Australian National University

Crawford School of Public Policy

CAMA

Centre for Applied Macroeconomic Analysis

Leverage and Time-Varying Effects of Monetary Policy on the Stock Market

CAMA Working Paper 7/2023
January 2023

Severin Bernhard
Reserve Bank of New Zealand

Philip Vermeulen
Auckland University of Technology
Centre for Applied Macroeconomic Analysis, ANU

Abstract

Using high-frequency identification, we investigate leverage of the firm and economy-wide leverage as determinants of the sensitivity of a firm's stock price to monetary policy announcements. We show that the effect of economy-wide leverage is substantially larger than the effect of the firm's own leverage. It is sufficient for the response of a firm's stock price to strengthen that other firms in the economy become more leveraged. We further show that economy-wide leverage fluctuations explain the time-varying effects of monetary policy on stock prices. Our results are robust controlling for a variety of common business cycle variables and household leverage.

Keywords

Monetary policy, stock returns, leverage

JEL Classification

E44, E52, G14

Address for correspondence:

(E) cama.admin@anu.edu.au

ISSN 2206-0332

Leverage and time-varying effects of monetary policy on the stock market

Severin Bernhard[1] and Philip Vermeulen[2,3]

[1]Reserve Bank of New Zealand

[2]Auckland University of Technology

[3]Centre for Applied Macroeconomic Analysis, ANU

Version: 20 December 2022

Abstract

Using high-frequency identification, we investigate leverage of the firm and economy-wide leverage as determinants of the sensitivity of a firm's stock price to monetary policy announcements. We show that the effect of economy-wide leverage is substantially larger than the effect of the firm's own leverage. It is sufficient for the response of a firm's stock price to strengthen that other firms in the economy become more leveraged. We further show that economy-wide leverage fluctuations explain the time-varying effects of monetary policy on stock prices. Our results are robust controlling for a variety of common business cycle variables and household leverage.

Keywords: monetary policy, stock returns, leverage
JEL classifications: E44, E52, G14

Corresponding author: Philip Vermeulen, Auckland University of Technology, School of Economics, WY Building (level 2), 120 Mayoral Drive, Auckland, New Zealand. *E-mail*: `philip.vermeulen@aut.ac.nz`. Severin Bernhard was working at the Reserve Bank of New Zealand (RBNZ) as an Economic Adviser when key parts of this analysis were conducted. *E-mail*: `severin.bernhard@gmail.com`. We thank Jacob Punnoose, Andrew Coleman, Bob Reed, Tom Coupe, Kuntal Das, Alfred Guender, Moritz Wagner and participants of the joint RBNZ-AUT seminar and University of Canterbury Seminar for useful comments and discussions.

Despite the cries of newspapers to lower the interest rates, the Federal Reserve (Fed) would sometimes do much better to attend to the economy-wide leverage and leave the interest rate alone. Geanakoplos (2010)

In an environment where leverage in the economy is high, small rate increases might have larger effects. Panetta (2022)

1 Introduction

Twelve years after Geanakoplos (2010) has warned for the dangers of elevated economy-wide leverage, it seems that central banks have taken notice. Panetta (2022), senior policymaker at the European Central Bank (ECB), is using high leverage in the economy as one argument to advocate gradualism in the normalisation of monetary policy after the Covid crisis. The literature so far has identified a firm's leverage as a key determinant of its sensitivity to exogenous events. We address this briefly, but then turn towards another channel of leverage: Does the leverage of *other* firms in the economy matter too, as propagation models would suggest, or is it only the firm's *own* leverage that matters? To address this question, we evaluate the high-frequency responses of firms' stock prices around monetary policy releases, and how they interact with different leverage measures, using a classic event studies methodology (Bernanke and Kuttner (2005) and others). Our findings confirm that a firm's leverage matters for the firm's own response, but more importantly, we establish that the leverage surrounding the firm has an even stronger effect on its response. Overall, our findings strongly support Panetta's concerns that (overall) leverage in the economy alters the effects of monetary policy, and thereby provides insights on another aspect of time-varying monetary policy effects.

A central idea behind the dangers attributed to increases in leverage is that it augments the risk of a propagation of negative shocks. Leverage is the key mechanism behind prominent theories that embed propagation, such as through the financial accelerator (Bernanke and Gertler (1989), Bernanke et al. (1999)) or the credit cycle (Kiyotaki and Moore (1997)). These theories imply that highly leveraged firms suffer more from contractionary monetary policy shocks, as they experience larger declines in net worth, and predict that propagation becomes stronger the more high leverage is wide-spread. If the propagation assumption is correct, then the stock price of a firm should react not only as a function of the firms *own* leverage, but also react stronger in an environment of higher overall leverage. Even if a firm is not highly leveraged, it would still suffer from the expected propagation of shocks through other highly leveraged firms.

Stock markets are an ideal place to test such hypotheses, for two main reasons. First, they are forward-looking and prices tend to react immediately to shocks. We can exploit this and extract the immediate effect on investors' expectations (noting that all other information available prior to the release of monetary policy decisions should be 'priced in' into current prices).[1] Second, firms listed on stock markets release their financial accounts publicly and timely, which makes leverage observable and known to all investors. Importantly, investors can observe it for *all* firms on the stock market, and thus are able to observe, in Panetta's words, *'an environment where leverage in the economy is high'*.

Throughout the paper, we distinguish between the firms' own leverage and the leverage that is present and observable in the economy. The former is straightforward and referred to as *firm-specific* leverage.[2] We refer to the latter as *economy-wide* leverage and one proxy we use is the average leverage of all firms listed on the stock market at each point in time.[3] We expect firms' stock prices to react more strongly to shocks if either type of leverage is high: Higher firm-specific leverage implies more idiosyncratic risk of default, higher economy-wide leverage implies a higher risk of propagation through other leveraged firms. Both should increase the sensitivity to news in general, but monetary policy surprises specifically in our case.[4]

We analyse the above questions for the New Zealand (NZ) case, combining three main data sets. First, we use daily stock prices for all firms listed on NZX, the New Zealand stock exchange, and calculate changes in daily windows around all monetary policy releases of the Reserve Bank of New Zealand (RBNZ) between 2000 and 2017. Second, we use monetary policy surprises, to measure the impact of a given monetary policy release from the RBNZ. Third, we collect and extract financial accounts information for all firms listed on NZX, and carefully match it time-wise such that only publicly available information has been used. We use this to calculate the different leverages, generally defined as long-term debt over equity.

The NZ case has a number of advantages. First, there was no domestic sub-prime mortgage crisis in our sample, contrary to the US case, such a crisis could be a confounding factor and blur the interpretation of the results. Second, the RBNZ maintains a regime of inflation targeting

[1]This opposite to the identification of the real effects of monetary policy, which struggle with the long time span and a mixture of other potential shocks.

[2]We construct three proxies for *firm-specific* leverage: *firm-leverage* measured as long-term debt over equity, *target-leverage* as the average of the firm-leverage over time and *within-leverage* as the deviation of firm-leverage from target-leverage.

[3]Another proxy we use is the average *within-leverage* of all firms listed on the stock market.

[4]Monetary policy surprises measure the surprise content of a release. If a rate hike has been perfectly anticipated by markets, there should no reaction in asset prices on the release day itself, despite the actual change in interest rates, and that should ceteris paribus hold for our analysis of leverage.

(it started before the Federal Reserve (FED) and the European Central Bank (ECB)), and has been fairly transparent about its policy ever since. This makes it reliable, predictable, and also comparable to other inflation targeters. Third, the monetary policy framework has been the same throughout our sample period: The RBNZ used the Offical Cash Rate (OCR) as their main policy instrument until March 2020, when it also started using unconventional monetary tools.[5] This makes our monetary policy shocks comparable over the entire sample, in contrast to those of most other central banks, which have reached the zero lower bound during the Great Financial Crisis (GFC). Fourth, New Zealand has experienced a notable leverage cycle throughout the sample (see Figure 1 in Section 2). Combined, these four features make New Zealand a unique and convenient case for our analysis.[6]

Our main results are threefold. First, we find that stock prices of firms that are highly leveraged react stronger to monetary policy surprises. This results confirms earlier findings for the US and Japan, see Ozdagli (2017) or Shibamoto and Tachibana (2014). We add a new insight to these earlier papers. Namely, we find that firms' stronger reaction to monetary policy surprises as a function of leverage is dependent on leverage being higher than usual for the firm, and not related to the firms being highly leveraged on average over time. This result confirms an earlier notion in Ottonello and Winberry (2020) who show that a firms' *within-leverage* (i.e. the leverage of the firm minus its long-term average) matters for the reaction of investment to monetary shocks, not its average level of leverage. Second, and the key result in this paper, we show that stock prices of firms also react stronger in the presence of other firms that are highly leveraged. As far as we know, this result is new to the literature, and strongly supports the propagation mechanism that is behind the macro theories of the financial accelerator (Bernanke and Gertler (1989), Bernanke et al. (1999)) and the credit cycle (Kiyotaki and Moore (1997)). In addition, the effect of the economy-wide leverage is much larger than that of the firms' own leverage; an equal rise in economy-wide leverage as a rise in the firms own leverage has an almost tenfold effect on the sensitivity of stock returns to monetary policy shocks. Third, our results also imply economy-wide leverage as an important driver of the time-varying reaction of stock prices to monetary policy shocks. We show that the economy-wide leverage effect is not simply a proxy for the business cycle or the leverage of households.

