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In copertina: "Un banchiere e sua moglie" (1514) di Quentin Metsys (Lovanio, 1466 - Anversa, 1530), Museo del Louvre - Parigi.

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EXPLORING THE TRANSMISSION MECHANISM OF MONETARY POLICY: THE PORTFOLIO REBALANCING CHANNEL. EMPIRICAL EVIDENCE FROM US STOCKS

ELISA MONTELEONE*

Abstract

Is the widely acknowledged "portfolio rebalancing channel" so relevant in the transmission mechanism of monetary policy? Does its impact differ between value and growth stocks? This article provides valid empirical evidence from the US equity market, analyzing its relationship with monetary policy and exploring how the rebalancing device really works. Empirical findings reveal that rebalancers' behavior generally exert a negative but non-significant effect on all equities, notwithstanding their different fundamentals; only in response to forward guidance policies, while still insignificant, portfolio rebalancing appears to be responsible of mismatching stock performances, signaling potential rebalancing trends *within* the equity market.

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La politica monetaria e il suo meccanismo di trasmissione: il* portfolio rebalancing channel. *Evidenze empiriche dal mercato azionario statunitense. – Abstract

Che importanza riveste il noto "canale di ribilanciamento del portafoglio" (portfolio rebalancing channel) *nel meccanismo di trasmissione della politica monetaria? Il suo impatto sulle performance azionarie è uniforme oppure varia in virtù delle caratteristiche delle singole imprese? Questo articolo investiga in termini empirici la relazione tra la politica monetaria ed il comportamento degli investitori, esplorando il funzionamento del* portfolio rebalancing channel *nel contesto del mercato azionario statunitense. I risultati delle analisi rivelano che l'attitudine di alcuni investitori a ribilanciare il proprio portafoglio incide generalmente in modo negativo, anche se non significativo, sulle performance di tutti titoli azionari, indipendentemente dalla loro natura e dai loro attributi. Un'eccezione, tuttavia, è rappresentata dall'effetto di tale fenomeno in risposta alle politiche di* forward guidance*: pur rimanendo insignificante, infatti, esso sembra influenzare in modo asimmetrico i rendimenti di azioni dal profilo differente, mettendo in luce l'esistenza di tendenze al ribilanciamento anche all'interno del mercato azionario stesso.*

Parole chiave: *Politica monetaria; Shock monetari; Ribilanciamento di portafoglio; Titoli "value"; Titoli "growth".*

Codici JEL: C32; C33; C36; E52; E58; G12; G23.

Keywords: Monetary policy; Monetary shocks; Portfolio rebalancing; Value stocks; Growth stocks

1. Introduction

The impact of monetary policy on financial markets and the real economy has been widely explored in the literature. Countless papers investigated the rationale behind both conventional and unconventional monetary resolutions, their transmission mechanism, and their effect on financial and macroeconomic indicators. This article enters the same framework, adopting a more specific focus on the target indicator under analysis and the transmission channel of interest. The study, indeed, centers on the relationship between monetary policy and stock returns only, without generalizing to additional metrics; moreover, it places attention on portfolio rebalancing as the only mean through which impulses get transmitted to markets, despite it being just one of the multitude of the recognized channels of monetary policy.

Rebalancing can be described as the "process of buying and selling assets in a portfolio to adjust their weightings back to the target allocation of the portfolio" (Kitces, 2015); whether a deviation from a pre-agreed target rule occurs due to oscillating asset valuations, investors and funds' managers can easily restore the original asset allocation by engaging in active portfolio management. It is therefore not surprising that rebalancing is commonly employed by many institutional investors subject to pre-established investment mandates.[1] A completely different policy drives buy-and-hold strategies: with the same securities held over the entire investment horizon, passive portfolios remain unaltered despite eventual variations in the value, return or risk profile of the assets.

The superiority of rebalancing schemes against other, more traditional, alternatives, has been widely acknowledged by the literature. A comparison of rebalanced and non-rebalanced portfolios made by Tsai (as cited by Meyer-Bullerdiek, 2018) shows that the former enjoys substantially higher risk-ad-

1 Pension funds, balanced funds and sovereign wealth funds are the best examples of rebalancing institutions (Lu & Wu, 2022). Mutual funds are not straightforwardly accounted as rebalancers; still, some of them fall within this category as well.

justed returns in terms of Sharpe ratios. Norges Bank (2012) documents that, over a sample spanning from 1970 to 2011, rebalanced portfolios experienced both higher returns and lower risk than passive portfolios mimicking broad market indexes. Meyer-Bullerdiek (2018) examines how rebalancing affects portfolio diversification and risk-adjusted returns, concluding that rebalanced portfolios are better diversified and enjoy, on average, higher risk-return ratios vis-à-vis their buy-and-hold counterparties.

The success and the academic interest portfolio rebalancing gained openly call for the identification of the dynamics behind it; to that extent, an analysis of the sources of asset prices' fluctuations should be performed as the first step. Xie, Xia and Gao (2021) attribute financial markets' volatility not only to "fundamental" factors – such as industrial or monetary policy – but also to "sentiment" factors – subjective beliefs and overconfidence amongst others – directly linked to investors' decisions and originated from their limited rationality. Attention is here placed on the former category, that explicitly lists monetary policy as one of the concurrent and most relevant causes of asset prices volatility. Indeed, while monetary policy does not have asset prices as its main target, it inevitably affects them *indirectly*; this occurs via the above-mentioned portfolio rebalancing device acting on investors' decisions and behaviors.

This paper develops a model of rebalancing demand to investigate whether, and in which proportion, investors' rebalancing attitude plays a role in the transmission mechanism of monetary policy to the equity market. Methodological tools the analysis draws upon do not represent a novelty: the functioning of the rebalancing device is indeed evaluated by means of standard regression analysis, levering on changes in firms' rebalancer ownership around central banks' announcements as measures of the degree of rebalancing activity. Rather, innovation lies in the scope and in the object of research: the sample of stocks is indeed distinguished into a "value" and "growth" category based on a set of companies' core characteristics – size, equity duration and book-to market ratio among the others – in the attempt to determine whether such features matter for rebalancers' investment decisions, thereby affecting stock returns themselves.

Baseline results from such portfolio rebalancing analysis support the idea of a uniform approach of rebalancing institutions toward the equity sector, notwithstanding stocks' categorization as "value" or "growth", in response to a combination of conventional and forward guidance policies. The rebalancing mechanism triggered by restrictive policies, indeed, causes the price of *both* kinds of stocks to fall, signaling an increased selling pressure in the market; in numerical terms, the effect is a bit more pronounced for growth stocks, but the difference is negligible.

The scenario looks different when central bank's conventional and unconventional forward guidance policies are considered individually, as hypothesized in section 3.4. The distinction between the two policies is technically achieved by employing separate measures of monetary shocks – namely, "policy rate" and "forward guidance" shocks. A policy rate surprise is proven to affect similarly rebalancers' perception of value and growth stocks: higher rates incentivize a "runaway" from the equity market, independently of companies' underlying features. By contrast, the effect of forward guidance shocks does depend on type of stock: rebalancers, indeed, appear willing to substitute growth for value stocks in their portfolios in response to restrictive forward guidance behaviors, driving down the former's return and up the latter's one.

An investigation of the portfolio rebalancing channel, as much as accurate, would only be partially complete if directly presented. The paragraphs above clarified that rebalancing demand is a channel *through which* monetary policy affects securities' prices and influences stock market performance. Logically, the examination of the vehicles that characterize the relationship between monetary policy and equities is linked and conditional upon the *existence* of such relationship. From this standpoint, some preliminary questions must be tackled before diving into the proposed model of rebalancing demand: *do* monetary shocks *affect* the equity market? And if yes, *how*? Can its impact be considered *significant* in statistical terms?

Consistently with the necessity of answering the above questions, section 2 presents a quantitative excursus on the *bilateral* relationship between monetary policy and stock returns, aimed at defining the expected impact of policy shocks on the equity market. To that extent, a structural vector autoregression with instrumental variables (SVAR-IV) is implemented, on the wave of the success and the widespread application it has been recently enjoying in econometrics. In line with the outstanding literature, results show that monetary policy negatively affects the stock market; a contractionary policy of higher interest rates therefore lowers equity returns, in line with the expectations. Such effect, however, is here proven not be statistically significant; while different depending on the measure of shock employed, its effect is indeed always insignificant. Methodological approaches, data and time horizons adopted in section 2 are different from those employed to implement the portfolio rebalancing model, consistently with the view that the former should only frame the sensitivity of stock returns to monetary policy at a high-level, without detailing the means through which they are linked.

