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Monetary policy surprises, stock returns, and financial and liquidity constraints, in an exchange rate monetary policy system

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Abstract: This study examines the impact of monetary policy surprises on the stock price behaviour of a small developed economy, whose monetary policy is based on the exchange rate. We find that monetary policy surprises associated with all contractionary policy levers and a neutral policy lever, have a consistently significant and negative impact on stock returns. In comparison, only monetary policy surprises associated with a downward re-centering policy lever, has a significantly positive effect on stock returns. Using a recalibrated classification system, we also find that monetary policy surprises differ across sectors of the economy. Our results show how monetary policy surprises can have a significant impact on the stock market by having a disproportionate effect on sectors that face financial and liquidity constraints.

Keywords: Monetary policy, Sector classification, Financial constraints, Liquidity Constraint

1. Introduction

Research into the relationship between monetary policy and stock returns has focused mainly on large developed economies that adopt an interest rate monetary policy system. Central to much of the work in this area are studies that examine the effect of monetary policy surprises on stock price behaviour around the policy announcement date. Like Bernanke and Kuttner (2005), many of them find that contractionary monetary policy surprises have a negative impact on stock returns, while expansionary monetary policy surprises tends to increase stock returns. In this paper, we shed light on the findings for a small developed economy, whose monetary policy is based on the exchange rate. We obtain these results for Singapore, a country that has adopted an exchange rate monetary policy system over the last forty years, with the primary objective of price stability. Khor, Lee, Robinson, and Supaat (2007), who evaluated the efficacy of Singapore's monetary policy, finds that it has been effective in successfully keeping inflationary pressures in check.

To achieve the price stability objective, the Monetary Authority of Singapore (MAS), the country's central bank, incorporates several key features of the basket, band and crawl (BBC) regime. In the BBC regime, inflationary pressures are managed by adjusting a policy band that comprises a basket of currencies of Singapore's major trading partners. Contractionary monetary policy in this regime involves shifting the policy band upwards or increasing its slope, while expansionary monetary policy involves shifting the policy band downwards or decreasing its slope. The BBC regime also allows for a neutral policy stance, in which the policy band is maintained on a zero slope trajectory. Compared to an interest rate monetary system, this set of five policy levers in the BBC regime allows for a more detailed analysis, since the effect of monetary policy surprises on the stock market can be analyzed with respect to the particular policy lever adopted by the central bank.

Various studies also find that monetary policy effects differ across sectors of the economy. Jansen, Kishan, and Vacaflores (2013), for instance, observe significant heterogeneity across industries in firm-level responses to monetary policy actions. In the context of Singapore, we find that the four broad sectors based on the Singapore Standard Industrial Classification (SSIC) system,

also respond differently to monetary policy surprises. More importantly, the different sector responses to monetary policy surprises may be attributed to the financial and liquidity constraints they face. Of the four main constraints that we analyze, only cash has a significant impact on the stock price response to monetary policy surprises in the domestic-oriented and other industries sector. In the trade-related sector, it is leverage and liquidity. Only in the modern services sector, is the stock price response to monetary policy surprises significant in all four constraints.

Our sector analysis also unearthed the limitations of the current SSIC system for investment analysis. In Singapore, all businesses are classified into their respective industry according to the SSIC system. The SSIC system adopts the basic framework and principles of the International Standard Industrial Classification of All Economic Activities (ISIC) based on the economic activity undertaken by a business entity. When the SSIC system is applied to firms listed on the Singapore Exchange (SGX), about 60% of them are classified in the 'Financial and Insurance Activities' industry.[1] This inordinately large number of firms classified in one particular industry limits the usefulness of the SSIC system for investment analysis. To address this shortcoming, we propose an industry classification system that re-calibrates the SSIC system, resulting in a fully-adjusted and a partially-adjusted system. The partially-adjusted system outperforms the fully-adjusted system based on regression tests, and is selected as the classification system for all firms in this study.

The remainder of the paper is organized as follows. Section 2 describes the exchange rate monetary policy system in Singapore. Section 3 discusses the data and methodology. Section 4 explains our recalibrated industry classification system. Section 5 presents the empirical results. Section 6 examines the impact of financial and liquidity constraints. Section 7 concludes the paper.

2. The exchange rate monetary policy system in Singapore

Monetary policy in Singapore is conducted by the Monetary Authority of Singapore (MAS) with the objective of maintaining price stability that is conducive to the sustained growth of the economy. To achieve this objective, the MAS adopts an exchange rate monetary policy system that has several key features of the basket, band and crawl (BBC) regime popularized by Williamson (1998). In this regime, the Singapore Dollar is managed against an undisclosed trade-weighted basket of currencies of Singapore's major trading partners, with the composition of the basket revised periodically to reflect changes in trade patterns over time. The nominal effective exchange rate (NEER) that is created by the basket of currencies, in fact, provides a more effective means of monitoring movements in the Singapore dollar compared to a single currency, especially given Singapore's diversified trade relationships. Monetary policy is implemented in the BBC regime by allowing the NEER to fluctuate within a policy band, the level and slope of which are announced bi-annually to the market. The policy band also incorporates a crawl feature, whereby the policy band is periodically reviewed to reflect the continuous assessment of the path of the exchange rate, so that it remains consistent with the underlying fundamentals of the economy.[2]

The MAS adopts the exchange rate monetary policy system mainly because the exchange rate has a greater influence on inflation as compared to interest rates for small and open economies like Singapore.[3] As Singapore is too small an exporter or importer to have a discernible effect on international prices, its domestic prices are largely determined by world prices for a given exchange rate. Wilson (2015) highlights that the MAS turned the high import dependence into a virtue by exploiting the strong link between the exchange rate, import prices and domestic prices. Instead of raising interest rates to curb inflation, the MAS appreciates the Singapore dollar, which effectively lowers import prices and increases wholesale and consumer prices, as the impact of appreciation is transmitted through the domestic economy. The Singapore dollar appreciation also indirectly exerts a downward pressure on inflation by reducing the revenues of Singapore-based exporters and effectively lowers their demand for labour and capital.