[5]The cut-off in 2017 is motivated by the fact that the RBNZ changed the release time, from 9am local NZ time to 2pm NZ time. In order to ensure consistency, we omit this last part of the sample.

[6]Obviously, the Great Financial Crisis has also affected New Zealand deeply, and we do not intend to ignore it. We merely argue here that the shocks are derived from a regime of conventional monetary policy and are not a mixture of conventional and unconventional policy as would be the case for the US and the Eurozone over the period we consider.

Our paper speaks to a series of strands of the literature. A first strand is on leverage and fluctuations in the aggregate economy. Recently, economy-wide leverage has seen a revival as a topic of interest in the empirical business cycle literature. High leverage of the private sector has been blamed for the depth of the Great recession and the slow recovery afterwards. Schularick and Taylor (2012) show that financial crises are often preceded by credit booms and Jordà et al. (2013) show that credit-intensive booms tend to be followed by deeper recessions and slower recoveries. Mian et al. (2017) show that increased household-debt-to-GDP ratios predict lower GDP growth, and most recently Giroud and Mueller (2021) show that build-ups in firm leverage are associated with boom-bust cycles and declines in employment in the future. Our results indicate that stock markets become more sensitive to monetary policy in a more leveraged economy, and thus seem to support the above. By construction, our paper also contributes to a few literature strands that use event studies on stock market returns to assess the effect of monetary policy shocks. First, our paper speaks to the literature that tries to explain the across-firm-heterogeneity in the reaction of firm stock prices to monetary shocks, pointing to the role of balance sheet variables. Only a few studies investigate firm-leverage in particular. In accordance with the findings in Shibamoto and Tachibana (2014) (for Japan) and Ozdagli (2017), but contrary to those in Ehrmann and Fratzscher (2004), we find that firms react stronger to monetary policy shocks the higher is their own leverage.

Further, our paper is related to the literature that shows that effects of monetary policy shocks on stock returns are time-varying. Our results imply that since economy-wide leverage is time-varying, so will be the reaction of stock prices to monetary shocks. Our findings are complementary to a number of other mechanisms which induce time-varying effects of monetary policy shocks that have been studied in this literature, including tightness of credit conditions, recessions-vs-booms, bull-vs-bear markets, in-out GFC, or generally sub-samples – a brief overview is available in footnote 7.[7] Most existing evidence stems from studies using US stock

[7] Basistha and Kurov (2008) show that the effect of monetary policy shocks varies with the business cycle and tightness of credit conditions. Stock market reactions are more than twice as large in recessions and when credit conditions are tight. Similarly do Balafas et al. (2018) for UK firms: stock returns react more during periods of tight credit conditions. Jansen and Tsai (2010) find large differences in the effect in bull versus bear markets. Kurov (2012) finds differences between US recessions and booms. Kontonikas et al. (2013) show that the US stock markets reacted differently to monetary policy shocks during the great financial crisis, when unexpected interest rate cuts were predominantly interpreted as bad news on the economy. Jansen and Zervou (2017) estimate time-varying parameter regressions and find that a surprise increase on the federal funds rate has five times stronger and statistically significant effects on stock returns during the period 2000 to 2007, versus statistically insignificant effects during the period from 1989 to 2000. Recent evidence by Paul (2020) for the US, using event studies combined with VARs, suggest lower effects before the 2007 crisis. Paul (2020) is different from the other papers in this literature as he focuses on the dynamic response of stock prices to monetary policy (i.e. over the next 40 months), whereas the other papers address contemporaneous effects.

market data. We complement this literature by investigating the particularly distinctive role of economy-wide leverage in explaining the reaction of firm stock prices, and provide evidence on time-varying effects outside the US.

Our results may have considerable implications for policy-makers at central banks. Economy-wide leverage is able to induce substantial time-variation in the effects of monetary policy on stock markets, and central banks should thus expect stronger reactions to their policies in highly leveraged environments. This, in turn, may warrant keeping a firm eye on economy-wide leverage as suggested by Geanakoplos (2010), and may support gradualism as advocated by Panetta (2022).

The rest of the paper is structured as follows. Section 2 describes the data. Section 3 presents and discusses the empirical results, split into three subsections providing evidence on average monetary policy effects, effects of leverage, and time-variation in effects. Section 4 concludes.

2 Data

2.1 Monetary policy releases and stock market response

Our approach relies on high-frequency changes in stock prices around monetary policy releases. This method ensures a relatively clean identification of the impact of monetary policy releases – the longer the window, the higher the risk of confounding monetary policy with other potential drivers. For this, we require three main ingredients: (i) a set of monetary policy releases and monetary policy shocks to measure their surprise element, (ii) high-frequency changes in stock prices for all firms around these events, and (iii) balance sheet data for all firms in order to calculate their leverage. This section outlines the first two, the next section focuses on the third.

Our event set covers all monetary policy announcements from the RBNZ from July 5th 2000 to November 9th 2017. The RBNZ generally published eigth releases per year, typically at 9am local time. In our sample, there is only one unscheduled event in 2001, all other events have been announced ex-ante. We exclude the period of unconventional monetary policy, which the RBNZ resorted to from 16 March 2020 onwards, and releases between 2018 and 2020, where the RBNZ changed the release time to 2pm. The focus on the conventional era avoids difficulties with the changing nature of monetary policy from 2020 onwards, where primary tools became bond purchases and forward guidance instead of policy rate changes. This would require a separate analysis, as others point out (see e.g. Rogers et al. (2014) for evidence on asset market reactions to unconventional policy). Similarly for the period between 2018 and 2020: The RBNZ changed the release time to 2pm local time, and we exclude these events for consistency reasons.

As our measure of monetary policy surprises, we use the Target monetary policy shocks series for New Zealand, provided by Bernhard and Leong (2022), and denote them as s_t. These shocks are constructed using the well-established method of Gürkaynak et al. (2005). The Target series primarily captures interest-rate related surprises (others series capture other aspects of monetary policy releases, such as the medium-term outlook), which serves us well given our focus on leverage, and thus long-term debt and equity.[8]

To measure the response of stock prices to these releases (Δp_i), we use daily stock price data for all firms listed on the New Zealand stock market, the NZX Main Board, as provided by Refinitiv (formerly called Thomson Reuters). To avoid cross-border and currency issues, we only include firms located in New Zealand, and exclude Australian firms. We also exclude investment funds. In total, our sample contains 98 firms. As stock markets do not open before 10am – one hour after the RBNZ's releases – we use the closing price of the prior trading day as the price before the event, and the closing price of the event day to calculate the log-price change, see equation (2).

$$(\textit{monetary policy surprise}) \qquad s_t \quad (\textit{Target series}) \tag{1}$$

$$(\textit{change in stock price}) \qquad \Delta p_{it} = p_{it}^{close} - p_{it-1}^{close} \tag{2}$$

All together, our sample spans a long time period of 17 years and 137 monetary policy events. This is a notably longer sample than usual in this literature, and since periods of both high and low leverages occur, ideal for the purpose of estimating the importance of economy-wide leverage.[9] As firms enter and leave the stock market over the sample, we don't have stock market data for all firms for the full sample period. On average, we have 54 observations per firm.[10] Our total sample size (number of observations of firm-events) is 5310.

[8] The Target series has a high correlation with near-term futures on the policy rate, underlining the focus on interest rate changes. We leave the effects of other series in Bernhard and Leong (2022) for further work.

[9] Ehrmann and Fratzscher (2004) cover 79 FOMC meetings over 9 years from February 4, 1994 to January 29, 2003; Bernanke and Kuttner (2005) cover 131 events over 13 years from June 1989 to December 2002. Gürkaynak et al. (2005) cover a fifteen year period from 1990 to 2004. Basistha and Kurov (2008) cover 130 events over fifteen years (1990-2004) and Kurov (2012) covers 126 events over a fifteen year period (1994-2008).

[10] This is somewhat smaller than Ehrmann and Fratzscher (2004) which uses stocks in the S&P 500 and observe stocks for on average 71 event days.

2.2 Calculation of leverage

To calculate the leverage of firms, we collect and match the stock price data with balance sheet data from Refinitiv, which is widely used by sophisticated financial investors. While matching, we make sure to use only the balance sheet available to investors at the time of the event (which is usually the last available accounting year before the event).