The paper is structured as follows. Section 2 develops a SVAR-IV model to investigate how, and to what extent, the stock market is expected to react to a monetary policy shock. First, the SVAR-IV methodology is theoretically reviewed and data are illustrated; outcomes of the analysis are then presented and discussed. Section 3 proposes a model of rebalancing demand following Lu and Wu (2022). The section opens with an introduction to the methodology and the variables employed; such description is complemented with several appendixes detailing the construction of the dataset. The second and the third part then provide and comment the results of the portfolio rebalancing analysis, evaluating its dynamics in response to joint and individual monetary policies respectively. Section 4 concludes.

2. Monetary policy and the stock market

2.1. A SVAR-IV with monetary shocks

Whether monetary policy effectively influences financial markets and the real economy is an endlessly open issue to which empirical evidence appears to be unable to provide a definite answer; discrepancies in the conclusions obtained by operating different inputs or econometric models, indeed, prevent from making univocal inference about their relationship and adequately quantifying their relevance. Following Lu and Wu (2022), this study employs external instruments in a SVAR-IV methodology as keys to uncover the true impact of monetary policy on stock returns. This choice is motivated by the innovation brought by the SVAR-IV, or "external instruments approach", to overcome the impossibility to directly estimate a SVAR model to characterize their relationship. A direct estimation of a SVAR model, indeed, would require structural shocks to the endogenous variables to be observable; being them unobservable in practice, SVAR models are left "unidentified", therefore suffering from the "SVAR identification issue", as commonly referred to in the literature. The latter is briefly illustrated in Appendix A.

The SVAR-IV procedure primarily builds on three key steps. First, the estimation of a reduced form VAR aimed at deriving reduced form shocks. A basic VAR model, in its easiest formulation with just one lag, is specified as:

$$y_t = A(L)\,y_{t-1} + u_t \tag{1}$$

where – according to the notation provided by Cesa-Bianchi (2022) – y_t is a $K \times 1$ "state vector" of K (economic and financial) endogenous variables, $A(L)$ is a $K \times K$ "dynamic matrix" describing the effect of lagged endogenous variables on the same variable at time t and u_t is a $K \times 1$ vector of reduced form shocks (errors). The variable of interest is denoted as $y_{i,t}$; clearly, $y_{i,t} \in y_t$.

Second, the identification of an instrumental variable (Z_t), suitable in terms of exogeneity and relevance, for the structural shock of interest. Finally, the implementation of a two-stages least-squares (TSLS) regression to derive the effect of the structural shock of interest on each endogenous variable via the instrument Z_t.

In the first stage of TSLS, reduced form residuals from the VAR of interest (u_t^i) are regressed on Z_t to derive fitted values $\widehat{u}_t^i$:

$$u_t^i = \gamma_0 + \gamma_1 Z_t + \varepsilon_t \tag{2}$$

Such fitted values represent the projection of u_t^i on the instrument, i.e., the component of $y_{i,t}$ which is left unexplained by VAR, and which can be instead explained by the instrument.

In the second stage, u_t^j, for all $j \neq i$, is regressed on fitted values $\widehat{u}_t^i$ obtained in (2):

$$u_t^j = \beta_0 + \beta_1 \widehat{u}_t^i + \eta_t \tag{3}$$

where β_1 denotes the effect of the structural shock of interest on variable j, for $j \neq i$. The coefficient β_1 in (3), as well as γ_1 in (2), quantifies the impact of a structural shock on output variables in the state vector; in the economic language, it is labelled as "impulse response function" (IRF).

The VAR state vector under analysis consists of six endogenous variables, namely the one-year Treasury yield, inflation, industrial production, dividend-price ratio, relative T-bill rate and excess equity return;[2] the former, also referred to as the *monetary policy indicator,* is the variable of interest ($y_{i,t}$). As Gertler and Karadi (2015) point out, the monetary policy indicator must be distinguished from the Federal Reserve's monetary policy *instrument*, which is an overnight – and therefore very short-term – rate. Opting here for a longer-term rate aims at capturing both policy rate and forward guidance

2 Excess equity return is defined as the S&P 500 return relative to the 1-month T-bill rate.

shocks, i.e., shocks to *current* and *future* federal funds rates respectively. Consequently, innovations to the monetary policy indicator might be the result of either policy rate or forward guidance shocks or, more frequently, of their joint effect.

Monetary policy shocks enter the SVAR-IV methodology as instruments for structural shocks to the monetary policy indicator. This study adopts multiple series of monetary shocks to challenge the validity of the evidence gathered; specifically, shock series come from Gertler and Karadi (2015) and Romer and Romer (2004). They are more extensively discussed in Appendix B, where other "traditional" measures of monetary shocks are mentioned as well; here, only their key features are summarized, with a focus on the alternative estimation techniques adopted by the authors.

Such computation strategies, indeed, structurally differ in both the variables underlying the shock measure and the estimation window considered. On the one hand, Gertler and Karadi (2015) surprises depend on the rate at which Federal Funds Futures are traded, i.e., the Federal Funds Futures Rate (FFFR), on the selected FOMC meeting days. Specifically, they are obtained from changes in market expectations about the FFFR over a thirty-minute window around FOMC meetings; the very tight estimation window employed is typical of a "high frequency identification" approach, that does not characterize Romer and Romer (2004) surprises. On the other hand, the latter is computed as the component of the change in the federal funds rate that cannot be predicted from the Fed's staff forecasts (Acosta, 2022): Romer and Romer (2004) measure, indeed, equals the difference between *predicted* and o*bserved* changes in the federal funds rate before and after FOMC meetings, with the former values derived from Greenbook forecasts about macro-economic outlook, generally released six days before a FOMC meeting. The absence of major links across the two methodologies is remarkable but voluntary; as anticipated in the previous paragraph, relying on intrinsically different shocks is intended to test the reliability of the results obtained.

Data related to economic and financial variables as well as to Gertler and

Karadi (2015) surprises are taken from the dataset used by Kekre and Lenel (2022). The dataset contains all the relevant figures at monthly frequency over a sample spanning from July 1979 to June 2012; only Gertler and Karadi (2015) shocks are provided for a shorter period between November 1988 and July 2012. Romer and Romer (2004) shocks are instead obtained from an updated version by Wieland and Yang (2019) for the period July 1979 – December 2007. The authors provide two distinct shock series by estimating Romer and Romer (2004) regression twice: the first is based on a sample spanning from July 1979 to December 2007; in the second regression, the sample is extended to July 2012. Both series are used in the SVAR-IV analysis, where they are distinguished as "short sample" and "long sample" Romer-Romer (2004) surprises for convenience. Correlation values among the three series over the time window spanned by all of them (November 1988 – December 2007) are provided in Table 1.

Time windows for the SVAR-IV analysis follow those for which shock measures are considered, i.e., the estimation window goes from November 1988 to July 2012 when Gertler and Karadi (2015) are employed and from July 1979 to December 2007 when the analysis is repeated with Romer and Romer (2004) ones. This approach is meant to exploit data availability as much as possible, and it allows to detect that, even with different estimation windows and estimation methodologies, outcomes are rather similar. Finally, all shocks, computed at monthly frequency, are normalized to a unit standard deviation to ease the interpretation of IRFs and align it with Gertler and Karadi (2015), Lu and Wu (2022) and Kekre and Lenel (2022).

2.2. S&P 500 response to monetary shocks

Consistently with the analytical approach explained above, a reduced form VAR with six lags is first estimated for each endogenous variable in the state vector to get reduced form residuals; the subsequent TSLS is then replicated three times with the help of each external instrument.

In the first-stage, residuals from the one-year Treasury yield VAR are predicted by instrumental variables; Table 2 summarizes the results, reporting the coefficients and the F-statistics associated to each regression. The latter is extremely useful to assess instruments' relevance, on which the unbiasedness of the coefficients themselves is heavily conditional upon. The higher the first-stage F-statistic, the stronger the instrument; according to the most conservative rule of thumb provided by Staiger and Stock (as cited in Stock and Yogo, 2002), whenever the F-statistic is below 10, the instrument should be considered "weak". Following such rule, with an F-statistics of 11.71 in Gertler and Karadi (2015) regression and 81.02 and 72.87 in long and short sample Romer and Romer (2004) ones, all instruments are strong: the appreciable gap among such values, however, undeniably suggests that both Romer and Romer (2004) shocks are stronger instruments.

