Targeted Taylor Rules: Some Evidence and Theory

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Abstract

We introduce the concept of *targeted Taylor rules*: monetary policy rules which allow for different reactions to demand– and supply–driven inflation. This new concept tallies with Federal Reserve's strategy as reflected in its official communications. When estimated for the United States, the targeted rule suggests that monetary policy reacted almost fourfold stronger to demand– than to supply–driven inflation since Paul Volcker's Chairmanship. These results obtain both when using off–the–shelf decompositions of inflation in demand and supply factors, as well as novel measures of demand– and supply–driven inflation derived with an advanced reasoning Large Language Model (LLM) applied to FOMC transcripts. We show how to embed the new rule into a New-Keynesian model with simultaneous demand and supply shocks, and discuss its implications for business cycle fluctuations and welfare.

Keywords: monetary policy trade–offs, targeted Taylor rules, inflation targeting

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> “*The response of monetary policy to higher prices stemming from an adverse supply shock should be attenuated because it would otherwise amplify the unwanted decline in employment.*”
>
> Powell (2023)

> “*The Committee’s employment and inflation objectives are generally complementary. However, if the Committee judges that the objectives are not complementary, it follows a balanced approach in promoting them.*”
>
> Federal Reserve Board (2025)

1 Introduction

Monetary theory typically prescribes a forceful reaction to demand–driven inflation and an attenuated response, if any, to supply–driven inflation (*e.g.* Blanchard and Galí (2007), Erceg et al. (2000), Bodenstein et al. (2008), Werning et al. (2025)). According to FOMC members’ speeches (*e.g.* Brainard (2022b), Powell (2023)), as well as its Federal Reserve Board (2025), the U.S. Federal Reserve seeks to follow in practice a similar targeted approach with respect to inflation.[1]

The Taylor–type rules used in macroeconomic models and central banks’ toolkits to describe the conduct of monetary policy, however, do not account for such a state-dependent policy response. They assume instead a “one-size-fits-all” reaction to inflation regardless of its drivers (*e.g.* Taylor (1993), Clarida et al. (2000), Smets and Wouters (2007)). In this paper, we refine existing monetary policy rules to allow for a different (targeted) response to demand– versus supply–driven inflation. We refer to this new type of rule as a *targeted Taylor rule*.[2] From a practical point of view, this new rule may provide both a more accurate ex–post summary of central banks’ monetary policy reaction functions, as well as a new benchmark to be consulted

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[1] The US long-run goals and monetary policy strategy statement was first adopted on January 24, 2012. The differentiated policy response depending on the complementary of the inflation and employment objectives is mentioned in all statement vintages. The background material underpinning the latest August 22, 2025 monetary policy framework review in the U.S. explicitly links the “balanced approach” with respect to employment and inflation to supply shocks and their associated macro-economic trade-offs (*see e.g.* Chung et al. (2025)).

[2] The reader may note that conventional Taylor rules which assume a policy rate reaction to aggregate inflation and real activity feature only an *implicit* state-dependent reaction to demand and supply shocks. Specifically, as inflation and real activity tend to move in the same direction in response to the former, and in opposite directions in response to the latter, for given inflation and real activity levels, the conventional rule prescribes a larger rate hike in response to expansionary demand shocks than to adverse supply shocks. The policy rule itself, however, is not state-contingent since the reaction coefficients to inflation and real activity are the same regardless of the type of shock. Hence, in contrast to the targeted rule, the conventional one falls short from capturing the explicit state-dependent response to inflation embedded in the Federal Reserve’s monetary policy strategy.

during monetary policy deliberations — alongside other conventional Taylor–type rules which already serve this purpose.[3]

In the first part of the analysis, we use the new targeted Taylor rule to study whether the U.S. Federal Reserve followed in practice a targeted approach to inflation consistent with its official communications. To do so, we first estimate Taylor (1993)–type rules where we replace aggregate inflation with its demand– and supply–driven components, relying on recent inflation decomposition methods developed by Eickmeier and Hofmann (2025) and Shapiro (2024). These methods provide a convenient ex–post summary of inflationary pressures exerted by competing demand and supply forces at the time of monetary policy decisions.[4] We complement this first set of estimates with those based on novel measures of demand– and supply–driven inflationary pressures assessed during FOMC meetings, which we derive using an advanced reasoning Large Language Model (LLM) applied to historical transcripts.[5]

In the second part of the analysis, we show how to embed the new targeted Taylor rule into the New Keynesian model and we study the implications of monetary policy following this rule instead of a conventional one for business cycle fluctuations and welfare. For this purpose, we choose as our analytical framework the textbook New Keynesian model with sticky prices and wages and assume that business cycle fluctuations are concurrently driven by both demand and supply shocks. For ease of comparison with the textbook analysis, we model in our baseline specification demand shocks as demand preference ("discount factor") shocks and supply shocks as technology shocks. In addition, whenever relevant, we consider the case of cost-push shocks as supply shocks.

Our main findings are fourfold.

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[3] The Federal Reserve consults in its monetary policy deliberations a number of monetary policy rules. *See e.g.* Yellen (2012), Bernanke (2015), James Bullard's intervention during the March 2019 FOMC meeting on the use of the Taylor (1999) rule as a benchmark during monetary policy deliberations, and, most recently, Daly (2025) or Board of Governors (2025). From a normative perspective, in principle, central banks may also want to consult the predictions of targeted rules which allow as well for a differential reaction to demand– versus supply–driven output gap fluctuations. The absence of a decomposition of the output gap into demand and supply factors would render, however, the monitoring of such a policy rule unfeasible at the moment.

[4] Crucially, both methods used to decompose inflation in demand and supply factors are agnostic with respect to the monetary policy reaction function. Thus, as it will become clear in our analysis, they are not subject to potential biases characterizing alternative methods based on estimated DSGE models which postulate that the central bank follows a conventional (unconditional) Taylor–type rule (*e.g.* Madeira et al. (2023)).

[5] Notably, these new *real-time* measures are positively and highly statistically correlated with the *ex-post* demand and supply factors of inflation derived with the inflation decomposition methods used in the first part of our empirical analysis, suggesting that FOMC participants were able to broadly disentangle in real time the nature of inflation drivers. Relatedly, Kwon et al. (forthcoming) find similar positive and highly statistical correlations for these series with indices of demand-driven and supply-driven inflation for the U.S. derived using different LLMs techniques (GPT instead of advanced reasoning) applied to a comprehensive corpus of financial news articles from the Wall Street Journal for the post–2000 period.

First, our empirical analysis suggests that, over the past four decades or so, the conduct of monetary policy in the United States has been in line with the Federal Reserve's doctrine as reflected in its official communications. Specifically, for the period following Paul Volcker's appointment as chairman of the Federal Reserve, the estimated reaction to demand–driven inflation is significantly larger than that to supply–driven inflation. For our baseline specification, the estimated response to demand–driven inflation is almost four, while that to supply–driven inflation is slightly above one. Notably, the results are robust across different Fed chairmanships. These findings suggest that the Federal Reserve's dual mandate has been followed in a targeted fashion, with the central bank looking to stabilize inflation and employment around their long–run targets in a more balanced way in response to supply shocks (when the two objectives are not complementary) than in response to demand shocks (when the two objectives are complementary).[6]

Second, we show that monetary policy deliberations can be used to build indicators of the weights given by policy makers to demand and supply in their discussions of the drivers of inflation, using now widely available LLMs. Given the importance of distinguishing supply and demand driven inflation, building such decompositions of inflation with LLM will greatly help analyzing monetary policy decisions not only in the United States but also for other countries. In particular, we show in Hofmann et al. (2024) that central banks in Australia, Canada, the euro area, Japan, Korea and the United Kingdom also have, like the Federal Reserve responded more to demand driven inflation than to supply driven inflation.

Third, simulations from our textbook New Keynesian model show that aggregate output and inflation display very different business cycle properties when the central bank follows our estimated targeted *versus* conventional Taylor rules. To compare business cycle fluctuations under the two alternative monetary policy rules, we set the non–policy parameters of the model at their textbook values in Galí (2015), and simulate time series data from the model conditional on monetary policy following either the estimated targeted rule or the estimated conventional rule, subject to the same random series of (simultaneous) demand and supply shocks. This experiment shows that, everything else equal, inflation is driven to a larger extent by supply shocks under the targeted Taylor rule than under the conventional Taylor rule. This is because, compared to the conventional rule, the targeted Taylor rule offsets the effect of demand shocks on inflation and accommodates that of supply shocks. Furthermore, as the effect on output is

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[6] This approach is in fact consistent with the formulation of the Federal Reserve's longer-run goals and monetary policy strategy (Federal Reserve Board, 2025).

counteracted by more in response to demand shocks, while is attenuated in response to supply shocks, output ends up being less volatile under the targeted rule compared to the conventional one. These results suggest that imposing a conventional Taylor–type rule in macroeconomic models may not be without loss of generality if actual monetary policy decisions are taken in a targeted fashion. Furthermore, to the extent that such models are part of central banks' toolkits, this may also impact monetary policy decisions.

Fourth, we show how a targeted Taylor rule can approximate better optimal policy than a conventional Taylor rule when business cycle fluctuations are driven by both demand and supply factors. To do so, we derive the optimal monetary policy with commitment within our framework— still assuming concomitant demand and supply shocks.[7] We use the outcome under optimal policy as a benchmark for the evaluation of optimal simple conventional and targeted Taylor rules which central banks could *a priori* follow in practice. We find that the optimal targeted rule entails reacting very aggressively to demand–driven inflation, and only weakly to supply–driven inflation. In our textbook model, this rule is shown to improve welfare upon the optimal conventional (unconditional) Taylor rule in the textbook model, regardless of the variances of the demand and supply shocks, as long as inflation expectations remain anchored around the long–run target.[8]

In a model extension where the central bank can only observe the demand and supply components of inflation up to a measurement error, we further show that the optimal targeted rule still performs better than the optimal conventional one, provided the measurement error is not excessively large. Notably, as the measurement error increases, the optimal responses to demand– and supply–driven inflation in the targeted rule and the associated welfare losses converge to those of the optimal conventional rule. As a corollary, the latter finding provides one theoretical underpinning for the finite response of monetary policy to (measured) demand–driven inflation retrieved in the data.

Hereafter, we proceed as follows. Section 2 highlights the contributions of the paper to various strands of the literature. Section 3 estimates a targeted Taylor rule for the United States allowing for a different response to demand– versus supply–driven inflation. Section 4 presents a

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[7] According to the decomposition of inflation in demand and supply factors, this case is most often the relevant one in practice (*see e.g.* Figure 1 for instance for the decomposition based on the method in Shapiro (2024)).

[8] In the model, long-run inflation expectations remain anchored around the inflation target. This feature is inherited from the basic New Keynesian framework. Should the model allow inflation expectations to de-anchor when inflation reaches a certain upper bound, the optimal response to supply–driven inflation would likely be higher in order to avoid such contingencies. Thus, in that case, while still positive, the welfare gains under the targeted rule relative to those under the conventional one would decrease with the variance of supply shocks.

theoretical model featuring a targeted Taylor rule akin to that estimated in the previous section, and Section 4.3 analyzes the equilibrium of the model under this new type of rule. Section 4.4 compares business cycle fluctuations under the estimated targeted Taylor rule to those under the estimated conventional Taylor rule. Section 4.5 discusses the merits in terms of welfare of a targeted Taylor rule compared to those of a conventional one. A final section concludes.

2 Related literature

The paper is related to several strands of research.

The first strand of research concerns the empirical literature estimating and assessing the Federal Reserve's policy reaction function by means of simple monetary policy rules in the spirit of Taylor (1993). Such policy rules have been shown to be reasonable representations of how the Federal Reserve adjusts the federal funds rate in response to deviations of inflation from its medium–term target and of real activity from its potential level. This literature covers debates over how to estimate such policy rules (*e.g.* Carvalho et al. (2021)), whether monetary policy in the U.S. has changed over time (*e.g.* Judd and Rudebusch (1998), Clarida et al. (2000), Orphanides (2004)), or whether the observed persistence in interest rates stems from policy inertia or persistent monetary policy shocks (*e.g.* Rudebusch (2002), Coibion and Gorodnichenko (2012)). In none of these analyses do monetary policy rules depend on the nature of the underlying aggregate shocks and, in particular, on the underlying drivers of inflation. We contribute to this literature by providing empirical evidence that monetary policy in the United States has historically reacted much more forcefully to demand– than to supply–driven inflation. In the process, we exploit the recent decompositions of inflation into demand– and supply–driven components by Eickmeier and Hofmann (2025) and Shapiro (2024), as well as novel measures of demand– and supply–driven inflationary pressures assessed during FOMC meetings derived with advanced reasoning LLM techniques.

The second strand of related research is the companion normative literature which looks for simple monetary policy rules that perform well across a wide range of monetary models and that central banks could *a priori* follow in practice (*e.g.* Taylor (1993), McCallum (1999), Taylor (2007), Orphanides (2010), Taylor and Williams (2010)). Such "robust monetary policy rules" were first derived from research on empirical monetary models with rational expectations and sticky prices in the 1970s and 1980s, and have been continuously refined and tested ever since within a variety of newer and more rigorous models and policy evaluation methods. One notable policy rule derived within this line of research is the Taylor (1993) rule which calls for appropriate adjustments in the short–term interest rate in response to deviations of inflation and output from their respective targets. A central conclusion of this literature is that simple rules — in the spirit of the one proposed by Taylor (1993) — are generally more robust than model–specific fully optimal ones (McCallum (1988), Schmitt-Grohé and Uribe (2007), Taylor (2007), Taylor (2017)).

We contribute to this normative literature by highlighting that policy rules should not necessarily impose that monetary policy reacts in the same way to deviations of inflation from target, regardless of the nature of factors driving them — the standard premise of existing studies. Allowing for a shock–dependent response in the spirit of the targeted Taylor rule can improve welfare upon conventional (unconditional) Taylor rules.[9] Implementing such rules in practice depends, of course, on the central bank's ability to distinguish in real time between supply and demand disturbances. The availability of methodologies to decompose inflation in demand and supply factors such as those used in the first part of our empirical analysis may facilitate the operability and monitoring of such targeted rules in practice.[10]

Our paper further notably relates to the inflation targeting literature (*e.g.* Kahn (1996), Fischer et al. (1996), Taylor et al. (1996), Posen et al. (1998), Cecchetti and Ehrmann (1999), Truman (2003), Svensson (2010), Hammond (2012), McCallum (2000), Taylor (2000)). The presence of trade–offs for certain types of shocks such as supply shocks is used in this literature to justify the choice of flexible inflation targeting instead of strict inflation targeting (*e.g.* Bernanke and Mishkin (1997), Posen et al. (1998), Svensson (1999), Lomax (2004), Walsh (2009)).[11] Flexible inflation targeting is defined as a regime in which central banks not only aim to stabilize inflation around a target, but also put some weight, implicitly or explicitly, on stabilizing the

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[9] More broadly, recent findings on monetary policy and financial stability — theoretical and empirical (Boissay et al. (2021), Boissay et al. (2025)) — suggest that the targeted Taylor rules may have also merits in terms of financial stability. In these studies, the trade–off between price and financial stability depends on the nature of inflation drivers. For demand shocks, there is no such trade–off because strict inflation targeting avoids the build–up of financial vulnerabilities and associated financial stability risks. By contrast, a trade–off does exist for supply shocks: both strictly targeting inflation in the face of adverse supply shocks, or strictly fighting disinflation in response to expansionary supply shocks increase the probability of a financial crisis.

[10] Even though central banks are reluctant to "tying their hands" around a specific monetary policy rule, they do use such rules as benchmarks to crosscheck the outcome of their regular monetary policy deliberations (*e.g.* Daly (2025)). In this context, the concept of a targeted Taylor rule may provide an additional such benchmark.

[11] According to monetary theory, the trade–offs faced by central banks between inflation and output stabilization around their desired levels are shock dependent. When the economy faces a demand shock, the central bank does not face any policy trade-off and can achieve the "first best" through *strict inflation targeting* — a result coined in the literature as the "divine coincidence" (Blanchard and Galí (2007)). By contrast, when the economy faces a supply shock, a monetary policy rule whereby the central bank responds only moderately, if at all, to inflation, and aims to stabilize the output gap — outperforms strict inflation targeting in terms of welfare (*see* Erceg et al. (2000) and Blanchard and Galí (2007) for a technology shock, Bodenstein et al. (2008) and Nakov and Pescatori (2010) for an oil price shock, and Werning et al. (2025) for a tariff shock).

real economy (Svensson (2010)). The monetary policy reaction function of this regime has been typically described by the means of unconditional Taylor–type rules, whereby the central bank reacts to deviations of (aggregate) inflation from its target and of output from its desired level and aims to fulfill its inflation target over the medium run as opposed to on a period-by-period basis.

We contribute to this literature by showing that flexible inflation targeting can also be thought of as being implemented in a targeted fashion, with the monetary policy reaction function being different for supply versus demand shocks. In particular, we provide evidence that such a targeted reaction function has historically characterized the conduct of monetary policy by the Federal Reserve, whose monetary policy framework has aligned with all features of flexible inflation targeting since Alan Greenspan's Chairmanship at the Federal Reserve in 1987 despite being labeled as such only from 2012 on (*e.g.* Goodfriend (2007)).

Our analysis also marginally connects to the literature discussing the merits of targeting core inflation instead of headline inflation. According to this literature, central banks should "look through" the direct effects of energy and food prices on headline inflation and only respond to variations in core inflation (Aoki (2001), Bodenstein et al. (2008)). These prescriptions are in line with both the doctrine of the Federal Reserve as reflected in its official communications (*e.g.* Mishkin (2007), Brainard (2022a), transcripts of FOMC meetings), as well as with recent estimates of the Federal Reserve's monetary policy reaction function, which use as an operational inflation measure core instead of headline inflation (Carvalho et al. (2021)). Similarly to the targeted Taylor rule proposed in this paper, this literature prescribes a distinct monetary policy reaction function depending on the nature of shocks. The prescribed state–contingent nature is, however, different: in this literature, the response to commodity price shocks should be different from that to other shocks, in the sense that it should only concern their indirect effects on core inflation, ignoring the direct effects on headline inflation.

Finally, from a methodological point of view, the new type of monetary policy rule proposed in our paper is similar in nature to the recent fiscal shock–specific monetary-fiscal policy mix from the literature on monetary–fiscal interactions (Bianchi and Melosi (2019), Bianchi et al. (2023)). In these models, the monetary and fiscal authorities are assumed to react differently to fluctuations in inflation and in the fiscal surplus, respectively, depending on whether they are driven by unfounded fiscal transfer shocks (i.e. fiscal transfer shocks supposed to be financed via inflation) or any other type of business cycle shock.[12] Also related, Nakamura et al. (2025) further introduce the complementary concept of *fundamental* versus *non-fundamental* state-contingent monetary policy rules, whereby the central bank reacts differently to fundamental shocks (demand and supply) than to nonfundamental "sunspot" shocks. By adding a nonfundamental component, this new type of rule grants nominal determinacy to monetary policy rules which would otherwise lack this property and can be used to mimic more closely the optimal response to supply shocks. Based on this new rule, the authors show that indeterminacy does not prevent the central bank from reacting optimally to supply shocks, with the only remaining challenge being to keep long-term inflation expectations anchored to the medium-term target.

3 Federal Reserve's policy reaction function: some new evidence

In this section we estimate Taylor (1993)–type rules to summarize the Federal Reserve's monetary policy reaction function. We first estimate a conventional Taylor rule whereby the Federal Reserve is assumed to adjust the federal funds rate in response to deviations of aggregate inflation and output from their respective targets. We then proceed to estimate a targeted version of this policy rule in which we replace aggregate inflation by its supply– and demand–driven components.

3.1 A conventional Taylor Rule

We begin with a conventional specification for the monetary policy reaction function — as described by a Taylor–type rule allowing for interest rate smoothing:

$$i_t = \rho i_{t-1} + (1-\rho)\Big[i^* + \phi_\pi(\pi_t - \pi^*) + \phi_y \widehat{y}_t\Big] + \varepsilon_t \tag{1}$$

where i_t is the policy rate, π_t is inflation, $\widehat{y}_t$ is the output gap, π^* is the inflation target, and i^* is the equilibrium long-run nominal interest rate or, the desired nominal rate when both inflation and output are at their target levels.