In the empirical analysis, we use three different leverage measures as a proxy for *firm-specific* leverage. First, we define the leverage of firm i as the ratio of its total long-term debt over its total equity at time t, as specified in equation (3), and refer to this as *firm-leverage*.[11] Banks generally use this measure to decide if they want to extent more loans to the firm. *Ceteris paribus*, a higher firm-leverage indicates a riskier firm.

$$(\textit{firm-leverage}) \qquad lev_{it} \equiv \frac{total\ long\text{-}term\ debt_{it}}{equity_{it}} \tag{3}$$

In recent work, Ottonello and Winberry (2020) make the distinction between permanent firm heterogeneity and time-varying heterogeneity with respect to leverage. Basically, some firms might have permanently higher leverage levels and might be permanently more risky. They thus argue that it is the within-firm variation in leverage that matters for the reaction of investment to monetary policy shocks.[12] Ottonello and Winberry (2020) measure the long-term *target-leverage* ($\overline{lev_i}$) as the average over time of the firm's leverage. We then define the *within-leverage* as the within-firm variation in leverage, or the deviation of leverage from its target ($wlev_{it}$).

$$(\textit{target-leverage}) \qquad \overline{lev_i} \equiv \frac{1}{N_i} \sum\nolimits_{t=0}^{T_i} lev_{it} \tag{4}$$

$$(\textit{within-leverage}) \qquad wlev_{it} \equiv lev_{it} - \overline{lev_i} \tag{5}$$

We measure the economy-wide leverage in two ways. First, we measure it as the cross-sectional average of the firm-leverage of the firms in our sample ($elev_t$), equation (6), with N_t the number of firms in our sample at time t. We refer to this as the *economy-leverage*. To be consistent with the within-leverage measure at the firm level, we also define the *economy- within-leverage* ($ewlev_t$). It is measured as the cross-sectional average of within-leverage, equation (7). Note that in a fully balanced sample, these two measures would only differ by a constant: the

[11] We exclude firms with negative equity from our sample. This leads to a loss of 88 observations.

[12] They estimate the reaction of the firm's investment to a monetary policy shock, not that of the stock price.

average target level of leverage in the economy. In our unbalanced sample this is no longer the case, as the number of firms and therefore the average target level of leverage changes over time. However, the correlation in our sample between the two measures of economy-wide leverage is relatively high with 0.89.

$$(economy\text{-}leverage) \qquad elev_t \equiv \frac{1}{N_t}\sum\nolimits_{i=1}^{N_t} lev_{it} \tag{6}$$

$$(economy\text{-}within\text{-}leverage) \qquad ewlev_t \equiv \frac{1}{N_t}\sum\nolimits_{i=1}^{N_t} wlev_{it} \tag{7}$$

Figure 1 shows the evolution over time of our two measures for the economy-wide leverage. There is clearly a full leverage cycle: Leverage increased steadily up to the Great Financial Crisis, reaching above 100%, then sharply dropped thereafter and remained muted. Note that the scope of this paper is not to explain this pattern, but how it might help explaining the time-varying aspect of monetary policy effects on the stock market.

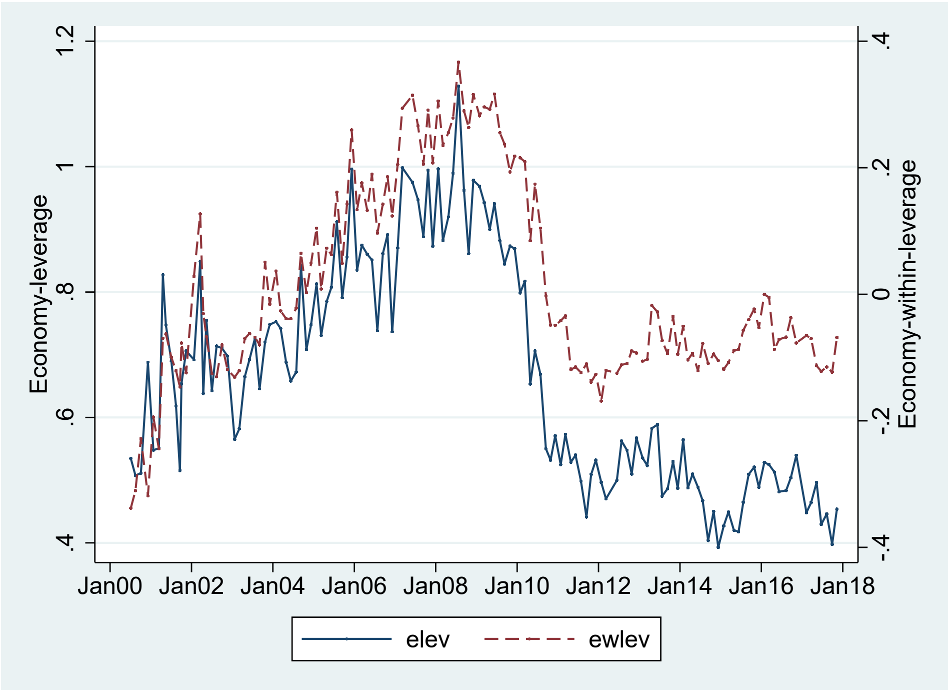

Figure 1: Economy-wide leverage

Table 1 provides a summary of the data. An average surprise has a mean of 0 percent and a standard deviation of 0.07 percent (7 basispoints). The average daily stock return on an event day is 0.19 percent with a standard deviation of 2.50 percent. The average firm-leverage is 63 percent with a standard deviation of 87 percent. Some firms have no long-term debt and therefore zero leverage and the highest firm-leverage observed is 521 percent. The target level of leverage is quite different across firms with an average of 63 percent and standard deviation of 68 percent. The firm within-leverage fluctuates substantially with a standard deviation of 55 percent. Both the economy-leverage, $elev_t$, and the economy-within-leverage, $ewlev_t$, fluctuate substantially over time with a standard deviation of 18 percent and 14 percent respectively.

Table 1: Summary Statistics

	Mean	SD	Min	Max	N
s_t	0.00	0.07	-0.36	0.23	137
Δp_{it}	0.19	2.50	-19.11	40.55	5310
lev_{it}	0.63	0.87	0.00	5.21	5310
$\overline{lev}_i$	0.63	0.68	0.00	2.93	5310
$wlev_{it}$	0.00	0.55	-2.28	4.23	5310
$elev_t$	0.63	0.18	0.39	1.13	5310
$ewlev_t$	0.00	0.14	-0.34	0.37	5310

Note: s_t is monetary policy surprise in percent. Δp_{it} is daily stock return in percent (measured as log price change times 100). lev_{it} is firm leverage: long-term debt divided by equity; $\overline{lev}_i$, $wlev_{it}$, $elev_t$, and $ewlev_t$ defined as within text.

3 Empirical Results

3.1 Average effect of a monetary policy surprise

In this section, we discuss the average effect of a RBNZ monetary policy surprise on daily stock market returns over the period from July 5th 2000 to November 9th 2017, *without* controlling for any form of leverage. This is the classic event study approach following Bernanke and Kuttner (2005) and others: Regress the change in asset price on the monetary policy shock. Formally, we run the following regression:

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \epsilon_{it}^p \tag{8}$$

where Δp_{it} is the daily return measured as the log-price change of stock i, s_t is the policy surprise, and the error term ϵ_{it}^p captures all factors other than monetary policy that affect individual stock returns on the event days.

This regression estimates the average effect of a policy surprise over the entire sample, and over all firms. We cluster standard errors at the firm and event level. Results are presented in column 1 of Table 2. We find that a 100 basis points tightening surprise (i.e. positive shock) lowers stock market prices by 2.67 percentage points, and that this effect is highly statistically significant at the 1 percent level. Despite its significance, this effect is around half of what the literature found for the S&P 500 with Federal funds surprises (in the period 1994-2003): Ehrmann and Fratzscher (2004) estimate an effect of 5.5 percentage points, Bernanke and Kuttner (2005) find an effect of 5.3 percentage points. Our estimate is closer to that of Brown and Karpavičius (2017) for Australia, who find an effect of 2.3 percentage points. One possible explanation for the lower sensitivity in Australia and New Zealand is that both are small open economies where firms are generally less affected by domestic monetary policy.

Columns 2 to 6 of Table 2 show that these results are highly robust to alterations in the sample, and *not* driven by a few event days (i.e. surprises) or a few large stock market movements. In the order of the columns, we omit (i) the largest negative surprise in the sample, (ii) the four largest negative surprises, (iii) the four largest positive surprises, (iv) the four largest negative and four largest positive surprises, and (v) the events with the 1 percent highest and 1 percent

Table 2: Average effect of monetary policy surprise on stock returns

	(1)	(2)	(3)	(4)	(5)	(6)
s_t	-2.67***	-2.78***	-3.41***	-2.47***	-3.29***	-2.67***
	(0.86)	(0.93)	(1.06)	(0.94)	(1.24)	(0.70)
Constant	0.20***	0.20***	0.22***	0.21***	0.22***	0.17***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)
Observations	5310	5291	5199	5197	5086	5199

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Note: (1) full sample; (2) excluding Sept 19, 2001 unscheduled event ; (3) excluding four largest negative surprises ; (4) excluding four largest positive surprises ; (5) excluding four largest negative and four largest positive surprises (6) excluding 1 percent largest and 1 percent lowest stock market returns.

lowest changes in stock prices.[13] The estimated sensitivity is slightly stronger if we remove the largest negative surprises, but remain highly significant and economically comparable. We therefore continue our analysis with the full sample.

Is the effect of monetary surprises itself time-varying? To figure this out we estimate equation (8) on a rolling window of 4 years. Figure 2 shows the estimate of $-\beta_0$, placed at the mid-point of the window. The estimates strongly suggest that monetary policy surprises indeed have time-varying effects on stock markets. The effects are strongest between 2005 and 2010, where economy-wide leverage has been large as well (c.f. Figure 1). The analysis in subsequent sections strongly suggests that a large part of this time-variation can be explained by the time-variation in economy-wide leverage.