At the MAS, there is a clear separation between policy formulation and implementation, with the Economic Policy Group responsible for reviewing and recommending the appropriate monetary policy at the Monetary and Investment Policy Meeting (MIPM) for approval. The MIPM is the equivalent of the Monetary Policy Committee of other central banks, and comprises the Chairman of the MAS, the Deputy Chairman, appointed board members and the Managing Director of the MAS. The policy formulation process, in particular, usually begins with the collation of data, a comprehensive survey of the macroeconomic environment, and a consideration of several hypothetical NEER policy paths. This process is supported by a combination of approaches including spreadsheet modelling, industry consultations, and policy simulations using large macroeconometric models. It ends with the decision on monetary policy that is communicated to the public in the form of a Monetary Policy Statement issued on the MAS website twice a year, in April and October.[4]

3. Data and methodology

3.1. Firm-level variables and macroeconomic controls

All information on MAS monetary policy announcement dates and Monetary Policy Statements are obtained from the MAS Website, with the earliest publicly available Monetary Policy Statement dated in February 2001. The MAS website also contains historical data on the 1-month MAS US Dollar/Singapore dollar (USD/SGD) forward swap, which is used to compute the monetary policy surprise variable. As the 1-month MAS USD/SGD forward swap is only available after 3 January 2006, we only include MAS monetary policy announcements from April 2006 to October 2019. Daily stock prices of all SGX-listed stocks are obtained from the WRDS Global Compustat database over the period from December 2005 to December 2019. The extra year of data before 2006 is needed for the estimation period in the event study. Following standard practice, we exclude all firms in the 'Financial and Insurance Activities' industry.[5] We also remove stocks that have less than 60 days of trading volume needed to compute the illiquidity measure in Amihud (2002) and firms with a missing SIC code.

[1] The information on the 347 firms classified in the 'Financial and Insurance Activities' industry was collected from the ACRA Bizlink Portal over the period from February 2020 to June 2020.

[2] The MAS also has the flexibility to intervene and widen the policy band to prevent excessive market volatility, which it has implemented on two occasions over the sample period. This occurred during the MAS monetary policy announcements on 10 October 2001 and 14 November 2010.

[3] The MAS website states that the exchange rate has a much stronger influence on inflation than the interest rate in Singapore since gross exports and imports of goods and services are more than 300 percent of GDP, and domestic expenditure has a high import content.

[4] The earliest Monetary Policy Statement available on the MAS website was dated February 2001. For a few years afterward, the Monetary Policy Statement was released regularly in January and July. Since 2004, however, the MAS changed its release date to April and October, with off-cycle policy announcements made only infrequently. Over the sample period, this only occurred in July 2007 and Jan 2015, due to prevailing macroeconomic developments.

[5] We did not exclude stocks with a share price of less than $0.10, which is typically carried out to mitigate microstructure effects associated with low price stocks, since this had minimal impact on the overall results.

To examine the impact of financial constraints, we also collected quarterly data on total liabilities, long-term debt, 'cash and short-term investments', and total assets for all SGX-listed firms from WRDS Computstat Global Database. Matching quarterly data from the financial statements with twice-yearly MAS monetary policy announcement periods, however, resulted in repeated data observations for firms that change their fiscal year-end over the sample period. For these observations, we select firm-level data based on the fiscal year with the least number of missing financial variables. Where two or more fiscal year-end observations have the same number of missing financial variables, we choose the observation with the most recent quarter.

3.2. Event study

Our analysis uses an event study to examine the impact of monetary policy surprises on SGX-listed stocks around the MAS monetary policy announcement date. Stock price reaction is gauged by estimating the abnormal returns of all firms over the event window based on the forecast errors of a specific normal return generating model. For our analysis, we use the Fama-French 3-factor model with the Straits Times Industrial Index as the market index. The results based on the standard Market Model and the Cahart 4-factor model, as well as the MSCI Singapore Index as the market index, are qualitatively similar. For the estimation window, we use a 100-day period, restricting the minimum estimation period to 30 days, ending 5 days before the MAS monetary policy announcement date. The event study is also conducted for several event windows to determine whether the effects persist over a longer time period.

3.3. Monetary policy surprise variable

Although many studies use the federal fund futures in Bernanke and Kuttner (2005) to devise the US monetary surprise variable, others such as Craine and Martin (2008) obtain monetary policy shocks as a by-product from an estimated vector autoregressive model, adopt time-series specifications and monetary policy rules in Gurkaynak, Sack, and Swanson (2005) and Evans (1998), or estimate the policy surprise based on the heteroskedasticity of policy shocks that take place on particular dates in Rigobon and Sack (2004). In our paper, we devise a simple monetary policy surprise variable, *Surprise*, which is the difference between the 1-month MAS USD/SGD forward swap on the MAS monetary policy announcement date and the prior day, multiplied by −1, so that a positive (negative) surprise is expansionary (contractionary):

$$Surprise = -(f_t - f_{t-1}) \tag{1}$$

where f_t is the 1-month MAS USD/SGD forward swap points on the MAS monetary policy announcement date and f_{t-1} is the prior day's value. The 1-month MAS USD/SGD forward swap points are daily values used to find the expected USD/SGD exchange rate since they represent a discount or premium to the forward USD/SGD exchange rate. *Surprise* effectively captures the market's reaction of future events on the MAS monetary policy announcement date, making it an effective measure of monetary policy surprises that is expansionary (or positive) when *Surprise* is greater than or equal to zero, and contractionary (or negative) otherwise. Although the 1-month MAS USD/SGD forward swap is based on the USD/SGD currency rather than the basket of currencies in the NEER, it is nevertheless a good proxy for the monetary policy surprise variable, since the MAS implements monetary policy by buying and selling US dollars to adjust the policy band. The only downside to using the 1-month MAS USD/SGD forward swap is that it is only available from 2006, restricting the number of MAS monetary policy announcements between 2001 and 2005 that could have been included otherwise.

3.4. Stock liquidity measure

As our analysis includes liquidity as one of the non-financial constraints examined in this study, we also compute the illiquidity measure in Amihud (2002). However, we use the square root version of this measure as suggested in Gopalan, Kadan, and Pevzner (2012) to adjust for skewness. We also multiply it by −1, so that larger values are associated with higher stock liquidity. The final measure, which we denote as *Liquidity*, is given as follows:

$$Liquidity_{i,t} = -\left(\frac{1}{N_{i,t}}\sum_{j=1}^{N_{i,t}}\sqrt{\frac{|r_{i,j}|}{Vol_{i,j}P_{i,j-1}}}\right) \tag{2}$$

where $N_{i,t}$ is the number of trading days for stock i in year t, $r_{i,j}$ is the stock return on day j, $Vol_{i,j}$ is trading volume in millions, and $P_{i,j-1}$ is the closing stock price. *Liquidity* captures the stock return per 1 million Singapore dollars of trading volume. It shows the price impact of the trade and is computed for all SGX-listed stocks.

4. Recalibrating the industry classification system

In this section, we propose an industry classification system that recalibrates the current Singapore Industrial Classification (SSIC) system, resulting in a fully-adjusted and a partially-adjusted system. We also discuss how the classification system in this study is selected, based on the results of regression tests.

