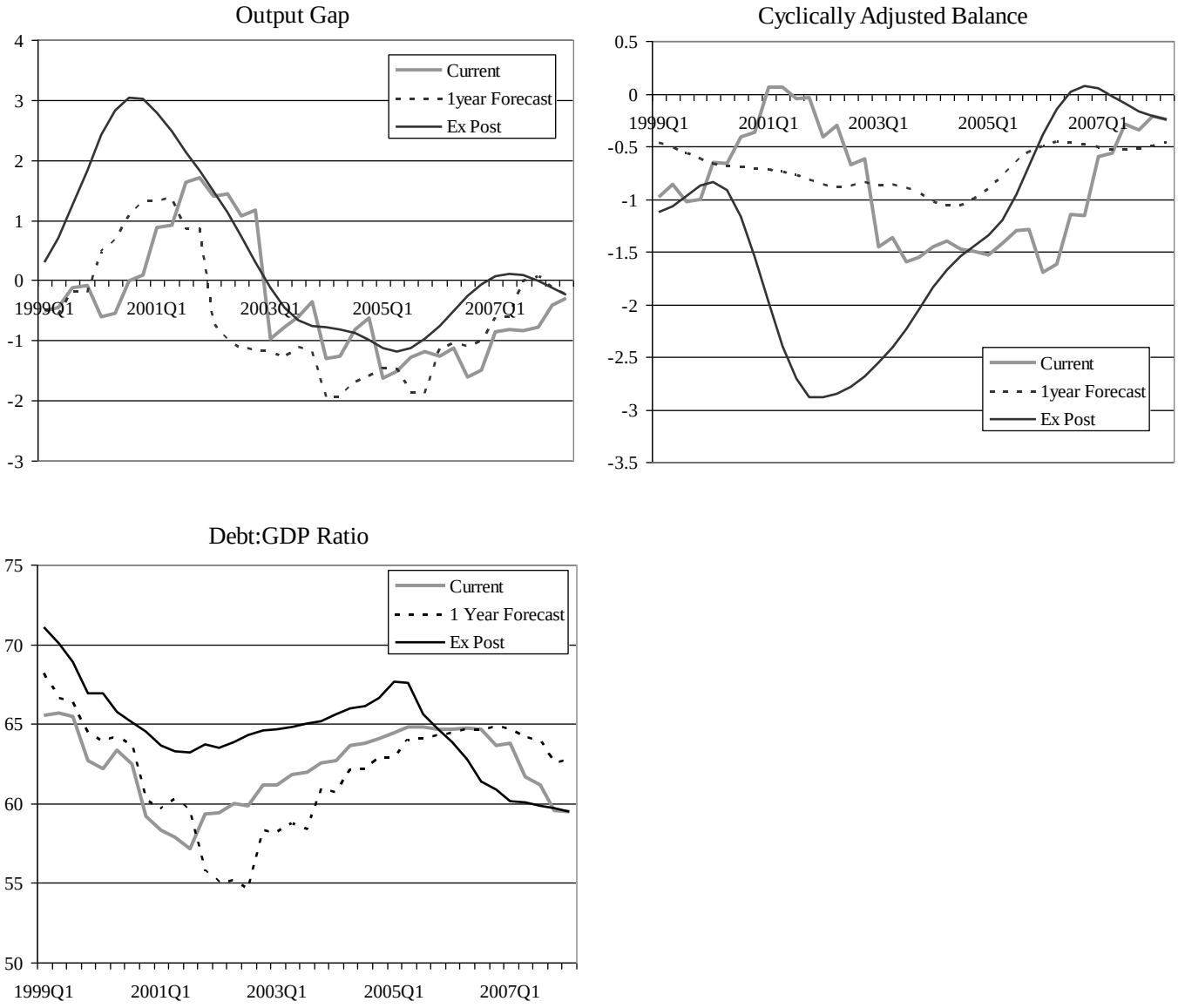
Figure 1 compares ex post data with the current and forecast values available in real time. In each panel, the forecast variable is lagged by one year so that the figure reported for year X quarter Q is the forecast, made at X-1:Q, for the variable at time X:Q. Similarly, the current variable denotes to the X:Q estimate of the variable made at time X:Q.

