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Forecast Targeting and Financial Stability: Evidence from the European Central Bank and Bank of England

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ABSTRACT

This paper investigates whether financial markets stability matters in setting monetary policy in the case of the European Central Bank and Bank of England. We show that our Tri-mandate Taylor rule better explains the deviations of the observed policy rate from the implied interest rates for both central banks. The forward-looking version shows that the monetary policy conducted by the ECB is largely affected by the US financial market stability, while only the domestic financial market stability affects the BOE. Lastly, we show that the preferences of monetary policy makers have shifted in the aftermath of the 2008 financial crisis.

1. Introduction

Should a central bank include financial market stability in its mandate? While a consensus has developed that a central bank cannot ignore financial stability, there is no agreement on the extent to which financial stability should be incorporated into monetary policy or only tackled non-monetary policy tools. Central bank intervention activity has evolved considerably over time, and changes have often occurred to address economic shocks and crises. The 2008 financial crisis has raised concerns with regards to the responsibilities of central banks in preventing and managing financial crises, triggering the need for redefinition of the main objectives in most central bank mandates (BIS 2011).

This paper makes two main contributions to the existing central bank literature that relies to the Taylor (1993) rule framework. Firstly, it contributes to the literature on the Tri-mandate policy model adopted by central banks by investigating whether financial market stability is on par with the standard Taylor rule factors in setting interest rate. Studies on FED's monetary policy show that policymakers' discussions on financial stability systematically explain deviations of observed policy rates from the rate implied by the Taylor rule (see Oet & Lyytinen, 2017). These findings support the dominance of the Tri-mandate policy model for guiding the FED monetary policy in the aftermath of the financial crisis. While there is empirical literature for the case of FED,[1] little is known about the

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[1] See, for instance, Žáček (2020), Franceschi (2020), Wischnewsky et al. (2021).

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monetary policy of the European Central Bank (ECB) and the Bank of England (BOE), though both put prominent importance on financial stability in the Eurozone and in the United Kingdom, respectively. Previous studies on ECB have found that media coverage of ECB's policy decisions has impacted the monetary policy objectives (Bennani, 2018). Moreover, professional forecasters form their expectations regarding the policy rate consistent with the Taylor rule (Czudaj, 2021), though this nexus has diminished over time.

In this paper, we test if the financial market stability has additional explanatory power in the monetary policy conducted by the ECB and BOE and explains the deviation of realized interest rates from the predicted values. Secondly, this paper adds to the literature on judgment in monetary policy through targeting rules. This research area has been developing as central banks have adopted an inflation-targeting framework, which integrate targeting rules and extra-model information. However, as monetary policy became more elaborate (Svensson 2003, 2010), a "forward-looking" monetary policy rule is the more appropriate guide for policy makers, as it captures the lags in the effects of monetary policy on the economy as well as the intrinsic forward-looking features of market interest rates (Svensson 2020). Empirical research testing the validity of the forward-looking Taylor rule has been documented only for the ECB over the period prior to the financial crisis (Gorter et al., 2008). Lack of empirical evidence is found in the case of the ECB in the period after 2007 and in the case of BOE. Therefore, we fill this void by testing whether monetary policymakers adopted a forward-looking Taylor rule in the Eurozone and the UK over the period 2003-2018.

Lastly, we enrich our empirical approach by controlling for potential time-varying impact of the variables under investigation as well as additional financial market factors, such as the stability of international financial markets and exchange rates.

2. Empirical Approach

2.1. Data sources and variable construction

Our period of analysis extends from January 2003 to December 2018 and includes 192 monthly observations for each central bank.[2] Data are retrieved from different databases. Ex-post data include inflation and GDP growth rate, which are retrieved from the OECD website; the nominal interest rate, inflation rate, and GDP growth rate forecasts are retrieved from the central bank websites. We use Bloomberg database to collect the Euro Stoxx 50 Volatility Index (VSTOXX) for the Eurozone and the FTSE 100 Volatility Index (VFTSE)[3] for the UK to construct our proxy of financial market stability, as they are usually employed in the literature (see, for example, Becker et al. (2009) and Fernandes et al. (2014)).

To estimate the different versions of Taylor rules, we build the two traditional variables, namely the inflation gap and the output gap, and estimate them using both the ex-post and forecasted data. The inflation gap to be included in the traditional and Tri-mandate Taylor rule is computed as the difference between the ex-post inflation rate data and the inflation target (2%). For the corresponding forward- looking version, we estimate the inflation gap considering the forecast inflation rate data.[4] The same for the output gap, wherein the potential growth rate is measured by the average GDP growth rate in the pre-crisis period.[5] Moreover, we build the financial market stability slack following the methodology proposed by Oet & Lyytinen (2017)[6] as the difference between the equilibrium level of the financial market volatility and its current value. The equilibrium level of the volatility is estimated as the average of the financial market indexes in the pre-crisis period (2000-2007).