4.1. The recalibrated industry classification system

To recalibrate the current industry classification system, we accessed ACRA Bizfile to obtain the SSIC industry classification for all SGX-listed firms in our study.[6] The ACRA Bizfile is the business filing portal of the Accounting and Corporate Regulatory Authority (ACRA), which provides online information on all business entities in Singapore. The Portal adopts the SSIC system, which is the national standard in Singapore for classifying all economic activities, and is adopted from the basic framework of the International Standard Industrial Classification of all Economic Activities Revision 4 (ISIC) developed by the United Nations Statistics Division. The SSIC system has a hierarchical structure that comprises 21 broad categories known as sections, with each section denoted by a single alphabetical letter. The section themselves comprises one or more divisions, which are further classified into smaller units according to a 5-digit coding system.[7]

Using the ACRA Bizfile portal, we find that 347 firms or about 60% of our SGX-listed firms are classified as 'Other Holding Companies' whose relevant section is K in the 'Financial and Insurance Activities' industry. We cite the three following examples to illustrate this occurrence: Yangzigiang Shipbuilding, Propnex Limited and Hyflux Limited. The three firms are placed in the 'Financial and Insurance Activities' industry based on their SSIC classification. Yangzigiang Shipbuilding is, however, a shipbuilding firm that investors would normally classify in the 'Manufacturing' rather than 'Financial and Insurance Activities' industry. Moreover, information from the company's website and its 4-digit SIC code also classifies the firm in 'Shipbuilding and Repairing'. Propnex Limited, a well-known property group in Singapore with a 4-digit SIC code

[6] SSIC codes are not available for REITs and Trusts and hence they do not possess a unique entity number which is required for business filing in ACRA Bizfile. These firms are classified in our analysis in the 'Financial and Insurance Activities' industry.

[7] Singapore Airlines Limited, for instance, is classified under Airlines (Passenger) with a corresponding SSIC industry classification code of 51001, whose relevant section is H in the 'Transportation and Storage' industry.

in 'Real Estate Agents and Managers' and Hyflux Limited, a well-known utilities firm with a 3-digit SIC code in 'Sanitary Services', are also classified by ACRA Bizfile in the 'Financial and Insurance Activities' industry.

On the face of it, the SSIC system would appear to have misclassified the three firms. However, the underlying reason for this occurrence is that the SSIC system classifies firms according to their value-added and naturally selects the business activity with the highest value-added. In all three firms, the business activity with the highest value-added is 'Other Holding Companies', which is classified in the 'Finance and Insurance Activities' industry. About 60% of our SGX-listed firms are classified in this manner, leading to an inordinately large proportion of firms in one industry, limiting the usefulness of the SSIC system for investment analysis. We also observed a similar pattern for a number of firms classified by SSIC system in the 'Administrative and Support Service Activities' industry, where further checks of the affected firms based on local knowledge, information from their company websites, and respective SIC codes, suggest otherwise.[8]

This limitation of the SSIC system can, however, be addressed by recalibrating the classification system to make it applicable for investment analysis. For this purpose, we combine information from the Standard Industrial Classication (SIC) system and the SSIC system,[9] leading to two recalibrated industry classification systems, namely, a fully-adjusted and a partially-adjusted system. In the fully-adjusted system, all firms are re-classified into SSIC industries based on their respective SIC codes.[10] This is done by obtaining the industry description of each firm from their 2-digit SIC code, which is then matched against the description that is closest to the SSIC industry description provided in Table 1. The partially-adjusted system, on the other hand, only re-classifies firms that are classified by the SSIC system into the 'Other Holding Companies' category or 'Administrative and Support Service Activities' industry. All other firms retain the SSIC industry classification assigned by ACRA Bizfile.

4.2. Selecting the industry classification system

Table 2 compares the regression results from the fully-adjusted and the partially-adjusted system. The first set of results are estimates from a regression of industry GDP growth against the corresponding industry stock returns, where industry classification is based on the fully-adjusted system. The second set are regression estimates for the industry classification based on the partially-adjusted system. To choose between the two systems, we first require the estimate on *Coeff* to be statistically significant. Thereafter, we compare the adjusted R^2 for each industry where *Coeff* is statistically significant in both sets of regressions, and choose the system with the higher adjusted R^2. Finally, between the two systems, the one with the larger number of industries chosen is selected as the overall industry classification system. Table 2 shows that *Coeff* is statistically significant in both systems for Business Services, Construction, Transportation & Storage, and Information & Communications. A comparison of the adjusted R^2 in these industries shows that it is higher in all cases for the partially-adjusted system. As such, the partially-adjusted system will be used to classify all SGX-listed stocks into their respective industries.

Table 1
Industry classification criteria.

SIC codes	SSIC industry
7000 <= SIC <= 7099, 5800 <= SIC <= 5899	Accommodation &Food Service
2000 <= SIC <= 3999	Manufacturing
1500 <= SIC <= 1799	Construction
4900 <= SIC <= 4999, SIC=5065	Utilities
0100 <= SIC <= 0999	Agriculture &Fishing
1000 <= SIC <= 1499	Other Goods Industries
5000 <= SIC <= 5199, 5200 <= SIC <= 5799, 5900 <= SIC <= 5999	Wholesale &Retail Trade
4000 <= SIC <= 4799	Transportation &Storage
4800 <= SIC <= 4899, 7370 <= SIC <= 7376, 7800 <= SIC <= 7833, SIC=7313, 7383	Information &Communications
6000 <= SIC <= 6499, 6700 <= SIC <= 6799	Financial &Insurance
6500 <= SIC <= 6599, 7330 <= SIC <= 7336, 7338 <= SIC <= 7349, 8700 <= SIC <= 8999, 7353 <= SIC <= 7363, 7379 <= SIC <= 7382, 8700 <= SIC <= 8999, SIC=7291, 7312, 8111, 7221, 7384, 7311, 7319, 7323, 7322, 7377	Business Services
9000 <= SIC <= 9999, 8200 <= SIC <= 8299, 8300 <= SIC <= 8399, 7900 <= SIC <= 7999, 8400 <= SIC <= 8422, 7200 <= SIC <= 7219, 7230 <= SIC <= 7261, 8000 <= SIC <= 8099, 7520 <= SIC <= 7699, 8600 <= SIC <= 8699, SIC=7299, 7378, 7352, 7389, 7841	Other Services Industries

This table lists the 4-digit SIC codes for each SSIC industry in the recalibrated classification system.

We adopt regression tests to select the classification system, since it provides a simple way to correlate industry returns with a corresponding measure of macroeconomic activity, namely, industry GDP. In this way, the chosen system will more closely align monetary policy actions with stock market performance. The partially-adjusted system also facilitates the grouping of the 11 industries into four broad sectors that are frequently analyzed by the MAS and government agencies. These sectors are the trade-related, modern services, domestic-oriented, and other industries sector. The trade-related sector includes manufacturing, transportation and storage, and wholesale trade; the modern services sector includes financial and insurance activities, business services, and information & communications; the domestic-oriented sector includes construction, utilities, other service activities, other goods industries, and retail trade; and the other industries sector comprise all remaining industries not included in the other sectors, which are mainly small and largely tourism-related firms that include accommodation as well as arts, and entertainment & recreation. Table 3 shows the detailed list of SSIC industries and firms with 4-digit SIC codes that make up the respective sectors.