The second-stage regression finally allows for the impact of a monetary policy shock on the other five economic variables in the state vector to be determined and easily interpreted through the lens of the monetary policy indicator (Kekre and Lenel, 2022). Table 3 shows the outcomes for the S&P 500 excess return only. Column 1 reveals that a positive Gertler and Karadi (2015) shock causes the excess stock return to fall by roughly 8 percentage points (pp). Such decrease is quite high, especially if compared with results derived from the other two regressions: a positive short sample Romer and Romer (2004) surprise implies 0.53 pp lower returns only; in case of a positive long sample Romer and Romer (2004) shock, instead, the negative impact amounts to 1.78 pp, not far from 1.9 pp value estimated by Kekre and Lenel (2022).

Despite the differences in the magnitude of the decline, all analyses coherently predict that contractionary policies worsen equity performance; the very high p-values, however, testify that this effect is never significant. Still, it is surprising the difference between the outcomes obtained with the two different series of Romer and Romer (2004) shocks – in terms of coefficients and related p-values; with a correlation almost close to one, as visible in Table

1, more aligned results were expected.

The effect of monetary policy shocks on the one-year Treasury yield and S&P 500 excess return can be immediately seized by looking at IRFs in Figure 1.1, 1.2 and 1.3.[3]

3. The portfolio rebalancing channel

3.1. An overview of the rebalancing mechanism

The transmission mechanism of monetary policy is a complex and manifold process working through a variety of different and interlaced channels. The literature generally distinguishes the latter into "primary" and "secondary" (or "amplification") channels; according to such classification, the portfolio rebalancing one is generally placed within the former category. The multidimensionality that characterizes this transmission process allows real economy developments to be interpreted as the output of several intermediate steps: monetary policy affects the banking sector, asset prices, exchange rates and wages before showing its *real* impact. The introduction of unconventional monetary policy measures during the global financial crisis further affected this system, promoting new transmission channels while emphasizing the essentialness of some of the existing ones. According to Gnabo and Soudant (2022), indeed, the already established portfolio rebalancing and the signaling channels are those that contributed the most to the propagation of unconventional impulses – during and after the Great Recession.

The portfolio rebalancing device is here illustrated under the assumption of central banks pursuing an inflation targeting strategy and acting in *normal* times; in such framework, monetary authorities regularly implement conventional monetary policy (CMP) by adjusting their policy rates in accordance

3 Plots of IRFs are retrieved through Cesa-Bianchi (2022) Matlab codes.

with preset goals.[4]

Interest rate changes by the central bank influence agents' expectations about inflation and macroeconomic outlook *(signaling or expectation channel)* and longer-term rates *(interest rate channel)*. In framework of expansionary monetary policies – realized through policy rates' cuts – agents reasonably expect economic growth, higher inflation and lower unemployment; moreover, longer term rates fall, dragged down by the decline in shorter term ones. These are immediate, "first layer" effects, commonly referred to as the "direct effects" of CMP. Direct effects then trigger a "cascade process", affecting asset prices *(asset pricing or portfolio rebalancing channel)*, bank lending rates *(bank-lending channel)* as well as the exchange rate *(exchange rate channel)*, whose variations are in turn reflected into changes in money demand, investments, wages and prices, thereby exerting their impact on the real economy.

Portfolio rebalancing enters the process at the second layer of the chain, allowing the transmission of monetary policy impulses through financial markets and asset prices. The hypothesized policy rates' cut drives lower yields on agents' original portfolios; this encourages some investors – the "rebalancers"– to reassess their investments, moving away from unprofitable money market securities toward riskier and more rewarding instruments, in a "search for yield" behavior (Oshima, 2020). Class, underlying features and maturity heavily shape an asset's risk profile: equities, real estate, corporate bonds and longer-term securities, all deemed as risky instruments due to their attributes, become rebalancers' primary target during low rates phases. Contractionary policies initiate the opposite process: higher yields on safer assets attract investors, incentivizing them to transfer their positions away from risky securities.

Many authors provide evidence in favor of the existence of such portfolio rebalancing channel, active in the transmission of both conventional and unconventional monetary policies. Lu and Wu (2022) find out that higher re-

4 The rebalancing mechanism works the same during unconventional monetary policy (UMP) – QE amongst others. The fundamental difference relates to the *underlying cause* of its activation, i.e., the implementation of UMP rather than CMP, and not to its operational aspects.

balancer ownership has a statistically significant negative impact on US stock returns in response to restrictive monetary surprises. Jarociński and Karadi (2018) distinguish two kinds of shocks originating from monetary policy announcements on the grounds of their correlation with the stock market; specifically, they identify "monetary policy shocks", which negatively comove with stock returns, as well as "central bank information shocks", exhibiting instead a positive correlation with equity performance. Albertazzi, Becker and Boucinha (2016) study the transmission mechanism of the European Central Bank (ECB)'s Asset Purchase Program (APP) in the euro area countries and validate importance of the portfolio rebalancing channel especially in more vulnerable countries. Gnabo and Soudant (2022) also point out the major role of the signaling and the portfolio rebalancing channels in the frameworks of conventional and unconventional policies in the Eurozone between 2003 and 2016.

Broad consensus has therefore been reached about both the *existence* and the *quantitative importance* of a portfolio rebalancing device. The following study contributes to the strand of research on this topic, expanding previous literature by addressing, as anticipated in the introduction, the relevance that firm characteristics potentially have on the functioning of such portfolio rebalancing channel.

3.2. Data and methodology

The impact of rebalancing demand on stock returns is concretely assessed by means of the panel fixed effects regression model in (4):

$$r_{i,t} = \beta_0 + \beta_1 RO_{i,t} + \beta_2 RO_{i,t} xMS_t + \\ + \beta_3 Controls_{i,t} + \beta_4 Controls_{i,t} xMS_t + \delta_t + \varepsilon_t \qquad (4)$$

where the subscripts i and t denote the firm and the time index respectively. Specifically, t indexes *days of interest*, that is, days in which the FOMC releases new monetary policy announcements.[5]

Variables are defined as follows: $r_{i,t}$ is daily return of firm i on day t;[6] MS_t is the monetary shock on day t; $RO_{i,t}$ is the percentage of rebalancer ownership of firm i on day $t-1$, i.e., the percentage of traded shares held by "rebalancers" the day before the FOMC meeting;[7] $Controls_{i,t}$ is a matrix of control variables – namely, size (market capitalization), book-to-market ratio and the monetary policy exposure (MPE) index – of firm i on day t; δ_t is a set of time and industry fixed effects – the latter intended as the interaction between the firm industry, identified through its four-digits NAICS code, and monetary shocks; ε_t is error term of the regression.

The interaction term $RO_{i,t}xMS_t$ captures the relationship between the level of rebalancer ownership and monetary shocks, thereby allowing to numerically estimate the impact of the portfolio rebalancing channel on stock performance. In technical terms, assuming a potential correlation between $RO_{i,t}$ and MS_t, the marginal effect of a policy surprise MS_t on $r_{i,t}$ is equal to:

$$\frac{\Delta r_{i,t}}{\Delta MS_t} = \beta_1 RO_{i,t} \tag{5}$$

Notwithstanding its sign, a coefficient β_1 different from zero signals that a stock revaluation following a monetary shock depends on the level of rebalancer ownership; when negative (positive), stocks with a higher percentage of rebalancer ownership are subject to a more (less) remarkable downward price adjustment in response to a positive exogenous shock ($MS_t > 0$).

The stock samples' setup allows to widen the scope of the portfolio rebalancing analysis by detecting whether stock fundamentals influence rebalancers' decisions in response to central bank's policies. Indeed, the 114 equities under analysis are split into a sample of value stocks (NYSE sample), with

5 Day t only refers to *scheduled* FOMC meetings, organized eight times per year; *unscheduled* meetings arranged due to extraordinary situations and emergencies are instead excluded from the sample.

6 Stock returns are computed at the daily level as: $r_{i,t} = \ln(P_{i,t}/P_{i,t-1})$, where $P_{i,t}$ is the closing price of stock i on the FOMC announcement day and $P_{i,t-1}$ is firm i's closing stock price the day before.

7 More details about the construction of variable $RO_{i,t}$ are provided in Appendix C.

firms included in NYSE Composite Index, and a sample of growth stocks (NASDAQ sample), whose firms all belong to NASDAQ-100 Index. The two sets are equally sized but totally independent. Importantly, all companies are chosen among those incorporated in the US, consistently with the goal of assessing the effect of FOMC monetary shocks on US stock returns only; therefore, the few Chinese and UK stocks belonging to NYSE Composite and NASDAQ-100 indexes are excluded. Moreover, due to changes occurred over time – firms have been added or removed – the indexes both happen not to have a constant composition throughout the entire period under analysis. To have data on all companies in the sample, only US companies that have been part of the index from January 1995 to (at least) December 2015 are considered.