Looking at the output gap (upper left panel) it is evident that, compared to ex post data, the real time figures (and the 1 year forecast) underestimated the extent of the boom in the first half of the sample, and were overly pessimistic during the recovery in the latter years of the sample. Similarly, the real time CAPB figures (upper right panel) failed to pick up the substantial fiscal loosening in the early part of the sample, and were sluggish in picking up the improvement in public finances later on. Lastly, the debt figures (lower panel) show the ex post debt ratio was higher than its real time counterpart for most of the sample period. The one year forecast follow similar dynamics, but shows a much pronounced fall in the early part of the sample, and a noticeably larger rise in the latter half. Thus the real time output gap appears to be too pessimistic and lag the ex-post, actual figures by one or two quarters. The CAPB figures are less

[8] Gorter et al (2007), Sauer and Sturm (2007), Gerlach (2007), Begg et al (1998) and Alesina et al (2001)
[9] These weights are determined at the beginning of each year, and are not subsequently revised. Therefore the "real time" and the "ex post" HICP weights are identical.
[10] "In contrast, the consumer price data are typically not revised at all", (Coenen et al, 2003, p980)

reliable; they are alternately optimistic and pessimistic, but lag the actual outcomes. The debt figures meanwhile are mostly too optimistic, but pessimistic about any improvements.

Figure 1: Data Across Vintages (in percentage points)



3. Empirical Estimates of Reaction Functions

To capture the behaviour of the ECB, we start by estimating a standard Taylor rule of the form:

$$i_t = \rho i_{t-1} + (1-\rho)[\beta_0 + \beta_\pi \pi_{t+k} + \beta_y y_{t+k} + \lambda z_t] \quad (1)$$

where i_t is the policy rate, π_t is the rate of inflation[11], y is the output gap and z is a vector of additional variables. The index k captures the policy horizon of the central bank: $k=0$ means the authorities respond to contemporaneous data, $k>0$ implies forward looking behaviour. The parameter ρ captures the degree of persistence, gradualism or inertia in monetary policy[12].

3.1 Econometric Considerations

Theory suggests that the output gap should be stationary, and if expectations are well anchored, then inflation should also be stationary. A KPSS test on both variables fails to reject the null of a unit root at the 5% level. Accordingly, we proceed on the basis that our variables are stationary, in keeping with most of the related literature.

To overcome the problem of simultaneity, our reaction functions were estimated using a two stage Generalised Method of Moments estimator with a variable bandwidth. We report Newey-West heteroscedasticity and autocorrelation corrected (HAC) standard errors for the results.

In the canonical Taylor rule regression we use the following instruments for output and inflation one year ahead: one to four lags of the (real time) inflation and output gap series, plus the real time and one year ahead forecasts of the US output gap and the annual percentage change in the price of oil. The j-statistic is reported for each regression, and in each case exogeneity is strongly supported for the instruments.

Favourable results for tests of the exogeneity of instruments are a necessary condition for the choice of instruments in our final regression. But it is also important that instruments are "relevant"- i.e. well correlated with the explanatory variables that they replace. In fact an optimal choice of instruments requires exogeneity with respect to the error term, and a maximised correlation with the variable being instrumented. Stock and Yogo (2002) point out that many applications of GMM and IV suffer from a problem of weak (but nevertheless exogenous) instruments. If instruments are of low relevance, then not only do standard asymptotic results

[11] In many representations, the inflation term is written as a deviation from some target value π^*. However, if that target value, π^*, remains constant over the sample period, estimating such a reaction function would yield identical results apart from a difference in the constant to accommodate π^*.

[12] For a detailed discussion of the role and causes of inertia, see Castelnuovo (2003)

fail to hold, but the asymptotic standard errors are increased and the power of the hypothesis tests is reduced.

Staiger and Stock (1997) propose the rule of thumb that, for one endogenous regressor, the first stage F-statistic should be more than ten. Subsequently they computed critical values for cases with more than one endogenous regressor (Staiger and Stock, 2002). For sixteen instruments and two endogenous regressors, our case, the critical value is 10.96[13]. In our case, the first stage regression of the inflation forecast yielded a test statistic of 18.39, and the forecast of the output gap yields 14.19, in both cases implying well chosen (strong) instruments.

Exogeneity of instruments is tested for using the J-statistic. The reported value (taken from e-views) needs to be multiplied by the number of observations in order to generate a test statistic which follows the chi-squared distribution. Generally speaking, to exceed the critical value the J-statistic needs to exceed 0.5. Our results make it plain that, for all our specifications, the J-statistic is in fact well under this level which implies our instruments are valid.