To estimate the policy rule above, we follow closely Carvalho et al. (2021). The latter paper estimates by OLS the following reduced-form econometric specification:

$$i_t = \alpha + \rho i_{t-1} + \phi_\pi^{aux}\pi_t + \phi_y^{aux}\widehat{y}_t + \varepsilon_t$$

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[12] Smets and Wouters (2024) further extend the methodology in Bianchi et al. (2023) to allow for *partial* fiscal backing in response to fiscal transfer shocks and other types of business cycle shocks. In this case, the monetary and fiscal authorities are assumed to react differently to the shares λ and $1-\lambda$ of each type of shock.

in order to obtain $\widehat{\alpha}$, $\widehat{\rho}$, $\widehat{\phi}_\pi^{aux}$ and $\widehat{\phi}_y^{aux}$, and then it backs out the Taylor rule coefficients in (1) by computing $\widehat{\phi}_\pi = \frac{\widehat{\phi}_\pi^{aux}}{1-\hat{\rho}}$, $\widehat{\phi}_y = \frac{\widehat{\phi}_y^{aux}}{1-\widehat{\rho}}$, and the inflation target as $\pi^* = \frac{\widehat{\alpha}-(1-\widehat{\rho})r^*}{(1-\widehat{\rho})(1-\phi_\pi)}$ given an estimate of the equilibrium real rate $r^* \equiv i^* - \pi^*$ computed based on the observed sample average.[13]

In our baseline estimation, we purposely stay away from the zero lower bound period and use quarterly data from 1979Q3 to 2007Q4 – as in Carvalho et al. (2021). The policy rate is the federal funds rate, inflation is the year-on-year rate of change in core PCE, and the output gap is constructed using the Congressional Budget Office estimate of potential GDP.[14] All data is downloaded from the St Louis FRED database. The main difference with respect to Carvalho et al. (2021)'s approach is that we use the most recent vintage of the data instead of real-time data.[15] We do so for ease of comparison with the targeted Taylor rules analyzed in the next section, which use series of demand– and supply–driven inflation which were developed only recently and hence were not available in real time. Thus, our estimated rules can be thought as an *ex-post summary* of the realized monetary policy reaction function, and not necessarily as the *intended* monetary policy reaction function, any potential discrepancies between the two being explained by measurement errors in real time. The other difference is that we use only

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[13] Carvalho et al. (2021) show that even though Ordinary Least Squares (OLS) estimation of monetary policy rules produces potentially inconsistent estimates of policy parameters, the related bias is likely very small. For other studies estimating Taylor–type rules using OLS see for instance Coibion and Gorodnichenko (2011) or Shapiro and Wilson (2022). A bias arises in principle because central banks react to variables that are endogenous to monetary policy shocks. Endogeneity implies a correlation between regressors and the error term – hence, an asymptotic bias. The paper shows analytically that the bias is proportional to the fraction of the variance of regressors due to monetary policy shocks which tends to be small according to the empirical VAR literature (*e.g.* Leeper et al. (1996), Christiano et al. (1999)). In our case, everything else equal, the estimated coefficient of demand-driven inflation will likely be biased downwards as the residual is expected to be negatively correlated with respect to demand-driven inflation (a monetary tightening leads to lower demand-driven inflation as it contracts aggregate demand), while that the estimated coefficient of supply-driven inflation is expected to be biased upwards (a monetary tightening leads to higher supply-driven inflation as it contracts the supply side of the economy; note that if firms face credit constraints, monetary policy also affects aggregate supply (*e.g.* Manea (2020))). Thus, the actual difference between the two coefficients is expected to be even larger (we thank Andy Glover for this observation). Relatedly, according to the analysis in Carvalho et al. (2021), the bias of OLS estimates almost disappears when the true policy parameter is close to the limit imposed by the Taylor principle, and is negative for larger coefficients (see Figure 2 and the discussion in Section 2.2). In the context of our analysis, this implies that the OLS estimate for the response coefficient to supply–driven inflation (which is slightly higher than one) is likely unbiased, while the strong response to demand–driven inflation (which is slightly below four) may be even higher. Last, but not least, our current estimation exercise may be additionally subject to an omitted variable bias if the real-time measurement error of the demand versus supply decomposition of inflation would be systematically correlated with the demand and supply inflation factors used in our analysis, i.e. if the FOMC participants would systematically over or under estimate one of the two components of inflation. Given the similarity of the results with those based on real-time data (presented later) such a bias, if it exists, it is likely small.

[14] We follow Carvalho et al. (2021) and use core inflation as opposed to headline inflation as the inflation measure in our baseline regressions. Even though the inflation target is stated in terms of headline inflation, the Federal Reserve uses core inflation as its operational target (see for *e.g.* Mishkin (2007) or Bodenstein et al. (2008)). As clarified by Bernanke (2015), this is because core PCE inflation is viewed by the FOMC as "a better measure of medium-term inflation trend, and thus as a better predictor of future [overall] inflation", "not because core inflation itself is the target of policy". The same explanation is given in Board of Governors (2025), page 46.

[15] While using real–time data would admittedly be more in line with the Fed's information set at the time of policy rate decisions, Carvalho et al. (2021) note that estimates based on historical data are similar to those based on real time data (see footnote 19).

one lag of the interest rate instead of two lags, as the second lag is not statistically significant in our specification based on the most recent vintage of data (its *p-value* $\gg 0.9$).

The estimated coefficients of the conventional Taylor rule specification described by (1) are reported in Table 1 (first row). The estimates have the expected sign, are highly statistically significant and their values are close to those reported in Carvalho et al. (2021). The point estimate of ρ equals 0.74, suggesting considerable interest rate inertia and confirming the conventional wisdom that the Federal Reserve smooths adjustments in the fed funds rate. Moreover, the estimated response coefficient to inflation is slightly above 2, while that of the output gap is around 0.25 consistent with the Taylor principle being satisfied during our baseline estimation period. Finally, for an estimated real equilibrium rate equal to 3.15, we obtain an (average) inflation target $\pi^* = 2.7$.

Table 1: Estimated Taylor rules

	ρ	ϕ_π	ϕ_π^d	ϕ_π^s	ϕ_y
Taylor rule	0.74^{***}	2.11^{***}			0.26^{***}
	(0.04)	(0.18)			(0.10)
Targeted Taylor rule	0.72^{***}		3.75^{***}	1.02^{**}	0.22^{***}
	(0.04)		(.60)	(0.40)	(0.05)

Notes: Values expressed in quarterly rates. The Taylor rule specification is described by equation (1) and that of the targeted Taylor rule by equation (2). The estimation sample runs from 1979Q3 to 2007Q4, *i.e.* from Paul Volcker's chairmanship up to the pre-ZLB period. The Durbin-Watson (DW) and Breusch-Godfrey (BG) tests cannot reject the null hypothesis of serially-uncorrelated residuals. Standard errors are derived by the Delta method reported in parentheses. Statistical significance at 5%/1% level is indicated with **/***. The difference between the estimated responses to demand– and supply–driven inflation in the targeted Taylor rule specification is statistically significant at 1% level. The null that the Taylor rule provides a better fit than the targeted rule is rejected by a Likelihood Ratio test at a level of statistical significance $\ll 1\%$.

3.2 A targeted Taylor Rule

As a next step, we re-estimate the monetary policy rule described in (1) but replace the year–on–year core PCE inflation rate π_t with its demand– and supply–driven components π_t^d and π_t^s –

as derived by Shapiro (2024) and shown in Figure 1:[16]

$$i_t = \rho i_{t-1} + (1-\rho)\Big[i^* + \phi^d_\pi(\pi^d_t - \pi^*_d) + \phi^s_\pi(\pi^s_t - \pi^*_s) + \phi_y \widehat{y}_t\Big] + \varepsilon_t \tag{2}$$

where $\pi^*_d + \pi^*_s = \pi^*$, with the constants π^*_d and π^*_s standing for the targets for demand– and supply–driven inflation.

Following the same approach as for the conventional Taylor rule, we estimate the policy rule in (2) by applying OLS to the reduced–form econometric specification

$$i_t = \alpha^{aux} + \rho i_{t-1} + \phi^{d,aux}_\pi \pi^d_t + \phi^{s,aux}_\pi \pi^s_t + \phi^{aux}_y \widehat{y}_t + \varepsilon_t,$$

and we then back out the structural monetary policy rule coefficients of equation (2) as follows: $\widehat{\phi}^d_\pi = \frac{\widehat{\phi}^{d,aux}_\pi}{1-\widehat{\rho}}$, $\widehat{\phi}^s_\pi = \frac{\widehat{\phi}^{s,aux}_\pi}{1-\widehat{\rho}}$, $\widehat{\phi}_y = \frac{\widehat{\phi}^{aux}_y}{1-\widehat{\rho}}$, and $\pi^* = \frac{\widehat{\alpha}-(1-\widehat{\rho})r^*}{(1-\widehat{\rho})[1-(\widehat{\phi}^d_\pi+\widehat{\phi}^s_\pi)/2]}$ for $\pi^*_d = \pi^*_s = \frac{\pi^*}{2}$.

Inflation decomposition in demand and supply factors As our baseline, we choose the inflation decomposition based on the method proposed by Shapiro (2024) because it is available for core inflation. We use the inflation decomposition based on the method proposed by Eickmeier and Hofmann (2025) — which is currently available for headline inflation only — to check the robustness of our findings. Note that these decompositions were not available in real time at the time of monetary policy decisions. Thus, the Taylor rule estimates based on these series can be thought as an *ex-post* summary of the realized monetary policy reaction function, and not necessarily as the intended reaction by the central bank.

The estimated coefficients of the targeted Taylor rule described in equation (2) are reported in Table 1 (third row). The baseline estimates of the interest rate smoothing coefficient (column "ρ") and of the output gap coefficients (column "ϕ_y") are essentially the same as those of the conventional Taylor rule (first row). The estimated response to demand–driven inflation (column "ϕ^d_π") is around four and almost four times larger than that to supply–driven inflation (column "ϕ^s_π") which is slightly above one. The difference between the two estimated responses is highly statistically significant at 1% level. These results suggest that *on average* the Federal Reserve

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[16] The baseline decomposition of inflation in demand and supply factors proposed by Shapiro (2024), regularly published by the Federal Reserve Bank of San Francisco, is based on the sectoral decomposition of the PCE index. Inflation is demand–driven in a given sector if prices and quantities move in the same direction in that specific area of consumption. If, on the other hand, inflation tends to be supply–driven, prices and quantities should move in different directions. The method thus identifies periods that have been dominated by either supply or demand shocks for each consumption area. This is done with the aid of estimated equations. Weights for the different categories are then used to calculate the supply- and demand–related contributions to aggregate price growth. An extension of this methodology allows for the possibility that supply and demand shocks occur simultaneously. The demand and supply contributions to inflation in this case are very similar to those in the baseline case, with cross–correlations above 0.95 for demand and above 0.98 for supply (*see* Table 1 in Shapiro (2024)).

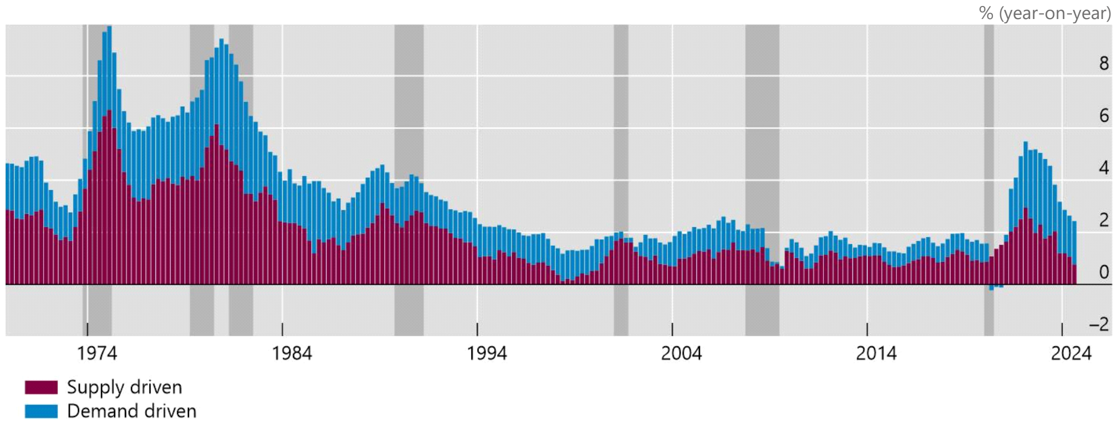

Figure 1: Decomposition of year-on-year core PCE inflation in demand and supply components

Notes: Inflation decomposition based on the method proposed by Shapiro (2024). The sum of the two components equal year-on-year core PCE inflation. X-axis: quarterly dates. Y-axis: percent.

reacted much more strongly to demand– than to supply–driven inflation.[17] We also obtain an estimated (average) inflation target π^* of 2.45. The residuals are serially–uncorrelated according to both the Durbin-Watson (DW) and Breusch-Godfrey (BG) tests: both tests cannot reject the null hypothesis of serially uncorrelated residuals at a level of statistical significance of 1%.[18]

The targeted Taylor-rule specification further provides a better fit than the simple rule. The adjusted R-squared of the targeted Taylor rule specification (0.9502) is higher than that of the simple rule (0.9474). Furthermore, a Likelihood Ratio (LR) test rejects the null that the simple rule provides a better fit than the targeted rule at a significance level $\ll 1\%$. To perform the LR test, the two specifications are nested by adding the supply–driven component of inflation in the simple Taylor rule and testing whether the nested (simple) specification provides a better fit, leveraging on the fact that the supply–driven and demand–driven components of core inflation derived by Shapiro (2024) add up to aggregate core inflation.

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[17] Readers of our paper wondered whether the targeted response we uncover in our analysis is not due to the Federal Reserve reacting to financial conditions on top of inflation and real activity measures. According to the transcripts, members of the FOMC meetings recurrently stress explicitly that monetary policy decisions consistent with the dual mandate, with financial conditions playing no independent role in the monetary policy assessment apart from their effect on the two dual mandate variables (*e.g.* January 2019 FOMC meeting, page 195, Governor Charles: "I don't think we want to signal a willingness to respond to financial markets beyond their effect on the dual mandate variables"; page 198, Governor Kashkari: "I think that [alternative B] lends itself to three potential misinterpretations. [...] The second is that we are reacting to the stock market, which I don't think we want to get in the habit of signaling about.").

[18] The associated Durbin-Watson d-statistic reported by STATA for our specification with 5 variables and 114 observations equals 1.8846, which is greater than 1.647– the tabulated DW upper bound value for the lowest nearest tabulated sample size at the 1% significance level implying that one cannot reject the null hypothesis of non-autocorrelated residuals. The *p-value* of the Breusch–Godfrey LM test for autocorrelation equals $0.5576 \gg 0.01$, implying that one cannot reject the null hypothesis of non-autocorrelated residuals.

Link to the demand- and supply-driven inflation *observed* by FOMC participants To what extent are the off-the-shelf decompositions of inflation in demand and supply factors used in our empirical analysis linked to Federal Reserve's assessment of supply– and demand–driven inflationary pressures at the time of monetary policy deliberations? To answer this question, we use advanced reasoning Large Language Model (LLM) techniques to gauge the degree of supply– and demand–driven inflationary pressures in real time based on the information available in each FOMC transcript.[19] The LLM measures at each date the supply– and demand–driven inflationary pressures on a scale from one to ten, where one denotes strong disinflationary pressures, five/six no inflationary pressures, and ten strong inflationary pressures. An example of such an assessment for the January 2019 FOMC meeting is provided in Section A.1.2.

Figure 2 shows the time series of supply– and demand–driven inflationary pressures at the time of each meeting according to the transcripts. The series look very much in sync with those derived using the latest vintages of (sectoral and macroeconomic) data. The positive and highly statistically significant correlation coefficients of the quarterly averages of the real-time series derived from FOMC transcripts with the demand and supply driven components of headline inflation (Figure A1) confirm these similar patterns. These findings suggest that the Federal Reserve has generally succeeded in assessing in real time the supply–versus demand–driven nature of inflation from their indicators, analytical toolboxes (*e.g.* statistical and structural models), household and business surveys, key business contacts (the "Beige Book"), judgment, and awareness of specific shocks buffeting the economy at a certain point in time (*e.g.* fiscal packages, oil price shocks, tariff changes).

We use next the real-time measures of demand and supply-driven inflation derived using LLM techniques and Greenbook real-time output gap estimates from Philadelphia Fed to assess the *intended* monetary policy reaction function.[20] The estimates of the targeted Taylor rule specification using these real-time series point to a more than fourfold *intended* policy response to demand-driven inflation than that to supply-driven inflation, with the difference between the two statistically significant at 1% level (Table 2). Note that only the *relative* magnitudes of the estimated responses to the demand– and supply–driven inflation indices derived based on

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[19] For a brief primer on the use of LLMs for economists see Kwon et al. (2024), and for a more extended one Dell (2025). See also Shapiro and Wilson (2022) which applies text analysis to historical FOMC transcripts to estimate the inflation target and the policy objectives of the U.S. Federal Reserve and Dunn et al. (2024) which reports a high accuracy of recent LLMs when used to analyze the minutes of FOMC meetings. Our analysis was run in April 2025 using the advanced reasoning model o3 from OpenAI.

[20] Consistent with our baseline specification, we take quarterly averages of the Greenbook real-time output gap measures available to FOMC participants at the time of monetary policy deliberations.

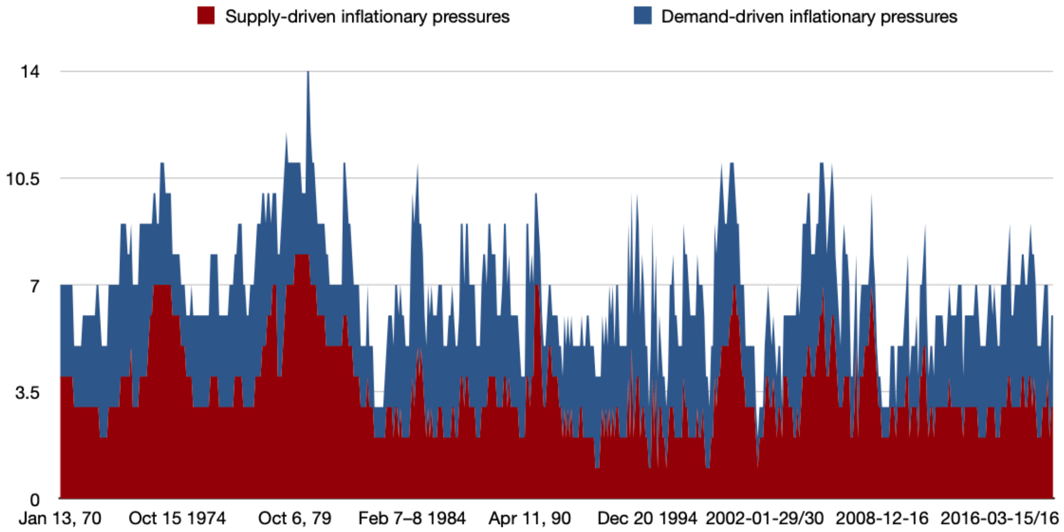

Figure 2: Supply- and demand-driven inflationary pressures according to FOMC statements

Source: Evaluation on a scale from one to ten based on an advanced reasoning Large Language Model (LLM). One denotes strong disinflationary pressures, five/six no inflationary pressures, and ten strong inflationary pressures. Ratings averaged at the quarter level. X-axis: quarterly dates.

FOMC transcripts are directly comparable to those of the responses to the demand and supply components of inflation derived with the method in Shapiro (2024). The absolute magnitudes are not because the two type of series have different units: scores from one to ten and percentage points, respectively. The uncentered R-squared is very high (0.9948), consistent with the targeted real-time specification being a good description of the *intended* monetary policy reaction function.

Table 2: Real-time targeted Taylor rule estimates: FOMC transcripts and Greenbook data

	ρ	ϕ_π^d	ϕ_π^s	ϕ_y
Targeted Taylor rule *real-time data*	0.91^{***} (0.02)	3.65^{***} (1.16)	0.88^{***} (0.34)	0.1^{**} (0.04)

Notes: Values expressed in quarterly rates. The targeted Taylor rule specification described by equation (2). Real-time data: demand and supply measures derived using an advanced reasoning LLM model based on the FOMC transcripts and Greenbook real-time output gap measures. The sample starts in 1996Q1 when the real-time output gap measure becomes available and ends in 2024Q2, which is the last date in our full sample. The policy rate is the fed funds rate. The baseline specification excludes in the estimation observations in the vicinity of the zero lower bound defined as values of the fed funds rate strictly lower than 0.5%. DW and BG test reject the null hypothesis of uncorrelated residuals at 1% level. Newey-West robust standard errors derived with the Delta method reported in parentheses. Statistical significance at 5%/1% level indicated with **/***. The difference between the estimated responses to demand– and supply–driven inflation statistically significant at 1% level.

3.3 Robustness analysis

In this section, we check the robustness of our results along several dimensions. We re-estimate the targeted Taylor–rule (1) over varied sample periods; (2) allowing for a time-varying intercept or adding the (time-varying) natural rate; (3) using headline instead of core inflation; (4) using Eickmeier and Hofmann (2025)'s alternative inflation decomposition into demand and supply factors; (5) using lagged instead of current values for inflation and output gap; (6) using alternative real activity measures, and (7) we make sure that our results are not (entirely) explained by the transitory nature of supply shocks. Our results carry through all these checks.

Alternative sample periods. We first rerun our estimation distinguishing between different Federal Reserve Chairmanships as in Carvalho et al. (2021). Table 3 reports the results of this exercise and shows that our estimates have been remarkably stable since Paul Volcker's chairmanship, with the Fed's response to demand–driven inflation being consistently around fourfold that to supply–driven inflation.

Second, we run our analysis on an extended sample, including the most recent period up to 2024Q2. The sample includes the post-GFC period where the zero lower bound (ZLB) was occasionally binding. Since our focus is on conventional monetary policy, we estimate the policy rule excluding those observations. We do so by conditioning the policy rates to be above 0.5 percent (or above a smaller, but still positive, threshold) in the estimation sample.[21] Compared to baseline estimates reported in Table 1, we obtain similar reactions to both demand–driven inflation (3.79 instead of 3.75) and supply–driven inflation (1.37 instead of 1.02), and slightly higher interest rate smoothing (0.82 instead of 0.72) and output gap (0.3 as opposed to 0.22) coefficients (Table 3).[22]

Finally, we run our analysis over the pre–Volcker Burns–Miller chairmanship (1969Q4–1979Q2). Results in this case are essentially opposite our baseline. During that period, the Federal Reserve responded particularly aggressively to supply–driven inflation and did not

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[21] We also considered alternative thresholds such as 0.1 or 0.25 and results do not change.