The classification of NYSE companies as "value" stocks and of NASDAQ companies as "growth" stocks calls for a deeper analysis of their core features, whose appreciable degree of heterogeneity justifies such categorization. A non-exhaustive list of differences between them includes companies' fundamental features such as book-to-market ratio and cash flow (equity) duration, i.e., the sensitivity of their cash flows to interest rates. Value (growth) stocks are characterized by high (low) book-to-market ratios (Haitsma, Unalmis and de Haan, 2015) and low (high) equity duration; yielding earlier (delayed) cash flows, indeed, they are generally less (more) sensitive to discount rate's fluctuations. Univariate analyses in terms of these two variables for NYSE and NASDAQ firms in Tables 4 (a) and (b) provide incontrovertible evidence in favor of their classification as value and growth stocks respectively. [8] The nature of a firm's business may also help to identify them. In this respect, technology and innovation-based companies are typically the best candidates to be growth stocks; contrarily, firms belonging to more conservative industries and with already well-established cash flows generally fall within the value category.

8 Cash flow (equity) duration is here computed following Dechow, Sloan and Soliman (2004).

Monetary shocks come from Nakamura and Steinsson (2018) series as updated by Acosta (2022) as well as from Gürkaynak, Sack and Swanson (2005) – henceforth GSS (2005). GSS (2005) characterize monetary policy announcements through a "policy rate" and a "forward guidance" shock, retrieved via Principal Component Analysis (PCA) and identified as "target" and "path" factor respectively. While still applying PCA, Nakamura and Steinsson (2018) develop a single "policy news shock", condensing GSS (2005) surprises into a unique dimension. Accordingly, employing both series allows to examine rebalancers' actions in the transmission of *individual* as well as *joint* conventional (policy rates) and forward guidance policies. Appendix A provides much information about both measures.

Unsurprisingly, GSS (2005) factors and Nakamura and Steinsson (2018) shocks appear to be positively correlated. Pairwise correlation coefficients in Table 5 indicate a higher covariation between Nakamura and Steinsson (2018) measure and GSS (2005) path factor, stressing that the former mostly incorporates unexpected news affecting *future* rather than *current* rates. Such evidence is consistent with GSS (2005), who point out that in recent years forward guidance shocks make up the bulk of unexpected FOMC announcements.

Countless variables may then affect the reaction of stock returns to monetary surprises besides rebalancer ownership. To account for the most relevant ones, the model also considers a set of control variables along with their interaction with Nakamura and Steinsson (2018) and GSS (2005) shocks. While many papers introduce a wide collection of variables, data availability poses remarkable constraints on the number of controls that could be added as well as on the methodology to retrieve them. Therefore, model (4) accounts for three of them only – namely:

- Size (market capitalization) – measured as the natural logarithm of market equity; [9]

9 Market equity is computed as the product between the number of shares outstanding during a quarter and the average price during the same quarter. Since Thomson Reuters does not provide average price measures, the

- Monetary policy exposure (MPE) index;
- Book-to-market ratio.[10]

Controlling for the company's size and book-to-market ratio is rather standard in the literature, on the wave of the revisions of the Capital Asset Pricing Model (CAPM) proposed by Fama and French (1992). Already during 80s, a vast stream of research indeed challenged the main assumptions of the CAPM, among which the existence of a single risk factor – the excess return on the market portfolio – shaping firms' expected return. Puzzling empirical results of higher actual risk-adjusted returns compared to CAPM's predictions led to the identification of other factors affecting returns and to the necessity to incorporate them in the original model. Major evidence is provided by Banz (as cited in Fama & French, 1992), who found out that stocks with low market equity tend to outperform large stocks as well as by Rosenberg, Leid and Landstein (as cited in Fama & French, 1992), who noticed a similar behavior between high and low book-to-market stocks.[11] Accordingly, Fama and French (1992) proposed an extended version of the CAPM incorporating two additional dimensions of risk – that is, firms' relative size and book-to-market ratio. This three-factors model remained pillar in the asset pricing literature for many years, before being further modified to include other risk factors.

Considering such evidence, size and book-to-market ratio reasonably enter model (4) as control variables; this allows to depurate the analysis from the impact they might have on returns, thereby wiping out the possibility of high (low) returns driven by the firm's small (large) size or its high (low) book-to-market ratio.

The monetary policy exposure (MPE) index introduced by Ozdagli and

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latter is found as the mean of each company's closing price on each trading day during a specified quarter.

10 Despite stocks are classified into a "value" and "growth" category based on their book-to-market ratios, there is still a remarkable within-sample variability which justifies the latter's inclusion as a control variable. Table 4 (a) supports this choice by providing a snapshot of the univariate analyses of the book-to-market variable for both samples.

11 This is not an exhaustive list of authors and their findings; for example, Bhandari (as cited in Fama and French, 1992) finds a positive relation between leverage and return as well. Challenges to the empirical validity of the CAPM attracted much attention during 80s and 90s; studies on the topic are indeed numerous.

Velikov (2016) allows to control for extra firm characteristics deemed to shape the relationship between monetary policy and stock returns. Specifically, the MPE index considers the firm's liquidity position, the duration and the volatility of its cash flows, its financial constraints – measured through the Whited-Wu (WW) index – and its operating profitability as the five most relevant drivers of an asset's exposure to monetary policy. More details about such variables and their construction are provided in Appendix C.

Data on prices, institutional holdings and control variables are taken from Thomson Reuters database for the period January 2000 – December 2015; only for variables whose calculation requires a longer time span (for example equity duration) data starting from January 1995 are employed. Monetary shocks are coherently considered for the same 16 years sample.

3.3. Portfolio rebalancing and joint policies

Outcomes of regression (4) using Nakamura and Steinsson (2018) surprises are reported in Table 6 (a) and (b). The first column in both panels shows the output of a "plain" model including only rebalancer ownership and its interaction with monetary shocks; from column (2) to column (4) the model is then gradually expanded, incorporating the three control variables along with their interaction with shocks; column (4) provides results for the complete (or "fully saturated") model. Meeting and industry fixed effects are enclosed in all four regressions.

The previous excursus about the interpretation of the coefficient β_1 is a precious guideline to examine figures in Table 6. Column (4) in panel (a) reveals that NYSE stocks with additional 10% rebalancer ownership are subject, on average, to 1.41 basis point (bp) higher fall in returns for a given 10 bp unexpected increase in policy rates. The underlying explanation is immediate: perceiving them as risky securities, rebalancers tend to shift away from value stocks when policy rates increase. The negative impact of rebalancing demand is, however, never significant, even at the 10% threshold.

Moving to panel (b), the scenario is almost unchanged when NASDAQ stocks are considered; higher rebalancer ownership is again associated to a higher fall in the price of growth stocks in the context of a monetary policy contraction. The 3.08 bp fall in return is larger than that experienced by value stocks and much closer to that estimated by Lu and Wu (2022), but it is still not significant at all relevant thresholds. With a return difference of about 1.7 bp, the fall in growth stock return is roughly four times that faced by value stocks; expressly, growth equities are characterized by a more prominent rebalancing activity, with greater selling (buying) pressures during restrictive (expansionary) times.

Leaving out such minor differences, however, the effect of portfolio rebalancing is similar across the two segments of the equity market, suggesting that that specific stock features do not drive remarkable differences in rebalancers' behaviors in response to joint policies.

As far as the goodness of fit is concerned, the two analyses do not allow to assess the best model – whether a fully saturated or a basic one without controls; the behavior of the Adj. R^2 is indeed peculiar and hard to interpret. Adding variables increases performance of NASDAQ sample regressions; the peak is indeed reached in the fully saturated model. When employing NYSE sample, the fully saturated model has instead the lowest Adj. R^2; with a value of 0.2972, it is, indeed, 0.002 lower than the Adj. R^2 of the basic model with no extra regressor.

3.4 Portfolio rebalancing and individual policies

Model (4) is also estimated with GSS (2005) target and path factors to evaluate the effect of CMP and forward guidance policies as standalones. Table 7 (a) and (b) outline the results for the plain and the fully saturated versions only; Table 8 merely summarizes the latter in a more visual scheme.