3.2 Estimation Results for the ECB

Table 1 shows the results of our estimation of the ECB's Taylor rule. In each case k is set at 4, which implies monetary policy is set with horizon of one year ahead. The coefficients on the explanatory variables are the long run reactions. The immediate reaction (impact effect) is given by $(1-\rho)$ times the reported coefficients.

Regression I is the canonical Taylor rule with terms in inflation and output gap, and gives results that are in line with studies elsewhere. The ECB reacts to both inflation and the output gap, but do so more strongly to inflation than to output. The coefficient on inflation is greater than one, and the "Taylor Principle" is satisfied (although possibly not significantly so, in the sense of β_π being significantly different from 1. The test is marginal at 5%, but accepted at the 10% level).

Regression II adds a forward looking debt term (a 1 year real time forecast of the debt to GDP ratio). The responses to inflation and to the output gap look fairly similar, and the response to debt is significant. Specifically, for every percentage point rise in the debt to GDP ratio, interest rates will rise by about 3 basis points immediately, and by about 10 or 11 basis points in the long run. This form of the Taylor rule is robust to different specifications of the debt term, and the debt coefficient is stable under all variations in the specification of the rest of this policy rule. This is our preferred specification.

[13] Staiger and Stock (2002, p39) report critical values for different TSLS biases: 10.96 corresponds to the hypothesis that the TSLS bias is 10% or less: the criterion used in the "F stat less than 10%" rule of thumb.

Table 1: Taylor Rules with Real Time Data

	I	II	III	IV	V
β_0	**1.41***** (0.49)	-5.47 (3.32)	**-5.87*** (2.68)	**-7.25**** (2.90)	-6.40 (6.82)
β_π	**1.41***** (0.28)	**1.55***** (0.33)	**1.58***** (0.32)	**1.74***** (0.40)	**1.42***** (0.32)
β_y	**1.31***** (0.18)	**1.37***** (0.16)	**1.22***** (0.23)	**1.21***** (0.24)	**1.72*** (0.33)
ρ	**0.63***** (0.08)	**0.62***** (0.09)	**0.66***** (0.09)	**0.58***** (0.09)	**0.51***** (0.13)
β_{DEBT}		**0.10**** (0.05)	**0.11**** (0.04)	**0.11**** (0.04)	**0.16****
β_{CAPB}				0.206 (0.27)	
β_{LRI}					0.52 (0.21)
J-stat	0.113	0.116	0.114	0.108	0.118
R^2	0.865	0.871	0.891	0.880	0.849

Instruments used: up to 4 lags of the real time output gap, inflation, the current and one year ahead forecast of US output gap and inflation, the one year ahead forecast of the cyclically adjusted primary balance, the real time debt ratio and the annual percentage change in oil prices.
Estimation method: Instrumental Variables GMM, with a variable Bartlett Kernel, Newey-West HAC Standard Errors in brackets
,** and ** denote significance at the 10, 5 and 1 % significance levels

Regression II adds in a forward looking debt term (a 1 year real time forecast of the debt to GDP ratio). The responses to inflation and to the output gap look fairly similar, and the response to debt is significant. Specifically, for every percentage point rise in the debt to GDP ratio, the interest rate will rise by about 3 basis points immediately, and by about 10 basis points in the long run.. This form of the Taylor rule is robust to different specifications of the debt term, and the debt coefficient is stable under all variations in the specification of the rest of the policy rule. This is our preferred specification.

In regression III, the contemporaneous real time level of the debt ratio, rather than its forecast value at that point, is used. This yields virtually identical results in terms of coefficients. In fact it induces a small drop in the output gap coefficient, and a weakening of the effect of expected inflation[14], both of which suggest that the monetary authorities react to and are worried by the sustainability and (to a lesser extent) the future inflation effects of overly loose fiscal policies.

[14] β_π rises if expected debt is dropped, so inflation aversion rises if fiscal policies are not allowed for explicitly.

Regression IV checks if our reaction to debt is really a reaction to the current fiscal stance, rather than sustainability per se, by including the one year ahead of forecast of the cyclically adjusted primary balance (structural balance). The coefficient on the CAPB is not significant and has the wrong sign. That suggests that the ECB does not attempt to "undo" the effects of fiscal policy in the short run (e.g. by tightening its stance when fiscal policy loosens, in some kind of policy game), but it does tighten with long term fiscal developments such as the possibility of unsustainable fiscal policies or financial instability in the form of an excessive build-up of debt.[15] We have extended this regression to test for the possibility of an asymmetry or threshold effect in the ECB's responses to large fiscal deficits. However, replacing CAPB by its squared value did not produce a significant coefficient either.