[22] In alternative exercises, we used the Wu and Xia (2020) shadow interest rate when the policy rate was in the vicinity of its effective lower bound (i.e when the funds rate was below 0.5 percent, or below lower, but positive thresholds). In those cases, we obtained a slightly higher interest rate smoothing parameter (0.88 instead of 0.72), a stronger reaction to demand–driven inflation (4.49 instead of 3.75) and a smaller statistically insignificant response to supply–driven inflation (0.69 instead of 1.02). Similar results obtained when we used the funds rate, ignoring that the ZLB was occasionally binding during this period. We also performed a similar exercise using the alternative shadow rate series from Krippner (2013) which are available until 2019Q3. In that specification, we obtained results very close to our baseline: an estimated response to demand–driven inflation of 3.72, one to supply–driven inflation equal to 1.43, with the difference between the two highly statistically significant, as well as both being highly statistically significant from zero; an output gap coefficient equal to 0.31 (quarterly) and an interest rate smoothing coefficient equal to 0.83.

Table 3: Robustness analysis: alternative samples

	ρ	ϕ_π	ϕ_π^d	ϕ_π^s	ϕ_y
Baseline sample 1979Q3-2007Q4					
Taylor rule	0.74^{***}	2.11^{***}			0.26^{***}
	(0.04)	(0.18)			(0.05)
Targeted Taylor rule	0.72^{***}		3.75^{***}	1.02^{**}	0.22^{***}
	(0.04)		(0.60)	(0.40)	(0.05)
Volcker-Greenspan 1979Q3-2005Q4					
Taylor rule	0.74^{***}	2.10^{***}			0.27^{***}
	(0.04)	(0.19)			(0.06)
Targeted Taylor rule	0.72^{***}		3.73^{***}	1.03^{**}	0.22^{***}
	(0.04)		(0.62)	(0.42)	(0.05)
Greenspan-Bernanke 1987Q3-2007Q4					
Taylor rule	0.80^{***}	2.18^{***}			0.38^{***}
	(0.02)	(0.22)			(0.04)
Targeted Taylor rule	0.83^{***}		4.62^{***}	1.26^{**}	0.34^{***}
	(0.02)		(0.95)	(0.42)	(0.04)
Full-sample 1979Q3-2024Q2					
Taylor rule	0.88^{***}	2.14^{***}			0.35^{***}
	(0.02)	(0.37)			(0.13)
Targeted Taylor rule	0.82^{***}		3.79^{***}	1.37^{**}	0.30^{***}
	(0.03)		(0.85)	(0.59)	(0.08)
Pre-Volcker 1969Q4-1979Q2					
Taylor rule	0.84^{***}	0.83^{***}			0.33^{***}
	(0.06)	(0.26)			(0.13)
Targeted Taylor rule	0.69^{***}		-0.65	1.69^{***}	0.37^{***}
	(0.0)		(1.14)	(0.50)	(0.09)

Notes: The Taylor rule specification is described by (1), while that of the targeted Taylor rule by (2). Standard errors are reported in parentheses. Statistical significance at 5%/1% level indicated with **/***. Differences between the estimated responses to demand–driven and supply–driven inflation in the targeted Taylor rule specification are statistically significant at 1% level. Estimates for the full-sample exercise are conditional on the (annualized) policy rate being strictly higher than 0.5%, and hence away from the close vicinity of the ZLB. The Greenspan-Bernanke tenure refers to their aggregate tenure within the baseline sample, hence its end date 2007Q4.

respond to demand–driven inflation (Table 3). This finding is consistent with the Federal Reserve reacting strongly to supply shocks such as oil price shocks as they were seen as potential causes of wage-price spirals (Bernanke (2006), Kilian and Lewis (2011)).[23]

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[23] Bernanke (2006) notes that *"In the past, notably during the 1970s and early 1980s, both the first-round and second-round effects of oil-price increases on inflation tended to be large, as firms freely passed on rising energy costs to consumers, workers reacted to the surging cost of living by ratcheting up their wage demands, and longer-run expectations of inflation moved up quickly. [...] The Federal Reserve attempted to contain the inflationary effects of the oil price shocks by engineering sharp increases in interest rates, actions which had the*

Time-varying intercept We also re–estimate the monetary policy rule (1) allowing for a break in its intercept α^{aux}. Before 2001:Q2 the intercept of the regression is estimated to be 0.43 higher at 5% statistical significant level. The higher intercept in the earlier period is consistent both with the switch in the inflation target π^* in the early 2000s identified by Shapiro and Wilson (2022), as well as with the recent decline in the equilibrium long-run real interest rate. Under this specification, the interest rate smoothing coefficient equals 0.69, the estimated response to demand–driven inflation equals 3.23, the response to supply–driven inflation equals 1.08, and the response to the output gap equals 0.2. All coefficients and the difference between demand– and supply–driven inflation are statistically significant at 1% level.

Time-varying natural rate We also run specifications of the two types of rule including the natural rate of interest (Laubach and Williams (2003)'s "r^*") as an intercept restricting its coefficient to equal one.[24] Our baseline results still hold in this case with the response coefficient to demand-driven inflation being equal to 2.52, that to supply-driven inflation to 1.01 (with the difference between the two significant at 1%), and the coefficient to the output gap to 0.26.[25] Moreover, the Root Mean Square Error (RMSE) of the targeted rule is lower than that of the simple rule (1.479 against 1.524) suggesting again that the targeted rule provides a better fit.

Alternative measures of inflation We re–estimate the monetary policy rule (1) using headline instead of core inflation. The results are reported in Table 4. For both the conventional and the targeted Taylor rules, the estimated smoothing parameter is slightly higher when using headline instead of core inflation: it equals around 0.83-0.92 against 0.72-0.74 when using core inflation. For the targeted Taylor rule, the estimated coefficients of demand–driven inflation, supply–driven inflation and output gap are all very similar to those based on core inflation.[26]

Alternative decomposition of demand– and supply–driven inflation. Next, we check whether our results hold when using Eickmeier and Hofmann (2025)'s decomposition of inflation

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consequence of sharply slowing growth and raising unemployment, as in the recessions that began in 1973 and 1981. Since about 1980, however, the Federal Reserve and most other central banks have worked hard to bring inflation and expectations of inflation down. An important benefit of these efforts is that the second-round inflation effect of a given increase in energy prices has been much reduced. To the extent that households and business owners expect that the Fed will keep inflation low, firms have both less incentive and less ability to pass on increased energy costs in the form of higher prices, and likewise workers have less incentive to demand compensating increases in their nominal wages."

[24] As in Shapiro and Wilson (2022), such specifications do not feature interest-rate smoothing so as to be able to impose that the coefficient of the natural rate rate equals one.

[25] The estimated coefficients of the simple rule are equal to 1.63 for core inflation and 0.32 for the output gap.

[26] Notably, the R–squared of the specification with headline inflation is lower than that for core inflation, suggesting that the latter is a better description of the monetary policy reaction function in line with narratives of the Federal Reserve's policy reaction function (*see for e.g.* Mishkin (2007) or the transcripts of FOMC meetings).

into demand and supply factors. This methodology relies on the same basic conceptual consideration as in Shapiro (2024) that demand factors move inflation and output in the same direction, while supply factors move them in opposite direction, but in the context of a very different econometric model and type of data. Specifically, the methodology is based on the estimation of a factor model with sign restrictions using more than 140 quarterly macro-economic time series of aggregate inflation and real activity measures. The decomposition delivers a decomposition of quarter-on-quarter demeaned headline PCE inflation. Thus, the demand and supply inflation series included in this specification should be interpreted as the deviations of the two components from a long-run target (without any implications for the interpretation of our results, given that the inflation target is lumped into the intercept of our baseline specification in (2)). The year-on-year transformation of those series is reported in Figure A2 in the Appendix. Notably, the authors highlight that the series are realible measures of demand– versus supply–driven inflation in real time, by showing that they barely change as more data are added to the model. The results based on this alternative decomposition are consistent with our baseline (Table 4). They point to a strong and highly statistically significant response to demand–driven inflation and to a weak response to supply–driven inflation, with the difference between the two being highly statistically significant at the 2% level.

Table 4: Robustness analysis: alternative variables

	ρ	ϕ_π	ϕ_π^d	ϕ_π^s	ϕ_y
Headline inflation					
Taylor rule	0.84***	1.89***			0.26**
	(0.03)	(0.29)			(0.10)
Targeted Taylor rule					
Shapiro (2024)	0.83***		3.36***	1.09**	0.22**
	(0.03)		(0.94)	(0.54)	(0.09)
Eickmeier and Hofmann (2025)	0.85***		3.45***	1.13**	0.10
	(0.03)		(0.66)	(0.57)	(0.12)

Notes: The Taylor rule specification is described by (1), while that of the targeted Taylor rule by (2). Standard errors are reported in parentheses. Statistical significance at 5%/1% confidence level indicated with **/***. The differences between the estimated responses to demand–driven and supply–driven inflation in the targeted Taylor rule specification are statistically significant at 1% level. Pre-ZLB baseline sample from 1979Q3 to 2007Q4.

Backward–looking specification We further check the robustness of our results by reporting the estimates for backward-looking rules where we use lagged values for inflation and output gap measures in our policy rules.[27] All the qualitative features of our baseline specification estimates seem to hold here as well: the demand inflation coefficient equals 2.72, that of supply inflation equals 1.4, the difference between the two is significant at 1% level and both are statistically significant at 1% level. The output gap coefficient equals 0.17, while the interest rate smoothing coefficient equals 0.7.

Alternative measures of real activity We complete our robustness analysis by reporting the estimates for alternative real activity measures.

We start by re–estimating the monetary policy rule specification in (1) using measures of unemployment instead of the output gap. We first use the unemployment gap defined as the difference between the unemployment rate and its natural rate (the NROU) published by the U.S. Congressional Budget Office. For both the conventional and the targeted Taylor rules, the estimated smoothing parameters equal 0.74 and 0.72, respectively, and are essentially the same as those under the baseline specification with the output gap. For the conventional Taylor-rule, the estimated coefficient of (aggregate) inflation is very close to that under the baseline specification (2.01 instead of 2.11), while the long-run coefficient of the unemployment gap equals −0.36 and is statistically significant at 1% level. The negative sign of the unemployment gap coefficient is consistent with the view that the Federal Reserve loosens (tightens) monetary policy when the unemployment rate is higher (lower) than its natural level. For the targeted Taylor rule, we obtain a similar coefficient for the unemployment gap (−0.32), while the coefficient of demand–driven inflation equals 4.17 and is statistically different at 1% level from the lower coefficient of supply–driven inflation which equals 0.64. We find very similar results when using the unemployment rate instead of the unemployment gap. The only notable difference is the slightly lower coefficients for the unemployment rate (i.e. −0.32 instead of −0.36 for the conventional rule, and −0.28 instead of −0.32 for the targeted rule).

We further provide estimates for a version of the targeted Taylor rule (2) where we replace the output gap with the demand– and supply components of its quarterly changes. Ideally, we would have preferred to use the decomposition of the output gap in levels ($\widetilde{y}_t$), instead of *quarterly changes* ($\Delta\widetilde{y}_t$), but such a decomposition was not available. To decompose the quarterly changes in the output gap in its demand– and supply components, we used the decomposition of the

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[27] According to Taylor (2007), Bennet McCallum has argued that it was not realistic to assume that policy can respond to current-quarter values as assumed by the Taylor (1993) rule. Taylor (2007) does not fully support this statement, as policymakers have some current-period information available when they make interest rate decisions. To account however for this potential critique, we check the robustness of our results in backward–looking specifications of the monetary policy rules.

quarterly changes in output in demand and supply factors from Eickmeier and Hofmann (2025), and the conventional theoretical assumption that the natural level of output (or the long-run level of output, depending on the interpretation of the output gap used in the estimation) is driven by supply disturbances only (*e.g.* see Galí (2015), and our model in Section 4).[28]

The results of this exercise are reported in Table 5. The main take–aways are twofold. First, the estimated response to demand–driven inflation in the targeted Taylor rule specification ($\phi_\pi^d = 3.12$) remains higher than that to supply–driven inflation ($\phi_\pi^s = 0.99$), consistent with our baseline results reported in Table 1. Second, the response to the demand–driven component of the quarterly change in output gap ($\phi_y^d = 1.64$) is significantly higher than that to its supply–driven component ($\phi_y^d = 0.61$). This finding is consistent with the perceived lack of trade-off for demand shocks (hence, the stronger responses to fluctuations in both inflation and output gap), and the presence of such a trade–off for supply shocks (explaining the weaker responses to both inflation and changes in the output gap).

Table 5: Targeted Taylor rules with real activity decomposition

	ρ	ϕ_π	ϕ_π^d	ϕ_π^s	ϕ_y^d	ϕ_y^s
Targeted Taylor rule 1: output gap	0.80***	1.86***			1.81***	0.76***
	(0.04)	(0.30)			(0.58)	(0.27)
Targeted Taylor rule 2: inflation and output gap	0.79***		3.12***	0.99*	1.64***	0.61**
	(0.04)		(.60)	(0.59)	(0.53)	(0.25)

Notes: Values expressed in quarterly rates. The targeted Taylor rule 1 (2) is described by specification (1) ((2)) where the output gap is replaced by the demand- and supply–driven components of the *quarterly change* in the output gap computed using the methodology in Eickmeier and Hofmann (2025) with coefficients equal to ϕ_y^d and ϕ_y^s, respectively. Standard errors derived by the Delta method are reported in parentheses. Statistical significance at 10%/5%/1% level indicated with */**/***.

Transitory nature of supply shocks Official communications by the Federal Reserve mention two distinct reasons for reacting less to supply– than to demand–driven inflation. One is the macroeconomic stabilisation trade-off between inflation and real activity induced by supply shocks.[29] The other is the transitory nature of certain categories of supply shocks such as

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[28] Under the assumption that demand factors do not affect the natural level of output, one can show that the output gap $\widetilde{y}_t$ can be decomposed into a supply–driven component $\widetilde{y}_t^s$ and a demand–driven component $\widetilde{y}_t^d$, where the supply–driven component is equal to the difference between the supply–driven component of output y_t^s and the natural output y_t^n, and the demand–driven component $\widetilde{y}_t^d$ is equal to the demand–driven component of output $\widehat{y}_t^d$:

$$\widetilde{y}_t = \widetilde{y}_t^s + \widetilde{y}_t^d, \quad \text{with} \quad \widetilde{y}_t^s = y_t^s - y_t^n \quad \text{and} \quad \widetilde{y}_t^d = \widehat{y}_t^d \tag{3}$$

One can then use this expression to decompose the quarterly change in output in demand and supply components:

$$\Delta\widetilde{y}_t = \Delta\widetilde{y}_t^s + \Delta\widetilde{y}_t^d \tag{4}$$

The same obtains when the output gap is defined with respect to the long-run (steady state) level of output.

[29] See for instance the citation from the speech by the Federal Reserve Chair Jerome Powell on page 2.

commodity price shocks.[30] Our baseline specification expressed in terms of core inflation already accounts for the Federal Reserve's "look through" approach with respect to the direct inflationary effects of transient energy and food price shocks. Thus, *a priori*, the estimated asymmetric response to supply– versus demand–driven fluctuations in core inflation should reflect concerns regarding distinct macroeconomic trade-offs implied by the two types of shocks, and the transient nature of some other supply shocks apart from those to energy and food prices.

Ideally, to study whether the weaker response to supply–driven fluctuations in core inflation is explained by the transitory nature of supply shocks, one would like to add in the targeted Taylor rule specification (2) the forecasts of demand– and supply–driven inflation. No decomposition for inflation forecasts in demand- and supply–driven factors is however currently available. We thus provide the following two substitutes for this experiment. First, we add the (aggregate) inflation forecast as an additional variable in our regressions. In this case, we obtain that the response coefficient to contemporaneous demand–driven inflation remains positive while that to supply–driven inflation turns negative. This result suggests that, all else equal, the Federal Reserve tended to react more strongly (weakly) to future inflation the higher its current demand (supply) component. Since inflation forecasts became available only in the late eighties, we include in our sample the most recent observations, using the Wu and Xia (2020) shadow rate instead of the policy rate whenever the latter was in the vicinity of the ZLB.

	Inflation forecasts		
	Consensus	Greenbook	
Inflation component	1 year ahead	1 quarter ahead	1 year ahead
Demand–driven	0.739^{***}	0.801^{***}	0.817^{***}
Supply–driven	0.743^{***}	0.789^{***}	0.716^{***}

Table 6: Correlation demand and supply factors of core PCE inflation with inflation forecasts

Notes: Statistical significance at 1% level indicated with ***. Inflation decomposition based on Shapiro (2024), year-on-year changes. Greenbook forecasts: available for 1986Q1:2018Q4, core CPI inflation (higher correlations for both components when using forecasts of headline CPI inflation; all corelation coefficients above 0.83). Consensus forecasts: available for 1989Q4:2024Q4, headline CPI inflation (core CPI unavailable, core PCE starting in 2018).

Second, we look at the correlation of inflation forecasts with the demand and supply components of core inflation. A lower correlation of supply–driven inflation to the inflation forecast would speak to a lower persistence of supply shocks. The results reported in Table 6 show, however, that the supply component of core inflation is highly correlated with the one-quarter-ahead and the one-year-ahead (Consensus and/or Greenbook) forecasts (with a correlation

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[30] "The standard monetary prescription is to "look through" commodities price shocks." (Brainard (2022b)).

coefficients above 0.7 and statistically significant at 1% level). The high correlation suggests that supply–driven inflation was not (entirely) transitory during the estimation period.

4 Targeted Taylor rules: theory

In what follows, we incorporate the targeted Taylor rule into a textbook monetary model. In the model, the central bank faces a macro-economic stabilization (welfare) trade-off between inflation and real activity only in response to supply shocks. By contrast, conditional on demand shocks, there is no such trade-off and strictly targeting inflation allows to reach the "first best". We use this theoretical framework to study the implications for business cycle fluctuations and welfare of monetary policy following a targeted Taylor rule instead of a conventional one when the economy is subject (simultaneously) to both demand and supply shocks.

4.1 Model

The analytical framework of our analysis is the textbook closed economy version of the New Keynesian model with staggered price and wage setting, without capital accumulation or a fiscal sector (*e.g.* Galí (2015), Chapter 6).[31] We consider two types of shocks: demand shocks and supply shocks. For ease of comparison with the textbook results, in the baseline model, demand shocks are modeled as demand preference shocks and supply shocks as technology shocks. Whenever relevant, however, we also consider the case of cost-push shocks as supply shocks.

4.1.1 Non–policy block

The non-policy block of the model – and our exposition thereof – is the same as in Galí (2015), Chapter 6. All equations are log-linearized around a steady state with zero price and wage inflation. We assume a constant wage subsidy (financed through lump-sum taxes) that exactly offsets the distortions resulting from price and wage markups in the steady state – which is thus efficient. Furthermore, this subsidy renders efficient the allocation without nominal rigidities (also known as the *natural* allocation) in the baseline version of the model without cost-push shocks. We present first the supply–side and then turn to the demand–side of the model.

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[31] The reader may wonder why we did not use the basic New Keynesian model with sticky prices instead, with supply shocks being defined as cost push shocks. A technical reason underpins our decision: as showed by Boehm and House (2019), despite an inflation-output stabilization trade-off characterizing cost-push shocks in the basic model with sticky prices only, the optimal simple rule in that framework implies an infinite response to both inflation and output conditional on such shocks. That implies that the same policy rule is optimal for both demand and cost-push shocks in that basic framework. For this reason, allowing for a targeted response to demand versus supply (cost push) shocks would not help improve welfare upon the optimal conventional (unconditional) Taylor rule.

The supply side of the economy is described by the following three equations representing the dynamics of price and wage inflation, π_t and π_t^w,

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \chi_p \tilde{y}_t + \lambda_p \tilde{\omega}_t \tag{5}$$

$$\pi_t^w = \beta E_t\{\pi_{t+1}^w\} + \chi_w \tilde{y}_t - \lambda_w \tilde{\omega}_t \tag{6}$$

$$\tilde{\omega}_t \equiv \tilde{\omega}_{t-1} + \pi_t^w - \pi_t - \Delta\omega_t^e \tag{7}$$

where $\tilde{y}_t \equiv y_t - y_t^e$ and $\tilde{\omega}_t \equiv \omega_t - \omega_t^e$ denote, respectively, the *welfare-relevant* output and wage gaps, with y_t^e and ω_t^e representing the (log) efficient output and (log) efficient wage).[32] The *efficient* output and wage are given by (ignoring constant terms):

$$y_t^e = \psi_{ya} a_t$$

$$\omega_t^e = \psi_{\omega a} a_t$$

where $\psi_{ya} \equiv \frac{1+\varphi}{\sigma(1-\alpha)+\varphi+\alpha}$, $\psi_{\omega a} \equiv \frac{1-\alpha\psi_{ya}}{1-\alpha}$, and a_t is a technology parameter which follows an exogenous $AR(1)$ process $a_t = \rho_a a_{t-1} + \varepsilon_t^a$. In addition, we note that $\chi_p \equiv \frac{\alpha\lambda_p}{1-\alpha}$, $\chi_w \equiv \lambda_w \left(\sigma + \frac{\varphi}{1-\alpha}\right)$, $\lambda_p \equiv \frac{(1-\theta_p)(1-\beta\theta_p)}{\theta_p} \frac{1-\alpha}{1-\alpha+\alpha\epsilon_p}$, where $\theta_p \in [0,1)$ and $\theta_w \in [0,1)$ are the Calvo indexes of price and wage rigidities, while $\epsilon_p > 1$ and $\epsilon_w > 1$ denote the elasticities of substitution among varieties of goods and labor services respectively. Parameters σ, φ and β denote the household's coefficient of relative risk aversion, the curvature of labor disutility and the discount factor respectively. Parameter α denotes the degree of decreasing returns to labor in production. As shown in Galí (2015), equations (1) and (2) can be derived from the aggregation of price and wage setting decisions of workers and firms, in an environment in which such re-optimization takes place with probabilities $1 - \theta_p$ and $1 - \theta_w$ respectively.