Prices of value and growth stocks with higher rebalancer ownership fall by around 0.8 and 2.5 bp in response to positive policy rate shocks; as in the previous model with Nakamura and Steinsson (2018) composite shocks, none of the coefficients is significant. Surprisingly, however, the selling pressure from rebalancers is higher for growth rather than for value stocks, given the 1.7 more pronounced downward revaluation experienced by NASDAQ portfolio.[12]

By contrast, rebalancing behaviors adopted by certain investors trigger opposing effects on stock valuations during periods of restrictive forward guidance policies. Precisely, value stocks appreciate by 1.43 bp while growth stocks revaluate downward by 2.46 bp, at least according to the fully saturated model in the second column. Both effects are not statistically significant; nevertheless, it is still worth to deeper investigate this phenomenon on account of close evidence provided by the literature. A similar pattern is, for example, documented by Avalos and Todorov (2022) in relation to the post-Covid 19 monetary tightening, that induced investors, between 2021 and 2022, to increase their holdings of value stocks while selling off growth equities. The different timing of cash flows provides the most reasonable explanation for such rebalancing trend: with prospects of higher *future* interest rates, rebalancers are incentivized to reduce their holdings of growth stocks, due to their delayed cash flows. This is the essence of an active "interest rate anticipation" strategy that Reilly and Brown (2012) primarily discuss as regards to bonds, but that could be easily applied to stocks as well [13]: when interest rates are expected to increase, investors are likely to shift to assets with a shorter duration, thereby less sensitive to interest rate changes (less volatile). Interestingly, Avalos and Todorov (2022) also consider the progressive deleveraging of leveraged exchange-traded funds (leveraged ETFs) as a potential exacerbating factor for the recent shift.[14]

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12 Both in the plain and the fully saturated model.

13 According to Reilly and Brown (2012), indeed, interest rate anticipation strategies are "highly scalable since they can be implemented with virtually any securities available in the market".

14 Leveraged ETFs mainly invest in risky growth stocks, thereby linking their asset under management (AUM) to their prices. There is a negative relationship between AUM and leverage: when the former falls, the latter increases and vice versa. However, with target levels of leverage to respect, when leverage exceeds the predefined target, these funds engage in selling offs of these securities; as in Avalos and Todorov (2022), this causes a "rotation" from growth to value stocks.

These "rebalancing flows across equities" (Gnabo & Soudant, 2022) testify that monetary policy does not only activate a portfolio rebalancing mechanism *across* asset classes but also *within* them or, at least based on the evidence here collected, within the equity market.

4. Conclusions

Research literature always placed impressive emphasis on the relevance of monetary policy for stock market developments; in this respect, rebalancing behaviors have frequently been considered the mainstream channel for the transmission of monetary impulses. This paper adds to the outstanding asset pricing literature on the relationship between monetary policy, stock prices and portfolio rebalancing; the statistics here presented, however, only partially support existing evidence, highlighting how previous studies may have strongly overstated the role of both central banks and rebalancing institutions in affecting equity performance.

According to the SVAR-IV model presented in section 2, monetary policy is indeed proven not to strongly influence the stock market. The effect of a monetary policy shock on equities is negative, as expected, but it is not significant in statistical terms. This result is robust to different shock estimation techniques: notwithstanding whether monetary surprises are retrieved through federal funds futures rates, as in Gertler and Karadi (2015), or leveraging on changes in federal funds rate only, as in Romer and Romer (2004), the outcome is unchanged.

Narrowing the attention on *how* monetary policy decisions propagate to the stock market, most studies stress the centrality of the portfolio rebalancing channel. From this standpoint, this study also describes a slightly different reality. Indeed, while matching the empirical prediction of a negative impact of rebalancing demand on stock returns in response to monetary policy shocks, none of the analyses proposed shows evidence of a significant relationship between them. This clearly downsizes the relevance of the rebalancing device in the transmission of monetary policy impulses.

This paper departs from other studies in two main aspects. First, it explores the effectiveness of portfolio rebalancing within distinct segments of the equity sector, in accordance with the view that the latter should not be considered as a uniform, homogeneous, market. Rather, the multitude of dimensions along which stocks may differ allows to further categorize it into more specific subsets; in this study, the categorization is based on some core features of the stocks, among which book-to-market ratio, equity duration and nature of the business. Second, it considers the distinction between conventional and unconventional policies as the possible tools through which central banks may influence financial markets. From this standpoint, the paper evaluates the impact of both *hybrid* monetary policies, i.e., the joint enforcement of CMP and forward guidance – as well as *individual* policies; this strategy turns out to be effective in that it allows to shed the light on the role of rebalancers in the transmission of monetary policy impulses under extremely different scenarios.

In this regard, panel analyses in section 3 offer mutual support in favor of the insignificance of portfolio rebalancing in explaining stock returns, independently of their classification as "value" or "growth" and in response to both joint and individual monetary policies. Small differences in the value of the coefficients allow to conclude that growth stocks appear a bit more sensitive to unexpected changes in monetary policy, but the effect is still largely negligible in statistical terms. Interestingly, however, the change in price of stocks with different fundamentals – while similar as to *significance* – may differ in terms of *direction* when monetary authorities engage in certain kinds of policies. Specifically, portfolio rebalancing only has a negative effect on both value and growth stocks when conventional policies are enforced, as standalones or in combination with forward guidance measures. By contrast, findings signal that rebalancers tend to disinvest in growth stocks while increasing their positions in value stocks in response to positive forward guidance shocks. These "rebalancing flows across equities", as defined by Gnabo and Soudant (2022), suggest that stock characteristics materially act as discriminant for rebalancers' investment decisions.

The dynamics of portfolio rebalancing on the aggregate stock market performance has been widely investigated by the literature. It is still remarkable, however, the scarcity of studies aimed at differentiating its importance and its functioning *within* the equity sector; this paper tried to fill this void by analyzing separately two major categories of stocks. Future research may add to this study in terms of equity differentiation, considering the multiple metrics along which stocks can be distinguished. Cyclicality, for example, allows to discriminate among stocks that are expected to react differently to the business cycle; to this end, accounting for this factor would ensure reliable inference about the relationship between monetary policy, investors' attitudes and the economic cycle itself. Attention might also be placed on ESG stocks, given the centrality of environmental and social issues in the modern society.

As for the type of policies under analysis, this study considers forward guidance as the only unconventional tool available to monetary authorities. This might be a serious pitfall. Unconventional policies enforced by central banks since the global financial crisis, indeed, embrace forward guidance as well as asset purchase programs, through which massive amounts of liquidity are injected in the economy. Extending the spectrum of central banks' policies would therefore complement this paper, seizing the relationship among monetary policy, portfolio rebalancing and the stock market from additional and meaningful perspectives.

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Tables and figures

1. Monetary policy and the stock market

Table 1 - Correlation matrix among Gertler and Karadi (2015) and Romer and Romer (2004) monetary shocks

Monetary Shocks	Gertler-Karadi	Short sample Romer-Romer	Long sample Romer-Romer
Gertler-Karadi	1	0.2440	0.2634
Short sample Romer-Romer	0.2440	1	0.9205
Long sample Romer-Romer	0.2634	0.9205	1

Table 2 - Results of the first stage regression

Variable	Gertler-Karadi	Short sample Romer-Romer	Long sample Romer-Romer
Intercept	0.1065	-0.0027	-0.0026
Monetary shock (Z)	0.0465	0.1767 ***	0.1692 ***
	(0.131)	*(0.000)*	*(0.005)*
F-stat	11.87	81.02	72.87
Observations	270	336	336

Each column shows the results of the first-stage regression estimated through different monetary shocks as external instruments: model (1) is estimated using Gertler and Karadi (2015) shocks; models (2) and (3) are estimated using short sample and long sample Romer and Romer (2004) shocks respectively.

The VAR residual of the regression of interest is taken as the outcome variable. Coefficients are reported in pp; p-values are in parentheses and symbols *, ** and *** indicate significance at 10%, 5% and 1%. F-statistics are also reported for each regression.

Table 3 - Results of the second stage regression for S&P 500 excess return

Variable	Gertler-Karadi	Short sample Romer-Romer	Long sample Romer-Romer
Intercept	0.1157	0.1224	0.1192
Predicted Treasury yield residuals	-8.0392	-0.5329	-1.7826
	(0.145)	*(0.677)*	*(0.182)*
F-stat	2.1382	0.1734	1.7883
Observations	270	336	336

The table shows results for the second-stage regression of reduced form residuals of the S&P 500 excess return regression on fitted values from first-stage regressions. Coefficients are reported in pp as in Kekre and Lenel (2022); p-values are in parentheses and symbols *, ** and *** indicate significance at 10%, 5% and 1%. F-statistics are also reported for each regression.

Figure 1.1 - Impulse response functions of the one-year Treasury yield (Panel A) and S&P 500 excess return (Panel B) to a Gertler and Karadi (2015) monetary policy shock.