3.2 Leverage and monetary policy

The previous section confirmed that firms in New Zealand on average react significantly to monetary policy surprises; in line with the existing literature. It also confirmed that these effects vary over time, and hinted at a potential influence of leverage. This section analyses the effect of leverage in detail, in three steps: The first part (section 3.2.1) evaluates whether firms' stock price response varies with their own firm-specific leverage, the second part (section 3.2.2) addresses the impact of economy-wide leverage, and the third part (section 3.2.3) compares the economy-wide to firm-specific leverage. Section 3.3 then addresses the linkage between time-

[13]Specifically, we remove the following negative surprises: For (i), we remove September 19, 2001, an unscheduled event in reaction to the September 11 terrorist attack in the US. The drop in the OCR by 50 basis points came as a surprise and was the largest negative shock over the entire sample period, i.e a 36 basis points surprise drop. For (ii), we remove not only the Sept 19th surprise, but also the next three largest negative surprises (April 24th 2003, September 11 2008 and 29th of January 2009), one large surprise in 2003 and the surprises related to the start of the financial crisis.

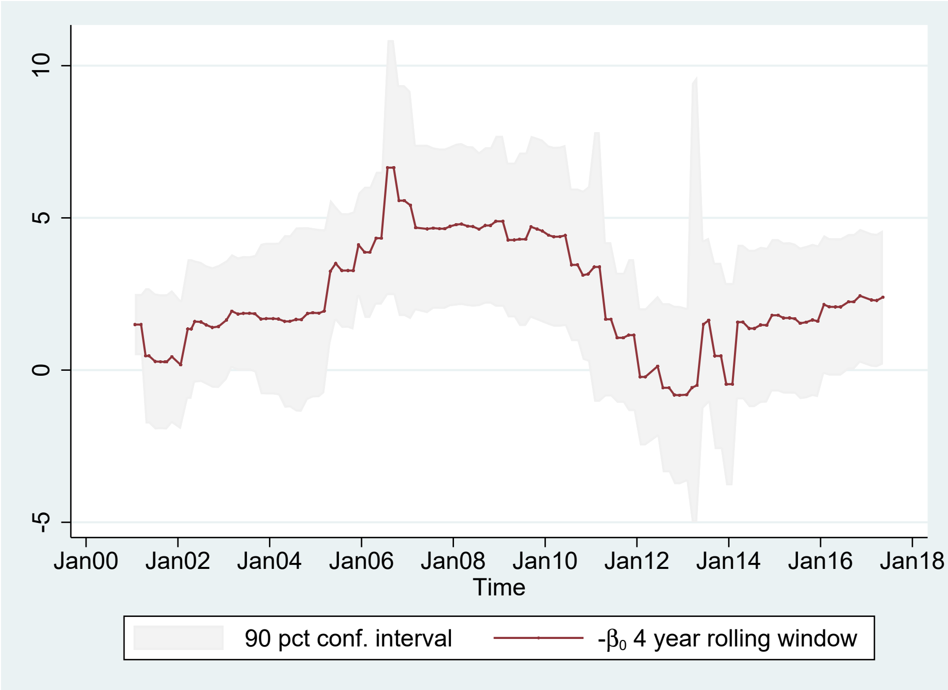

Figure 2: Time-varying effect of policy surprise on stock returns

varying monetary policy effects and leverage.

3.2.1 Firm-specific leverage and monetary policy

In order to evaluate how leverage affects the response of stock prices to monetary policy surprises, we first interact firm-leverage (lev_{it}) with the monetary policy surprise (s_t). Following Ozdagli (2017), we expect firms to react more strongly to monetary surprises when they are more leveraged ($\beta_1 < 0$). We also add the interaction terms separately to allow for the possibility that stock returns vary with the firm-leverage, irrespective of the monetary policy surprises.

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \beta_1 \left[s_t * lev_{it} \right] + \gamma_0 lev_{it} + \epsilon_{it}^p \tag{9}$$

Since firm-leverage can be written as the sum of target-leverage and within-leverage we then use equations (10) to (12) to evaluate whether it is the target or the within component of leverage that matters more (if firm-leverage matters overall), following the discussion in Ottonello and Winberry (2020) and using our definitions (3) to (5) from section 2.2. We first interact each component separately with the surprise, then combine them in equation (12).

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \beta_1 \left[s_t * \overline{lev}_i\right] + \gamma_0 \overline{lev}_i + \epsilon_{it}^p \tag{10}$$

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \beta_1 \left[s_t * wlev_{it}\right] + \gamma_0 wlev_{it} + \epsilon_{it}^p \tag{11}$$

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \beta_1 \left[s_t * \overline{lev}_i\right] + \beta_2 \left[s_t * wlev_{it}\right] + \gamma_0 \overline{lev}_i + \gamma_1 wlev_{it} + \epsilon_{it}^p \tag{12}$$

The first of these three regressions tests whether firms with a different target for leverage react differently to monetary policy shocks. In other words, whether permanent differences in leverage across firms matter. We do not have strong priors on the sign of β_1 for this regression.[14] The second regression tests our hypothesis that higher leverage *than usual*, measured by *within-leverage*, makes the firms more sensitive to unexpected changes in interest rates, and vice versa. Formally, we expect β_1 to be negative ($\beta_1 < 0$). The third regression combines the two interaction terms and measures which of these two components is more important.

Table 3 contains the results of the four regressions (9) to (12), one per column. Firm-leverage clearly matters, as indicated by the first column. Comparing the second to fourth column strongly suggests that it is the variation in *firm within-leverage* ($wlev_{it}$) that matters, and not (the differences in) the time-invariant *target-leverage* ($\overline{lev}_i$): The coefficient on the latter is small and insignificant in the second column, and virtually zero in the fourth column, whereas coefficients for both *firm-leverage* and *within-leverage* are negative and highly significant.

The effects of *firm-leverage* and *within-leverage* are quite noteworthy. A typical increase of one standard deviation in *firm-leverage* (equivalent to 0.87) or *within-leverage* (0.55) increases the response of firms' stock prices to monetary policy surprises by 0.74 percentage points ($-0.85 \cdot 0.87$) or 1 percentage points ($-1.82 \cdot 0.55$). This increase is substantial, comparing it to the general response to the surprises of -2.1 or -2.55 percent: stronger by up to 39 percent. Even when considering the differences in scaling of the two leverage measures, the effect of *within-leverage* on the response to monetary policy surprises is stronger both in absolute numbers and significance, and we use this as our preferred measure going forward.

3.2.2 Economy-wide leverage and monetary policy

In this section, we analyse whether economy-wide leverage matters as well. As in other countries around the world, New Zealand firms became increasingly more leveraged before the Great

[14] According to Ottonello and Winberry (2020), permanent differences in leverage can also be related to other permanent differences across firms that might either increase or decrease the reaction to shocks.

Table 3: Firm-specific leverage and the effect of monetary policy surprise on stock returns

	(1)	(2)	(3)	(4)
s_t	-2.07**	-2.49**	-2.55***	-2.56***
	(0.89)	(0.96)	(0.85)	(0.96)
$s_t * lev_{it}$	-0.85**			
	(0.41)			
lev_{it}	0.02			
	(0.03)			
$s_t * \overline{lev}_i$		-0.28		0.01
		(0.74)		(0.76)
$\overline{lev}_i$		0.01		0.01
		(0.05)		(0.05)
$s_t * wlev_{it}$			-1.82***	-1.82***
			(0.53)	(0.54)
$wlev_{it}$			0.04	0.04
			(0.05)	(0.05)
Constant	0.19***	0.20***	0.20***	0.20***
	(0.06)	(0.07)	(0.06)	(0.07)
Observations	5310	5310	5310	5310

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Financial Crisis (despite substantial increases in the policy rate), and leverage fell dramatically thereafter. We use the economy-leverage ($elev_t$) and the economy-within-leverage ($ewlev_t$) from section 2.2 as interaction variables in the regression to test if the reactions to monetary policy shocks are influenced by this pattern. Formally, we estimate the following two regressions

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \beta_1 \left[s_t * elev_t \right] + \gamma_0 \; elev_t + \epsilon^p_{it} \tag{13}$$

$$\Delta p_{it} = \alpha_0 + \beta_0 s_t + \beta_1 \left[s_t * ewlev_t \right] + \gamma_0 \; ewlev_t + \epsilon^p_{it} \tag{14}$$

Table 4 shows the corresponding results. As suspected, we find that both measures of economy-wide leverage matter quite strongly for the reaction to monetary policy shocks. A one standard deviation increase in the economy-leverage ($elev_t$) (18 percentage points) increases the reaction to a 100 basis points monetary policy surprise by 1.41 percentage points ($0.18 \cdot -7.85$). This effect is statistically significant at the 10 percent level. An increase of one standard deviation

(14 percentage points) in the economy-within-leverage ($ewlev_t$) increases the reaction to a 100 basis points monetary policy surprise by 1.54 percentage points ($0.14 \cdot -10.97$). This effect is statistically significant at the 5 percent level. The estimated effect of both measures is therefore rather similar.