The demand side of the economy is described by the dynamic IS equation:

$$\tilde{y}_t = E_t\{\tilde{y}_{t+1}\} - \frac{1}{\sigma}(i_t - E_t\{\pi_{t+1}\} - r_t^e) \tag{8}$$

where i_t is the nominal interest rate and r_t^e is the efficient rate of interest. Under our assumptions, the latter is given by $r_t^e = \rho + (1-\rho_z)z_t + \sigma E_t\{\Delta y_{t+1}^e\}$, where $\rho \equiv -log\beta$ is the discount rate and z_t is a discount factor shifter (which we refer to as "demand" shock) which follows an exogenous AR(1) process with autoregressive coefficient ρ_z.[33] Note that in the absence of nominal rigidities,

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[32] Derivations can be found in Galí (2015), Chapter 6. Note that, compared to the textbook model, we denote *price* inflation by π_t instead of π_t^p. We do so to ease notation in the specifications of the targeted Taylor rules, where additional superscripts are needed to distinguish between the demand and supply components of inflation.

[33] The demand shock can be also thought as a fiscal shock (see Clarida et al. (1999), footnote 11). Specifically,

demand shocks have no effect on output or employment; they only affect the real interest rate.[34]

4.1.2 Monetary policy

In our analysis we consider three alternative monetary policy regimes. The first regime is described by a conventional Taylor–type rule given by:

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \widehat{y}_t \tag{9}$$

where $\widehat{y}_t \equiv log(Y_t/Y)$ denotes the log deviation of output from its steady-state and where ϕ_π and ϕ_y are assumed to satisfy the standard determinacy condition:

$$\phi_\pi + \phi_y \left(\frac{1-\beta}{\sigma + \frac{\alpha+\varphi}{1-\alpha}} \right) \left(\frac{1}{\lambda_p} + \frac{1}{\lambda_w} \right) > 1 \tag{10}$$

This rule has been traditionally viewed as capturing in a parsimonious way the behavior of central banks in many advanced economies in the absence of a binding zero lower bound constraint on the policy rate.[35] The monetary policy rule in (9) can be rewritten in terms of the *welfare-relevant* output gap as

$$i_t = \rho + \phi_\pi \pi_t + \phi_y \widetilde{y}_t + \nu_t \tag{11}$$

where $\nu_t \equiv \phi_y \widehat{y}^e_t$. Equations (5) through (11) describe the equilibrium of the model under a conventional Taylor rule.

The second regime corresponds to a modified version of the Taylor rule in (9), where we replace aggregate price inflation π_t with its demand– and supply–driven components (π^d_t and π^s_t, respectively), akin to the targeted Taylor rule estimated in Section 3.2. The targeted Taylor

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it can stand for a function of expected (exogenous) changes in government purchases relative to expected changes in potential output.

[34] In the absence of nominal rigidities, the demand shock bares no effect on output or employment. The reason has to do with the particular way in which it is introduced in the model, namely as a shock to the discount factor, which changes in the same proportion the marginal disutility of labor and the marginal utility of consumption. As a result, labor supply does not change. Labor demand does not change either, so employment and output do not change, they are fully pinned down by the supply block of the model. Only the real rate adjusts in order to keep consumption unchanged. With nominal rigidities, there is no longer a simple mapping between the real wage and employment (because the markup is variable). Instead employment and output are determined by the aggregate demand for goods, which changes in response to the discount factor shock, as long as monetary policy does not offset it fully. See chapters 2 and 3 in Galí (2015) for details.

[35] In the original Taylor (1993) rule, the "output gap" was measured by the percentage deviation of real gdp from its deterministic trend. More recent empirical studies, including ours, use the Congressional Budget Office (CBO) estimate of potential output to measure the long-run level of output (*e.g.* Clarida et al. (2000), Carvalho et al. (2021)). These trend measures conventionally map into the *steady-state* level of output in the basic New-Keynesian framework (*e.g.* Woodford (2001), Galí (2015)), implying that the output gap measures used to estimate Taylor rules are very different from the model-based (welfare relevant) output gap $\widetilde{y}_t$ that is relevant for welfare.

rule in the model is given by

$$i_t = \rho + \phi_\pi^d \pi_t^d + \phi_\pi^s \pi_t^s + \phi_y \tilde{y}_t + \nu_t \tag{12}$$

with $\pi_t \equiv \pi_t^d + \pi_t^s$, where π_t^d and π_t^s are the demand and supply components of inflation. The details of the equilibrium determination in this case are deferred to Section 4.3.

Finally, the third regime corresponds to the optimal policy under commitment in the presence of (simultaneous) demand and supply shocks. That policy is a state contingent plan that maximizes the representative household's welfare, subject to a sequence of private sector constraints given by equations (5) through (8), all for $t = 0, 1, 2, ...$. That optimal policy problem is described formally in Section 4.5.1 and gives rise to a set of difference equations which, together with equations (5) through (8), describe the equilibrium under the optimal monetary policy with commitment.

4.2 Parametrization

The baseline parametrization for the non-policy block of the model is summarized in Table 7. The non-policy block is parametrized following Galí (2015). We set the discount factor β to 0.99, implying a (annualized) steady-state real interest rate of 2%. We set $\sigma = 1$, $\varphi = 5$ and $\alpha = 0.25$. Elasticity of substitution parameters ϵ_p and ϵ_w are set to 9 and 4.5, respectively, implying a steady-state subsidy $\tau = 0.31$.[36] We set $\theta_p = \theta_w = 0.75$, consistent with an average duration of price and wage spells of one year.

Table 7: Baseline parametrization: non-policy block

Parameter	*Description*	*Value*
β	Discount factor	0.99
σ	Curvature of consumption utility	1
φ	Curvature of labor disutility	5
$1-\alpha$	Index of decreasing returns to labour	0.25
ϵ_p	Elasticity of substitution of goods	9
ϵ_w	Elasticity of substitution of labor types	4.5
θ_p	Calvo index of price rigidities	0.75
θ_w	Calvo index of wage rigidities	0.75

Notes: Values are shown in quarterly rates.

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[36] The optimal steady-state subsidy satisfies $\tau = 1 - \frac{1}{\mathscr{M}_p \mathscr{M}_w}$, where $\mathscr{M}_p \equiv \frac{\epsilon_p}{\epsilon_p - 1}$ and $\mathscr{M}_w \equiv \frac{\epsilon_w}{\epsilon_w - 1}$. See chapter 6 in Galí (2015) for details.

4.3 Equilibrium under a *targeted* Taylor Rule

To implement the targeted Taylor rule, we first represent the equilibrium conditions by means of a system of difference equations with an unique equilibrium.

Recall that the non-policy block of the economy is described by equations (5), (6), (7), (8), while the targeted Taylor rule is described by (12). Assume the central bank can observe inflation in a shadow economy with supply shocks only and denote the inflation level in this economy by π_t^s. Under this assumption, using the (definition of the) inflation decomposition in demand and supply components $\pi_t \equiv \pi_t^d + \pi_t^s$, we can rewrite the policy rule (12) as a function of aggregate inflation π_t and inflation in the shadow economy with supply shocks only π_t^s as

$$\widehat{i}_t = \phi_\pi^d \pi_t + (\phi_\pi^s - \phi_\pi^d)\pi_t^s + \phi_y \widetilde{y}_t + \nu_t \tag{13}$$

where π_t^s solves the following dynamic system of equations describing the shadow economy with supply shocks only

$$\begin{aligned}
\pi_t^s &= \beta E_t\{\pi_{t+1}^s\} + \chi_p \widetilde{y}_t^s + \lambda_p \widetilde{\omega}_t^s && (14)\\
\pi_t^{w,s} &= \beta E_t\{\pi_{t+1}^{w,s}\} + \chi_w \widetilde{y}_t^s - \lambda_w \widetilde{\omega}_t^s && (15)\\
\widetilde{\omega}_t^s &\equiv \widetilde{\omega}_{t-1}^s + \pi_t^{w,s} - \pi_t^s - \Delta\omega_t^{n,s} && (16)\\
\widetilde{y}_t^s &= E_t\{\widetilde{y}_{t+1}^s\} - \frac{1}{\sigma}\left(\widehat{i}_t^s - E_t\{\pi_{t+1}^s\} - \widehat{r}_t^{e,s}\right) && (17)\\
\widehat{i}_t^s &= \phi_\pi^s \pi_t^s + \phi_y \widetilde{y}_t^s + \nu_t^s && (18)
\end{aligned}$$

where $\omega_t^{e,s} = \psi_{\omega a} a_t$, $\widehat{r}_t^{e,s} = -\sigma(1-\rho_a)\psi_{ya} a_t$, $\nu_t^s = \phi_y \psi_{ya} a_t$.[37] Equations (5), (6), (7), (8), (13), (14) – (18) describe a system of ten difference equations with ten unknowns.

To determine the equilibrium of the system, we first solve separately for the equilibrium of this shadow economy with supply shocks only described by equations (14) – (18). The latter equilibrium is unique if the nominal determinacy condition (10) is satisfied for $\phi_\pi = \phi_\pi^s$. If this is the case, one can determine the unique equilibrium in the shadow economy with supply shocks

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[37] Note that from a methodological point of view, this shadow economy is akin to the shadow economy in Bianchi et al. (2023) in which the fiscally-led policy mix is always in place and the economy is hit only by unfunded government spending shocks. Furthermore, in the fundamental versus non-fundamental monetary policy rules introduced by Nakamura et al (2015) to shield monetary policy rules from determinacy issues, the shadow economy used to implement such rules is the economy with fundamental shocks.

only to obtain

$$\pi_t^s = \delta_{\pi^s}^a a_t + \delta_{\pi^s}^{\omega} \widetilde{\omega}_{t-1}^s \tag{19}$$

where the coefficients $\delta_{\pi^s}^a$ and $\delta_{\pi^s}^{\omega}$ are functions of the structural parameters of the model. Using the values of π_t^s given by (19), we can now solve for the equilibrium of aggregate inflation π_t, output gap $\widetilde{y}_t$, real wage gap $\widetilde{\omega}_t$, wage inflation π_t^w, and nominal interest rate $\widehat{i}_t$ described by the system of the five difference equations given by (5), (6), (7), (8), (13). The equilibrium of the latter system is unique if the nominal determinacy condition (10) is satisfied for $\phi_\pi = \phi_\pi^d$. These conditions imply Proposition (1).

Proposition 1. *The equilibrium of the model is unique if the response coefficients to both demand– and supply–driven inflation (ϕ_π^d, ϕ_π^s) satisfy the Taylor principle given the response coefficient to the output gap (ϕ_y).*

If Proposition (1) is satisfied, we can compute the equilibrium paths of π_t, π_t^w, $\tilde{y}_t$ and $\tilde{\omega}_t$.[38]

The equilibrium of the model can be written as the sum of the two shadow economies with supply shocks only and with demand shocks only. To verify this result, one can compute the residual demand component π_t^d from the definition of the decomposition of inflation $\pi_t^d \equiv \pi_t - \pi_t^s$, using the expressions previously derived for aggregate inflation π_t and for inflation in the shadow economy with supply shocks only π_t^s. The residual demand component of inflation is equal to inflation in the shadow economy with demand shocks only.[39]

Note that we could also have solved the model by constructing a different (demand–driven) shadow economy with demand shocks only. As in Bianchi et al. (2023), this duality in solving models with shock-specific rules stems from the linearity of the model, which implies that the two shadow economies are additive subeconomies of the actual economy. This means that the sum of all variables, and in particular of inflation rates, in the two parallel economies equal their counterparts in the actual economy. For this reason, up to a first order approximation, our model–based counterparts of the demand– and supply–driven inflation series plotted in Figure 1 are the inflation series in the shadow economies with demand shocks only and, respectively, with supply shocks only.

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[38] The system of ten equations (5), (6), (7), (8), (13), (14) – (18) can be solved numerically using Dynare, Matlab or a similar software.

[39] This result can be easily verified using Dynare.

Proposition 2. *The equilibrium of the model with demand and supply shocks can be written as the sum of the two shadow economies with demand shocks only and with supply shocks only.*

Following a similar approach, one can write the dynamics of all other aggregate variables in our model as the sum of their dynamics in the shadow economies with demand and supply shocks only.[40] Thus, hereafter, anytime we refer in our analysis to the demand (supply) component of a variable, one may think of it as the level of that variable in a shadow economy with demand (supply) shocks only.

4.4 Business cycle fluctuations

What are the business cycle implications of monetary policy following a targeted —rather than a conventional— Taylor rule? One way to answer this question is to compare, for a given series of demand *and* supply shocks, the dynamics of our model under the two monetary policy regimes.

For the purpose of the experiment, we set the parameters of the monetary policy rules consistent with the estimated values in our empirical analysis – see Table 8 below.[41] We set the standard deviations of the demand and supply shocks to their textbook values, namely (i) that of the technology shock to 0.01 such that it implies a one percent variation in aggregate technology A_t, and (ii) that of the demand shock to 0.05 such that a one standard deviation positive shock implies on impact an exogenous decline of one percentage point in the annualized natural rate of interest. We choose a higher persistence of the demand shock (0.95 instead of 0.5) and of the supply shock (0.95 instead of 0.9) than the textbook values to match better the persistence of the demand and supply components of inflation in our simulations with those observed in the data (Figure 1, blue line).[42] Our findings, however, carry over qualitatively when using the textbook values of the parameters.

The simulated dynamics of inflation, output, and policy rates under the two alternative monetary policy regimes, as well as the series of demand and supply shocks are reported in Figure 3. Several findings stand out from their comparison under the two monetary policy

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[40] For instance, one can write $\widehat{y}_t = \widehat{y}_t^d + \widehat{y}_t^s$ where $\widehat{y}_t^d$ ($\widehat{y}_t^s$) is the deviation of output from its steady state value in the shadow economy with demand (supply) shocks only, etc.

[41] For simplicity, we abstract from the interest-rate smoothing term in the monetary policy rule. When including the latter, results remain materially the same (see Section A.1.3).

[42] The need for highly persistent demand shocks to match the persistence of demand-driven inflation observed in the data is consistent with the findings of estimated DSGE models that some categories of demand shocks such as fiscal shocks are very persistent (*e.g.* in Smets and Wouters (2007) their autocorrelation parameter equals 0.97). The slightly higher persistence of the technology shock compared to its textbook value (0.95 instead of 0.9) is standard in the literature (*e.g.* Erceg et al. (2000), as well as the estimated value in Smets and Wouters (2007)).

Table 8: Parametrization: monetary policy rules

Parameter	*Description*	*Value*
Taylor–type rule:		
ϕ_π	Response to aggregate inflation	2
ϕ_y	Response to the output gap	0.2
Targeted Taylor–type rule:		
ϕ_π^d	Response to demand–driven inflation	4
ϕ_π^s	Response to supply–driven inflation	1.01
ϕ_y	Response to the output gap	0.2

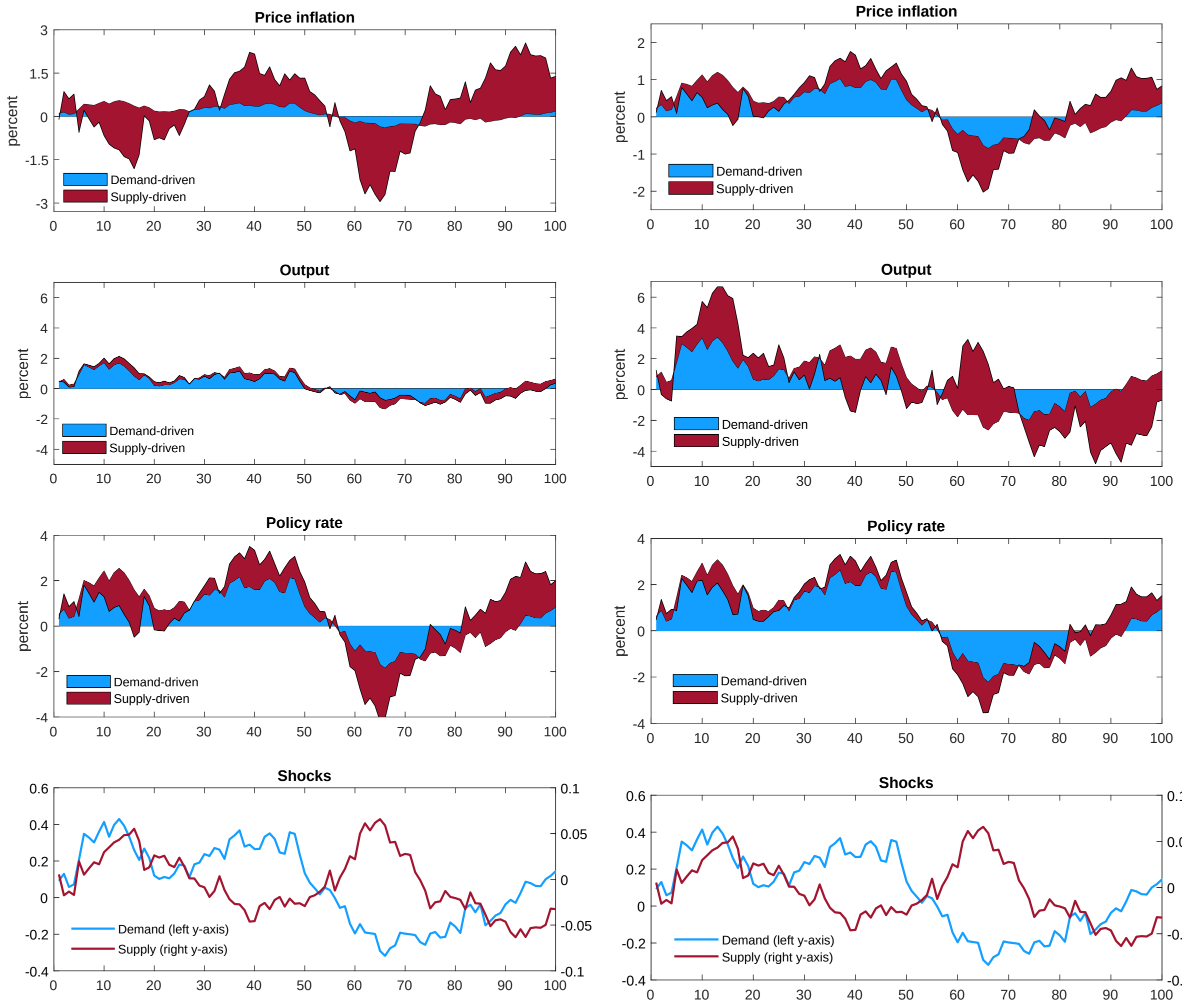
Notes: Values are shown in quarterly rates.

regimes. We focus on the three observable variables included in our estimated simple monetary policy rules: inflation, the deviation of output from its long-run trend and the policy rate.

Inflation The composition of inflation differs markedly across the two monetary regimes. Overall inflation is driven to a larger extent by supply factors under the targeted Taylor rule than under the conventional rule. This is because the supply component of inflation is more prominent (Figure 3, top panel, red), while that of demand is more subdued (blue). These dynamics reflect a weaker policy response to supply–driven inflation (1.01 versus 2) and a more forceful response to demand–driven inflation (4 versus 2) under the targeted rule compared to the conventional rule. Furthermore, in our model, the higher volatility of the supply–driven component is not fully compensated by the lower volatility of the demand–driven component, leading to a higher inflation volatility under the targeted rule compared to the conventional one.

Output The overall output volatility is smaller under the targeted Taylor rule, with both the demand and supply components of output being less responsive to the business cycle (Figure 3, middle panels). Under the targeted rule, output fluctuations in response to supply shocks are more muted because the economy adjusts to such shocks mainly through changes in prices (Figure 4, dark red versus light red lines). At the same time, the component of output driven by demand shocks is more subdued because the stronger reaction to demand–driven inflation simultaneously counteracts the demand–driven fluctuations in output (Figure 5, dark blue versus light blue lines). This is because the central bank does not face an inflation/output stabilization trade–off in response to demand shocks, i.e. the "divine coincidence" holds in that case.

Nominal interest rates Despite material differences in the composition and levels of aggregate inflation and output under the two monetary regimes, the change in nominal interest rates, as



(i) Targeted Taylor rule

(ii) Taylor rule

Figure 3: Simulated model dynamics with both demand and supply shocks

Notes: X-axis: quarters. The figure shows the simulated model dynamics under the baseline parametrization summarized in Tables 7 and 8 separately for the targeted Taylor rule (left panels) and for the simple Taylor rule (right panels). Variables: price inflation π_t, output $\widehat{y}_t$, policy rate $\widehat{i}_t$, demand shock z_t, supply shock a_t. Dynamics of price inflation, output, policy rate decomposed in demand-driven (blue) and supply-driven (red) components.

well as their drivers, are quite similar in the two cases (Figure 3, third row).

The variances of macro-variables under the two policy rules confirm these patterns (Table 9). In particular, under the targeted Taylor rule (first row), compared to the outcome under the conventional Taylor rule (second row), the relative variance of supply–driven inflation $\sigma^2_{\pi^s}/\sigma^2_{\pi}$ is higher (60% compared to 40%), while the variance of output σ^2_y is lower (0.17 compared to 2.33). The differences in the dynamics of inflation and output and the similarity of interest rate paths under the two types of rule are even more salient when allowing for interest-rate smoothing (Table A4, Figure A3).