5. Empirical results

In this section, we use a firm-level event study with panel data to examine the impact of monetary policy surprises on stock returns. We first analyze the impact of monetary policy surprises associated with each of the five policy levers in the BBC regime. Using the sector classifications based on the partially-adjusted system, we also examine how different sectors respond to monetary policy surprises.

5.1. The effect of monetary policy surprises on stock returns

The MAS adopts an exchange rate monetary system that has several key features of the BBC regime, where the Singapore dollar

[8] Creative Technologies, for example, is classified in 'Administrative and Support Service Activities' instead of 'Manufacturing' or 'Information & Communications'. We re-classified the firm in 'Information & Communications' based on information provided on the company's website and its SIC code.

[9] The SSIC system, which is adopted from the basic framework of the International Standard Industrial Classification of all Economic Activities Revision 4 (ISIC), is a completely different classification system from the SIC. While both systems are comparable at certain levels, they are, however, entirely independent from one another.

[10] Firms with SIC codes of 5000–5199 (Wholesale Trade) and SIC codes of 5200–5999 (Retail Trade) are combined to match the 'Wholesale and Retail Trade' industry in the SSIC system.

Table 2
Regression results from the recalibrated industry classification systems.

	Fully-adjusted			Partially-adjusted		
	Coeff	Obs	R^2	Coeff	Obs	R^2
Manufacturing	−0.0030	9338	0.3483	0.0460	8657	0.3481
	(−0.28)			(1.19)		
Business Services	0.0538***	2712	0.4354	−0.0024*	3532	0.4384
	(3.15)			(−1.95)		
Construction	−0.0243***	1597	0.5942	−0.0237***	1646	0.5982
	(−4.69)			(−4.71)		
Utilities	−0.0282	589	0.0498	−1.3150***	477	0.0517
	(−0.50)			(−4.75)		
Wholesale &Retail Trade	−0.0014	4823	0.5355	−0.0012	4946	0.5382
	(−1.16)			(−0.89)		
Transportation &Storage	−0.0300***	1308	0.2153	−0.0213*	1170	0.2156
	(−3.40)			(−1.87)		
Other Goods Industries	−1.8662	1255	0.0907	−0.1248	1274	0.0902
	(−1.06)			(−0.96)		
Information &Communications	0.0059***	819	0.0837	0.0006***	920	0.0857
	(22.18)			(21.96)		
Financial &Insurance	−0.4000	2314	0.3265	0.4056	2255	0.3259
	(−0.88)			(0.82)		
Accommodation &Food Service	0.3343	948	0.3437	0.2201***	945	0.3438
	(0.83)			(2.33)		
Other Services Industries	−0.0106	1339	0.2880	0.0241	1443	0.2856
	(−0.09)			(0.22)		

This table compares the regression results of the two recalibrated classification systems. *Coeff* is the estimated coefficient of the regression, *Obs* is number of firm-event observations, and R^2 refers to the overall R^2 for each regression. Figures in parentheses are *t*-statistics, where ***, ** and *, refers to significance at the 1, 5 and 10 percent level, respectively.

is managed against the NEER, the trade-weighted basket of currencies. Accordingly, monetary policy is implemented by allowing the NEER to fluctuate within a policy band, with the level and slope of the policy band forming the respective policy levers in this regime. Contractionary monetary policy is effected by re-centering the policy band upwards, increasing the slope of the policy band, or combining both policy levers to create a more abrupt effect on economic activities.[11] In contrast, expansionary monetary policy is carried out by re-centering the policy band downwards, decreasing the slope of the policy band, or combining both policy levers. The neutral policy stance forms the last policy lever in the BBC regime, which results from maintaining the policy band on a zero slope trajectory for at least two MAS monetary policy announcement periods.[12]

According to Campbell (1991) and Bernanke and Kuttner (2005), if stocks are priced according to the discounted present value model, a surprise increase in the monetary policy rate can decrease stock prices by decreasing expected future dividends, increasing the future risk-free rate, or increasing the equity premium required to hold equities. In an exchange rate-centred monetary policy regime, contractionary monetary policy causes the exchange rate to appreciate, making goods and services produced in Singapore less competitively priced in world markets in the short term. The strengthening of the currency also means that the prices of imported goods will be lower when converted into Singapore Dollars, dampening the domestic demand for Singapore-produced goods, as consumers substitute imported goods for Singapore-produced goods. The fall in both external and domestic demand for Singapore-made products and services consequently lowers production, leading to a weaker demand for capital and labour inputs. In terms of the discounted present value model, the surprise increase in monetary policy reduces the revenues of SGX-listed firms as overall demand for their products fall. This, in turn, decreases stock prices by decreasing expected future dividends. The extent of the stock price decline, however, depends on the type of policy lever applied by the MAS, with a re-centering of the policy band expected to have a larger impact on stock prices.

Expansionary monetary policy, on the other hand, causes the exchange rate to depreciate, raising exports initially, as Singapore-produced goods become cheaper in international markets. However, the currency depreciation also raises the costs of imports of intermediate inputs used for production in Singapore. So, while expansionary policy increases production and the demand for capital and labour inputs, the higher cost of imported capital and labour, however, partially offsets its positive impact on revenue. In the context of the discounted present value model, only a large enough policy surprise can therefore increase revenues significantly. This suggests that only a policy surprise associated with a downward

Table 3
Sector classification criteria.

SSIC industry &4-digit SIC code	Sector
Manufacturing, Transportation &Storage, 5000 <= SIC <= 5199	Trade-related
Financial &Insurance, Business Services Information &Communications	Modern Services
Other Goods Industries, Construction, Other Service Industries, Utilities, 5200 <= SIC <= 5799, 5900 <= SIC <= 5999, 8200 <= SIC <= 8299, 8000 <= SIC <= 8099, 8300 <= SIC <= 8399, 7230 <= SIC <= 7261, 7200 <= SIC <= 7219, 7520 <= SIC <= 7699, 8600 <= SIC <= 8699, 9000 <= SIC <= 9999, SIC = 7352, 7378, 7389, 7299, 7841	Domestic-related
All remaining industries	Other Industries

This table lists the SSIC industries and 4-digit SIC codes for each sector.

[11] In our analysis, we consider the combination of the upward re-centering and increase in the policy slope as an upward re-centering, since the effect of an upward re-centering significantly dominates the effect of a slope increase. Moreover, this combination of policy levers has only occurred on one occasion during the sample period, on 14 March 2010.

[12] We consider a zero slope policy announcement following an earlier contractionary policy announcement as expansionary, and a zero slope policy following an earlier expansionary policy announcement as contractionary.