Finally Regression V includes the long term interest rate (rate on 10 year government bonds) among the explanatory variables. Long rates are, in the traditional view of the yield curve, partly influenced by inflationary pressures to be expected in the future. However the ECB appears not to respond to such indicators. Again this suggests that the ECB is more concerned to ensure fiscal sustainability directly, there being sufficient terms representing future inflation pressures elsewhere in their policy rule. The implication is they react to debt directly because there is little advantage in trying to supplement market discipline (influence the yield curve) through short rates because they cannot rely on long rates being increased that way.

One qualification to be considered here: the reaction of interest rates to debt could be an artefact of reverse causality - i.e. higher policy rates lead to higher rates at the long end of the yield curve which push up debt service costs and hence the debt ratio itself. Three pieces of evidence allay this fear. First, when the long run interest rate is included in its own right in the Taylor rule, it is not significant. If the reverse causation story were true, then it would show up in the long-term interest rate as well as (or even instead of) the debt ratio. Second, when the one year ahead forecast of debt is instrumented (to take account of the simultaneity that would underlie any reverse causality), the coefficient on debt remains significant and of a very similar size. Indeed the coefficient on debt remains significant even when more distant lags are used as instruments. Third, our coefficient implies a 25 basis point rise in the policy rate is associated with a 250 basis point rise in the debt to GDP ratio. It is implausible that such a small rise in the policy rate could cause such a large change in the debt ratio.[16]

[15] This still suggests a competitive policy game, although not the one traditionally discussed in the literature. The appearance of debt in the ECB's reaction implies some kind of debt target in which the ECB aims to clear up past fiscal excesses. See Hughes Hallett (2008). But without the corresponding fiscal reaction functions, we cannot tell the form of the game (Nash non-cooperative, Stackelberg with fiscal or monetary leadership etc.).

[16] Suppose there was a one for one pass-through of interest rate changes; a 25 basis point rise in the policy rate would lead to a 25 basis point rise in the long term rate. If debt was initially 60% of GDP say, then this would lead to a 15 basis point rise in the debt to GDP ratio. Yet under reverse causality, the coefficient from our regression would imply a 250 basis point rise in the debt to GDP ratio.

Table 2: Taylor Rules with Ex Post Data

	I	II	III
β_0	**0.758***** *(0.03)*	**0.604***** *(0.03)*	**-10.31**** *(5.03)*
β_π	**1.14***** *(0.12)*	**0.49***** *(0.05)*	**1.75***** *(0.33)*
β_y	**0.85***** *(0.08)*	**0.90***** *(0.05)*	**1.08***** *(0.103)*
ρ	**0.758***** *(0.03)*	**0.604***** *(0.03)*	**0.743***** *(0.04)*
β_{DEBT}		**-0.118***** *(0.012)*	**0.147**** *(0.07)*
J-stat	0.208	0.164	0.159
R^2	0.884	0.820	0.808

Instruments used: up to 4 lags each of the ex post output gap, inflation, the expost US output gap and inflation, ex post cyclically adjusted budget, expost debt ratio and the annual percentage change in oil prices.
Estimation method: Instrumental Variables GMM, with a variable Bartlett Kernel, Newey-West HAC Standard Errors in brackets
,** and ** denote significance at the 10, 5 and 1 % significance levels

By way of contrast, Table 2 presents the corresponding Taylor rules estimated with ex post data. We use the same variables as instruments, but take the ex post observations to do so. In keeping with our rational expectations formulation, we do not include forward looking ex post variables as instruments.

These ex-post regressions show that the results of the ECB's actual behaviour, as it turns out, has been rather different from what the ECB evidently originally intended to do – but not, as it happens, with respect to loose fiscal policies that lead to high debt. Regression I, the canonical Taylor rule, implies that the ECB, when it comes to ex-post results, appears to pay a lot less attention to inflation than it had originally intended and only just respects the Taylor principle. It also appears to pay less attention to the output gap. What has taken the place of those two determinants of monetary policy is a 50% increase in policy persistence. If there is any genuine slippage here, it seems that when it comes to implementing their policies, the ECB has valued continuity and fewer changes in the direction of policy more than the economic circumstances might have suggested was desirable.