2.2. Methodology

The Taylor rule (1993) has been used unofficially by central banks as long as has been in existence for its convenient simplicity (Oet & Lyytinen, 2017). However, throughout the years it has been criticized and a new version has been developed to include more factors that can contribute to the decision-making process of monetary policy makers.[7] Among these factors, financial stability was identified across the years as a potential source of concern of policy makers for several central banks (Oet & Lyytinen, 2017), particularly in the aftermath of the financial crisis. Oet & Lyytinen (2017) propose a metric which proxies financial stability by an indicator of the relevance of financial systems stability considerations discussed during the Federal Open Market Committee meetings. In this paper, we examine a component of financial stability: the financial market stability. Compared to Oet & Lyytinen (2017), our financial stability factor captures a specific component of financial stability, though very relevant. In fact, financial markets play a role in the transmission mechanism of monetary policy (Bekaert et al., 2013), yet not explicitly mentioned in the mandates of central banks.

Our empirical method follows this stream of literature (Oet & Lyytinen, 2017) and compares the traditional Taylor rule (1993) *(TR)* to alternative Taylor rule models as improved monetary policy benchmarks. These are: (i) the Tri-mandate Taylor *(TTR)* rule; and (ii)

[2] In this time frame, the inflation target was set to be closed to 2% by both central banks (in 2003 and in 1992 by ECB and BOE, respectively).

[3] The Euro Stoxx 50 Volatility Index (VSTOXX) is based on the 30-day implied volatility on options on the Euro Stoxx 50 Index, similarly the FTSE 100 Volatility Index.

[4] Inflation forecasts are collected from the inflation reports available on BOE website and from the ECB website. The data are transformed following the methodology suggested by Gorter et al. (2008). Following the same reasoning, also the output gap forecasts are constructed as the change in the output gap rather than in the level.

[5] The average GDP growth rate in the pre-crisis is period is retrieved from the BOE Inflation Report for both the BOE and ECB and is set to 2.25% for the Eurozone and 3% for the UK, respectively.

[6] For additional explanations regarding the construction of the financial market stability slack variable see Section 4.2 in Oet & Lyytinen (2017).

[7] For a complete review of the criticisms and the development of the Taylor's rule see Section 3.2 in Oet & Lyytinen (2017).

the forward-looking (FL) versions of the traditional *(FL-TR)* and Tri-mandate Taylor rule *(FL-TTR)*.

The *TR* posits the nominal interest rate (i.e., Euribor for ECB and Libor for BOE) (r_t) as function of the interest rate in "equilibrium", (r^*), the inflation gap (IG_t),and the output gap (OG_t) as in Eq. (1):

$$r_t^{TR} = f^{TR}[r^*,\ IG_t,\ OG_t\ ] \tag{1}$$

The TTR posits r_t as function of r_t^{TR} and includes financial market stability slack ($FMSS_t$)as in Eq. (2):

$$r_t^{TTR\ rule} = g^{TTR\ rule}\ [r^*,\ IG_t,\ OG_t, FMSS_t] \tag{2}$$

where the financial market stability slack is defined as the difference between the long-run financial market volatility during "stability state" and the current conditions.[8] The forward-looking versions of (1) and (2) are estimated by replacing the ex-post inflation gap and output gap with the corresponding forecasted data. Similarly to Oet & Lyytinen (2017), we run an OLS regression model as it is a more effective way to estimate the Taylor rule given its higher efficiency compared to other methodologies (see Carvalho et al., 2021).[9] Overall, we estimate four OLS regressions for each central bank over the whole period of analysis. We compare the estimates of (1) against estimates of (2) to test whether financial market stability matters. Moreover, we compare the estimates of the *TR* and *TTR* forward-looking models to test which model better suits the monetary policies undertaken by ECB and BOE over the period 2003-2018.

Next, we test robustness of OLS estimates by running a horse race models across monetary policy regimes.[10] With that, we make a comparison of different models to identify temporary *vs.* systematic impact of regression variables. Moreover, we re-estimate the models including the FMSS variable estimated for US (FMSS_US)[11] as well as exchange rate (EX).[12] FMSS_US is included to account for the US financial market stability on the monetary policy of other central banks (Caputo & Herrera, 2017; Brusa et al. 2020); the exchange rates to control for their potential impacts in monetary policy setting, as found for BOE and Bank of Canada (Taylor, 1993, Lubik & Schorfheide, 2007).