Table 4
The effect of monetary policy surprises on stock returns.

	With GFC and year fixed effects					Without GFC and year fixed effects				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Neutral × Surprise	−0.2480*					−0.0228*				
	(−2.48)					(−2.86)				
Recenter Down × Surprise		0.9147*					1.0417*			
		(7.49)					(9.29)			
Recenter Up × Surprise			−0.0515*					−0.0067		
			(−7.26)					(−1.35)		
Slope Increase × Surprise				−0.0096*					−0.0018	
				(−5.17)					(−1.34)	
Slope Decrease × Surprise					−0.0065					−0.0067
					(−1.75)					(−1.66)
GFC	−0.0131*	−0.0135*	−0.0133*	−0.0253*	−0.0132*					
	(−2.50)	(−2.58)	(−2.53)	(−4.20)	(−2.52)					
Constant	0.0156*	0.0158*	0.0156*	0.0312*	0.0156*	0.0009*	−0.0015*	0.0002	0.0005*	0.0020+
	(3.92)	(3.98)	(3.93)	(5.84)	(3.92)	(4.89)	(−7.38)	(1.03)	(6.03)	(2.06)
Observations	11,551	11,551	11,551	11,551	11,551	11,551	11,551	11,551	11,551	11,551
Adjusted R^2	0.009	0.012	0.010	0.009	0.009	0.000	0.008	0.000	0.000	0.001
Year fixed effects	Yes	Yes	Yes	Yes	Yes	No	No	No	No	No
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the results from the estimating the following equation around MAS monetary policy announcement dates:
$CAR_{i,t} = \alpha + \beta_1(Policy_t \times Surprise_t) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t}$

re-centering is likely to have a significant impact on stock returns.[13]

In essence, the BBC regime has five policy levers: an upward re-centering, a slope increase, a downward re-centering, a slope decrease, and a neutral policy stance. To examine the impact of monetary policy surprises resulting from each of the five policy levers, we estimated regressions of the cumulative abnormal returns (CAR) obtained from the event study against an interaction term between *Surprise* and the particular policy lever, *Policy*. Since the sample period includes the global financial crisis, our regression models also include a dummy variable, *GFC*, in addition to year and firm fixed effects. We include *GFC* to control for the effects of crisis periods on monetary policy highlighted in Basistha and Kurov (2008), who finds a stronger response of stock returns to monetary policy surprises during a recession and in tight credit market conditions. The full model specification is given as follows:

$$CAR_{i,t} = \alpha + \beta_1(Policy_t \times Surprise_t) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t} \quad (3)$$

where $CAR_{i,t}$ is the cumulative abnormal return for stock i at time t. $Policy_t$ takes the value of 1 for the particular policy lever at time t, and is zero otherwise. GFC_t takes the value of 1 for all observations after 2008, and is zero otherwise, $Year_t$ refer to year fixed effects, and $FE_{i,t}$ refer to firm fixed effects.

Table 4 presents the results for two sets of regressions with each numbered column representing a particular policy lever. Column (1) reports the results for a neutral policy stance, column (2) for a downward re-centering, column (3) for an upward re-centering, column (4) for a slope increase, and column (5) for a slope decrease. The first set of results control for *GFC* and year fixed effects, while the second set do not.[14] In all regressions, the interaction term between *Policy* and *Surprise* provides a formal test for the impact of the monetary policy surprises on stock returns. The first set of results shows that contractionary policy surprises have a negative and statistically significant impact on stock returns. An upward re-centering causes stock returns to fall by about 5 basis points (bps). In comparison, the policy surprise from a slope increase leads to stock returns falling by only 1 bps. Between the two expansionary monetary policy levers, only a downward re-centering has a positive and significant impact, increasing stock returns by about 91 bps. This is consistent with the expectation that a slope reduction would have little impact on stock returns. The results also show that, in absolute terms, the policy surprise from a downward re-centering has the most pronounced effect on stock returns.

The results without the *GFC* and year fixed effects in the second set of regressions are included to highlight how excluding crisis periods could potentially produce spurious results. For instance, the policy surprise from an upward re-centering, while negative, is statistically insignificant. Even when the sign of the estimates are correct, the results for the policy surprise from the neutral policy stance is underestimated by more than ten times. Notably, the coefficients on *GFC* are all negative and statistically significant in all regressions.

5.2. Sector responses to monetary policy surprises

To examine the impact of monetary policy surprises by sector, we regress *CAR* on the MAS monetary policy announcement date against the interaction term comprising *Surprise*, *Policy*, and a sector dummy variable, *Sector*, as follows:

$$CAR_{i,t} = \alpha + \beta_1(Sector_i \times Surprise_t \times Policy_t) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t} \quad (4)$$

where $CAR_{i,t}$ is the cumulative abnormal return for stock i at time t. $Policy_t$ takes the value of 1 for the particular policy lever at time t, and is zero otherwise. $Sector_i$ takes the value of 1 for the particular sector, and is zero otherwise. GFC_t takes the value of 1 for all observations after 2008, and is zero otherwise. $Year_t$ refer to year fixed effects and $FE_{i,t}$ refer to firm fixed effects.

The effects of expansionary and contractionary policy on earnings follows from the discussion in Section 5.1. While contractionary monetary policy reduces the revenues of SGX-listed firms, its effect however varies by sector. Firms in the trade-related sector, whose exports become less competitive globally as the currency appreciates, tend to experience the largest drop in revenue across all sectors. In terms of the discounted present value model, this means that stock returns in this sector are likely to have the most negative response to contractionary monetary policy surprises. By

[13] The effect on a neutral monetary policy stance on stock returns is ambiguous. Movements in stock prices that occur when the MAS implements a neutral policy stance may be the result of firm-specific factors, since there is no change in currency with this policy tool.

[14] The estimates of the firm fixed effects and year fixed effects have the correct signs and are statistically significant in almost all regressions.

Table 5
Sector responses to monetary policy surprises.