Notably, the very same patterns emerge when supply disturbances are driven by cost-push

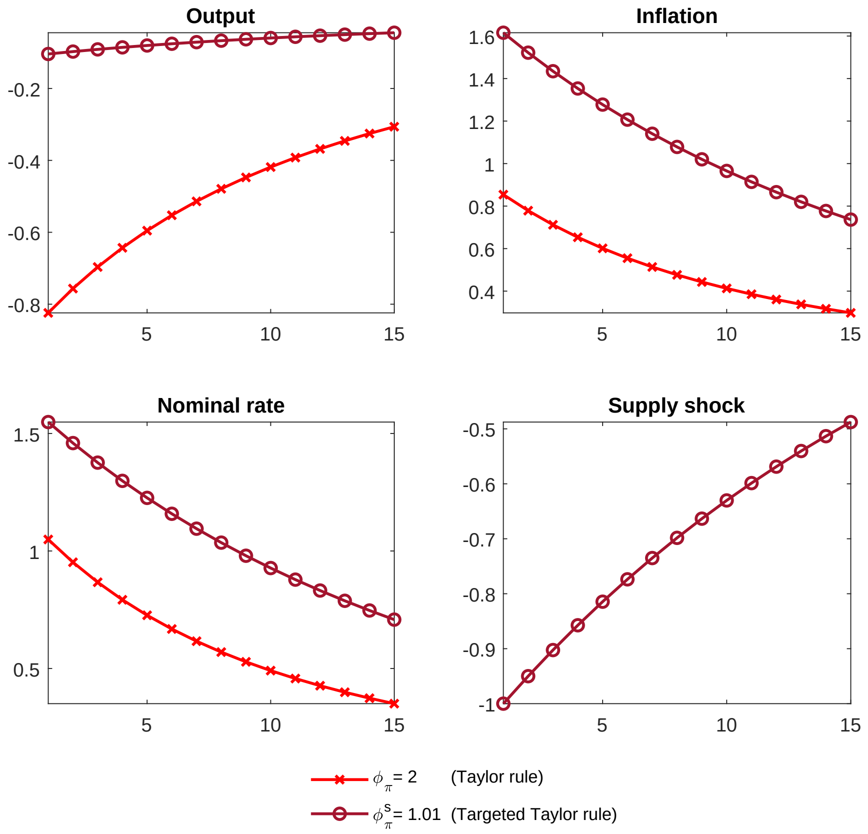


Figure 4: Dynamic responses to an adverse supply shock under the two alternative policy rules

Notes: Y-axis: percent. X-axis: quarters. Variables: output $\widehat{y}_t$; inflation π_t (annualised); nominal rate $\widehat{i}_t$ (annualised); supply shock a_t. One standard deviation shock which equals one percentage point *decrease* in aggregate technology A_t.

Table 9: Volatility of output, inflation and policy rates

	σ_y^2	σ_π^2	$\sigma_{\pi^d}^2$	$\sigma_{\pi^s}^2$	$\sigma_{y,d}^2$	$\sigma_{y,s}^2$	σ_i^2	$\sigma_{\pi^s}^2/\sigma_\pi^2$
Targeted Taylor rule	0.17	1.61	0.02	0.95	0.24	0.06	2.23	60%
Taylor rule	2.33	0.52	0.12	0.21	0.97	3.39	1.66	40%

Notes: Model-based variances of macroeconomic variables under the targeted Taylor–type rule versus the conventional Taylor–type rule. Variables expressed in percent. σ^2 stands for variance. Its subscript denotes a specific macroeconomic variable.

shocks instead of technology shocks (Figures A5 and A6 in the Appendix). The cost-push shock is modelled as a price mark-up shock (*see e.g.* Smets and Wouters (2007), Galí (2015), Chapter 5)). As shown in section A.1.4 in the Appendix, in the presence of this shock, the New-Keynesian Price Phillips curve (5) is replaced by

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \chi_p \tilde{y}_t + \lambda_p \tilde{\omega}_t + u_t \tag{20}$$

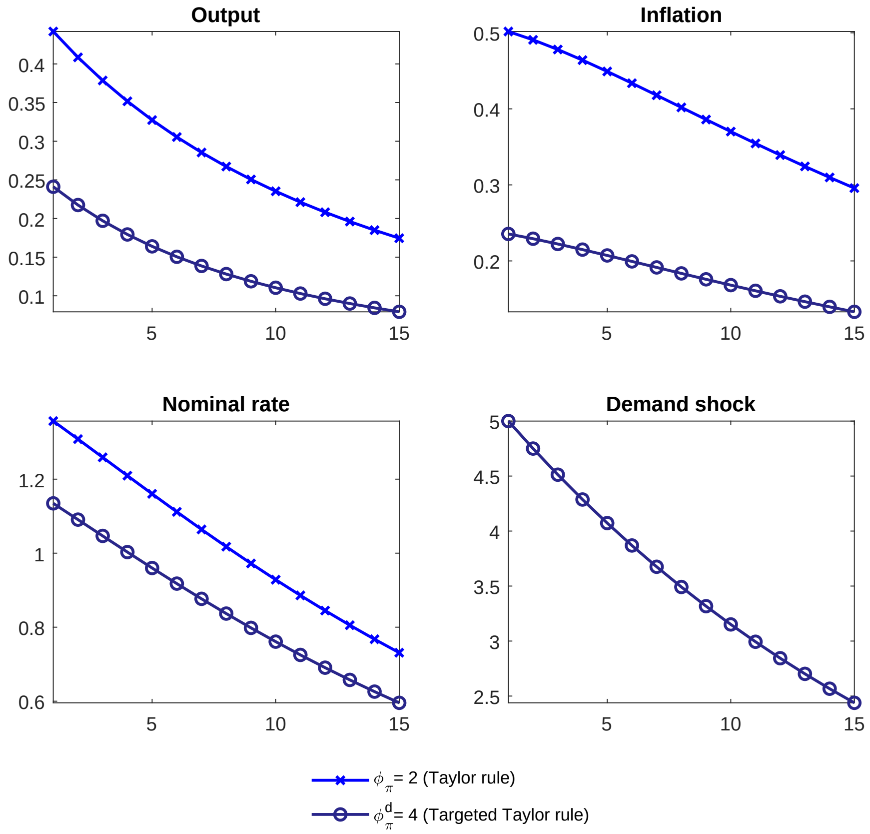


Figure 5: Dynamic responses to a positive demand shock under the two alternative policy rules

Notes: Y-axis: percent. X-axis: quarters. Variables: output $\widehat{y}_t$; inflation π_t (annualised); nominal rate $\widehat{i}_t$ (annualised); demand shock z_t. The shock is normalized such that it implies on impact an exogenous decrease of one percentage point in the annualized natural rate of interest.

where u_t follows the exogenous AR(1) process

$$u_t = \rho_u u_{t-1} + \varepsilon_t^u \tag{21}$$

with $\rho_u \in [0, 1)$ and $\{\varepsilon_t^u\}$ is a white-noise process with constant variance σ_u^2.

Our simulations clarify why the standard Taylor rule may fail to capture the full asymmetry in the monetary policy response to demand versus supply disturbances and, by extension, provide an incomplete account of its implications for business cycle dynamics. The conventional rule implies an *implicit* asymmetry: demand shocks widen output in a procyclical direction, whereas supply shocks narrow it countercyclically, prompting a correspondingly stronger or weaker policy response. Our counterfactual experiment demonstrates however that, if the asymmetric response of monetary policy goes beyond this implicit feature — in the sense that central bank's response to inflation (and potentially on the output gap) depends on the nature of the shock — the canonical Taylor rule will no longer provide an adequate description of rate-setting behavior and of its associated implications for business cycle fluctuations.

Distinguishing between the two monetary policy rules in the data In our empirical analysis (Section 3), the LR-test indicates that the targeted rule provides a better description of the policy rate path than the conventional rule at a high level of statistical significance ($\ll 1\%$). Nevertheless, the adjusted R-squared of the targeted rule specification is only slightly higher than that of the conventional rule. In this section, we show that a similar result obtains when data generated under the targeted Taylor rule (Figure 3, left panels) is used to estimate both a targeted Taylor rule and a conventional Taylor rule.

In the baseline case without interest rate smoothing, the estimates of the targeted Taylor rule (without interest rate smoothing) are the ones characterizing the data generating process, namely 4 for demand-driven inflation, 1.01 for supply-driven inflation, 0.2 for the output gap, with a zero constant. Those for the simple Taylor rule (without interest rate smoothing) equal 1.21 for inflation, 1.13 for output and with a small statistically insignificant positive constant equal to 0.0031. The adjusted R-squared of the targeted Taylor rule specification (which characterizes the true data generating process) equals 1 and the mean-squared-error (MSE) equal to zero. The adjusted R-squared of the conventional Taylor rule specification (0.9952) is very close to 1, with a mean-squared-error (MSE) equal to 0.128. Adding an interest rate smoothing term does not change results for the targeted Taylor rule specification; it however changes marginally the results for the Taylor rule by approaching its adjusted R-squared (0.9956) to that of the targeted specification (1), and by reducing the Root MSE to 0.109.

Results from a similar exercise using simulated data from the model with an interest rate smoothing parameter in the targeted Taylor rule (Figure A3, left panels), point to even smaller differences in the goodness of fit of the two specifications (despite the targeted one being again the true DGP). In this case, the estimates of the targeted Taylor rule equal the ones characterizing the data generating process, namely 4 for demand-driven inflation, 1.01 for supply-driven inflation, 0.2 for the output gap, and 0.7 for the interest rate smoothing parameter, while those for the simple Taylor rule equal 1.429 for inflation, 0.24 for output with a very small statistically insignificant negative constant. Notably, the adjusted R-squared of both regressions equals one, with a mean-squared-error (MSE) equal to zero for the targeted Taylor rule (which characterizes the true data generating process) and to a very small value (0.0036) for the simple rule. These results suggest that the central banks' preference to smooth interest rates approach even more the adjusted R-squared of the two specifications when the targeted Taylor rule is true DGP.

These results are consistent with the relatively small positive improvement in terms of goodness of fit characterizing the estimated targeted Taylor rule compared to the Taylor rule in our empirical analysis, as well as with the targeted specification being the preferred one at high statistical significance levels ($\ll 1\%$).

4.5 Welfare evaluation

The aim of this section is to derive optimal simple policy rules and evaluate welfare in our model economy. One novelty of our analysis is that we derive such rules in the presence of both demand and supply shocks — as opposed to each shock taken separately. Another novelty is that we compare the merits of following *targeted* Taylor–type rules relative to those of following conventional (unconditional) Taylor–type rules. We first derive results for the textbook case where the central bank can observe the demand and supply components of inflation, and then consider an extension where it can only do so up to a measurement error.

We start our analysis by deriving the optimal monetary policy with commitment when the economy is subject to both demand and supply shocks simultaneously. We then consider this hypothetical optimal policy as the relevant benchmark to assess the welfare implications of more operational ("simple") monetary policy rules. The welfare comparison across alternative monetary policy regimes is based on the average period welfare losses implied by each monetary policy regime given by:[43]

$$\mathbb{L} = \frac{1}{2}\left[\left(\sigma + \frac{\varphi+\alpha}{1-\alpha}\right)var(\tilde{y}_t) + \frac{\epsilon_p}{\lambda_p}var(\pi_t) + \frac{\epsilon_w(1-\alpha)}{\lambda_w}var(\pi_t^w)\right] \tag{22}$$

4.5.1 Optimal policy under commitment with demand *and* supply shocks

The optimal monetary policy under commitment when the economy faces simultaneously demand and supply shocks is characterized by the interest rate path which minimizes at each date

$$\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t\left[\left(\sigma + \frac{\varphi+\alpha}{1-\alpha}\right)\tilde{y}_t^2 + \frac{\epsilon_p}{\lambda_p}\pi_t^2 + \frac{\epsilon_w(1-\alpha)}{\lambda_w}(\pi_t^w)^2\right]$$

subject to equations (5)–(8).

Note that conditions (5)–(7) do not depend on the demand shock. Thus, with the exception of the path of the interest rate $\widehat{i}_t$, the paths of all other variables under optimal policy in the presence of both demand and supply shocks are identical to those in the presence of supply

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[43] For derivation details, see chapter 6 in Galí (2015).

shocks only. As described in Galí (2015), Chapter 6.4, the paths of π_t, π_t^w, $\tilde{y}_t$, $\tilde{\omega}_t$ conditional on supply disturbances driven by technology shocks are described by the solution of the following dynamic system of equations:

$$\left(\sigma + \frac{\varphi+\alpha}{1-\alpha}\right)\tilde{y}_t + \chi_p\xi_{1,t} + \chi_w\xi_{2,t} = 0 \tag{23}$$

$$\frac{\epsilon_p}{\lambda_p}\pi_t^p - \Delta\xi_{1,t} + \xi_{3,t} = 0 \tag{24}$$

$$\frac{\epsilon_w(1-\alpha)}{\lambda_w}\pi_t^w - \Delta\xi_{2,t} - \xi_{3,t} = 0 \tag{25}$$

$$\lambda_p\xi_{1,t} - \lambda_w\xi_{2,t} + \xi_{3,t} - \beta E_t\{\xi_{3,t+1}\} = 0 \tag{26}$$

for $t = 0, 1, 2, ...$, where $\{\xi_{1,t}\}$, $\{\xi_{2,t}\}$, $\{\xi_{3,t}\}$ denote the sequence of Lagrange multipliers associated with the previous constraints, together with the constraints (5)–(7), given $\xi_{1,-1} = \xi_{2,-1} = 0$ and an initial condition for $\tilde{\omega}_{-1}$. We hereafter index the solution path of the variables by the star symbol. Given the optimal paths of the output gap $\tilde{y}_t^*$ and price inflation π_t^*, we can now compute the optimal path of the interest rate $\widehat{i}_t^*$ as

$$\widehat{i}_t^* = \sigma E_t\{\Delta\tilde{y}_{t+1}^*\} + E_t\{\pi_{t+1}^*\} + \widehat{r}_t^e$$

for $t = 0, 1, 2, ...$, where $\widehat{r}_t^e = (1-\rho_z)z_t + \sigma\psi_{\omega a}(1-\rho_a)a_t$, which is a function of both supply and demand shocks.

Optimal policy completely insulates the economy from the effect of demand shocks, and solves efficiently the stabilization trade-off between inflation and the welfare-relevant output gap in the case of supply shocks so as to minimize their associated welfare losses. Table 10 (column two) reports the average welfare losses, as well as the variances of price inflation, wage inflation and output gap under optimal policy conditional on technology shocks only (rows 3 to 6), demand shocks only (rows 9 to 12), and both types of shocks (rows 15 to 18). The standard deviations of the technology σ_a and the demand σ_z innovations are both set to one percent, while the persistence of the technology and demand shocks, ρ_a and ρ_z, are set to 0.9 and 0.5, respectively, as in Galí (2015), Chapter 6. The remaining parameters equal their baseline values summarized in Table 7.

In the case with technology shocks only, the welfare losses under optimal policy equal those reported in Table 6.1 in Galí (2015). Notably, the standard deviations of the welfare relevant output gap and of wage inflation are three times smaller than that of price inflation. This suggests that, in response to technology shocks, the central bank should not aim to fully stabilize

	Optimal	*Strict targeting*	*Flexible targeting:*	
			unconditional	*targeted*
Technology shocks				
$\sigma(\pi)$	0.11	0	0.1487	0.1454
$\sigma(\pi^w)$	0.03	0.2665	0.1075	0.1076
$\sigma(\tilde{y})$	0.04	3.4174	0.7897	0.8261
$\mathbb{L}$	0.033	0.7952	0.1251	0.1248
Demand shocks				
$\sigma(\pi)$	0	0	0.0197	0
$\sigma(\pi^w)$	0	0	0.0442	0
$\sigma(\tilde{y})$	0	0	0.9611	0
$\mathbb{L}$	0	0	0.0468	0
Both shocks				
$\sigma(\pi)$	0.11	0	0.1467	0.1487
$\sigma(\pi^w)$	0.03	0.2665	0.1163	0.1076
$\sigma(\tilde{y})$	0.04	3.4174	1.2674	0.7897
$\mathbb{L}$	0.033	0.7952	0.1719	**0.1248**

Table 10: Welfare outcomes: optimal policy versus simple rules

Notes: As in Galí (2015), the standard deviations of the technology and demand shocks in the welfare analysis equal one percent. Reported values are rounded up to the third decimal. $\mathbb{L}$ denotes the welfare loss defined by (22), and $\sigma(\pi)$, $\sigma(\pi^w)$, $\sigma(\tilde{y})$ denote the standard deviations of price inflation, wage inflation and output gap. The unconditional flexible targeting rule denotes a conventional Taylor–type rule (9) with $\phi_\pi = 4$ and $\phi_y = 0$ set to minimize welfare losses conditional on the economy being buffeted by both technology and demand shocks. The targeted flexible targeting rule denotes a targeted Taylor–type rule (27) with $\phi_\pi^d = +\infty$, $\phi_\pi^s = 3.87$ and $\phi_y = 0$, where $\phi_\pi^d = +\infty$ is set to minimize welfare losses conditional on the economy being buffeted by demand shocks only and $\phi_\pi^s = 3.87$ and $\phi_y = 0$ are set to minimize welfare losses conditional on the economy being buffeted by technology shocks only. The optimal response coefficients to supply-driven inflation and to output deviations depend on the nature of supply shocks (*e.g.* for a cost-push shock $\phi_\pi = 0.86$ and $\phi_y = 0.35$, Table A6 in the Appendix).

price inflation. Results are very different for the case with demand shocks only, where the optimal monetary policy response is compatible with the full stabilization of price inflation. The welfare loss under optimal policy when the economy is subject to both types of shocks at the same time is the sum of losses in the case with technology shocks only and with demand shocks only. According to these findings, if the central bank chose to strictly target (aggregate) price inflation in an economy buffeted by both types of shocks, it would exacerbate the inefficient fluctuations in response to technology shocks, thereby moving away from optimal policy. Similar findings obtain when considering cost-push shocks instead of technology shocks (see Table A6 in the Appendix).

The optimal monetary policy under commitment does not have a simple characterization, requiring instead that the central bank follow a complicated target rule satisfying simultaneously the optimality conditions described by (23) to (26). Thus, it is of interest to know to what extent simple monetary policy rules — understood as rules that a central bank could arguably adopt in practice — may be able to approximate the optimal policy, an issue that is attended to next.

4.5.2 Evaluation of simple monetary policy rules

In what follows, we first consider conventional unconditional Taylor–type rules (9) and then turn to targeted Taylor–type rules (12).[44]

Taylor–type rules The specification of conventional Taylor–type rules described by (9) nests the description of strict inflation targeting (SIT) and the conventional (unconditional) description of flexible inflation targeting (FIT).

In particular, SIT is characterized by $\phi_\pi \to \infty$ and $\phi_y = 0$, and implies that price inflation is zero, and hence on target at all times (Svensson (1999)). As expected, given the outcome under optimal policy, Table 10 (column three) shows that such a regime avoids welfare losses in the presence of demand shocks, but exacerbates losses with respect to optimal policy in the presence of supply shocks. In particular, welfare losses in response to technology shocks are up to twenty four times higher under SIT than under optimal policy. The results for SIT conditional on either technology or demand shocks only are the same to those reported in Table 6.1 in Galí (2015) for *strict price targeting*. In the presence of both types of shocks, the order of magnitude of net welfare losses under SIT relative to optimal policy is the same as in the case with supply shocks since welfare losses subject to demand shocks are zero under both regimes.

The description of FIT conventionally entails finite positive values for $\phi_\pi \geq 0$, $\phi_y \geq 0$, and allows price inflation to temporary deviate from its medium-run target (Svensson (1999)). The two policy response coefficients may be optimally chosen to minimize welfare losses in response to business cycle fluctuations. For the purpose of our analysis, we set these coefficients to minimize welfare losses under the assumption that business cycle fluctuations are driven by both demand and supply shocks (unconditional FIT, hereafter U-FIT).[45] In this case, we obtain an optimal response coefficient to aggregate inflation (ϕ_π) equal to 4, one to output deviations from steady-state (ϕ_y) equal to 0, and a welfare loss equal to 0.1719. Notably, these values are specific

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[44] Notably, Erceg et al. (2000) shows that the optimal policy response to a supply shock can be well approximated by targeting the *output gap* or a weighted average of price and wage inflation (*composite inflation*). A practical difficulty with targeting the output gap is that the latter is not an observable variable (see Coibion et al. (2018) for a discussion of the pitfalls of output gap measures based on existing estimates of potential output). Its unobservability disqualifies it as argument of policy rules which central banks could *a priori* implement in practice which are the focus of our analysis. Similarly, contrary to price inflation, no broad-based measure of wage inflation is readily available, which might explain the absence of wage inflation as a standard input variable in simple monetary policy rules conventionally considered in the literature.

[45] For ease of comparison with the textbook results, we describe supply disturbances by the means of a technology shock in our baseline model. In practice, however, several types of supply disturbances may buffet the economy (e.g. technology shocks, oil supply shocks, labor supply shocks, market power shocks), and the optimal response to supply–driven inflation will depend on the mix of these shocks. Nevertheless, since strictly targeting inflation is not optimal for none of these shocks, the conclusions of our analysis would remain qualitatively the same.

to our baseline textbook experiment where the variance of both shocks is set to one percent, and may change with the variance and persistence of shocks. For instance, if we calibrated the demand shock to be larger and more persistence as in Section 4.4, the optimal response coefficient to inflation would equal 10, that to output deviations 0.3, and the welfare loss would raise to 2.188. More generally, the optimal values of the two policy rule parameters will vary with the composition, variance and persistence of different types of demand and supply shocks, as well as with the presence of additional real and financial frictions.[46]

Our findings reported in Table 10 (column four, U-FIT) show that welfare losses due to inefficient fluctuations subject to supply shocks can be substantially mitigated under U-FIT relative to the SIT (compare welfare outcomes under U-FIT and SIT for supply shocks only). Specifically, under our baseline calibration, welfare losses are reduced by more than six times (i.e. from 0.80 to 0.13).[47] Nevertheless, in our economy buffeted simultaneously by both demand and supply shocks, the welfare gains with respect to SIT due to an improved response to supply shocks come at a welfare cost caused by inefficient fluctuations subject to demand shocks (compare welfare outcome under U-FIT and SIT for demand shocks only).