Using the coefficient estimates, it is interesting to compare the reaction between times when leverage is low in the economy and when it is high. The lowest economy-leverage ($elev_t$) in our sample was 0.39, the highest was 1.13. Our estimates imply a total reaction to a 100 basis points monetary policy shock during lowest economy-leverage times of -0.10 percent (2.96-7.85*0.39) versus -5.90 percent during highest economy-leverage times (2.96-7.85*1.13). This is a considerable difference. We find comparable results when we consider the economy-within-leverage ($ewlev_t$): The lowest economy-within-leverage was -0.34, the highest was 0.37. Our estimates imply a total reaction to a 100 basis points monetary policy shock during lowest economy-within-leverage times of 1.79 percent (-1.94-10.97*-0.34) versus -6.00 percent during highest economy-within-leverage times (-1.94-10.97*0.37). Lastly, leverage itself does not change stock price returns, it matters only in interaction with the surprises.

Table 4: Economy-wide leverage and the effect of monetary policy surprise on stock returns

	(1)	(2)
s_t	2.96	-1.94**
	(2.88)	(0.83)
s_t*$elev_t$	-7.85*	
	(4.09)	
$elev_t$	-0.01	
	(0.34)	
$s_t * ewlev_t$		-10.97**
		(4.77)
$ewlev_t$		0.07
		(0.45)
Constant	0.20	0.20***
	(0.21)	(0.06)
Observations	5310	5310

Robust standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.2.3 Firm-specific vs economy-wide leverage

So far, we have analysed the impact of firm-specific and economy-wide leverage separately. Comparing the results of each section, a typical increase in economy-within-leverage ($ewlev_t$) would have a much stronger impact than the same increase in firm within-leverage ($wlev_{it}$), and hint at strong propagation effects. This section compares these two leverages formally.

In order to do so, we interact the monetary policy surprise twice, with one of the firm-specific leverage variables *and* one of the economy-wide leverage variables. Formally, we estimate

$$\Delta p_{it} = \alpha + \beta_0 s_t + \beta_1 \left[s_t * \textit{firm-specific-leverage}_{it}\right] + \beta_2 \left[s_t * \textit{economy-wide-leverage}_t\right] \quad (15)$$
$$+ \gamma_0 \textit{firm-specific-leverage}_{it} + \gamma_1 \textit{economy-wide-leverage}_t + \epsilon^p_{it}$$
$$\text{with } \textit{firm-specific-leverage}_{it} \text{ being one or a combination of } \left\{lev_{it}, \overline{lev}_i, wlev_{it}\right\}$$
$$\text{and } \textit{economy-wide-leverage}_t \text{ being one of } \left\{elev_t, ewlev_t\right\}$$

For the sake of brevity, we only report results for the economy-within-leverage measure ($ewlev_t$), results for the economy-leverage measure ($elev_t$) are available in the Appendix (overall, they are less precisely estimated but tell the same story).

Table 5 presents the results for these regressions, each column representing one or a combination of firm-specific variables together with the economy-within-leverage measure ($ewlev_t$). In all cases, we find economy-within-leverage ($ewlev_t$) to be significant at the 5 percent level. Furthermore, the coefficient estimates for the economy-within-leverage remain very close to those of the previous section, with a range from -9.9 to -11.0. The results for the firm-specific variables change more notably: While firm-leverage (lev_{it}) looses statistical significance (the coefficient also has changed from -0.85 to -0.53 denoting less sensitivity of the firm to lev_{it} when controlling for $ewlev_t$), firm-specific *within-leverage* ($wlev_{it}$) remains highly significant at the 1% level, albeit showing smaller sensitivity (down to -1.1, from -1.8). In either case, part of the earlier estimated impact of firm-specific leverage is thus taken up by our economy-wide leverage measure $ewlev_t$.

The impact of economy-within-leverage on the response to monetary policy surprises is also considerably larger than that of any of our firm-specific leverage measures. A typical, one standard deviation increase in the economy-within-leverage ($ewlev_t$) increases the reaction to a 100 basis points shock by 1.38 percentage points ($0.14 \cdot -9.89$). In comparison, a one standard deviation increase in within-leverage ($wlev_{it}$) increases the reaction to a 100 basis points shock

Table 5: Firm-specific and economy-within-leverage and the effect of monetary policy surprise on stock returns

	(1)	(2)	(3)	(4)
s_t	-1.60*	-1.78*	-1.94**	-1.89*
	(0.90)	(1.03)	(0.84)	(1.00)
s_t*lev_{it}	-0.53			
	(0.37)			
lev_{it}	0.02			
	(0.03)			
$s_t * \overline{lev}_i$		-0.25		-0.08
		(0.76)		(0.77)
$\overline{lev}_i$		0.01		0.01
		(0.05)		(0.05)
s_t* $wlev_{it}$			-1.09***	-1.08***
			(0.31)	(0.36)
$wlev_{it}$			0.03	0.03
			(0.04)	(0.04)
s_t*$ewlev_t$	-10.42**	-10.96**	-9.88**	-9.89**
	(4.79)	(4.77)	(4.76)	(4.76)
$ewlev_t$	0.05	0.07	0.03	0.03
	(0.45)	(0.45)	(0.44)	(0.44)
Constant	0.19***	0.19***	0.20***	0.19***
	(0.07)	(0.07)	(0.06)	(0.07)
Observations	5310	5310	5310	5310

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

"only" by 0.60 percentage points ($0.55 \cdot -1.08$); but would also remain lower using the coefficients from the regression without the economy-within-leverage (1 percentage point).

Our results confirm that *both* firms' within-leverage and the economy-within-leverage affect the firms' reaction to monetary policy shocks (third and fourth columns in Table 5). However, economy-within-leverage clearly leads to stronger effects, in particular once comparing equal rises in firm and economy-within-leverage. To illustrate the relative importance, consider the following thought experiment: If all firms increase their leverage by 10 percentage points, both within-leverage and economy-within-leverage would increase by 10 percentage points. Using the estimates in column 3 of Table 5, this would lead to an increase in the firms' sensitivity to a monetary policy surprise of 100 basis points by 1.1 percentage points.[15] However, 90 percent of this added sensitivity would come from the increase in leverage from *other* firms, and only 10 percent of the effect of the firms own leverage increase. Such a 10 percent rise in economy-within-leverage is nothing extraordinary: The economy-within-leverage rose from -33.88 percent in July 2000 to 36.67 percent in July 2008, just before the Lehman Brothers collapse that heralded the great recession. This is a substantial increase by 70 percentage points in a period of 9 years. Our estimate suggest that in those nine years, the stock market had increased its sensitivity to a 100 basis points shock by -6.9 percentage points ($-9.88 \cdot 0.7$), only due to a rise in economy-within-leverage. The same story holds when using economy-leverage as our measure. (See Table A1 in the Appendix for the estimates.)

3.3 Leverage and time-varying effects of monetary policy

Previous sections have shown that economy-wide leverage in particular has large effects on the response of firms' stock prices to monetary policy surprises. Can this also help explaining the time-varying nature of the impact of monetary policy surprises, as shown in section 3.1?

3.3.1 Economy-wide leverage explains the time-varying effects of monetary policy

Using the estimates of our two measures of economy-wide leverage in Table 4, Figure 3 depicts the contribution of economy-leverage at each point in time ($\beta_0 + \beta_1 * elev_t$) and also shows the 4-year rolling window estimates as depicted earlier in Figure 2. Similarly, Figure 4 depicts the contribution of economy-within-leverage at each point in time ($\beta_0 + \beta_1 * ewlev_t$), together with the 4-year rolling window estimates.

Quite remarkably, both figures clearly show that the contribution of those two measures of economy-wide leverage exhibit a very similar pattern to that of the rolling regressions. This strongly suggests that economy-wide leverage contributes to these time-varying effects. In the next sections we show that this leverage effect is not a proxy for a business cycle effect or a household leverage effect.

[15] The sensitivity increases by ($-1.09*0.1 = -0.11$) with the increase in (firm) within-leverage and ($(-9.88)*0.1 = -0.99$) with the increase in economy-within -leverage, hence by (-1.1) in total.