	Neutral	Recenter Down	Recenter Up	Slope Increase	Slope Decrease
Domestic-oriented × Surprise × policy	−0.2710*	1.2322*	−0.0423*	−0.0037	−0.0013
	(−2.59)	(5.47)	(−5.30)	(−1.07)	(−0.55)
Modern Services × Surprise × Policy	−0.2417+	1.1681*	−0.0528*	−0.0154*	−0.0034
	(−2.31)	(5.14)	(−7.13)	(−3.70)	(−1.31)
Other Industries × Surprise × Policy	−0.2321+	0.5889*	−0.0458*	−0.0119+	0.0003
	(−2.26)	(2.67)	(−6.33)	(−2.25)	(0.17)
Trade-related × Surprise × Policy	−0.2424*	0.7415*	−0.0553*	−0.0094*	−0.0112
	(−2.50)	(4.03)	(−5.44)	(−5.04)	(−1.51)
GFC	−0.0132*	−0.0135*	−0.0133*	−0.0258*	−0.0130*
	(−2.52)	(−2.58)	(−2.53)	(−4.22)	(−2.48)
Constant	0.0156*	0.0158*	0.0157*	0.0316*	0.0155*
	(3.93)	(3.97)	(3.93)	(5.84)	(3.92)
Observations	11,551	11,551	11,551	11,551	11,551
Adjusted R^2	0.01	0.012	0.01	0.009	0.009
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes

This table presents the results from estimating the following equation around MAS monetary policy announcement dates:
$CAR_{i,t} = \alpha + \beta_1(Sector_i \times Surprise_t \times Policy_t) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t}$

the same token, the trade-related sector is also expected to benefit the least from expansionary monetary policy. While currency depreciation leads to an increase in production, the increased cost of imported intermediate goods partially offsets its positive impact on revenues in this sector, which rely heavily on imported raw materials and intermediate components. As a result, stock returns in the trade-related sector are also likely to have the least positive response to expansionary monetary policy surprises.

In Table 5, each column presents the results for each policy lever, with the first four rows reporting the findings for each sector. Expansionary monetary policy surprises from a downward re-centering has the expected stock price reaction, with all sectors responding positively. The domestic-oriented sector benefits the most, with the policy surprise from a downward re-centering increasing stock returns in this sector by about 123 bps. Relative to other sectors, the trade-related sector benefits the least due to its heavy reliance on intermediate inputs, where stock returns increase by only 74 bps. In comparison, the policy surprise from a slope decrease has no statistically significant impact on stock return in all sectors. The result is consistent with the expectation that only a larger policy surprise will have a significant impact on stock returns.

Contractionary monetary policy surprises, on the other hand, have a significant and negative impact on almost all sectors. Exports in the trade-related sector are hit the hardest when the currency strengthens, and is reflected in this sector experiencing the largest drop in stock returns of about 6 bps when the policy surprise is associated with a upward re-centering. Notably, in all cases, the policy surprise from an upward re-centering has a significantly larger negative effect on stock returns as compared to a slope increase. It is about 3 times higher in the modern services sector and about 11 times higher in the domestic-oriented sector.[15] Also, while the policy surprise from a slope increase is statistically significant, its impact in economic terms is small relative to an upward re-centering, with the average drop in stock returns across all sectors of about 1 bps. Finally, monetary policy surprises from the neutral policy stance have a consistently negative and significant impact on stock returns in all sectors, with the domestic-oriented sector experiencing the largest drop in stock returns. On average, the stock returns in this sector falls by about 27 bps.

6. The impact of financial and liquidity constraints

In this section, we examine whether financial and liquidity constraints impact the stock price behaviour of firms to monetary policy surprises in an exchange rate monetary policy system. We also apply this analysis by sector and show that each sector's response to monetary policy surprises may be explained by the financial and liquidity constraints they face.

6.1. Firm-level responses to monetary policy surprises

In a recent study, Chava and Hsu (2020) finds that a hypothetical unanticipated increase in the Fed funds rate by 1% leads to the cumulative returns for firms facing financial constraints falling by about 7% on average over the 4-day period following the monetary policy announcement. This drop in returns is mainly due to external funds being more costly than internal funds for financially constrained firms, affecting their ability to invest in positive net present value projects, and hence leading to a negative impact on firm value. In this study, we also examine how financial constraints impact the stock price response to monetary policy surprises. Unlike Chava and Hsu (2020), who construct a financial constraint proxy based on Whited and Wu (2006), our study however analyzes the impact of three financial constraints separately. Our choice of firm size, cash and leverage, as financial constraints is motivated by studies which include Ehrmann and Fratzscher (2004), who finds that small, low cash flow, poor credit rating and low leverage firms, react more to monetary policy surprises. We also include liquidity as a non-financial constraint based on Kashyap, Lamont, and Stein (1994), who finds that liquidity constrained firms experience a larger impact when monetary policy tightens.

We compute *Cash* as the ratio of 'cash and short term investments' to total assets, *Mktcap* as the natural logarithm of market capitalization, and *Liquidity* based on the adjusted Amihud measure discussed in Section 3.4. For leverage, we compute two related measures, *Debt1* and *Debt2*. *Debt1* is defined as the ratio of long-term debt to total assets, while *Debt2* is defined as the ratio of long-term liabilities to total assets. We sort all firms at the end of each year according to these variables and designate the lowest decile as the financially constrained portfolio of firms. Accordingly, *Low Cash* takes the value of 1 for firms in the lowest decile for *Cash*, and is

[15] When compared in absolute terms, the upward re-centering also pales in comparison to the downward re-centering, where it is about 13 times lower in the trade-related sector and about 24 times lower in the domestic-oriented sector.

zero otherwise. We create similar dummy variables for the remaining constraints, forming *Low Mktcap*, *Low Liquidity*, *Low Debt1* and *Low Debt2*.[16] The dummy variables for the four constraints are used in the following regression to examine their impact on the stock's response to monetary policy surprises:

$$CAR_{i,t} = \alpha + \beta_1(FC_{i,t} \times Surprise_t) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t} \quad (5)$$

where $CAR_{i,t}$ is the cumulative abnormal return for stock i at time t. $FC_{i,t}$ takes the value of 1 for the respective financial or liquidity constraint for firm i at time t, and is zero otherwise. GFC_t takes the value of 1 for all observations after 2008, and is zero otherwise. $Year_t$ refer to year fixed effects and $FE_{i,t}$ refer to firm fixed effects.

Table 6 presents the results showing the impact of the financial and liquidity constraints on stock returns. For each constraint, we also report the results for the (−1, 0) event window, which refers to the 2-day period from one day before the MAS monetary policy announcement date to the MAS monetary policy announcement date, and the (0,0) event window, which refers to the 1-day period on the MAS monetary policy announcement date. We test the impact of each constraint by the statistical significance of the interaction term between *FC* and *Surprise*.[17] When the financial constraint is *Low Cash*, we observe a negative and significant response towards monetary policy surprises in both event windows. Stock returns fall by about 2.4 bps during the (−1,0) event window and about 1.5 bps on the MAS monetary policy announcement date, suggesting that the impact of the policy surprise persists when the financial constraint is *Low Cash*.