In our baseline experiment where the standard deviation of both shocks equals one percent, the net welfare gains under U-FIT are positive (compare welfare outcome under U-FIT and SIT for both shocks). In this case, the transitory deviation of inflation from its long-run target under U-FIT improves overall welfare in the presence of both types of shocks. But this is not a general result. As shown in Figure 6, for relatively high variances of demand shocks, SIT (red shaded area) may improve welfare upon optimal U-FIT (violet shaded area). In those cases, the welfare gains of U-FIT subject to small supply shocks are more than offset by the welfare losses incurred in the face of the relatively larger demand shocks.

Targeted Taylor–type rules We now turn to the targeted Taylor–type rules described by

$$i_t = \rho + \phi_\pi^d \pi_t^d + \phi_\pi^s \pi_t^s + \phi_y \widehat{y}_t \tag{27}$$

These rules allow to tailor the monetary policy response to the nature of inflation drivers.[48]

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[46] Optimal Taylor coefficients for aggregate inflation derived within richer medium-scale macroeconomic models are in the ballpark of $1.2 - 2$ (*e.g.* Levin et al. (2005), Taylor (2007), Adjemian et al. (2007)), suggesting that the optimal response to aggregate inflation is remarkably close to its empirical U.S. estimate.

[47] Results under FIT are different from those under *flexible price targeting* conditional on the each type of shock in the textbook version, since we define FIT as the optimal Taylor rule in the presence of both types of shocks instead of of a Taylor rule responding to price inflation only with a coefficient of 1.5.

[48] In principle, one could allow the reaction to real activity to depend on the nature of its supply versus demand drivers as well. In our baseline specification however, this would be without loss of generality. Specifically,

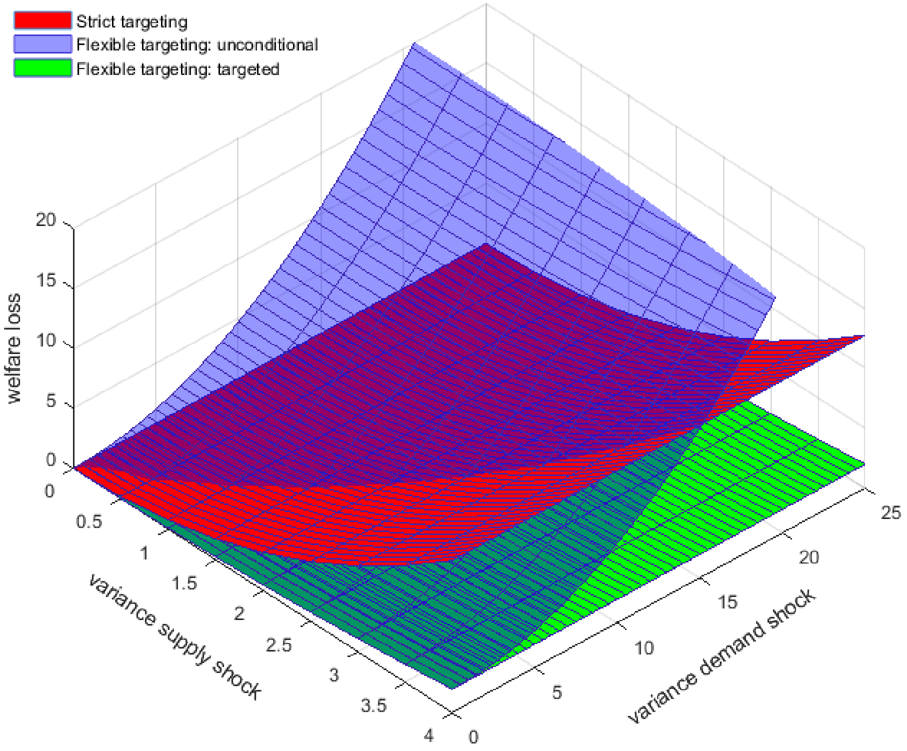

Figure 6: Welfare losses and shock variances: Taylor rules versus targeted Taylor rules

Notes: The relative welfare gains of conventional unconditional flexible inflation targeting (U-FIT) compared to strict inflation targeting (SIT) increase in the relative standard deviation of supply shocks compared to that of demand shocks. Targeted flexible inflation targeting (TA-FIT) always outperforms SIT and U-FIT regardless of the variance of the two types of shocks. U-FIT is defined by an unconditional Taylor–type rule whose coefficients were chosen optimally to minimize welfare losses in the presence of both demand and supply shocks.

Consistent with the shock dependent nature of the optimal monetary policy derived in Section 4.5.1, the optimal coefficients of the targeted policy rule (27) are characterized by: (i) a strong reaction to demand–driven inflation (i.e. $\phi_\pi^d \to \infty$) that insulates the economy from inefficient fluctuations in response to demand disturbances; (ii) a finite and moderate response to supply–driven inflation required by the optimal response in the case with supply shocks only.

The optimal response coefficient to supply–driven inflation (ϕ_π^s) equals $3.87 < \phi_\pi^d \to \infty$ in our baseline model specification, while the policy response coefficient to the deviation of output from steady-state (ϕ_y) equals 0. If we considered cost-push shocks instead of technology shocks (as the supply disturbances), the optimal response to supply-driven inflation would be 0.86 and that for supply-driven output would be 0.35. More generally, the optimal values of the two parameters will vary with the composition and persistence of different types of *supply shocks*, as

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compared to the the optimal targeted rule (27), the welfare loss in this case would be the same, the coefficient of supply-driven output would be equal to that of ϕ_y in (27), while the coefficient of demand-driven inflation could take any positive value as long as $\phi_\pi^d = +\infty$.

well as with the presence of additional real and financial frictions.[49]

Since the monetary policy regime described by a targeted Taylor–type rule (27) also satisfies the definition of flexible inflation targeting, we label it as *targeted flexible inflation targeting* (TA-FIT). Note that in our baseline model such regimes do not require a targeted response to the output (gap). This may change if demand shocks also pose a stabilization trade-off to central banks (albeit less severe than in the case with supply shocks) or in the presence of uncertainty regarding the nature of supply versus demand inflation drivers (see Section **??**).

As shown in Table 10 (column "targeted"), this targeted way to conduct monetary policy mimics more closely optimal policy than both SIT or U-FIT in the presence of both types of shocks. This is because the central bank can adjust optimally the policy response to demand (supply) shocks, without constraining its response to supply (demand) shocks. As a result, the welfare outcome is characterized by the linear combination of outcomes in an economy subject to demand shocks only where the central bank responds optimally to such shocks by strictly targeting inflation (see case with demand shocks only), and those in an economy subject to supply shocks only where the central bank responds optimally to such shocks by flexibly targeting inflation (see case with supply shocks only).

These conclusions remain valid when interest rate smoothing is incorporated into the optimal simple rules for the TA-FIT and U-FIT regimes (Table A5). Interestingly, in this case the welfare outcome under the TA-FIT regime comes very close to that under optimal monetary policy under commitment (0.044 instead of 0.033). This is because the interest rate smoothing serves as a commitment device, enhancing the central bank's ability to manage the welfare trade-off in response to supply shocks. As with optimal policy, the ability to commit to future policy actions helps narrow the deviations of inflation and real activity from their efficient levels (Figures 7).[50] The interest rate smoothing further improves the welfare outcome under U-FIT for the same reason. In this case, however, since the central bank needs to strike a balance between targeting aggressively inflation in response to demand shocks and managing a welfare trade-off between inflation and real activity in response to supply shocks, welfare losses still end up twofold higher than those under TA-FIT (0.088 compared to 0.044).

Notably, TA-FIT performs better than SIT and U-FIT irrespective of the variance of the

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[49] Note that in contrast to U-FIT, the welfare outcome under this targeted regime will be independent of the variance and persistence of demand shocks as long as the strong policy reaction to demand-driven inflation insulates the economy from such disturbances.

[50] See also Figure A4 in the appendix which shows the responses of variables entering the welfare criterion. For optimal monetary policy, responses are identical to the textbook ones (*see* Figure 6.3, Chapter 6, Galí (2015)).

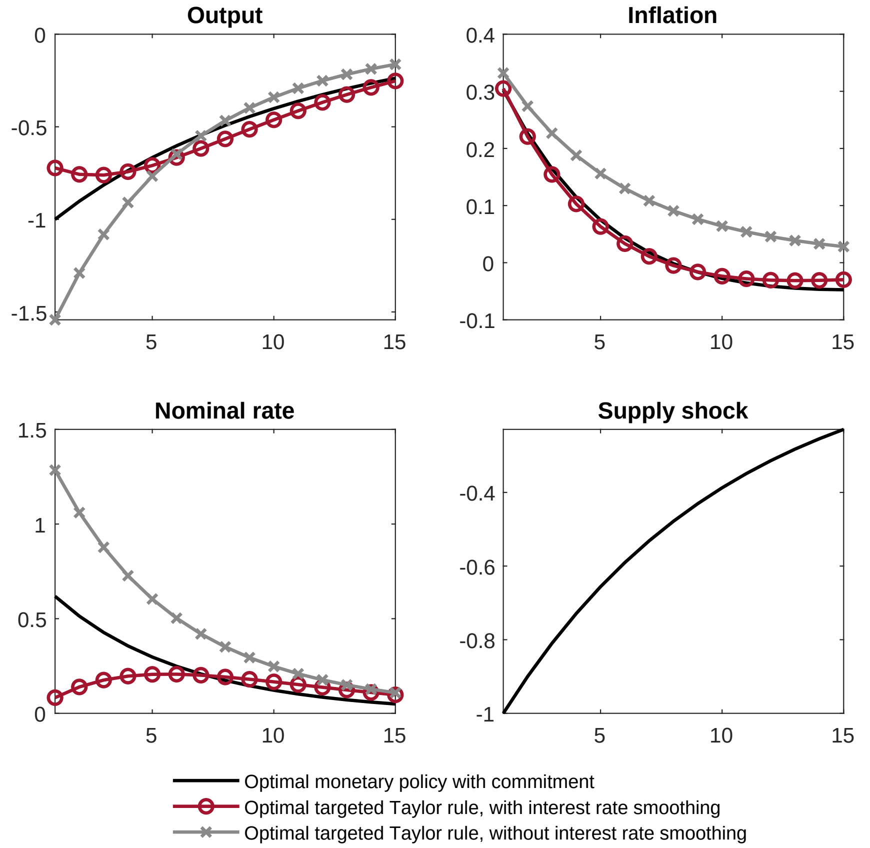

Figure 7: Dynamic responses to a supply shock: the role of interest rate smoothing

Notes: The Figure compares the dynamic response to an adverse supply shock under three different monetary policy regimes: (i) optimal monetary policy under commitment, (ii) an optimal targeted Taylor rule with interest rate smoothing, and (iii) an optimal targeted Taylor rule without interest rate smoothing. Y-axis: percent. X-axis: quarters. Variables: output $\widehat{y}_t$; inflation π_t (annualised); nominal rate $\widehat{i}_t$ (annualised); supply shock a_t. One standard deviation adverse shock which equals one percentage point *decrease* in aggregate technology A_t.

two types of shocks (Figure 6, compare the green area to the red and violet areas), as long as inflation expectations remain anchored around their long-run target as in our model.[51] The welfare gains of TA-FIT relative to U-FIT reported in Table 10 concern relatively small demand shocks, but such gains will increase in the size of the demand shocks. This is because, welfare

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[51] Notably, the results reported in Table 10 are derived under the assumption that long-run inflation expectations remain anchored to the inflation target. This feature, embedded into the basic New Keynesian model, is arguably realistic for a low inflation environment such as the “Great Moderation”, but it may be less so for an environment where inflation reaches unusually high levels. This may be the case for instance in the presence of large supply shocks when the central bank operates according to a targeted Taylor rule. As shown in Figure 3, for given shocks, supply–driven inflation reaches higher values under the targeted Taylor rule than under the conventional Taylor rule. As a result, large and persistent adverse supply shocks may drive inflation under the targeted rule to elevated values, for which assuming that inflation expectations remain anchored is not realistic anymore. In those cases, a stronger reaction to supply–driven inflation may be warranted to avoid the de-anchoring of inflation expectations, leading to a narrower optimal difference between the responses to demand- and supply–driven inflation. Consequently, in an environment where inflation expectations may de-anchor, the welfare gains of TA-FIT relative to SIT or U-FIT will likely decrease with the variance of supply shocks (while still remaining in positive territory). Similarly, an environment with more volatile (larger) supply shocks, where a stronger reaction to supply-driven inflation is warranted as the price setting frequency increases (Karadi et al. (2025)), would also call for a less targeted approach to inflation conditional on its drivers.

losses are insensitive to the variance of demand shocks under TA-FIT, while they increase in the variance of such shocks under U-FIT.

Implementing TA-FIT in practice depends, of course, on the central bank's ability to distinguish in real time between the effects of supply and demand disturbances on inflation, an issue to which we attend next.

4.6 Imperfect measure of demand– and supply–driven inflation

So far, we have assumed the central bank can perfectly observe in real time the demand and supply components of inflation. In this section, we study the case where it can only do so up to a measurement error. Specifically, we assume the monetary authority sets the policy rate in line with the following targeted Taylor rule

$$i_t = \rho + \phi_\pi^{d,m}\pi_t^{d,m} + \phi_\pi^{s,m}\pi_t^{s,m} + \phi_y \widehat{y}_t \tag{28}$$

where $\pi_t^{d,m}$ and $\pi_t^{s,m}$ are the *measured* demand and supply components of inflation, defined by

$$\pi_t^{d,m} \equiv \pi_t^d - m_t \tag{29}$$

$$\pi_t^{s,m} \equiv \pi_t^s + m_t \tag{30}$$

with m_t the measurement error which follows an $AR(1)$ process: $m_t = \rho_m m_{t-1} + \nu_t^m$.

As the central bank can observe the overall level of inflation $\pi_t^{s,m} + \pi_t^{d,m} = \pi_t^s + \pi_t^d = \pi_t$. Using the latter relation, one can express the targeted rule in (28) as

$$i_t = \rho + \phi_\pi^d \pi_t + (\phi_\pi^s - \phi_\pi^d)\pi_t^{s,m} + \phi_y \widehat{y}_t \tag{31}$$

Using (5), (6), (7), (8), (14) – (18), and replacing (13) by (31) and (30), we can now solve the equilibrium of the model as a system of eleven difference equations with eleven unknowns as in the baseline case described in Section 4.3 where the central bank could observe the demand and supply components of inflation.

We use this extension of the model to study how the size of the measurement error affects the welfare gains of operating under a targeted Taylor rule relatively to a conventional one and the optimal policy coefficients of the targeted rule.[52] The measurement error is assumed mildly persistent with an autocorrelation coefficient ρ_m equal to 0.5 and the standard deviation of the

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[52] Note that the coefficients of the optimal conventional Taylor rule and its associated welfare losses are the same as in the textbook model because this rule is not affected by the measurement error.

idiosyncratic measurement error component ϵ_t^m is expressed in terms of standard deviations of aggregate inflation. Figure 8 shows the results for the same textbook calibration used for the experiment in Table 10.

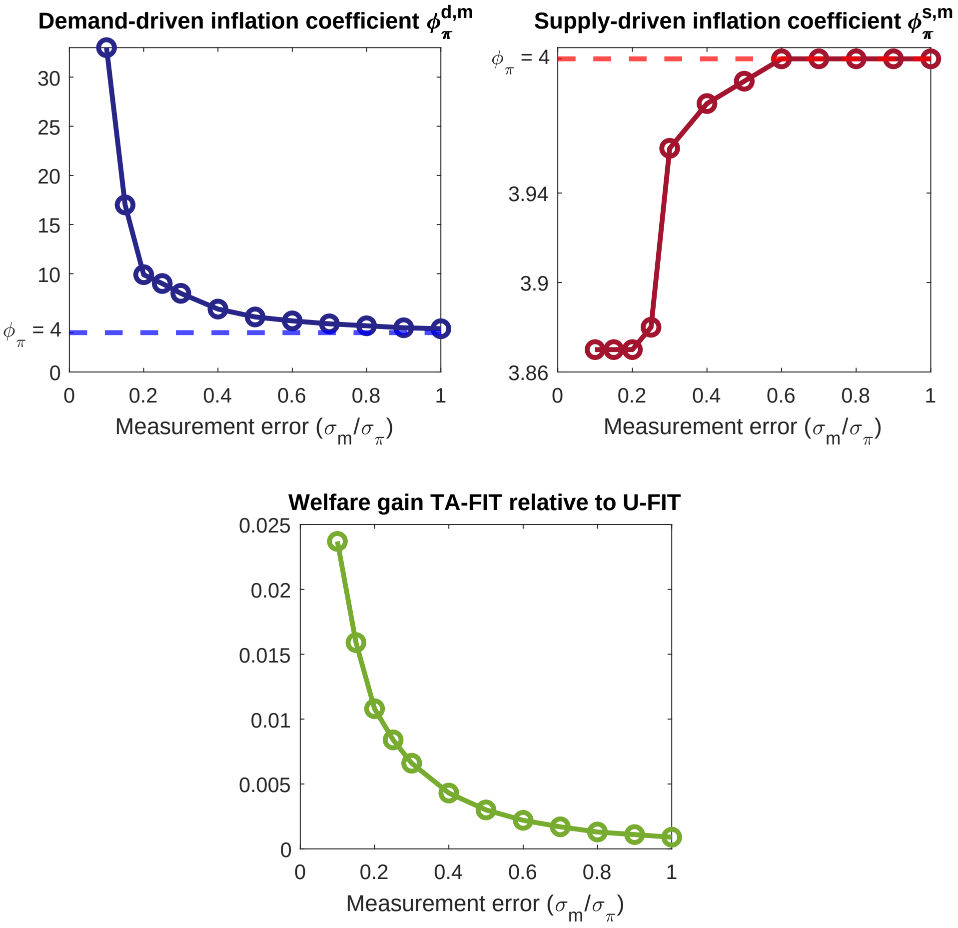

Figure 8: TA-FIT coefficients and welfare gain as the measurement error increases

Notes: X-axis: standard deviations measurement error of the demand ans supply components of inflation (σ_m) relative to the standard deviation of aggregate inflation (σ_π). TA-FIT: optimal targeted Taylor rule with measured demand/supply driven inflation described by (28); U-FIT: optimal conventional Taylor rule (same as in Table 10)

As the measurement error increases, several findings stand out. First, the response coefficient to measured demand–driven inflation in the targeted Taylor rule ($\phi_\pi^{d,m}$) goes from $+\infty$ in the case without measurement error, to finite positive values and then decreases converging to the response coefficient to aggregate inflation in the optimal conventional Taylor rule (top left panel). Notably, this result suggests one theoretical justification for the finite monetary policy response to (measured) demand–driven inflation retrieved in the data.[53] Second, the response coefficient to measured supply-driven inflation ($\phi_\pi^{s,m}$) increases from the small value in the

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[53] Another theoretical underpinning of this empirical finding is the presence of a macro-economic stabilisation trade–off in the face of certain demand shocks, such as fiscal shocks.

case without measurement error to the optimal response coefficient to aggregate inflation in the conventional Taylor rule (top right panel).[54] Third, the welfare gains of TA-FIT relative to the U-FIT decrease converging to zero (bottom panel). One corollary of these findings is that improvements in the accuracy of central banks' real-time assessment of the demand versus supply inflationary pressures will allow them to optimally adopt more aggressive reactions to demand–driven inflation, and less aggressive reactions to supply–driven inflation, and ultimately to improve welfare.

Our empirical analysis suggests that the U.S. Federal Reserve has generally succeeded so far to infer information about the supply– versus demand–driven nature of inflation from their indicators, household/business surveys, analytical toolboxes, professional contacts, judgment, and awareness of specific shocks buffeting the economy at the time of monetary policy decisions (*e.g.* fiscal packages, oil price shocks, credit easing policies, changes in tariff policies). This hypothesis is further supported by the highly statistically significant correlation of the recent inflation decomposition series with those derived based on the information available to FOMC members at the time of monetary policy deliberations according to the FOMC transcripts. Going forward, the availability of direct measures of demand– versus supply–driven inflation (which were developed only very recently) should further help refine the assessment of the tightness of demand versus supply conditions at the time of monetary policy deliberations and improve the implementability and desirability of targeted Taylor rules.

5 Conclusion

We refined the specification of Taylor–type rules — conventionally used to describe the conduct of monetary policy — to allow for a different (targeted) reaction to demand– versus supply–driven inflation. We refer to the new type of rule as a "targeted Taylor rule". This new specification is in line with the doctrine of the Federal Reserve as reflected in its official communications, which calls for a more attenuated monetary policy response when inflation is driven by supply factors (provided inflation expectations remain anchored). Our contribution to the literature on monetary policy rules is both empirical and theoretical.

In the first part of the analysis, we show empirically that, starting with Paul Volcker's tenure at the Federal Reserve, monetary policy in the United States responded significantly more aggressively to demand–driven inflation than to supply–driven inflation. These findings are based

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[54] The optimal response to output deviations in the targeted Taylor rule ϕ_y does not change, but this is likely not a general result. Note that the value of the coefficient in the conventional Taylor rule was also zero.

on an otherwise standard Taylor–type rule estimation (*e.g.* Carvalho et al. (2021), Clarida et al. (2000)) in which we replace aggregate inflation with its demand– and supply–driven components, as identified in recent studies by Eickmeier and Hofmann (2025) and Shapiro (2024), and with the help of LLM techniques applied to FOMC transcripts.