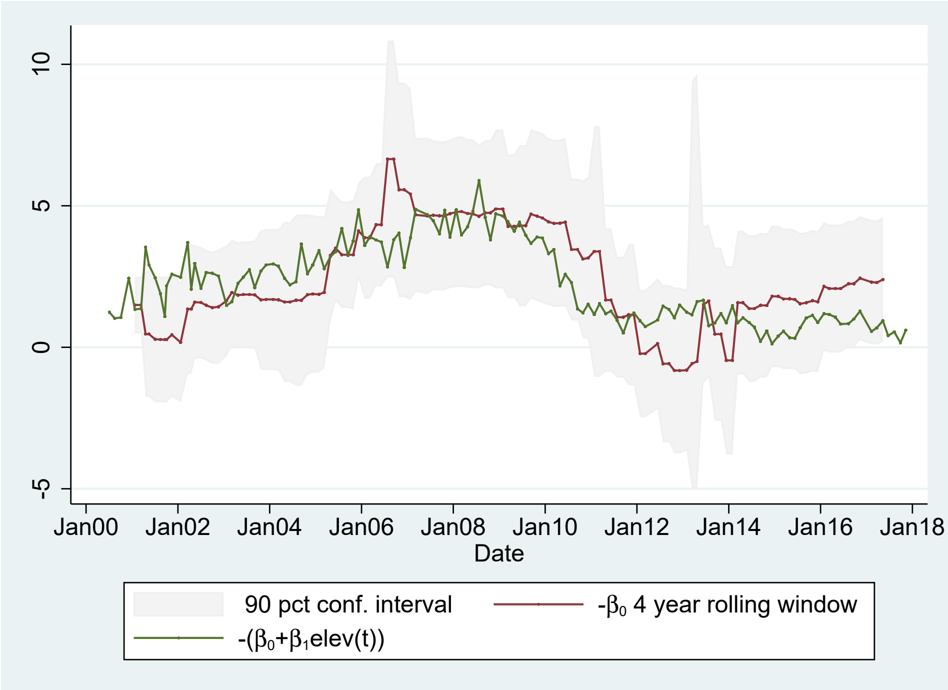

Figure 3: Time-varying effect of monetary policy surprise on stock returns and effect of economy-leverage

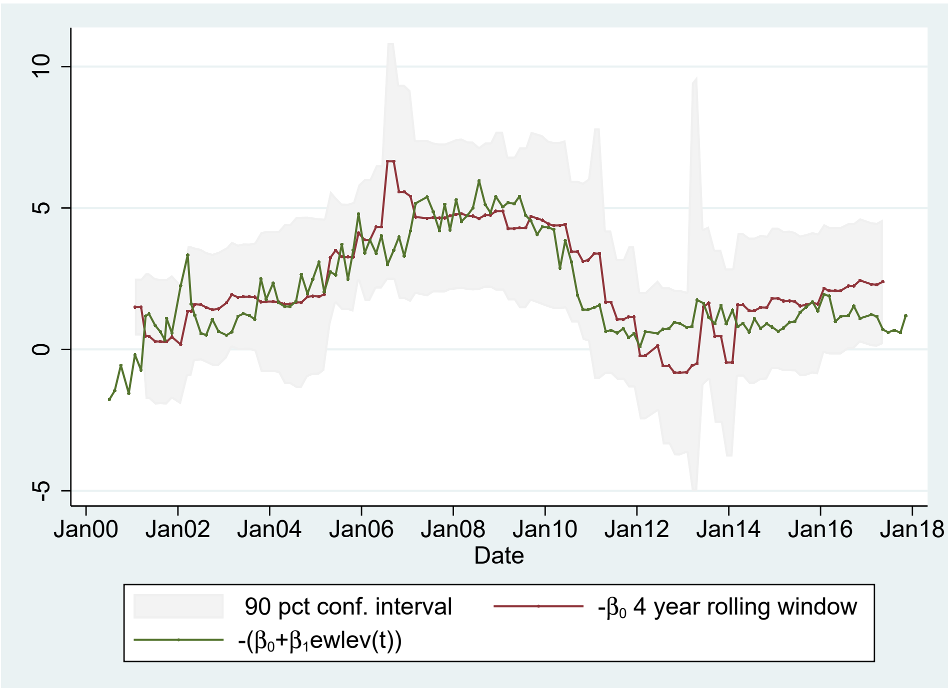

Figure 4: Time-varying effect of monetary policy surprise on stock returns and effect of economy-within-leverage

3.3.2 Is the economy-wide leverage-effect proxying a business cycle-effect?

Is it possible that the economy-wide leverage effect we have found is simply a proxy for a different effect, that of the business cycle? For instance, if the business cycle is a driver of the impact of monetary policy (surprises), and if leverage and business cycle variables are correlated, then leverage might pick up an effect that is actually due to the business cycle. In more formal terms, we might suffer from an omitted variable bias. Real GDP growth in New Zealand, as one proxy for the business cycle, e.g. is negatively correlated with the economy-within-leverage (correlation coefficient of -0.39), high enough to warrant a closer look.

To test if the economy-wide leverage-effect is proxying a business cycle effect we first construct four proxies for the 'business cycle' in New Zealand.

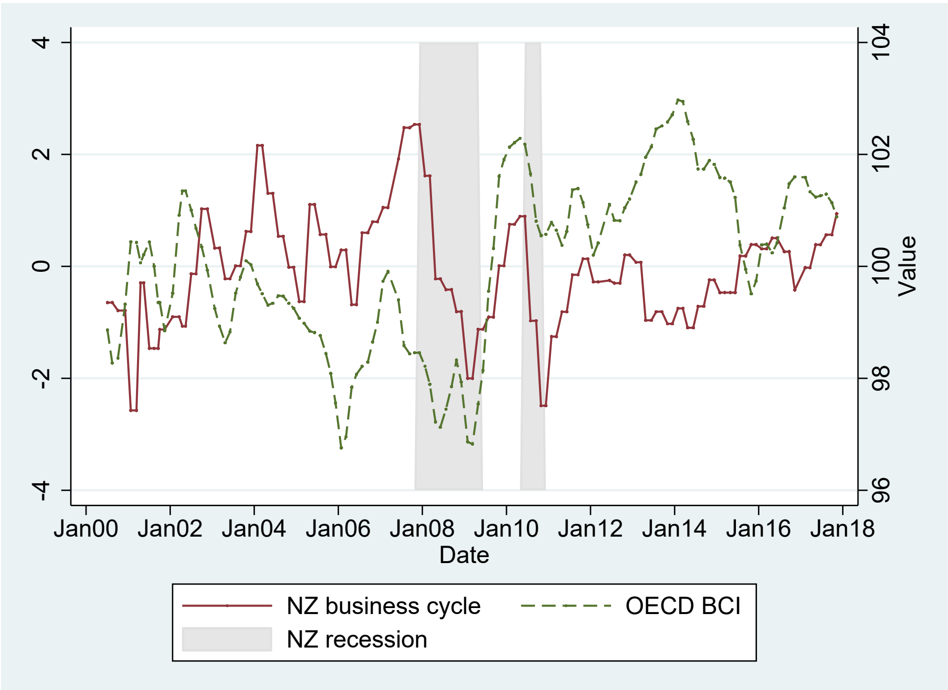

Figure 5: New Zealand business cycle measures

The first proxy is demeaned *real GDP growth* itself ($growth_t$), subtracting the sample mean from annual growth rates.[16] For the second proxy we extract the NZ business cycle from the quarterly log real GDP series using the Hodrick-Prescott filter (with standard smoothing parameter of 1600), ($cycle_t$). The third proxy consists of a *recession dummy*, ($recession_t$). We take the peak and trough dates from the Economic Cycle Institute and set our dummy equal to 1 in the periods between a peak and a trough. The Economic Cycle Institute states that the New

[16]Demeaning the growth rate is done for easy interpretation purposes. In a regression with the growth proxy, the shocks s_t and their interaction, the coefficient on the shock series can then be interpreted as the average reaction (when growth is at its mean).

Zealand economy reached a peak in November 2007 and a trough in Mai 2009, so this coincides with the Great Recession. Another peak was reach in Mai 2010 and a trough in October 2010. This dating gives us two recessions in our sample period. There were a total of 16 events in those two recessions. The fourth proxy is the *OECD business confidence index* for New Zealand, also demeaned, (BCI_t). This is a more direct measure of the confidence of businesses and is more forward looking.

Figure 5 shows the NZ business cycle (i.e. our second proxy) together with the recessions (shaded) and the OECD BCI index (our fourth proxy). The drop in the business cycle proxy, constructed using the HP-filter, indeed coincides with the recessions as identified by the Economic Cycle Institute. The forward-looking index OECD BCI behaves quite differently, recovering more rapidly and staying high after the GFC. Most importantly, the pattern of the NZ business cycle depicted here is quite different than the leverage cycle depicted earlier in Figure 1.

We first test if these proxies have explanatory power per se for the effect of monetary policy shocks on stock prices, and interact each proxy with the monetary policy surprise

$$\Delta p_{it} = \alpha + \beta_0 s_t + \beta_1 \left[s_t * \textit{business-cycle}_t \right] + \gamma_0 \textit{business-cycle}_t + \epsilon^p_{it} \quad (16)$$
$$\text{with} \quad \textit{business-cycle}_{it} \quad \text{being one of} \quad \{growth_t, cycle_t, BCI_t, recession_t\}$$

Table 6 shows the results of regression (16) for the four proxies. None of the interaction terms for the proxies are statistically significant. The point estimate for growth at 0.50 suggest that a 1 percent increase in the annual growth rate reduces the effect by 0.50. However, the effect is imprecisely estimated.