Firm size also matters with respect to monetary policy surprises, with stock returns falling by about 1.3 bps in the (−1,0) event window when the financial constraint is *Low Mktcap*. Stock returns also fall by about the same amount on the MAS monetary policy announcement date when the constraint is *Low Liquidity*. For *Low Debt1*, where leverage is defined as the ratio of long-term debt to total assets, the interaction term between *Surprise* and *Debt1* is not statistically significant in both event windows, suggesting that leverage does not significantly impact the stock price response to monetary policy surprises. However, using *Low Debt2*, where leverage is defined as the ratio of long-term liabilities to total assets, stock returns fall by about 0.8 bps in the (−1,0) event window and about 0.6 bps on the MAS monetary policy announcement date. The different responses arising from *Low Debt1* and *Low Debt2* may be explained by SGX-listed firms relying more on bank financing rather than corporate debt issuance as a source of external funds, making *Low Debt2* the more appropriate measure of leverage. Fig. 1 shows that the median value of *Debt1* was, on average, only about 10% of *Debt2* over the sample period. In what follows, we will consider *Low Debt2* as the relevant proxy for *Low Leverage*.

6.2. Sector responses to monetary policy surprises

Figs. 2–5 plot median values of the financial and liquidity constraints over the sample period. A cursory observation of the various time plots provide a casual inference regarding the sector that would most likely be impacted by a particular constraint. Fig. 2, for instance, shows that the other industries sector has consistently the lowest median value of *Debt2*, implying that *Low Leverage* is more likely to have a significant impact on the response

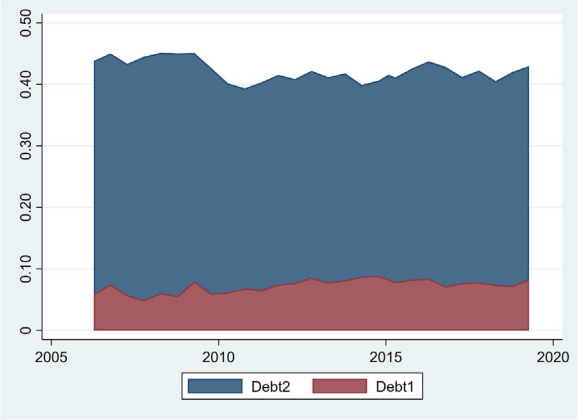

Fig. 1. Median values of *Debt*1 and *Debt*2 for SGX-listed Firms, 2006 to 2019.

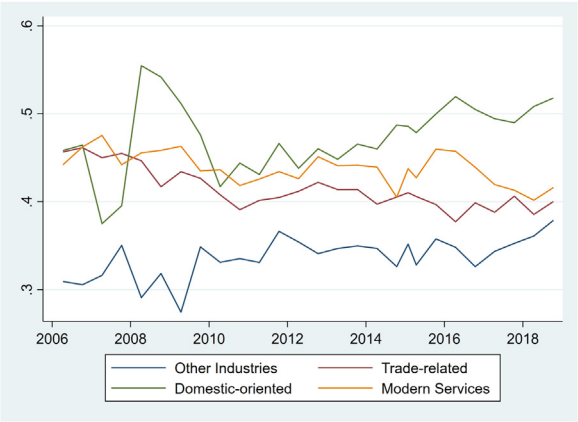

Fig. 2. Median value of *Debt*2 for all Sectors, 2006–2019.

of stock returns to monetary policy surprises in this sector, relative to the other sectors. At the same time, the domestic-oriented sector, which has the highest median value of *Debt2*, also implies that *Low Leverage* is unlikely to have any significant impact in this sector. Figs. 3 and 4, on the other hand, shows the trade-related sector having the lowest median values for *Mktcap* and *Liquidity* among all sectors, implying that *Low Mktcap* and *Low Liquidity* are more likely to significantly impact the stock price response to monetary policy surprises in this sector. Fig. 5 however does not clearly indicate any sector with the lowest median value for *Cash*. While the graphical analysis is useful in highlighting the financial and liquidity constraints that are likely to impact the sector's response to monetary policy surprises, this approach however treats each constraint in isolation when sectors can, in fact, be impacted by more than one constraint at one time.

We augment the graphical analysis by estimating the following equation, where the statistical significance of the interaction term comprising *Surprise*, *FC* and *Sector*, provides a formal test of the impact of the financial and liquidity constraints on monetary policy surprises in each sector:

$$CAR_{i,t} = \alpha + \beta_1(Sector_i \times Surprise_t \times FC_{i,t}) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t} \quad (6)$$

where $CAR_{i,t}$ is the cumulative abnormal return for stock i at time t. $FC_{i,t}$ takes the value of 1 for the respective financial or liquidity constraint for firm i at time t, and is zero otherwise. $Sector_i$ takes the value of 1 for a particular sector, and is zero otherwise. GFC_t takes the value of 1 for all observations after 2008, and is zero otherwise. $Year_t$ refer to year fixed effects and $FE_{i,t}$ refer to firm fixed effects.

[16] *Low Mktcap* takes the value of 1 for firms in the lowest decile for *Mktcap*, and is zero otherwise; *Low Liquidity* takes the value of 1 for firms in the lowest decile for *Liquidity*, and is zero otherwise; *Low Debt1* takes the value of 1 for firms in the lowest decile for *Debt1*, and is zero otherwise; and *Low Debt2* takes the value of 1 for firms in the lowest decile for *Debt2*, and is zero otherwise.

[17] The interaction term between *FC* and *Surprise* is not statistically significant for event windows extending beyond the announcement date, suggesting little evidence of a delay in the response of monetary policy surprises on stock returns.

Table 6
The effect of monetary policy surprises on stock returns with financial and liquidity constraints.

	Low Cash		Low Mktcap		Low Leverage		Low Liquidity	
	(−1,0)	(0,0)	(−1,0)	(0,0)	(−1,0)	(0,0)	(−1,0)	(0,0)
Low Cash × Surprise	−0.0244+	−0.0153*						
	(−2.24)	(−2.66)						
Low Mktcap × Surprise			−0.0125*	−0.0073				
			(−2.42)	(−1.91)				
Low Debt1 × Surprise					−0.1166	−0.0412		
					(−1.15)	(−1.22)		
Low Debt2 × Surprise					−0.0078+	−0.0056+		
					(−2.29)	(−2.29)		
Low Liquidity × Surprise							−0.0015	−0.0122*
							(−0.08)	(−3.00)
GFC	0.0011	−0.0171	0.0131	−0.0096	0.0268	0.0130	−0.0029	−0.0300
	(0.08)	(−1.22)	(0.99)	(−0.77)	(1.77)	(1.05)	(−0.14)	(−1.92)
Constant	0.0125	0.0252+	0.0011	0.0105	−0.0140	0.0018	0.0137	0.0265
	(0.98)	(2.15)	(0.12)	(1.56)	(−1.15)	(0.18)	(0.58)	(1.75)
Observations	3070	3068	3451	3451	3077	3068	3427	3427
Adjusted R^2	0.019	0.022	0.012	0.018	0.020	0.021	0.009	0.018
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents results from estimating the following equation around MAS monetary policy announcement dates:
$CAR_{i,t} = \alpha + \beta_1(FC_{i,t} \times Surprise_t) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t}$,

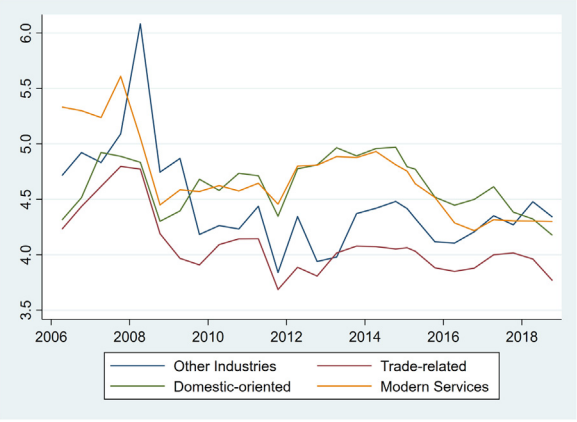

Fig. 3. Median value of *Mktcap* for all Sectors, 2006–2019.