3. Empirical Analysis

3.1. Main empirical findings

Table 1 presents results for the ECB (Panel A) and the BOE (Panel B). Results of *TR* and *TTR* are estimated using ex-post data of inflation gap and output gap. *LF-TR* and *LF-TTR* are estimated using the forecasts of the same variables.[13]

In both central banks' cases, estimates of the *TTR* indicate that financial market stability slack is positive and statistically significant. This evidence indicates that during times of relatively low stress[14] policy makers would tighten the nominal interest rate, whereas they would relax rate during times of high stress conditions. This finding suggests that financial market stability is part of the monetary policy setting of both ECB and BOE.

Comparing the *TR* and *TTR* models to the *FL* versions, it is evident that the latter models outperform the former ones for both ECB and BOE, as shown by the consistently higher explanatory power (R^2) and lower Residual Mean Square Error (RMSE). This result provides evidence of the better suitability of forward-looking models

Interestingly, the *FL* models confirm the positive impact of financial market stability in the setting of monetary policy only for the ECB. This could be explained by two main facts. First, ECB took stock price developments into account in setting interest rates even before the great financial crisis 2008/2009 (Botzen & Marey, 2010). Second, with the 2011 sovereign debt crisis the ECB has developed an unprecedented experience in the management of Eurozone monetary policy. On the other hand, the lack of impact of financial market stability for BOE might be due to its higher speed of response to economic variables, in particular inflation, given the strict commitments towards the government in maintaining a stable inflation rate (Altavilla and Landolfo, 2005).

We run an alternative regression model to test whether US currency exchange rates and financial market stability in US could alter

[8] Our measure is computed by following the same economic logic as for the potential growth, considering the average financial market volatility (represented by the VSTOXX for the ECB and VFTSE for the BOE) in the pre-crisis period (2000–2007) and the current financial market volatility. The average VSTOXX and VFTSE are 23.717% and 19.624%, respectively.

[9] Carvalho et al. (2021) found compelling evidence that the OLS methodology is adequate to estimate the Taylor Rule and outperforms Instrumental Variables (IV) as well as GMM methodologies, both usually employed to reduce the endogeneity bias between macroeconomic variables and monetary policy instruments. Furthermore, our monetary policy proxies are the reference interest rates (EURIBOR for the ECB and LIBOR for the BOE), which likely reduce the endogeneity bias among variables.

[10] The sample regimes are identified by adopting the structural break analysis (Bai & Perron, 1998, 2003) of the overnight interest rate (i.e., EURIBOR) for the ECB and the London interbank offered rate (i.e., LIBOR) for BOE.

[11] The FMSS variable for the US is built following the same logic as the FMSS variable employed for both the ECB and BOE, where the current financial stability is given by the level of VIX and the long-run "stability state" is computed as the average level of the VIX index in the pre-crisis period (2000-2007).

[12] The euro to dollar and the pound to dollar exchange rate for ECB and BOE, respectively.

[13] As a precaution, we check whether our data series satisfy the stationary condition, by performing an Augmented Dickey- Füller (ADF) Test. We confirm that both our ex-post and forecasted IG are stationary, as well as the OG and the FMSS. In Table 1, we report the ADF tests performed on the residuals and confirm their stationarity.

[14] This when FMSS > 0.

Table 1
Regression estimates over the whole period.

	Panel A: ECB				**Panel B**: BOE			
Models	(1) TR	(2) FL-TR	(3) TTR	(4) FL-TTR	(5) TR	(6) FL-TR	(7) TTR	(8) FL-TTR
*r**	0.870***	1.345***	0.936***	1.520***	1.280***	2.321***	1.426***	2.327***
	(0.052)	(0.073)	(0.058)	(0.077)	(0.09)	(0.138)	(0.108)	(0.14)
IG	0.980***	3.067***	0.953***	3.032***	0.480***	-1.805***	0.437***	-1.762***
	(0.092)	(0.263)	(0.091)	(0.248)	(0.168)	(0.637)	(0.167)	(0.659)
OG	0.037	0.278	0.104*	0.642***	0.266***	3.129***	0.359***	3.129***
	(0.047)	(0.179)	(0.055)	(0.184)	(0.078)	(0.333)	(0.086)	(0.334)
FMSS			0.747**	1.292***			1.158**	0.098
			(0.314)	(0.257)			(0.488)	(0.371)
R^2	0.656	0.711	0.666	0.745	0.567	0.697	0.580	0.697
MAPE	2.535	4.249	2.653	4.755	1.908	1.453	1.8	1.461
RMSE	1.223	1.122	1.205	1.054	2.047	1.713	2.017	1.712
ADF	-1.911	-3.121	-2.108	-3.171	-2.015	-2.017	-1.949	-2.036
Obs.	192							