The strongest effect is obtained when the recession dummy is used as a proxy. Basistha and Kurov (2008) and Kurov (2012) have shown that in the US the business cycle has an effect on the strength of the reaction of stock prices to monetary policy of the Federal Reserve Bank, with stronger effects in recessions. We find a point estimate of -3.43 for the interaction term between the surprise and the recession dummy, suggesting that the reaction to a 100 basis points shock increases by almost 3.43 percentage point in a recession. However, the coefficient is rather imprecisely estimated with a standard error of 2.40, and we cannot reject the null that in recessions there is no additional sensitivity. This might be due to the limited number of observations for recessions in NZ (only 16 events). The point estimate of the shock coefficient, representing the effect outside recessions, is -1.77. Hence, although the coefficient on the interaction term between

Table 6: Business cycle and the effect of monetary policy surprise on stock returns

	(1)	(2)	(3)	(4)
s_t	-2.56***	-2.83***	-1.95**	-1.77**
	(0.86)	(0.87)	(0.90)	(0.87)
s_t* $growth_t$	0.50			
	(0.43)			
s_t* $cycle_t$		-0.58		
		(0.51)		
s_t* BCI_t			0.68	
			(0.58)	
s_t* $recession_t$				-3.43
				(2.40)
$recession_t$				0.11
				(0.27)
$growth_t$	0.00			
	(0.03)			
$cycle_t$		0.00		
		(0.05)		
BCI_t			-0.01	
			(0.04)	
Constant	0.20***	0.21***	0.19***	0.18***
	(0.06)	(0.06)	(0.06)	(0.05)
Observations	5310	5310	5310	5310

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the surprise and the recession dummy is statistically insignificant, it points in the direction of a tripling of the effect in recessions (albeit imprecisely estimated), consistent with Basistha and Kurov (2008) and Kurov (2012).

The results so far seem to suggest that business cycle proxies are unlikely to explain the time variation in monetary policy effects. However, does the economy-wide leverage effect remain robust when adding the business cycle proxies to the regression? To evaluate this, we add the business cycle proxies to our earlier regressions with firm-level and economy-wide leverage measures. For the sake of readability, we focus on our baseline leverage variables ($\overline{lev}_i$, $wlev_{it}$, and $ewlev_t$)

$$\Delta p_{it} = \alpha + \beta_0 s_t + \beta_1 \left[s_t * \textit{leverage-variables}_{it}\right] + \beta_2 \left[s_t * \textit{buscycle}_t\right]$$
$$+ \gamma_0 \textit{leverage-variables}_{it} + \gamma_1 \textit{buscycle}_t + \epsilon_{it}^p \tag{17}$$

$$\text{with} \quad \textit{leverage-variables}_t \quad \text{being the vector} \quad \left\{\overline{lev}_i, wlev_{it}, ewlev_t\right\}$$
$$\text{and} \quad \textit{buscycle}_{it} \quad \text{being one of} \quad \{growth_t, cycle_t, BCI_t, recession_t\}$$

Table 7 shows the results of regression 17, each column represents one business cycle proxy. None of the business proxies have a significant impact on the effect of monetary policy shocks, or on stock returns per se (some even have a wrong sign). In contrast, both (firm) within-leverage ($wlev_{ti}$) and economy-within-leverage ($ewlev_{ti}$) remain statistically significant, and show to considerably increase sensitivity to monetary policy shocks . Overall, this strongly indicates that the leverage effects are not proxies for the effects of the business cycle, and seem to contribute to the time-varying effects of monetary policy independently.

Table 7: Firm-specific leverage, economy-within-leverage, business cycle proxies and the effect of monetary policy surprise on stock returns

	(1)	(2)	(3)	(4)
s_t	-1.83*	-2.05*	-2.07*	-1.75*
	(1.03)	(1.05)	(1.08)	(1.02)
$s_t * \overline{lev}_i$	-0.08	-0.07	-0.11	-0.07
	(0.78)	(0.78)	(0.77)	(0.77)
$\overline{lev}_i$	0.01	0.01	0.01	0.01
	(0.05)	(0.05)	(0.05)	(0.05)
s_t* $wlev_{it}$	-1.07***	-1.08***	-1.07***	-1.08***
	(0.35)	(0.35)	(0.35)	(0.36)
$wlev_{it}$	0.03	0.03	0.03	0.03
	(0.04)	(0.04)	(0.04)	(0.04)
s_t*$ewlev_t$	-11.65*	-9.79**	-11.61**	-7.73**
	(5.90)	(4.81)	(5.35)	(3.68)
$ewlev_t$	0.14	0.05	-0.00	-0.11
	(0.50)	(0.47)	(0.47)	(0.34)
s_t*$buscycle_t$	-0.21	-0.55	-0.32	-0.96
	(0.53)	(0.57)	(0.66)	(2.45)
$buscycle_t$	0.02	0.01	-0.01	0.10
	(0.04)	(0.06)	(0.03)	(0.26)
Constant	0.19***	0.20***	0.20***	0.18***
	(0.07)	(0.07)	(0.07)	(0.06)
Observations	5310	5310	5310	5310

$buscycle_t$ is : column (1) $growth_t$; column (2) $cycle_t$, column (3) BCI_t; column (4) $recession_t$

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.3.3 Is the leverage-effect proxying a household leverage-effect?

Is it possible that the economy-wide leverage of firms is a proxy for the leverage of households? Are firms truly reacting to the leverage of firms or are they reacting to the leverage of households? If households are highly leveraged, monetary surprises would be expected to affect household demand and through this expectation channel affect firm stock prices.

We use two standard measures of household leverage. Both measures are regularly used by the RBNZ to monitor the economy.[17] Our first measure is the ratio of household debt to disposable income, which we call household debt to income, $hdebtincome_t$. Our second measure is household debt servicing as a percentage of disposable income, which we call household debt service, $hdebtservice_t$. Both indicators are depicted in Figure 6. Household debt to income increased dramatically up to the GFC, from below 1.2 to almost 1.8 and remained relatively high thereafter. Debt servicing initially increased dramatically before the GFC from around 9 percent to 16 percent Thereafter it shows an equally dramatic drop, which can large be explained by the significant drop in interest rates.

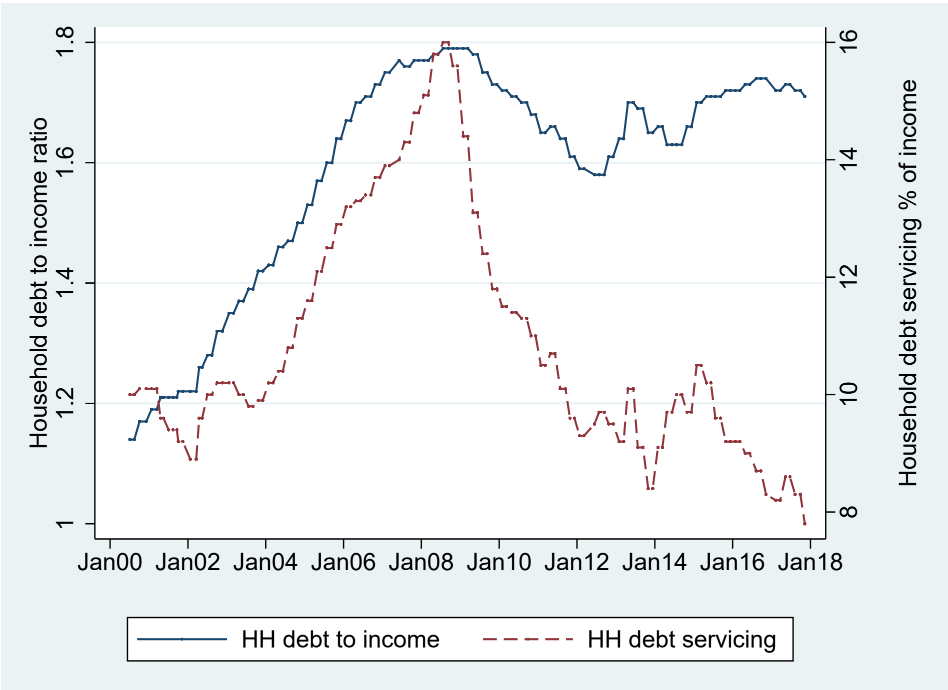

Figure 6: Household leverage cycle in New Zealand

We perform a similar exercise as we did with the business cycle proxies. We first test if these measures of household leverage have any explanatory power on their own. We interact both

[17]These can be obtained from the RNBZ website:https://www.rbnz.govt.nz/statistics/key-statistics/household-debt

measures with the monetary policy surprise and estimate[18]

$$\Delta p_{it} = \alpha + \beta_0 s_t + \beta_1 \left[s_t * \textit{household-leverage}_t\right] + \gamma_0 \textit{household-leverage}_t + \epsilon^p_{it} \tag{18}$$

$$\text{with} \quad \textit{household-leverage}_{it} \quad \text{being one of} \quad \{\textit{hdebtincome}_t, \textit{hdebtservice}_t\}$$

Results of regression 18 are presented in Table 8. Both the coefficient on household debt to income and on household debt servicing are imprecisely estimated and not statistically significant. However, their (large) negative point estimate does suggest it they have some effect. The standard deviation of $hdebtincome_t$ is 0.15 (and the variable ranges from a minimum of -0.36 to a maximum of 0.23), and that of $hdebtservice_t$ is 2.03 (and ranges from a minimum of -2.79 to a maximum of 5.41).The point estimates imply that a one standard deviation increase in household debt to income would lead to an increase in the firms' sensitivity to a monetary policy surprise of 100 basis points by 0.76 percentage points (0.15*-5.09), and 1.28 percentage points respectively (2.03*-.63). Together, these results do seem to suggest that household leverage might matter. However, these results do not prevail in a contest with the explanatory power of the leverage of firms.