Panel A *Panel B*

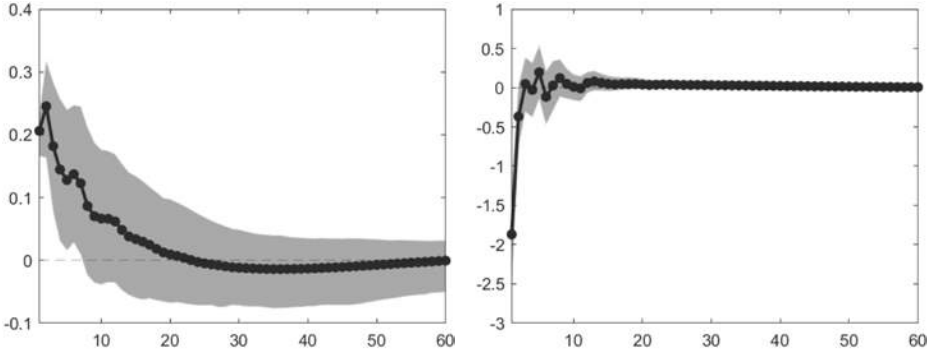


Figure 1.2 - Impulse response functions of the one-year Treasury yield (Panel C) and S&P 500 excess return (Panel D) to a short sample Romer and Romer (2004) monetary policy shock.

Panel C *Panel D*

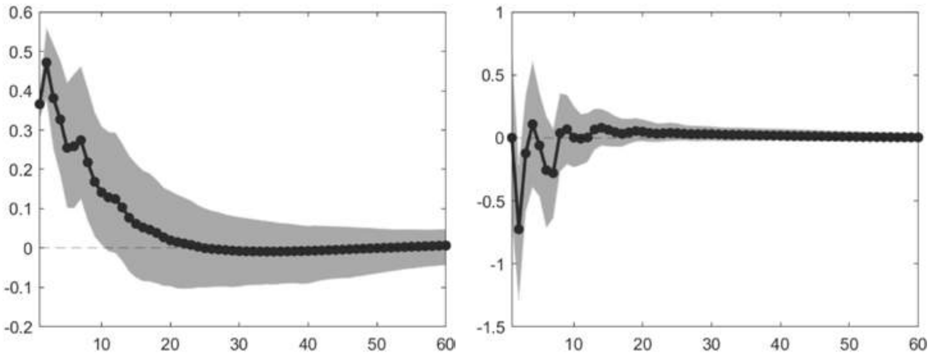
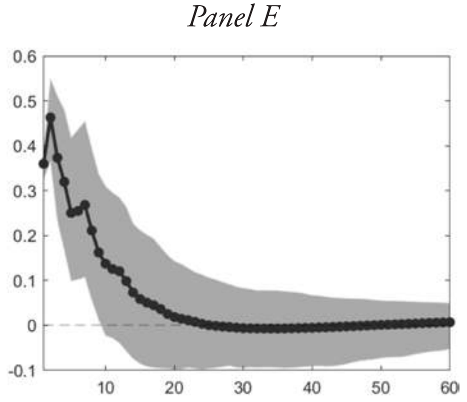


Figure 1.3 - Impulse response functions of the one-year Treasury yield (Panel E) and S&P 500 excess return (Panel F) to a long sample Romer and Romer (2004) monetary policy shock.



2. The portfolio rebalancing channel

Table 4 (a) - Univariate descriptive statistics of the book-to-market ratio variable for both samples

Book-to-market	Obs	Mean	SD	Min	Median	Max
NYSE	7296	1.77	19.95	-46.51	0.54	746.34
NASDAQ	7222	0.36	0.47	-16.90	0.28	9.46

The table reports univariate analyses for NYSE and NASDAQ samples' book-to-market ratios. Book-to-market ratio is computed as the ratio between a firm's book value of equity and its market capitalization. Book value of equity is found as the difference between total assets and total liabilities; market capitalization is the product between number of shares and price. A negative book-to-market ratio originates from a negative book value of equity.

NYSE stocks exhibit a much higher book-to-market ratio, being thereby classified as value stocks. Moreover, the figures provide evidence of the within sample variability (standard deviation) in terms of book-to-market ratio, especially in NYSE sample. This justifies its inclusion as a control variable in model (4).

Table 4 (b) - Univariate descriptive statistics of the equity duration variable for both samples

Equity duration	Obs	Mean	SD	Min	Median	Max
NYSE	7165	22.86	35.04	-100	11.42	100
NASDAQ	7062	23.22	31.04	-100	11.90	100

The table reports univariate analyses for NYSE and NASDAQ samples' cash flow (equity) duration. Equity duration is computed following Dechow, Sloan and Soliman (2004), using a time horizon of 40 quarters and a discount rate equal to 0.12. Differently from bond duration, there is no upper or lower bound for equity duration; to avoid biases caused by potential outliers, the maximum and the minimum values for yearly duration are therefore set equal to 100 years and -100 years.

Over the 16 years sample considered, NYSE stocks exhibit lower duration compared to NASDAQ stocks, in line with its classification as a sample of value stocks.

Table 5 - Correlation matrix among Nakamura and Steinsson (2018) policy news shocks and GSS (2005) target and path factors

Monetary Shocks	NS	GSS target	GSS path
NS	1	0.6263	0.7767
GSS target	0.6263	1	-0.0036
GSS path	0.7767	-0.0036	1

Table 6 (a) - Results of model (4) applied to NYSE sample

Variable	(1)	(2)	(3)	(4)
RO x MS	-0.58	-1.11	-1.42	-1.41
	(0.839)	*(0.630)*	*(0.520)*	*(0.527)*
RO	-2.85	-4.59	-5.52*	-5.69*
	(0.390)	*(0.140)*	*(0.072)*	*(0.067)*
MPE x MS		-	-	-
MPE		-	-	-
Market cap x MS			-	-
Market cap				-
BM				-
BM x MS				-
Meeting FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	3,452	3,406	3,406	3,406
Adj. R^2	0.2997	0.2974	0.2977	0.2972

The model is progressively saturated by adding control variables to counteract the potential biases caused by omitted variables. Standard errors are clustered at the industry level; p-values are reported in parentheses and symbols *, ** and *** indicate significance at 10%, 5% and 1%. Coefficients are reported in bp and rounded to the second digit. Meeting and industry fixed effects, the latter intended as the interaction between the firm industry and monetary shocks, are included in all regressions. Variables are as follows: "RO" denotes rebalancer ownership; "MS" refers to monetary shocks; "MPE" is the MPE index; BM stands for the book-to-market ratio.

Table 6 (b) - Results of model (4) applied to NASDAQ sample

Variable	**(1)**	**(2)**	**(3)**	**(4)**
RO x MS	-2.43	-3.11	-2.87	-3.08
	(0.595)	*(0.477)*	*(0.501)*	*(0.468)*
RO	-3.26	-3.32	-2.80	-3.17**
	(0.191)	*(0.104)*	*(0.115)*	*(0.039)*
MPE x MS		-	-	-
MPE		-	-	-
Market cap x MS			-	-
Market cap			-	-
BM				-
BM x MS				-
Meeting FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	4,940	4,890	4,890	4,886
Adj. R^2	0.3399	0.3442	0.3460	0.3487

The model is progressively saturated by adding control variables to counteract the potential biases caused by omitted variables. Standard errors are clustered at the industry level; p-values are reported in parentheses and symbols *, ** and *** indicate significance at 10%, 5% and 1%. Coefficients are reported in basis points and rounded to the second digit. Meeting and industry fixed effects, the latter intended as the interaction between the firm industry and monetary shocks, are included in all regressions. Variables are as follows: "RO" denotes rebalancer ownership; "MS" refers to monetary shocks; "MPE" is the MPE index; BM stands for the book-to-market ratio.

Table 7 (a) - Results of model (4) applied to NYSE sample using GSS (2005) target and path factors

	GSS target factor		GSS path factor	
Variable	**(1)**	**(2)**	**(1)**	**(2)**
RO x MS	-0.98	-0.79	0.15	1.34
	(0.714)	*(0.770)*	*(0.965)*	*(0.720)*
RO	-2.89	-3.33	-2.76	-3.02
	(0.389)	*(0.315)*	*(0.390)*	*(0.315)*
MPE x MS		-		-
MPE		-		-
Market cap x MS		-		-
Market cap		-		-
BM x MS		-		-
BM		-		-
Meeting FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	3,452	3,406	3,452	3,406
Adj. R^2	0.2997	0.2963	0.2997	0.2977

Regression (1) and (2) denote the plain and the fully saturated fixed effects regressions. Standard errors are clustered at the industry level; p-values are in parentheses and symbols *, ** and *** indicate significance at 10%, 5% and 1%. Coefficients are reported in bp and rounded to the second digit. Industry fixed effects should be intended as the interaction between the firm industry and monetary shocks (target and path factors, respectively). Variables are as follows: “RO” denotes rebalancer ownership; “MS” refers to monetary shocks; “MPE” is the MPE index; BM stands for the book-to-market ratio.