This last set of results deserves further explanation. If interest rates are not subject to revision or measurement error, and we have argued that any such revisions are likely to be very small in practice, then the action in going from real time to ex-post data is predominantly in the output gap variable. In fact, as nearly always in studies of this kind, what we the data actually shows is a

significant increase in the variability in the output gap figures, relative to target, in the ex-post compared to real time figures – mostly because of revisions to the official estimates of trend or potential output. So the softening of the ECB's *apparent* reactions to inflation and output are exactly what we should expect: the variance of the explanatory variable has increased, while that of the dependent variable has not. The question is whether we can associate these changes with shocks or measurement error; or with fiscal policy movements. If it is the former, then monetary policy has not been very successful in smoothing out the economy. But if is the latter, then fiscal policies have caused changes elsewhere and (with smaller response coefficients) we are moving towards a regime of greater institutional coordination in the outcomes. This is to underline the importance of being able to distinguish between "news" and "noise". However, this must remain a matter of speculation since we have neither data on whether the revisions to interest rates are indeed small; nor on whether the ex-post revisions to the output gap are associated with random errors, or systematically associated with fiscal policy changes.

When we come on to the reactions to debt and fiscal policy we find a second, and possibly more interesting set of results. If we take the case of future debt ratios, as forecasted one year ahead (regression II), we find that the ECB lowers interest rates when there is a projected build-up of debt. This might appear to be the wrong reaction (wrong sign). But it is saying that the ECB has in practice come to the aid of the fiscal policy makers when economic circumstances have suggested a need to reflate the economy through fiscal expansions. The fact that the ECB lowers its concern to control inflation at the same time, and abandons the Taylor principle, shows that the ECB is not just accommodating loose/undisciplined fiscal policies. Instead it is actually trying to moderate/support the fiscal policies: a de facto coordination of policies.

By contrast, Regression III shows that the story is quite different when it comes to the current level of debt. If past policies have led to too high a level of public sector debt then, for a given level of inflation and output gap, monetary policy will tighten. In fact all the characteristics from the standard Taylor rule return, but in stronger form. The Taylor principle with respect to inflation is stronger for the same degree of concern for the output gap; and policy persistence is again 50% larger than in the real time results. Yet higher debt already run up will be met with tighter monetary policy, at a rate that is one-third stronger than in the real time case. Thus the ECB has become more aggressive with the passage of time in response to past fiscal mistakes. The message is that when it comes to the crunch, the ECB changes its behaviour and tries to support fiscal policies where there is a perceived need to expand the economy in the future. But it reinforces its disciplining actions where fiscal policies have been loose in the past and excesses need to be cleaned up.

4. Conclusions

Estimating a reaction function for the central bank or fiscal authority using real time data yields very different characterisations of the policymaker's behaviour than when ex post data is used. In our application, we have shown that we get a very different interpretation of ECB behaviour if we use ex-post data instead of real time data, and would miss being able to uncover what the ECB really intended to do. In fact, using real time data, we find evidence that the ECB does take fiscal stance into account when setting monetary policy: while they do not respond to fiscal stance (as proxied by the cyclically adjusted primary balance), they do respond to debt. A 100 basis point (1 percentage point) rise in the debt to GDP ratio is associated with a 10 basis point rise in interest rates.

Thus in real time, monetary and fiscal policies do appear to conflict. The form of the game is not clear. It could be a non-cooperative game. But it is more likely to be a leadership game with monetary dominance since the ECB appears to react to problems of fiscal sustainability rather than to try to undo large deficits as such. But as we go through to ex-post data, it starts to appear (unfairly as the policymakers could not have used ex-post data) *as if* they were accommodating fiscal policy. That explains why so many researchers have thought central banks to be too weak, permissive or accommodating in the past. But that can be a misleading conclusion, as this paper has shown.

In fact our results reject the hypothesis that monetary policy passively accommodates looser fiscal policies. If anything, worsening public finances prompt a tightening in monetary policy via the debt to GDP ratio. In the ex-post data, we find the ECB supports expansionary fiscal policies if there is a need to reflate the economy, but reacts more aggressively to correct past excesses that have led to high debt ratios. In that sense, the ECB has been acting responsibly, and as a good citizen, even if it is rather different from the traditional view of the ECB's policy role.

Our results here are subject to the caveat common to all estimations of Taylor Rules, namely that they should not be taken too literally. Thus, we interpret the coefficients on debt, and other variables, as an "average response", rather than mechanistic policy reaction. This is consistent with the ECB's own explanations of its policy actions.

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