To compare firm-specific leverage with household leverage, we add the household leverage proxies to our earlier regression with firm-level and economy-wide leverage. Table 9 shows the results. The coefficient on household debt to income dramatically changes from our earlier point estimate of -5.09 to an insignificant positive number close to zero. Clearly the effect of household debt to income is not robust. In contrast, the point estimates for the (firm) within-leverage and economy-within-leverage coefficients remain close to our earlier estimates. The economy-within-leverage coefficient becomes somewhat less precisely estimated. Also for household debt servicing the coefficient flips sign and becomes an insignificant positive number close to zero. Clearly the effect of household debt servicing is not robust either. Again, (firm) within-leverage and economy-within-leverage coefficients remain close to our earlier estimates. Combined, these results indicate that stock markets did react to the leverage of firms but not to household leverage in New Zealand.

[18]For ease of interpretation, we use again both variables minus their sample mean in the regression. This way the coefficient on s_t has the interpretation of the effect when household leverage is at the sample mean.

Table 8: Household debt to income and debt servicing and the effect of monetary policy surprise on stock returns

	(1)	(2)
s_t	-2.93***	-2.14**
	(0.87)	(0.87)
s_t* $hdebtincome_t$	-5.09	
	(3.15)	
$hdebtincome_t$	0.46	
	(0.28)	
s_t* $hdebtservice_t$		-0.63
		(0.41)
$hdebtservice_t$		0.00
		(0.03)
Constant	0.21***	0.20***
	(0.06)	(0.06)
Observations	5310	5310

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Firm-specific-leverage, economy-within-leverage, household leverage and the effect of monetary policy surprise on stock returns

	(1)	(2)
s_t	-1.95*	-1.89*
	(1.01)	(1.00)
$s_t * \bar{lev_i}$	-0.09	-0.09
	(0.79)	(0.76)
$\bar{lev_i}$	0.02	0.01
	(0.05)	(0.05)
s_t* $wlev_{it}$	-1.07***	-1.07***
	(0.35)	(0.36)
$wlev_{it}$	0.03	0.03
	(0.04)	(0.04)
s_t*$ewlev_t$	-9.28	-13.86*
	(5.93)	(7.68)
$ewlev_t$	-0.16	0.08
	(0.51)	(0.63)
s_t* $hdebtincome_t$	0.29	
	(3.88)	
$hdebtincome_t$	0.46	
	(0.31)	
s_t* $hdebtservice_t$		0.33
		(0.68)
$hdebtservice_t$		-0.00
		(0.05)
Constant	0.19***	0.19***
	(0.07)	(0.07)
Observations	5310	5310

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4 Conclusion

Geanakoplos (2010) was right to warn the Fed, and Panetta (2022) was correct when stating that 'in an environment where leverage in the economy is high, small rate increases might have larger effects'.

We show that leverage matters for the reaction of stock prices to monetary policy shocks in two distinctive ways. First, firms that have higher leverage react stronger to monetary policy shocks. However, it is not so much the leverage as such that matters, but rather whether the firm has higher leverage than usual (the within-leverage). Second, firms' stock prices also respond to the leverage of other firms in the economy (the economy-within-leverage). This effect is much larger than the effect of the firm's individual leverage, about 9 times as strong as an equal increase in firm leverage, and has not been covered by the literature so far. A wide-spread increase in leverage is a clear sign that monetary policy will affect the stock market to a much larger degree. Our results are robust to controlling for a variety of business cycle variables and the leverage of households. This strongly suggests that economy-wide leverage itself contributes to the time-varying effect of monetary policy.

These findings have important implications for the conduct of monetary policy. The effects of monetary policy on the stock market are time-varying, which suggest that the real effects might be time-varying as well. The leverage present in the economy has a strong influence on stock market reactions to monetary policy shocks. This seems to strengthen the case for gradualism. I.e. in the face of a highly leveraged economy, the central bank would be wise to consider changing interest rates more cautiously, or it might get larger reactions than it expects. Our results are derived using a period of traditional monetary policy that uses the interest rate as policy instrument. Further research is needed on the importance of leverage in times of unconventional monetary policy.

References

Balafas, N., Florackis, C., and Kostakis, A. (2018). Monetary policy shocks and financially constrained stock returns: The effects of the financial crisis. *International Review of Financial Analysis*, 58(April):69–90.

Basistha, A. and Kurov, A. (2008). Macroeconomic cycles and the stock market's reaction to monetary policy. *Journal of Banking and Finance*, 32(12):2606–2616.

Bernanke, B. and Gertler, M. (1989). Agency Costs, Net Worth, and Business Fluctuations. *American Economic Review*, 79(1):14–31.

Bernanke, B. S., Gertler, M., and Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. *Handbook of Macroeconomics, in: J. B. Taylor & M. Woodford (ed.), Handbook of Macroeconomics, edition 1, volume 1, chapter 21*, pages 1341–1393.

Bernanke, B. S. and Kuttner, K. N. (2005). What explains the stock market's reaction to federal reserve policy? *The Journal of Finance*, 60(3):1221–1257.

Bernhard, S. and Leong, J. (2022). Unconventional monetary policy surprises for New Zealand – An initial analysis. Unpublished working paper, Reserve Bank of New Zealand.

Brown, A. and Karpavičius, S. (2017). The Reaction of the Australian Stock Market to Monetary Policy Announcements from the Reserve Bank of Australia. *Economic Record*, 93(300):20–41.

Ehrmann, M. and Fratzscher, M. (2004). Taking Stock : Monetary Policy Transmission to Equity Markets. *Journal of Money, Credit and Banking*, 36(4):719–737.

Geanakoplos, J. (2010). The Leverage Cycle. *NBER Macroeconomics Annual*, 24(1):1–66.

Giroud, X. and Mueller, H. M. (2021). Firm leverage and employment dynamics. *Journal of Financial Economics*, 142(3):1381–1394.

Gürkaynak, R. S., Sack, B., and Swanson, E. T. (2005). Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements. *International Journal of Central Banking.*

Jansen, D. W. and Tsai, C. L. (2010). Monetary policy and stock returns: Financing constraints and asymmetries in bull and bear markets. *Journal of Empirical Finance*, 17(5):981–990.

Jansen, D. W. and Zervou, A. (2017). The time varying effect of monetary policy on stock returns. *Economics Letters*, 160(C):54–58.

Jordà, Ò., Schularick, M., and Taylor, A. M. (2013). When credit bites back. *Journal of Money, Credit and Banking*, 45(SUPPL2):3–28.

Kiyotaki, N. and Moore, J. (1997). Credit Cycles. *Journal of Political Economy*, 105(2):211–248.

Kontonikas, A., MacDonald, R., and Saggu, A. (2013). Stock market reaction to fed funds rate surprises: State dependence and the financial crisis. *Journal of Banking and Finance*, 37(11):4025–4037.

Kurov, A. (2012). What determines the stock market's reaction to monetary policy statements? *Review of Financial Economics*, 21(4):175–187.

Mian, A., Sufi, A., and Verner, E. (2017). Household debt and business cycles worldwide. *The Quarterly Journal of Economics*, (October):1755–1817.

Ottonello, P. and Winberry, T. (2020). Financial Heterogeneity and the Investment Channel of Monetary Policy. *Econometrica*, 88(6):2473–2502.

Ozdagli, A. K. (2017). Financial Frictions and the Stock Price Reaction to Monetary Policy. *The Review of Financial Studies*, (617).

Panetta, F. (2022). Normalising monetary policy in non-normal times. Speech by Fabio Panetta, Member of the Executive Board of the ECB, at a policy lecture hosted by the SAFE Policy Center at Goethe University and the Centre for Economic Policy Research (CEPR) [Accessed: 2022 05 30].

Paul, P. (2020). The time-varying effect of monetary policy on asset prices. *Review of Economics and Statistics*, 102(4):690–704.

Rogers, J. H., Scotti, C., and Wright, J. (2014). Evaluating asset-market effects of unconventional monetary policy: a multi-country review. *Economic Policy*, (October).

Schularick, M. and Taylor, A. M. (2012). Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008. *The American Economic Review*, 102(2):1029–1061.

Shibamoto, M. and Tachibana, M. (2014). Individual Stock Returns and Monetary Policy: Evidence from Japanese Data. *The Japanese Economic Review*, 65(3):375–396.

A Table using economy-leverage ($elev_t$)

Table A1: Firm-specific leverage and economy-leverage, and the effect of monetary policy surprise on stock returns

	(1)	(2)	(3)	(4)
s_t	2.96	3.04	2.30	2.28
	(2.88)	(2.91)	(2.83)	(2.84)
s_t*lev_{it}	-0.57			
	(0.38)			
lev_{it}	0.02			
	(0.03)			
$s_t * \overline{lev}_i$		-0.15		0.04
		(0.75)		(0.76)
$\overline{lev}_i$		0.01		0.01
		(0.05)		(0.05)
s_t* $wlev_{it}$			-1.29***	-1.30***
			(0.35)	(0.37)
$wlev_{it}$			0.04	0.04
			(0.04)	(0.04)
s_t*$elev_t$	-7.28*	-7.81*	-6.81*	-6.82*
	(4.09)	(4.10)	(4.02)	(4.03)
$elev_t$	-0.03	-0.01	-0.03	-0.04
	(0.35)	(0.35)	(0.34)	(0.34)
Constant	0.20	0.20	0.22	0.21
	(0.21)	(0.21)	(0.21)	(0.21)
Observations	5310	5310	5310	5310

Robust standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$