Table 7 (b) - Results of model (4) applied to NASDAQ sample using GSS (2005) target and path factors

	GSS target factor		GSS path factor	
Variable	**(1)**	**(2)**	**(1)**	**(2)**
RO x MS	-1.8	-2.54	-2.49	-2.46
	(0.721)	*(0.563)*	*(0.565)*	*(0.418)*
RO	-2.9	-2.84*	-3.29	-3.22**
	(0.210)	*(0.067)*	*(0.161)*	*(0.025)*
MPE x MS		-		-
MPE		-		-
Market cap x MS		-		-
Market cap		-		-
BM x MS		-		-
BM		-		-
Meeting FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	4,940	4,890	4,940	4,890
Adj. R^2	0.3398	0.3480	0.3398	0.3483

Regression (1) and (2) denote the plain and the fully saturated fixed effects regressions. Standard errors are clustered at the industry level; p-values are in parentheses and symbols *, ** and *** indicate significance at 10%, 5% and 1%. Coefficients are reported in bp and rounded to the second digit. Industry fixed effects should be intended as the interaction between the firm industry and monetary shocks (target and path factors, respectively). Variables are as follows: "RO" denotes rebalancer ownership; "MS" refers to monetary shocks; "MPE" is the MPE index; BM stands for the book-to-market ratio.

Table 8 - Summary of the results in Table 7 (a) and (b)

	Policy rate shock (target)	Forward guidance shock (path)
NYSE Returns	↓ 0.79 bp	↑ 1.34 bp
NASDAQ Returns	↓ 2.54 bp	↓ 2.46 bp

The table summarizes effect of rebalancer ownership in response to a positive policy rate and forward guidance shock on stock returns for each sample, i.e., the coefficient of the variable $RO_{i,t}xMS_t$. The monetary shock (MS) corresponds to GSS (2005) target factor (policy rate shock) in the first column and GSS (2005) path factor (forward guidance shock) in the second column. Results, reported in basis points (bp), refer to the fully saturated fixed effect model (column (2) in Tables 7 (a) and (b)) only.

Appendixes

A. The SVAR identification problem

The SVAR identification problem should be investigated by analyzing the relationship between reduced form and structural VAR models. The former, under the assumption of just one lag, is specified as in formula (1), here repeated for convenience:

$$y_t = A(L)\,y_{t-1} + u_t \tag{A.1}$$

where – according to the notation provided by Cesa-Bianchi (2022) – y_t is a $K \times 1$ "state vector" of K (economic and financial) endogenous variables, $A(L)$ is a $K \times K$ "dynamic matrix" describing the effect of lagged endogenous variables on the same variable at time t and u_t is a $K \times 1$ vector of reduced form shocks (errors).

The link between structural and reduced form VARs is "hidden" within u_t. With ε_t indicating a $K \times 1$ vector of unobservable structural shocks, i.e., shocks to the endogenous variables in y_t and B being a $K \times K$ "impact matrix" (Lakdawala, 2017), the vector u_t can indeed be expressed as a linear combination of entries in ε_t:

$$u_t = B\varepsilon_t \tag{A.2}$$

Consequently, model (A.1) can be rewritten in terms of structural shocks as:

$$y_t = A(L)\, y_{t-1} + B\varepsilon_t \tag{A.3}$$

Coefficients in B, called "structural parameters", describe the impact of a structural shockon variables in y_t. In the economic language, they are labelled as "impulse response functions" (IRFs). The stream of research aiming at inspecting the effects of structural shocks – such as monetary policy shocks – on economic and financial variables is centered on the estimation of structural coefficients themselves. While pivotal in most analyses, however, structural shocks are unobservable. That being the case, it is not feasible to *directly* estimate a SVAR model; only indirect methods working through a first-step estimation of reduced form shocks allow to consistently estimate structural parameters in B.

At first sight, the formulation of reduced form shocks in (A.2) and (A.3) might (wrongly) suggest that there exists a one-to-one relationship between structural and reduced form shocks. In such hypothetical scenario, a structural shock to the i-th endogenous variable would be responsible of the i-th reduced form shock only; an extensive formulation of (A.3), however, clarifies the unlikeliness of such circumstance. In the easiest scenario with two endogenous variables only, i.e., = $y_t = [y_{1,t} y_{2,t}]'$, model (A.3) becomes:

$$\begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} \tag{A.4}$$

Reduced form shocks can then be derived from (A.4) as:

$$\begin{cases} u_{1,t} = b_{11}\varepsilon_{1,t} + b_{12}\varepsilon_{2,t} \\ u_{2,t} = b_{21}\varepsilon_{1,t} + b_{22}\varepsilon_{2,t} \end{cases} \tag{A.5}$$

As linear combinations of *multiple* structural shocks, there is no one-to-one relationship between a reduced form shock to variable i and a structural shock to the same variable i. The inability to disentangle the effect of each individual structural shock on reduced form ones is commonly referred to as the "SVAR identification problem".

Different methods have been pinned down to overcome the SVAR identification problem. Traditional techniques are based on "restrictions" – that is, additional equations imposed to the model to "induce" the above-mentioned one-to-one relationship between reduced form and structural shock. In this respect, the Cholesky decomposition or "zero short-run restrictions" is one of the most common methods. The underlying assumption of this methodology is that the structural shock of interest only has a *contemporaneous* effect on the variable of interest: denoting the latter with i, the structural shock only influences, in the current period, variable i, and not variable j (for all $j \neq i$), i.e., the coefficient b_{ij} in (A.5) equals zero. In the case at hand, a structural shock to the monetary policy indicator would therefore be assumed not to have a contemporaneous impact on any of the economic and financial variables except on the monetary policy indicator itself, that is, the one-year Treasury yield.

Other methodologies, instead of assuming a zero-contemporaneous impact, impose other kinds of restrictions as a workaround to the SVAR identification problem. The long-run restriction method, for example, assumes the absence of any effect of the structural shock to variable i on variable j

at a lagged time; the sign restriction method, on the contrary, does not focus on the *timing* of the impact, but on its *direction*, establishing the sign of the coefficient b_{ij} a priori.

The drawback of these methodologies is rather apparent: they all suffer from a too high degree of reliance on assumptions that, in most instances, are not true in the real world. In the first place, the assumption of a zero contemporaneous effect of monetary policy shocks on VAR endogenous variables, at the core of the zero short-run restriction methodology, is far from being plausible, especially when financial variables are under consideration (Gertler and Karadi, 2015).

From that, the need to find alternative approaches to shape the relationship between monetary policy shocks and economic and financial variables considered, while not imposing unlikely assumptions. Such approach is here chosen to be based on "external instruments" employed to identify the structural shocks of interest, as done in more modern studies (Nakamura & Steinsson, 2018; Olea, Stock & Watson, 2021; Lu & Wu, 2022).

B. Monetary shocks

Following Acosta (2022), traditional measures of high-frequency exogenous shocks include both a set of "market-based" measures as well as Romer and Romer (2004) surprises.

Market-based measures, as anticipated in section 2, are obtained from changes in market expectations of federal funds futures rates; various measures, listed in the following paragraphs and differing only in the number and the type of contracts considered, belong to this category.

Federal funds futures are monthly contracts traded on the Chicago Mercantile Exchange (CME) whose rate – the "federal funds futures rate" ($FFFR$) – is set as the average of the daily effective federal funds rates ($EFFR$) of the month of the contract itself (Robertson & Thornton, 1997).[15] Using Robertson and Thornton (1997) notation and adapting the formula to the context under analysis, the relationship between the $FFFR$ and the $EFFR$ could be written as:

$$FFFR_{t,i} = E_{t-1}\overline{EFFR}_{t+i} + \alpha_i \tag{B.1}$$

where t denotes the month of the FOMC meeting day; i indicates the month in which the future contract expires[16]; E_t denotes the expectation, conditional on all information up to the day before the FOMC meeting[17]; α_i is a "bias term".

Breaking down equation (B.1), it is clear that – absent any bias α_i – market expectations in month t about $EFFR$ in month i equal the i-month ahead $FFFR$ ($FFFR_{t,i}$). Reversing the two sides of the equation, can be interpreted as a predictor of market expectations in month t about $\overline{EFFR}_{t+i}$. Accordingly, *changes* in the federal funds futures rate could be interpreted as proxies for changes market expectations of the federal funds rate, i.e., monetary policy shocks.