In the second part of our analysis, we highlight that following a targeted Taylor rule instead of a conventional one has important implications for business cycle fluctuations and welfare. By design, a targeted rule counteracts to a larger extent the effects of demand (supply) shocks on inflation (output) than a conventional (unconditional) Taylor rule. Accordingly, simulations of a textbook New Keynesian model with both demand and supply shocks indicate that, all else equal, aggregate inflation is driven to a larger extent by supply factors, while output is less volatile when the central bank follows a *targeted* Taylor rule than when it follows a conventional unconditional Taylor rule.

In the last part of our analysis, we show that following the optimal targeted Taylor rule instead of the optimal conventional unconditional Taylor rule can lead to a positive welfare gain when the economy is subject to both demand and supply disturbances. In our textbook model where inflation expectations remain anchored around the long-run target and the central bank can observe the demand and supply components of inflation, this result always holds true. In an extension of the model where the central bank can only observe the demand and supply components of inflation up to a measurement error, this is still true, provided the measurement error is not excessively large. In this case, as the measurement error increases, the optimal responses to demand– and supply–driven inflation in the targeted rule and the associated welfare losses converge to those of the optimal conventional rule.

From a policy perspective, the concept of a targeted Taylor rule may be a new useful policy–rule benchmark to be consulted during monetary policy deliberations or used in model simulations, alongside other Taylor–type rules that already serve this purpose. This was made feasible by the recent availability of inflation decompositions in demand and supply factors.

Our analysis is meant as a first pass at this research question. Some possible extensions have been already mentioned, being framed as limitations of the current study. For instance, on the empirical side, one may want to re–estimate the targeted Taylor rules using (one-quarter-ahead) forecasts of the demand– and supply–driven components of inflation. To this end, developing forecasts of demand/supply–driven inflation would be highly welcome. Furthermore, on the theoretical side, one would like to allow inflation expectations to de-anchor once inflation reaches a certain threshold and to study how the relative welfare gains under the optimal targeted rule vary with the variance of supply shocks in this environment. The latter extension would be highly policy-relevant given the expected prominence of large supply shocks in the near future as a result of geopolitical tensions.

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A.1 Appendix

A.1.1 Headline inflation: demand and supply factors

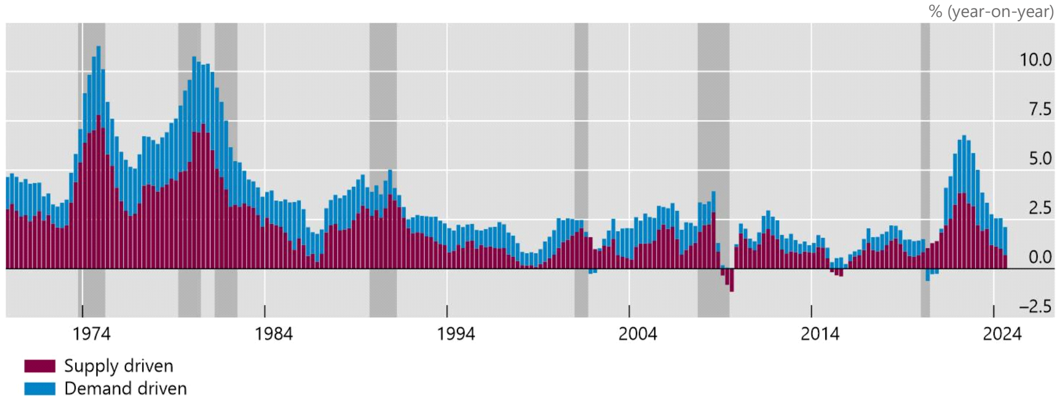

Figure A1: Decomposition of headline PCE inflation in demand and supply factors

Notes: Year-on-year inflation decomposition in demand and supply components based on Shapiro (2024). The sum of two components equals aggregate year-on-year headline PCE inflation. X-axis: quarterly dates.

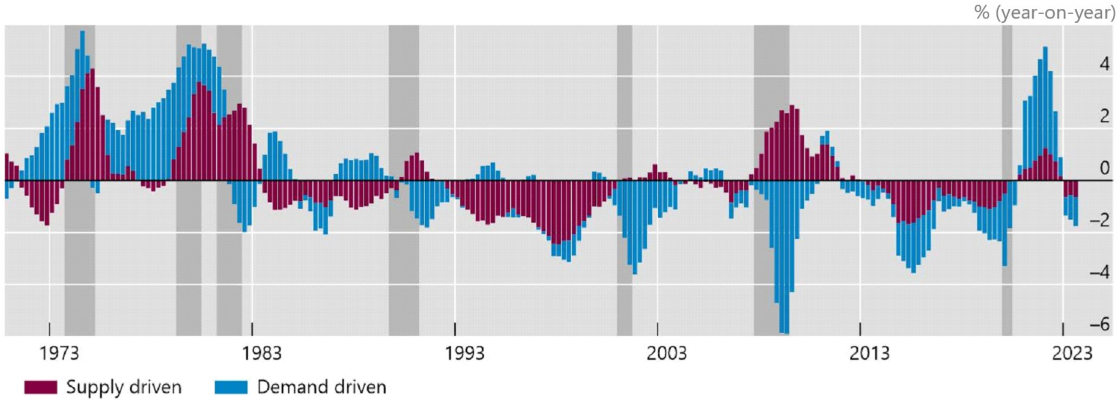

Figure A2: Decomposition demeaned headline PCE inflation in demand and supply factors

Notes: Demeaned year-on-year inflation decomposition based on the method in Eickmeier and Hofmann (2025).

A.1.2 Assessment supply– and demand–driven inflationary pressures at the time of the January 2019 FOMC Transcript

Table A1: Supply-Side Inflationary References in the January 29–30 2019 FOMC Transcript

#	Page	Speaker / Section	Exact paragraph (supply-side reference)	Likely effect on supply-driven inflation
1	94	Staff briefing	"… total PCE inflation will dip … to **about 1½ percent** as **previous declines in oil prices feed through to consumer energy prices**."	Lower fuel costs pull headline inflation down and cut firms' energy bills.
2	118	Gov. R. Clarida	"Nominal wage growth continues to pick up … gains are **in line with productivity** … **not a source of upward cost-push pressure**."	Unit-labour costs flat ⇒ higher pay does not feed through to prices.
3	119	Gov. R. Clarida	"We talk … about the **labor supply** … the increase in **labor-force participation**… "	More workers ease hiring constraints and temper wage-push inflation.
4	122	Pres. M. Daly	"I expect the **dollar to strengthen**, and that will **put downward pressure on prices** in the United States."	A stronger dollar makes imports cheaper, adding a dis-inflationary impulse.
5	125	Pres. L. Mester	"Firms continue to report a lack of qualified workers … **Wage pressures in the District remain elevated**… "	Elevated District wages add upward supply-side pressure.
6	125	Pres. L. Mester	"Price pressures in the District **remain elevated** … contacts report **increases in non-labour input costs**; **tariffs** are contributing."	Tariff-driven input-cost rises push inflation upward.
7	128	Pres. L. Mester	"Labour compensation has been **in line with productivity**; it **has not added to inflation-rate pressures**."	Nationally, unit-labour costs stable ⇒ little cost-push pressure.

Continued on next page

#	Page	Speaker / Section	Exact paragraph (supply-side reference)	Likely effect on supply-driven inflation
8	132	Pres. T. Barkin	"Contacts report that **capital-expenditure plans . . . remain unchanged**."	Ongoing investment adds capacity, reducing bottlenecks.
9	132	Pres. T. Barkin	"Some contacts indicate that **input-price increases are now slowing** in steel, pulp, freight and oil."	Slower input-cost growth eases cost-push inflation.
10	135	Pres. C. Evans	"**Transportation bottlenecks and higher shipping costs remain** common concerns, as do tariffs."	Freight constraints and tariffs add upward pressure.
11	135	Pres. C. Evans	"Contacts **noted a limited ability to pass through higher costs** . . . margins compressed."	Firms absorb shocks; little reaches consumer prices.
12	136	Pres. C. Evans	"**Some steel prices have come down**, and . . . a **significant easing in material-cost increases**."	Cheaper inputs restrain producer-price inflation.
13	137	Pres. R. Kaplan	"More businesses noted **decreases in pricing power** . . . **one-quarter** unable to pass on higher costs."	Limited pass-through keeps cost shocks in margins.
14	137	Pres. R. Kaplan	"We **expect global oil-consumption growth to soften** . . . **U.S. crude-oil output will grow by ≈ 1 mb/d**. . . "	Ample supply relative to demand caps energy costs.
15	138	Pres. R. Kaplan	"It's the view of our energy group . . . **price risk for 2019 remains to the downside**."	Further downside risk → lower energy-cost inflation.
16	139	Pres. R. Kaplan	"**Technology-enabled disruption and globalization are muting the pricing power of businesses**. . . "	Intense competition suppresses ability to raise prices.
17	139	Pres. E. George	"Contacts outside the energy sector **expect to maintain or increase capital spending**."	Planned cap-ex boosts productive capacity.

Continued on next page

#	Page	Speaker / Section	Exact paragraph (supply-side reference)	Likely effect on supply-driven inflation
18	140	Pres. E. George	"District **energy activity fell** in Q4 … over half **marked down 2019 cap-ex** after oil's drop."	Lower oil prices cut current costs; future drilling pull-backs affect later periods.
19	141	Pres. E. George	"The District's **agricultural sector remains downbeat because of large inventories**…"	Crop gluts push food prices lower.
20	144	Pres. E. George	"Last year's **dollar appreciation and oil-price drop are passed through**…price pressures likely subdued."	Stronger dollar & cheaper oil lower import and energy prices.
21	145	Pres. P. Harker	"Tariff **pass-through remains a mixed bag**, still largely B2B, with **limited effects on most retail prices**."	Costs stay upstream; minimal consumer-price impact.
22	147	Gov. R. Quarles	"**Labor-force participation can continue to grow**…prime-age participation up."	More workers moderate wage acceleration.
23	148	Gov. R. Quarles	"The recent **decline in oil prices will likely translate into weak readings on headline inflation**…"	Lower pump prices drag headline inflation lower.
24	149	Gov. R. Quarles	"No noticeable imprint of **import tariffs**…firms **absorbing them in margins**."	Tariff costs not passed through to consumers.
25	150	Gov. M. Bowman	"**Labor-force participation rose** in December…"	Fresh entrants enlarge labour supply, restraining wage-push inflation.
26	153	Gov. M. Bowman	"The **supply of commodities is weighing on prices in general**…"	Ample commodity supply pushes input costs down.
27	155	Gov. L. Brainard	"**Americans who had become discouraged … are coming back to work**…"	Re-entrants boost labour supply, limiting wage-led price pressure.

Continued on next page

#	Page	Speaker / Section	Exact paragraph (supply-side reference)	Likely effect on supply-driven inflation
28	158	Pres. N. Kashkari	“If wage growth picks up … maybe the **labor-supply response will be even stronger**…”	Elastic labour supply lets firms hire without sharp pay hikes.

Supply-side inflationary pressures were clearly subdued at the time of the FOMC’s 29–30 January 2019 meeting, warranting a score of **3 on a ten-point scale**.

Nationwide labour costs, according to Governors Clarida and Mester, were rising no faster than productivity, so unit-labour costs were essentially flat. At the same time the effective supply of workers was expanding as labour-force participation—especially among prime-age adults and re-entrants—continued to climb. Although Cleveland-District contacts did cite elevated wage pressures, this was an isolated pocket rather than a pervasive cost-push force.

Input-cost dynamics were moving in a dis-inflationary direction. The sharp decline in crude-oil prices near the end of 2018 was still feeding through to cheaper petrol and freight rates, and the staff projected headline PCE inflation would dip to about 1½ percent. President Kaplan’s energy briefing pointed to further downside risks for oil prices even as U.S. production was poised to expand by roughly a million barrels a day. Steel, pulp and other industrial materials had also stopped rising and in some cases were falling, while large crop inventories were depressing farm-gate prices.

Imported-goods costs were likewise restrained. Both Mary Daly and Esther George emphasised that the 2018 appreciation of the dollar was showing up in lower landed prices, adding an additional brake on goods inflation.

The few genuine sources of upward cost pressure came from freight bottlenecks and the tariff increases imposed the previous year. But field reports from several Districts indicated that competitive conditions left most firms unable to pass those higher costs on to consumers; many were accepting narrower margins instead. Kaplan went further, arguing that technology-driven competition and global supply chains were eroding business pricing power more broadly.

Because these isolated cost irritants were outweighed by falling energy and commodity prices, a stronger dollar, soft unit-labour costs, and muted pricing power, the overall supply-side impulse to inflation sat well below the mid-point of the scale. A score of **3 / 10** therefore captures an environment in which supply conditions were providing only minimal upward pressure—and in several respects an outright drag—on inflation.

Table A2: Demand-Side Inflationary References in the January 29–30 2019 FOMC Transcript

#	PDF page	Speaker / Section	Exact paragraph (demand-side reference)	Assessment of the likely effect on demand-driven inflation
1	9	Staff market briefing (Logan)	“The **S&P 500 remains nearly 9 percent lower** than its early-September peak, and **high-yield credit spreads are more than 100 basis points wider**.”	Tighter financial conditions and a negative wealth effect curb spending, softening demand-pull pressure.
2	91	Staff briefing (Bill Wascher)	“The **fundamentals that support household spending**—solid job gains, rising real incomes and wealth, low interest rates, and strong consumer sentiment—**remain firm**, and the recent **decline in gasoline prices should provide an added boost** to real purchasing power.”	Healthy labour income and cheaper energy lift real purchasing power, propping up demand.
3	92	Staff Tealbook	“The **partial government shutdown** . . . will subtract $\frac{1}{4}$ **percentage point** from annualised real GDP growth this quarter.”	Temporary fall in demand lowers near-term inflation risk.
4	92	Staff briefing (Bill Wascher)	“Although we think the economy entered 2019 with considerable forward momentum . . . growth in **consumer spending** has been faster than fundamentals, and we expect PCE growth to move back down to match real disposable income growth.”	Consumer demand still sturdy but expected to cool, easing future demand-pull pressure.

Continued on next page

#	PDF page	Speaker / Section	Exact paragraph (demand-side reference)	Assessment of the likely effect on demand-driven inflation
5	93	Staff briefing (Bill Wascher)	"…as the ongoing removal of monetary accommodation and **waning stimulus from fiscal policy** act to rein in spending and production, real output is anticipated to slow to a below-trend pace…"	Fading fiscal support restrains demand and tempers inflation.
6	115	Pres. Eric Rosengren	"The **sharp declines in stock prices** and an **increase in uncertainty**, accompanied by widening credit spreads, … *give me some pause*."	Risk-off sentiment can curb discretionary outlays, damping demand-driven inflation.
7	118	Vice Chair Richard Clarida	"The **fundamentals for household demand remain solid**—job gains are strong, real disposable income is rising, and household balance sheets are healthy—even though tighter financial conditions and the shutdown will likely **trim growth temporarily in Q1**."	Robust consumer fundamentals buoy demand, but near-term drags temper inflation pressure.
8	122	Pres. Mary Daly	"Higher **uncertainty** … acts like a **negative aggregate-demand shock**. It lowers both output and inflation … businesses stop hiring, consumers spend less and save more…"	Uncertainty-induced demand shortfall pulls inflation below target.

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#	PDF page	Speaker / Section	Exact paragraph (demand-side reference)	Assessment of the likely effect on demand-driven inflation
9	126	Pres. Loretta Mester	"Trade-policy uncertainty had **lowered demand** for the firm's products and demand from China and major economies in Europe had also fallen."	Weaker manufacturing demand, at home and abroad, dampens price pressure.
10	127	Pres. Loretta Mester	"I expect growth to slow … as the **effects of fiscal stimulus** wane."	Sees softer demand ahead as fiscal impetus fades, easing inflation risk.
11	131	Pres. Patrick Harker	"46.3 percent of firms reported **increased demand**; 27.8 percent reported decreasing demand; two-thirds expect activity to rise in Q1."	Regional demand expanding; mild upward impulse but cautious tone.
12	132	Pres. Thomas Barkin	"Contacts … report **strong consumer spending** for Q4, and capital-expenditure plans for 2019 largely unchanged."	Robust consumer demand could support inflation, though sentiment risks linger.
13	133	Pres. Thomas Barkin	"…a second **fiscal stimulus** like the infrastructure deal could boost demand, but the likelihood seems to be **fading**."	Dwindling odds of a fresh fiscal boost tilt demand outlook softer.
14	134	Pres. Charles Evans	"Directors indicated that **domestic demand continued to be solid**, although there were a few more notes of caution than last round."	Demand supportive yet still not strong enough to lift inflation above 2 percent.
15	138	Pres. Robert Kaplan	"**Surveys suggest a broad-based deceleration in activity**… contacts increasingly cite demand-side factors as well as heightened uncertainty."	Broad demand slowdown erodes pricing power and lowers demand-pull inflation risks.

Continued on next page

#	PDF page	Speaker / Section	Exact paragraph (demand-side reference)	Assessment of the likely effect on demand-driven inflation
16	139	Pres. Robert Kaplan	“Global growth is decelerating; **fiscal stimulus is fading**; Brexit and other issues all create uncertainty.”	Fading fiscal thrust among headwinds that weaken demand.
17	140	Pres. Robert Kaplan	“Later in the year, this may ultimately **affect the consumer** . . . weaker hiring with a lag . . . ultimately affect the spending ability of the consumer.”	Anticipates earnings-led cutback in hiring and income that would sap consumer momentum.
18	141	Pres. Esther George	“**Consumer spending appears poised to support** the expansion, as rising employment and compensation boost personal income.”	Healthy labour-income gains keep demand firm.
19	146	Gov. Randal Quarles	“The recent **decline in oil prices should support spending**. The United States has more drivers than equity holders.”	Cheaper gasoline raises real incomes, partly offsetting other drags.
20	146	Gov. Randal Quarles	“**Higher wages** over the past year have **boosted real incomes and buoyed consumption**.”	Sustained real-income growth props up demand.
21	148	Gov. Randal Quarles	“Firms have been **absorbing tariffs in margins**; there has been no noticeable imprint on consumer prices.”	With tariffs blunted, consumer prices face less near-term pressure.
22	150	Gov. Michelle Bowman	“The most recent **consumer-spending** data remain strong but have **slowed slightly**. . . ”	Spending growth has eased but remains solid; limited extra inflation pressure.

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#	PDF page	Speaker / Section	Exact paragraph (demand-side reference)	Assessment of the likely effect on demand-driven inflation
23	150	Gov. Michelle Bowman	“The **residential housing market has continued to decline**. . . borrowers express **affordability concerns**.”	Housing softness subtracts from demand.
24	151	Gov. Michelle Bowman	“**Farm profits will continue to decline**. . . agricultural loan delinquencies have slightly increased.”	Weak farm income restrains spending in rural regions.
25	155	Gov. Lael Brainard	“Shutdown dynamics raise the odds that **fiscal policy could revert to sequester levels** in 2020 . . . ”	Fiscal-policy uncertainty could damp public spending and weigh on demand-side inflation.

At the end of January 2019 the FOMC judged that demand–side forces were supportive *but noticeably softening*, leaving only modest upward pressure on prices. Household fundamentals—low unemployment, real wage gains, healthy balance sheets, and a windfall from cheaper gasoline—were still underpinning consumption, and several Reserve-Bank presidents cited “strong consumer spending” and “solid” domestic demand.

Yet this strength was increasingly counter-weighted by tighter financial conditions, a quarter-percentage-point drag from the government shutdown, fading fiscal stimulus, trade and Brexit uncertainty, a broad-based deceleration in business surveys, and specific pockets of weakness in housing and farm income.

Many contacts reported *absorbing* tariff costs rather than raising prices, while staff projected PCE inflation to dip below 2 percent.

Taken together, the transcript portrays an economy where demand was neither collapsing nor overheating—adequate to keep a floor under inflation, but too subdued and fragile to generate sustained price acceleration.

On a ten-point scale, that blend of still-solid spending fundamentals and rising headwinds merits a **4 / 10** for demand-driven inflation pressure.