This table shows regression results across the whole sample period and models, along with the R^2, the mean absolute percentage error (MAPE), the residual mean square error (RMSE), and the value for the Augmented Dickey-Füller test (ADF) performed on the residuals. Estimates related to the ECB and BOE are presented, respectively, in Panel A and Panel B. TR and TTR models (columns 1, 3, 5, and 7) are estimated using ex-post data of inflation gap (IG), output gap (OG), and financial market stability slack (FMSS). FL-TR and FL-TTR models (columns 2, 4, 6, and 8) are estimated using the forecasts of the same variables and FMSS. Standard errors are given in parentheses. ***, **, * denotes significance at the 1%, 5%, 10%-level, respectively.

our previous estimates of FMSS for the Eurozone and the UK. In Table 2, we confirm that both EX and FMSS_US variables alter previous results. The FMSS loses its significance in the Eurozone, in favor of the FMSS_US. We interpret this result as the influence of the US financial market, particularly during the financial crisis on the Eurozone financial market and the economy. This result parallels findings in Brusa et al. (2020). It is also worth recalling the strong willingness of the ECB to maintain the balance in the currency exchange rate euro-US dollar.[15] On the contrary, BOE shows a very little interest to the FMSS_US in the *TTR* model, while gaining interest in its own domestic financial market stability in both *TTR* and *FL-TTR* models. This result could be ascribed to the differences in the underlying economies, being the UK a small open economy compared to the Eurozone. Altogether, the results point to the direction of the BOE being more concerned with the future prospect of its own economy. Moreover, the negative relation between the UK interest rate and the FMSS_US in the *TTR* could be explained by the fact that BOE cut interest rates in the aftermath of the financial crisis almost contemporarily to the FED, whereas the ECB afterwards.

The IG controlling variable shows a stable and consistent positive impact on interest rate set by the ECB. However, we find differences for the BOE. In Table 1, we find that inflation gap forecasts negatively affect the interest rate, while in Table 2 we find the opposite. This "price puzzle"[16] is resolved when controlling for the EX, that is also be considered as proxy of international trade position (Taylor 1993).

3.2. Model horse-race across regime samples

Table 3 presents the results of the model horse-race across the regime samples analysis.[17] The results for the ECB (Panel A) show one initial deviation from the *FL-TTR* to the *TTR* just before the financial crisis, as shown by the highest R^2 in the first regime sample which spans January 2003 to June 2006. In the remaining regimes, it seems like the ECB follows a *TTR* framework in the setting of the interest rate. However, it is interesting to note that the goodness of fit of the models largely decreases over the time, suggesting the need for additional explanatory components.

A similar result is found for BOE, except for having the deviation in November 2008 and better fitting of the models throughout the regime samples.

4. Concluding Remarks

This paper contributes to the literature on monetary policy by providing novel evidence that financial market stability matters in monetary policy setting of the ECB and BOE under the Tri-mandate policy model. Our research confirms that *TTR* rule dominates the *TR* across regime samples, particularly after the financial crisis. On the other hand, the *FL-TTR* is able to better capture the monetary policy conducted by the ECB, and not by the BOE. Two additional novel results indicate that the US financial market stability

[15] See the Speech given by ECB President Mario Draghi on July, 26th 2012 (www.ecb.europa.eu/press/key/date/2012/html/sp120726.en.html)
[16] This terminology was first used by Sims (1992).
[17] The structural breaks are found on June 2006, December 2008, December 2011, and April 2015 for ECB and on June 2006, October 2008, November 2011, and June 2016 for BOE.

Table 2
Dissecting Financial Stability.