Kuttner (as cited by Acosta, 2022) just refers to changes in the *current month* federal funds futures rate as predictors of changes in the federal funds rate; Gertler and Karadi (2015) instead employ changes in *farther* ahead federal funds futures rates; finally, other authors such as Gürkaynak, Sack and Swanson (2005) – henceforth "GSS" (2005) – and Nakamura and Steinsson (2018) combine several federal funds and Eurodollar futures rates to come up with a shock measure. Specifically, they consider five variables, that is: the change in market expectations about federal funds rate over the remainder of

15 The daily effective federal funds rate is a volume-weighted median of all daily transactions from depository institutions in the FR 2420 Report (Federal Reserve Bank of New York, 2023). It is published every day by the Federal Reserve Bank of New York.

16 Clearly, $i > t$ (month i is later in time with respect to month t).

17 The formula provided by Robertson and Thorton (1997) employs the expectation conditional on all information up to t. The formula is here modified based on Gertler and Karadi (2015), whose assumption is that only information up to the day before the FOMC day ($t-1$) is relevant.

month t; the change in market expectations about federal funds rate in $t + 1$ (month of the next scheduled FOMC meeting); the change in price of three Eurodollar futures contracts, i.e., Eurodollar futures expiring in 2, 3 and 4 quarters, in month t .

Both GSS (2005) and Nakamura and Steinsson (2018) then apply Principal Component Analysis (PCA) to extract information from data and build the final shocks.

GSS (2005) employ PCA to compute a "target" and a "path" factor of the monetary surprise. The target factor – that is, the first principal component (PC1) of the five variables considered – isolates the component of the shock that affects the *current target* for federal funds rate. Consequently, it must be through as a "policy rate shock". The path factor – computed as the second principal component (PC2) of the same five variables – instead consists of the shock to *future* federal funds rates, which does not impact the current rate; for this reason, it must be interpreted as a "forward guidance shock". Following Hamilton (as cited in Barakchian & Crowe, 2010) and Barakchian and Crowe (2010), policy rate and forward guidance shocks could be labelled as a "level" and "slope" or "yield" factors respectively, with the former isolating the portion of new information in the FOMC announcement which influences near-term rates only and the latter instead quantifying the effect of new information on further out rates.

Nakamura and Steinsson (2018) make use of the same inputs, but they condense monetary policy surprises into a single dimension by taking only the first principal component of rates' changes (Bauer & Swanson, 2022) for simplicity, assuming it is sufficient to summarize all the relevant information; the authors refer to them as "policy news shocks". Positive policy rate, forward guidance and policy news shocks indicate that the Federal Reserve is more restrictive than expected, i.e., they characterize *contractionary* policies; by contrast, negative shocks identify *expansionary* monetary policies.

The high frequency shock series derived by Romer and Romer (2004) is also placed within the category of traditional measures, even though it is not estimated from futures rates by means of PCA. Rather, Romer and Romer (2004) measure monetary shocks as the component of the change in the federal funds rate that cannot be predicted from the Fed's staff forecasts (Acosta, 2022).

C. Rebalancer ownership

Thomson Reuters provides data on institutional investors' ownership for all 114 companies in the two samples, differentiating among multiple entities. For most firms, institutional investors are split into seven categories: closed-end funds, exchange-traded funds, hedge funds, insurance companies, investment trusts, mutual funds, and pension funds. The expression "institutional investor", however, is not a synonym of "rebalancing institution": rather, rebalancers only represent the sub-group of institutional investors that tend to adjust their portfolios to achieve predetermined investment targets; from this, the necessity to filter only for those institutional investors that could be reasonably deemed to be rebalancers. This is achieved through a "screening procedure" of institutional investors found in Thomson Reuters database.

First, among the seven above-mentioned categories, only mutual funds, insurance company portfolios and pension fund portfolios are selected as *potential* rebalancers. This approach slightly differs from that adopted by other authors in multiple aspects. Lu and Wu (2022), for example, do not list insurance funds among the rebalancers' category; however, since OECD (2008) explicitly classifies insurance companies and pension funds as belonging to the same subsector ("insurance and pension subsector"), they can be somehow assimilated to the latter, viewed as the best example of rebalancing institutions. Second, they carry out distinct analyses levering on pension and sovereign wealth funds separately from mutual funds, employing ownership data coming from multiple sources. Since Thomson Reuters provides comprehensive ownership data on the seven fund types, insurance companies, pension and mutual funds are here considered altogether. Additionally, sovereign wealth funds are excluded, being Thomson Reuters silent on them.

Pension funds, as anticipated before, are generally considered rebalancer institutions by construction; hence, percentage ownership by pension funds is straightforwardly accounted as rebalancer ownership. A wide set of filters is instead applied to the other two categories – insurance companies and mutual funds – based on the name of the fund itself. For instance, all institutions whose name contains references to the equity sector are excluded, consistently with the idea that they classify as "pure equity portfolios" (Lu and Wu, 2022), noticeably not subject to rebalancing mandates. Funds with the word "capital" in their name are disregarded as well: seeking, in most cases, capital appreciation, development, growth, or accumulation, they mainly invest in equities; hence, they are here consistently identified as pure equity funds. [18]

This approach ultimately yields rebalancer ownership for each firm i as the sum of the percentages of i held by pension funds, rebalancing mutual funds and rebalancing insurance companies.

D. MPE Index

The monetary policy exposure (MPE) index computed by Ozdagli and Velikov (2016) aims at synthetizing the exposure of a company to monetary policy as a function of a set of variables that are theoretically deemed to shape such relationship: capturing the riskiness, the profitability and the cash availability of the company, these variables may indeed play a role in explaining the effect of monetary policy shocks on stock performance. Consistently with the goal of estimating the impact of the portfolio rebalancing channel only on stock returns, controlling for the fraction of their exposure to monetary

18 Importantly, these are only examples of the filters applied. The set is wider, but here only few of them are mentioned to explain the logic behind the screening procedure followed.

policy coming from sources other than rebalancers' ownership is therefore fundamental.

Specifically, the index considers five firm characteristics: the firm's liquidity position, the duration and the volatility of its cash flows, its financial constraints – measured through the Whited-Wu (WW) index (Whited & Wu, 2006) [19] – and its operating profitability. These variables, measured on FOMC meeting days, are first interacted with monetary policy shocks; then, they become predictor variables in a regression with daily returns around FOMC dates as the outcome variable. The model is as follows:

$$r_{i,t} = \gamma_0 + \gamma_1 X_{i,t} x MS_t + \gamma_2 X_{i,t} x MS_t + \delta_t + u_t \tag{D.1}$$

where $X_{i,t}$ is a $N \times 5$ matrix – with N denoting the number of observations – containing the explanatory variables listed above; δ_t is a set of meeting and industry fixed effects.

This regression is a "preliminary step" to get the MPE index: the latter is finally set up by combining coefficients associated to interaction terms with sample data for the corresponding independent variables. To that end, the MPE index usefully combines several factors that are expected to influence the exposure of stock prices to monetary shocks into a unique variable.

A regression is implemented for each sample distinctly. For NYSE sample, the MPE index is:

$$\begin{aligned} MPE_{i,t} = {} & 0.00441 Cash_{i,t} + 0.0001 Dur_{i,t} + \\ & +0.0172 WW_{i,t} - 0.0317 Vol_{i,t} + 0.0775 Prof_{i,t} \end{aligned} \tag{D.2}$$

while for NASDAQ sample it equals:

19 The Whited – Wu (WW) index (Whited & Wu, 2006) provides a reliable measure of a firm's financial constraints, i.e., it tells how costly is to raise new equity compared to use internal financing, as a function of various observable firm characteristics. Here only four firm-specific characteristics, namely cash flows, dividends, total assets and sales growth, are considered. The index is here computed employing coefficients provided by Whited and Wu (2006).

$$MPE_{i,t} = 0.084Cash_{i,t} + 0.0109Dur_{i,t} + \\ +0.0186WW_{i,t} - 0.0099Vol_{i,t} + 0.0578Prof_{i,t} \tag{D.3}$$

where $Cash_{i,t}$ = cash and short-term investments, $Dur_{i,t}$ = cash flow duration, $WW_{i,t}$ = percentile rank of the Whited-Wu index, $Vol_{i,t}$ = cash flow volatility and $Prof_{i,t}$ = operating profitability of firm i in quarter t.[20] Interestingly, all coefficients preserve their sign across the two samples, despite having different values and significance levels. Signs match those derived by Ozdagli and Velikov (2016) and Lu and Wu (2022), except for the equity duration one. Positive duration coefficients in (D.2) and (D.3) are puzzling; in contrast with most evidence, indeed, stocks with higher duration exhibit lower returns in response to a positive monetary policy shock.

20 In model (D.1) and in formulas (D.2) and (D.3) t indexes quarters rather than days.

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