A.1.3 Model with interest rate smoothing

Table A3: Parametrization: monetary policy rules

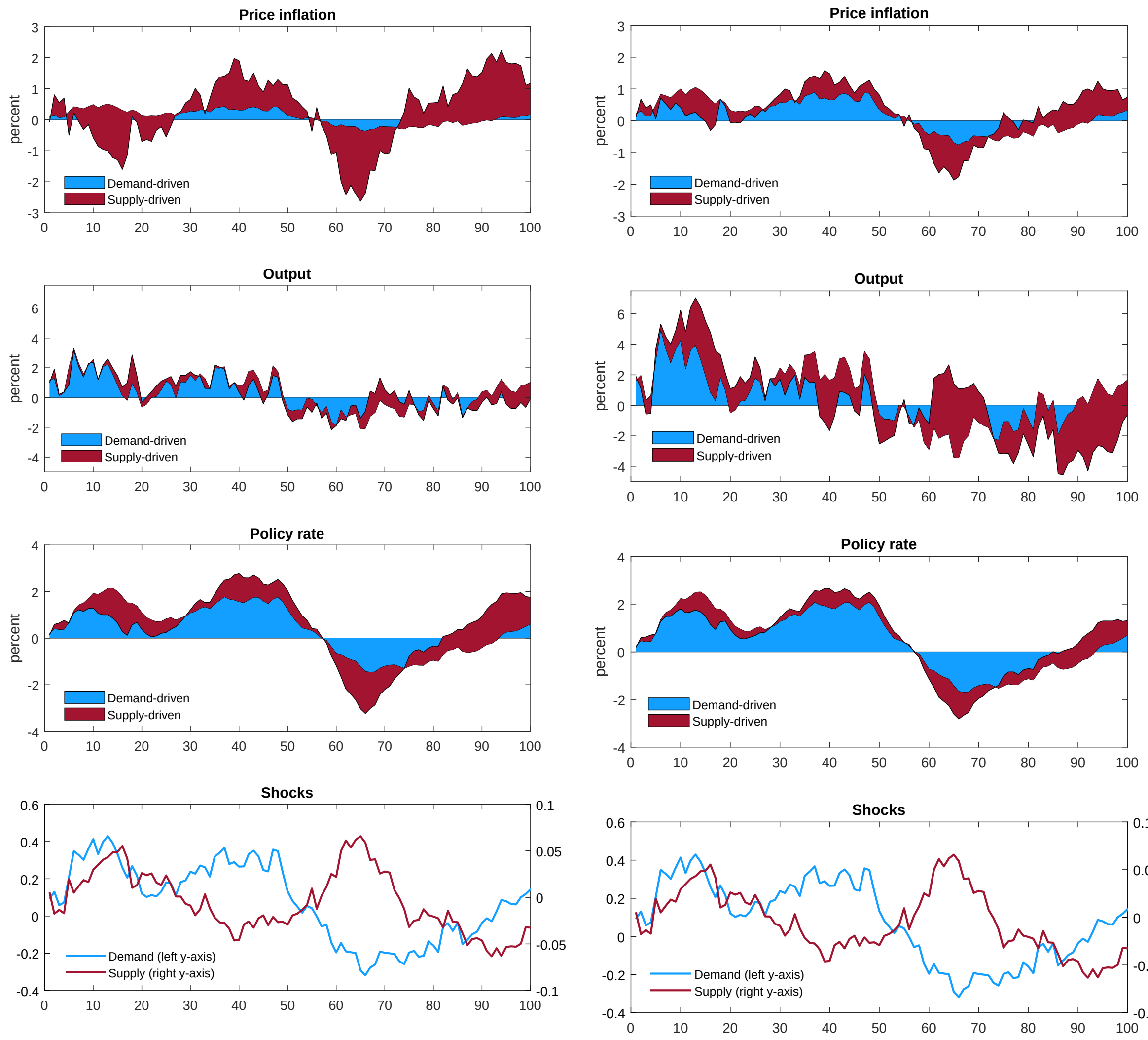
Parameter	*Description*	*Value*
Taylor–type rule:		
ρ	Interest-rate smoothing	0.7
ϕ_π	Response to aggregate inflation	2
ϕ_y	Response to the output gap	0.2
Targeted Taylor–type rule:		
ρ	Interest-rate smoothing	0.7
ϕ_π^d	Response to demand–driven inflation	4
ϕ_π^s	Response to supply–driven inflation	1.01
ϕ_y	Response to the output gap	0.2

Notes: Model with interest rate smoothing. Values are shown in quarterly rates.

Table A4: Volatility of output, inflation and policy rates

	σ_y^2	σ_π^2	$\sigma_{\pi^d}^2$	$\sigma_{\pi^s}^2$	$\sigma_{y,d}^2$	$\sigma_{y,s}^2$	σ_i^2	$\sigma_{\pi^s}^2/\sigma_\pi^2$
Targeted Taylor rule	0.78	0.9	0.02	0.73	0.65	0.35	1.46	82%
Taylor rule	2.55	0.43	0.09	0.19	1.6	3.10	1.41	45%

Notes: Model with interest rate smoothing. Model-based variances of macroeconomic variables under the targeted Taylor–type rule versus the conventional Taylor–type rule. σ^2 stands for variance. Its subscript denotes a specific macroeconomic variable.



(i) Targeted Taylor rule

(ii) Taylor rule

Figure A3: Simulated model dynamics with both demand and supply shocks

Notes: Model with interest-rate smoothing. The figure shows the simulated model dynamics under the baseline parametrization summarized in Tables 7 and 8 separately for the targeted Taylor rule (left panels) and for the simple Taylor rule (right panels). Variables: price inflation π_t, output $\widehat{y}_t$, policy rate $\widehat{i}_t$, demand shock z_t, supply shock a_t. Aggregate dynamics of price inflation, output, policy rate further decomposed in their demand-driven (blue) and supply-driven (red) components.

	Optimal	*Strict targeting*	*Flexible targeting:*	
			unconditional	*targeted*
Technology shocks				
$\sigma(\pi)$	0.11	0	0.11	0.11
$\sigma(\pi^w)$	0.03	0.2665	0.06	0.05
$\sigma(\tilde{y})$	0.04	3.4174	0.32	0.39
$\mathbb{L}$	0.033	0.7952	0.05	0.044
Demand shocks				
$\sigma(\pi)$	0	0	0.01	0
$\sigma(\pi^w)$	0	0	0.03	0
$\sigma(\tilde{y})$	0	0	0.91	0
$\mathbb{L}$	0	0	0.038	0
Both shocks				
$\sigma(\pi)$	0.11	0	0.11	0.11
$\sigma(\pi^w)$	0.03	0.2665	0.07	0.05
$\sigma(\tilde{y})$	0.04	3.4174	0.96	0.39
$\mathbb{L}$	0.033	0.7952	0.088	**0.044**

Table A5: Welfare outcomes: optimal policy versus simple rules with interest rate smoothing

Notes: As in Galí (2015), the standard deviations of the technology and demand shocks in the welfare analysis equal one percent. Reported values are rounded up to the third decimal. $\mathbb{L}$ denotes the welfare loss defined by (22), and $\sigma(\pi)$, $\sigma(\pi^w)$, $\sigma(\tilde{y})$ denote the standard deviations of price inflation, wage inflation and output gap. The unconditional flexible targeting rule denotes a conventional Taylor–type rule (9) with $\rho = 0.99$, $\phi_\pi = 52.5$ and $\phi_y = 1.15$ set to minimize welfare losses conditional on the economy being buffeted by both technology and demand shocks. The targeted flexible targeting rule denotes a targeted Taylor–type rule (27) with $\rho = 0.96$, $\phi_\pi^d = +\infty$, $\phi_\pi^s = 6.785$ and $\phi_y = 0$, where $\phi_\pi^d = +\infty$ is set to minimize welfare losses conditional on the economy being buffeted by demand shocks only and $\rho = 0.96$, $\phi_\pi^s = 6.785$ and $\phi_y = 0$ are set to minimize welfare losses conditional on the economy being buffeted by technology shocks only.

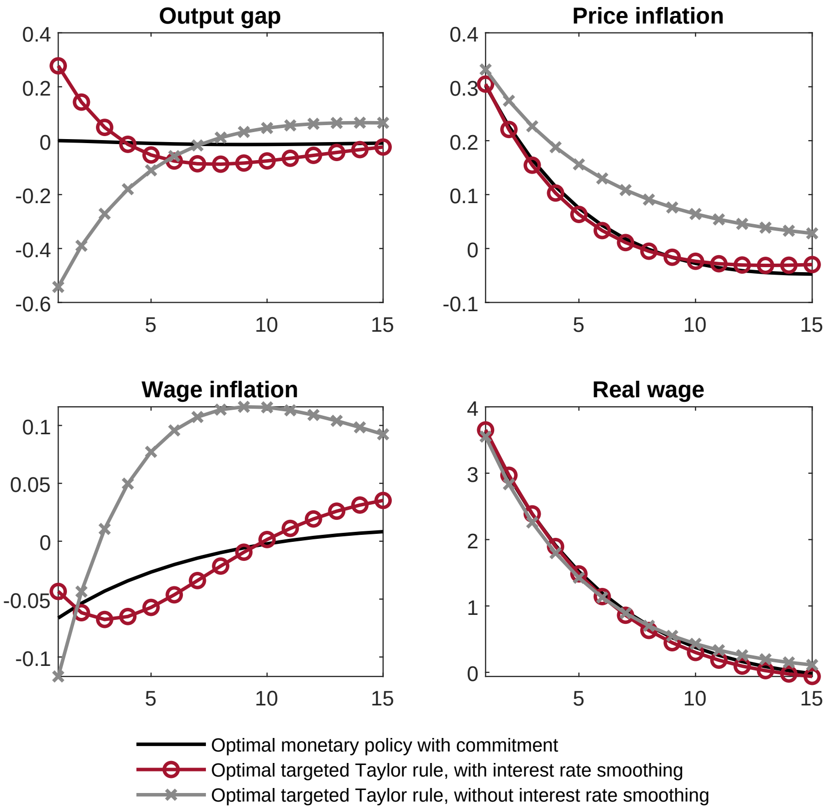


Figure A4: Dynamic responses to a supply shock: the role of interest rate smoothing

Notes: The Figure compares the dynamic response to an adverse supply shock under three different monetary policy regimes: (i) optimal monetary policy under commitment, (ii) an optimal targeted Taylor rule with interest rate smoothing, and (iii) an optimal targeted Taylor rule without interest rate smoothing. Y-axis: percent. X-axis: quarters. Variables: output $\widehat{y}_t$; inflation π_t (annualised); nominal rate $\widehat{i}_t$ (annualised); supply shock a_t. One standard deviation adverse shock which equals one percentage point *decrease* in aggregate technology A_t.

A.1.4 Model with ***cost-push shocks*** as supply shocks

We model the cost-push shock as a price mark-up shock. In the presence of this shock, the aggregate price setting equation writes (*see* Smets and Wouters (2007), Galí (2015), Chapter 5):

$$\pi_t = \beta E_t\{\pi_{t+1}\} - \lambda^p(\mu_t^p - \mu_t^{p,n}) \tag{32}$$

with μ_t^p the average price mark-up in the economy and $\mu_t^{p,n}$ the firm-level desired price mark-up, i.e. the price mark-up that each firm would set in the absence of nominal (price) rigidities. This equation can be further rewritten as:

$$\pi_t = \beta E_t\{\pi_{t+1}\} - \lambda^p \widehat{\mu}_t^p + u_t \tag{33}$$

where $\widehat{\mu}_t^p = \mu_t^p - \mu^p$ is the deviation of the average price mark-up from its steady-state value and $u_t \equiv \lambda^p(\mu_t^{p,n} - \mu^p)$ is the price mark-up disturbance acting as a cost-push shock. Following Galí (2015), we assume that u_t follows the exogenous AR(1) process

$$u_t = \rho_u u_{t-1} + \varepsilon_t^u \tag{34}$$

where $\rho_u \in [0, 1)$, and $\{\varepsilon_t^u\}$ is a white-noise process with constant variance σ_u^2. One can then use relation (33) to derive the New-Keynesian Price Philips curve as

$$\pi_t = \beta E_t\{\pi_{t+1}\} + \chi_p \tilde{y}_t + \lambda_p \tilde{\omega}_t + u_t \tag{35}$$

which will replace that in the baseline model (5). Apart from equation (35), the version of the model with cost-push shocks remains unchanged compared to that with technology shocks.

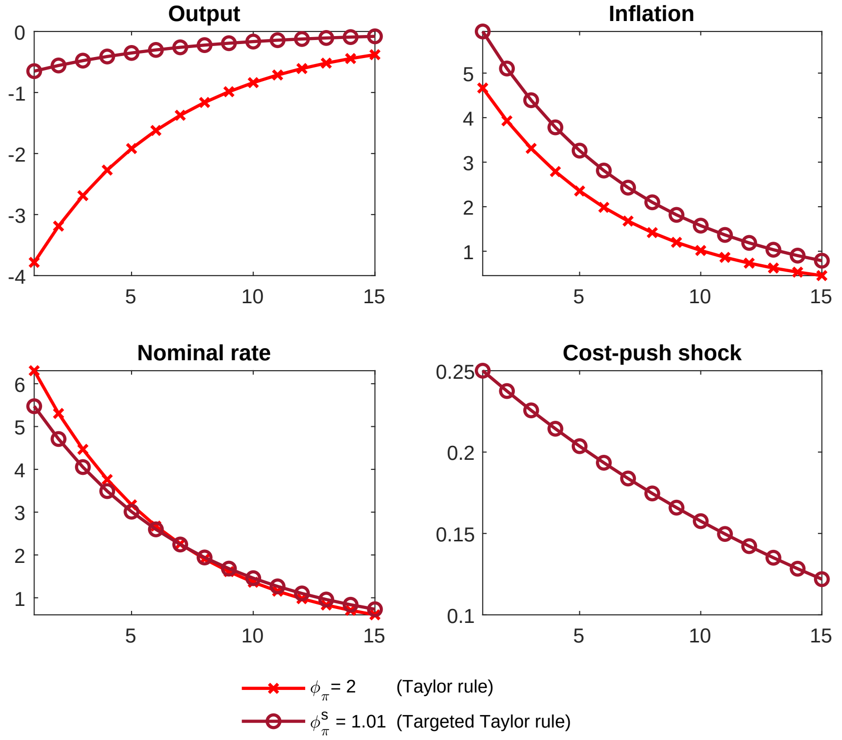
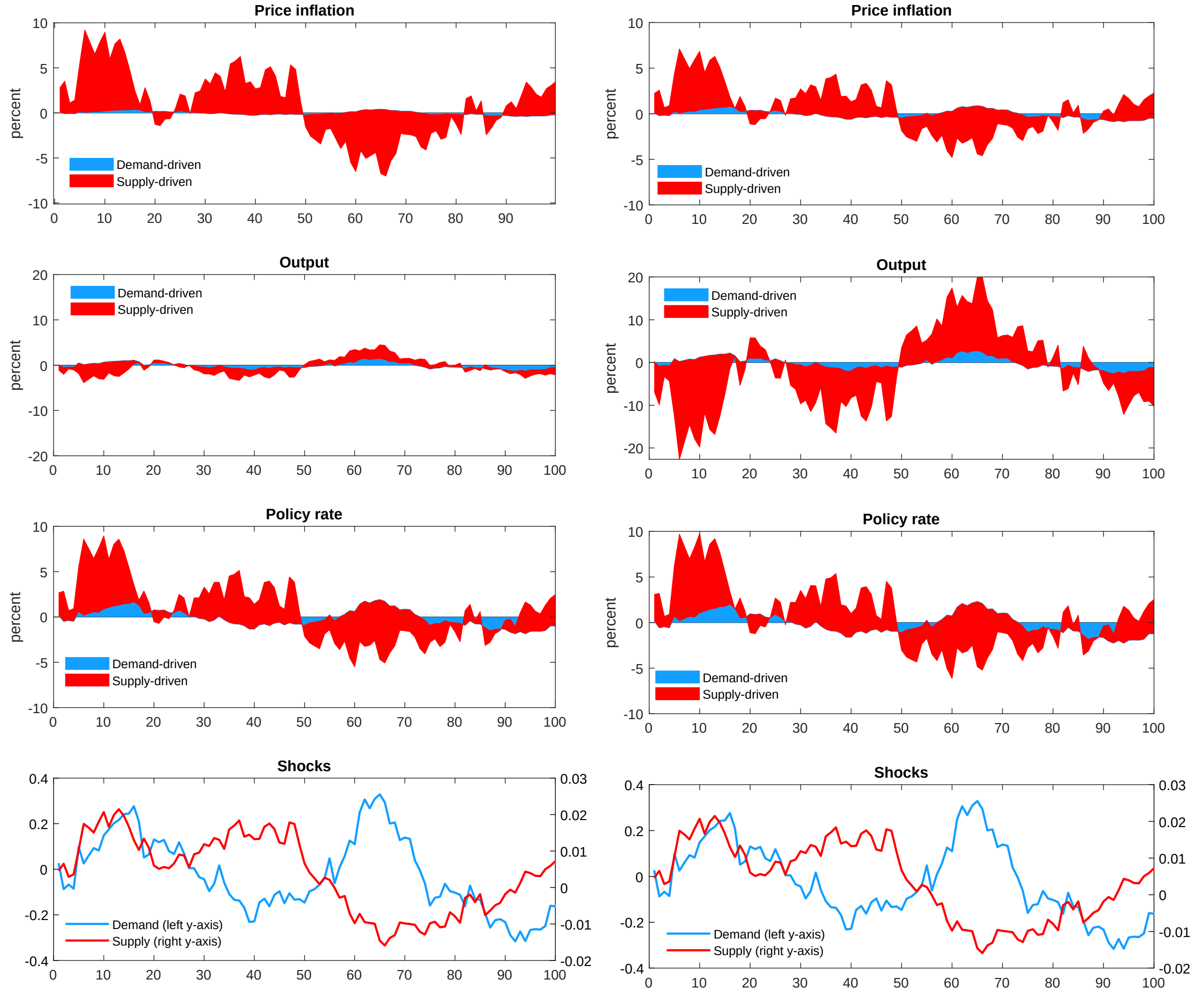


Figure A5: Dynamic responses to a cost-push shock under the two alternative policy rules

Notes: Y-axis: percent. X-axis: quarters. Variables: output $\widehat{y}_t$; inflation π_t (annualized); nominal rate $\widehat{i}_t$ (annualized); cost-push shock u_t. The standard deviation of the idiosyncratic component of the cost-push push shock σ_u is set to 0.01/4 such that a one standard deviation exogenous increase in u_t implies a one percent exogenous increase in annualised inflation. The shock leads to a one percent exogenous increase in contemporaneous annualized inflation. As in the baseline case in Figure 4, the persistence of both shocks (ρ_z, ρ_u) equals 0.95.



(i) Targeted Taylor rule

(ii) Taylor rule

Figure A6: Simulated model dynamics with demand and supply shocks: case of cost-push shocks

Notes: Model with cost-push shocks as supply shocks. The figure shows the simulated model dynamics under the baseline parametrization summarized in Tables 7 and 8 separately for the targeted Taylor rule (left panels) and for the simple Taylor rule (right panels). Variables: price inflation π_t, output $\widehat{y}_t$, policy rate $\widehat{i}_t$, demand shock z_t, cost-push shock u_t. Aggregate dynamics of price inflation, output, policy rate further decomposed in their demand-driven (blue) and supply-driven (red) components. Demand shocks are identical to those in Figure 3. The persistence of the cost-push shock u_t is set to 0.95 as that of the technology shock in the baseline model simulations Figure 3, while the standard deviation of its idiosyncratic component σ_u is set to 0.01/4 such that a one standard deviation exogenous increase in u_t implies a one percent exogenous increase in annualised inflation.

	Optimal	*Strict targeting*	*Flexible targeting:*	
			unconditional	*targeted*
Cost-push shocks				
$\sigma(\pi)$	3.6078	0	4.0183	4.0134
$\sigma(\pi^w)$	0.4570	9.028	0.6652	0.67
$\sigma(\tilde{y})$	5.5921	155.8545	1.5224	1.7530
$\mathbb{L}$	29.5113	13482	35.9977	35.975
Demand shocks				
$\sigma(\pi)$	0	0	0.0962	0
$\sigma(\pi^w)$	0	0	0.1805	0
$\sigma(\tilde{y})$	0	0	3.3783	0
$\mathbb{L}$	0	0	0.6264	0
Both shocks				
$\sigma(\pi)$	3.6078	0	4.0194	4.0134
$\sigma(\pi^w)$	0.4570	9.028	0.6892	0.67
$\sigma(\tilde{y})$	5.5921	155.8545	3.7055	1.7530
$\mathbb{L}$	29.5113	13482	36.6241	**35.975**

Table A6: Welfare outcomes: optimal policy versus simple rules: case of cost-push shocks

Notes: $\mathbb{L}$ denotes the welfare loss defined by (22), and $\sigma(\pi)$, $\sigma(\pi^w)$, $\sigma(\tilde{y})$ denote the standard deviations of price inflation, wage inflation and of the *welfare-relevant* output gap. Reported values are rounded up to the third decimal. The cost-push term $\lambda^p u_t$ follows an exogenous AR (1) process $u_t = \rho_u u_{t-1} + \varepsilon_t^u$ where $\rho_u = 0.8$ and $\{\varepsilon_t^u\}$ is a white noise process with constant variance σ_u^2 equal to one percent as in Galí (2015), Chapter 5. The targeted flexible targeting rule denotes a targeted Taylor–type rule (27) with $\phi_\pi^d = +\infty$, $\phi_\pi^s = 0.88$ and $\phi_y = 0.3$, where $\phi_\pi^d = +\infty$ is set to minimize welfare losses conditional on the economy being buffeted by demand shocks only and $\phi_\pi^s = 0.88$ and $\phi_y = 0.3$ are set to minimize welfare losses conditional on the economy being buffeted by cost-push shocks only. The unconditional flexible targeting rule denotes a conventional Taylor–type rule (9) with ϕ_π and ϕ_y set to minimize welfare losses conditional on the economy being buffeted by both cost-push and demand shocks. As in Table 10, for the baseline case with technology shocks as supply shocks, the demand shock z_t follows an exogenous AR (1) process $z_t = 0.5 z_{t-1} + \varepsilon_t^z$ where $\{\varepsilon_t^z\}$ is a white noise process with constant variance σ_z^2. The optimal coefficients of the unconditional rule depend on the relative variances of the two types of shocks. For a standard deviation of the idiosyncratic component of the demand shock (σ_z) of one percent, the optimal coefficients of the unconditional rule are materially the same as those of the targeted rule, with only the welfare loss being higher 36.0034. For higher σ_z, the optimal policy coefficients depart from those of the targeted rule and welfare losses increase by more relative to those of the targeted rule. In the table, we report results for σ_z equal to five percent. In this case the optimal coefficients equal $\phi_\pi = 0.86$ and $\phi_y = 0.35$.