	Panel A: ECB		**Panel B**: BOE	
Model	(1)	(2)	(3)	(4)
	TTR	FL-TTR	TTR	FL-TTR
r*	0.685***	1.238***	1.496***	1.397***
	(0.077)	(0.073)	(0.061)	(0.110)
IG	0.678***	2.226***	0.112	1.159**
	(0.092)	(0.207)	(0.096)	(0.495)
OG	0.239***	1.266***	0.047	-0.249
	(0.053)	(0.155)	(0.053)	(0.308)
EX	-4.262***	-5.096***	-8.325***	-9.215***
	(0.793)	(0.593)	(0.420)	(0.600)
FMSS	0.044	0.253	1.423**	1.196*
	(0.612)	(0.466)	(0.705)	(0.71)
FMSS_US	1.099*	1.189***	-1.294*	-0.982
	(0.599)	(0.451)	(0.722)	(0.713)
R^2	0.733	0.845	0.867	0.878
MAPE	2.675	2.34	1.134	1.123
RMSE	1.079	0.821	1.211	1.168
Obs.	192		192	

This table shows regression results across the whole sample period and the models, along with the R^2, the mean absolute percentage error (MAPE) and the residual mean square error (RMSE). Estimates related to the ECB and BOE are presented, respectively, in Panel A and Panel B. TTR models (columns 1, and 3) are estimated using ex-post data of inflation gap (IG), output gap (OG), exchange rate (EX), financial market stability slack (FMSS), and US financial market stability (FMSS_US). FL-TTR models (columns 2, and 4) are estimated using the forecasts of the same variables. Standard errors are given in parentheses. ***, **, * denotes significance at the 1%, 5%, 10%-level, respectively.

Table 3
Model horse-race.

	Panel A: ECB				**Panel B**: BOE			
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	TR	FL-TR	TTR	FL-TTR	TR	FL-TR	TTR	FL-TTR
	Regime 1: M1:2003-M6:2006				*Regime 1: M1: 2003 - M4:2006*			
R^2	0.992	0.994	0.993	**0.995**	0.993	0.998	0.997	**0.998**
MAPE	0.069	0.059	0.063	0.059	0.071	0.039	0.049	0.034
RMSE	0.21	0.177	0.188	0.154	0.365	0.197	0.253	0.173
	Regime 2: M7:2006 - M12:2008				*Regime 2: M5: 2006 - M10:2008*			
R^2	0.987	0.983	**0.987**	0.983	0.991	0.997	0.995	**0.997**
MAPE	0.094	0.116	0.094	0.115	0.079	0.04	0.06	0.039
RMSE	0.492	0.563	0.490	0.561	0.533	0.296	0.418	0.285
	Regime 3: M1:2009 - M12: 2011				*Regime 3: M11:2008 - M11: 2011*			
R^2	0.949	0.87	**0.966**	0.908	0.932	0.899	**0.953**	0.917
MAPE	0.168	0.36	0.161	0.294	0.224	0.281	0.161	0.283
RMSE	0.27	0.431	0.222	0.363	0.28	0.342	0.232	0.31
	Regime 4: M1:2012 - M4:2015				*Regime 4: M12:2011 - M6:2016*			
R^2	0.97	0.887	**0.973**	0.938	0.96	0.943	**0.968**	0.957
MAPE	0.39	0.542	0.37	0.496	0.163	0.153	0.149	0.151
RMSE	0.147	0.285	0.138	0.211	0.129	0.154	0.116	0.134
	Regime 5: M5:2015 - M12 2018				*Regime 5: M7:2016 - M12: 2018*			
R^2	0.678	0.552	**0.700**	0.553	0.957	0.944	**0.960**	0.957
MAPE	1.029	2.207	1.144	2.233	0.172	0.205	0.158	0.16
RMSE	0.149	0.175	0.144	0.175	0.116	0.132	0.111	0.116

This table presents the results of the model horse-race across the regime samples analysis for the ECB and BOE. Panel A presents the results for the ECB and Panel B presents the results for the BOE. The regime sample analysis is based on the structural breaks' analysis. For each regime, the R^2, the Mean Absolute Percentage Error (MAPE) and the Residual Mean Square Error (RMSE) are reported. In bold the highest R^2 within each regime.

influences monetary policy makers in the Eurozone, and not in UK. However, in the UK the domestic financial market stability affects the monetary policy setting. This may be an indication of both the large openness of Eurozone economies compared to the US economy but also of its dependence on the US economy.

These results have important implications for practitioners and academics alike. We identify a clear framework to explain and predict policy makers decisions, which could be useful for practitioners to forecast the path of nominal interest rates. A limitation of our study and therefore a potential research development could be the widening of the definition of financial market stability. Additional sources of uncertainty and exogenous shocks, such as the climate, healthcare, and disaster risks could be included. Moreover, future research should focus on potential structural breaks in macroeconomic and monetary policy time-series that have arisen with the COVID-19 pandemic.

Author Agreement Statement

We the undersigned declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We understand that the Corresponding Author is the sole contact for the Editorial process. He/she is responsible for communicating with the other authors about progress, submissions of revisions and final approval of proofs

Data Availability

The data employed are publicly available on central banks and OECD websites.

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