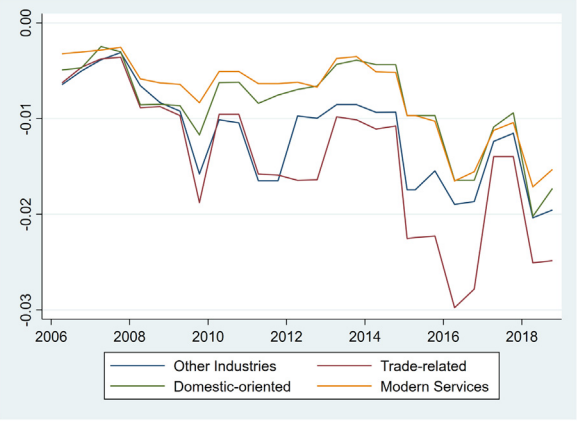

Fig. 4. Median value of *Liquidity* for all Sectors, 2006–2019.

Table 7 presents the estimation results for the financial and liquidity constraint over two event windows, (−1, 0) and (0,0), with the first four rows reporting the findings for each sector. The only interaction term that is statistically significant in the domestic-oriented sector is *Low Cash*, suggesting that it is the only constraint among the four that significantly impacts this sector's response to monetary policy surprises. Firms in this sector that are financially constrained by *Low Cash* experience a 1.8 bps reduction in stock returns as a result of monetary policy surprises that occurs only in the (−1,0) event window. This result is partly reflected in Fig. 5, which shows the domestic-oriented sector having the lowest *Cash* alongside the modern services sector, at least since 2017. Moreover, the domestic-oriented sector has almost the highest median value for all other constraints over the sample period, possibly explaining why the other three constraints have no significant impact on the sector's response to monetary policy surprises.

In the modern services sector, the interaction term is statistically significant for all four constraints. The *Low Cash* constraint, in particular, impacts firms in this sector in a similar manner to firms in the domestic-oriented sector, since both sectors share the lowest median value of *Cash*, as highlighted in Fig. 5. In response to a monetary policy surprise, they experience a 0.9 bps drop in stock returns on the MAS monetary policy announcement date. For all other constraints, firms this sector also experience a statistically significant drop in stock returns on the MAS monetary policy announcement date. The largest impact of a 2.5 bps drop in stock returns occurs when the constraint is *Low Liquidity*. Only for *Low Leverage*, does the monetary policy surprise result in a statistically significant drop in stock returns in both event windows of 1.3 bps in the (−1,0) window and 0.8 bps on the MAS monetary policy announcement date. These findings help to highlight the impact of *Low Leverage*, *Low Mktcap* and *Low Liquidity* that would otherwise be ignored based on their respective graphs, which show the modern services sector having almost the highest median value of *Debt2* in Fig. 2, and the second highest median value of *Mktcap* and *Liquidity* in Figs. 3 and 4, respectively.

The other industries sector behaves in a similar fashion to the domestic-oriented sector, where *Low Cash* is the only constraint that significantly influences the sector's response to monetary policy surprises. However, the stock returns in this sector falls by almost twice that of the domestic-oriented sector during the (−1,0) event window in response to monetary policy surprises. These findings are, at least between 2007 and 2010, and between 2013 and 2017, consistent with Fig. 5, showing periods with the other industries sector having the lowest *Cash* among all sectors. Although the other industries sector has the lowest median value for *Debt2*, this result is not reflected in the findings in Table 7, since the interaction term is not statistically significant. This result is not surprising,

Table 7
The effect of monetary policy surprises on sector returns with financial and liquidity constraints.

	Low Cash		Low Mktcap		Low Leverage		Low Liquidity	
	(−1,0)	(0,0)	(−1,0)	(0,0)	(−1,0)	(0,0)	(−1,0)	(0,0)
Domestic-oriented × Surprise × FC	−0.0176+	−0.0124	0.0169	0.0043	−0.0025	0.0000	−0.0089	−0.0054
	(−2.02)	(−1.08)	(1.36)	(0.25)	(−0.36)	(0.00)	(−0.93)	(−0.38)
Modern Services × Surprise × FC	−0.0085	−0.0086+	−0.0375	−0.0231+	−0.0127*	−0.0077+	−0.0290	−0.0251*
	(−1.34)	(−2.05)	(−1.79)	(−1.96)	(−2.33)	(−2.28)	(−1.89)	(−2.88)
Other Industries × Surprise × FC	−0.0315*	−0.0212	0.002	0.0045	−0.0014	0.0001	−0.0061	0.0127
	(−2.76)	(−1.79)	(0.17)	(0.53)	(−0.52)	(0.03)	(−0.72)	(1.15)
Trade-related × Surprise × FC	−0.0403	−0.0205	−0.0111	−0.0052	−0.0099	−0.0086*	0.0102	−0.0130*
	(−1.32)	(−1.61)	(−1.75)	(−1.17)	(−1.59)	(−3.07)	(0.34)	(−2.87)
GFC	0.0016	−0.0168	0.0131	−0.0099	0.0271	0.0135	−0.0041	−0.0299
	(0.12)	(−1.19)	(1.00)	(−0.82)	(1.79)	(1.09)	(−0.20)	(−1.92)
Constant	0.0118	0.0254+	0.0008	0.0158	−0.0143	0.0013	0.0149	0.0262
	(0.93)	(2.10)	(0.08)	(1.64)	(−1.17)	(0.13)	(0.65)	(1.75)
Observations	3070	3068	3451	3451	3077	3068	3427	3427
Adjusted R^2	0.021	0.023	0.015	0.02	0.02	0.022	0.01	0.02
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the results from estimating the following equation around MAS monetary policy announcement dates:
$CAR_{i,t} = \alpha + \beta_1(Sector_i \times Surprise_t \times FC_{i,t}) + \beta_2 GFC_t + Year_t + FE_{i,t} + \epsilon_{i,t}$

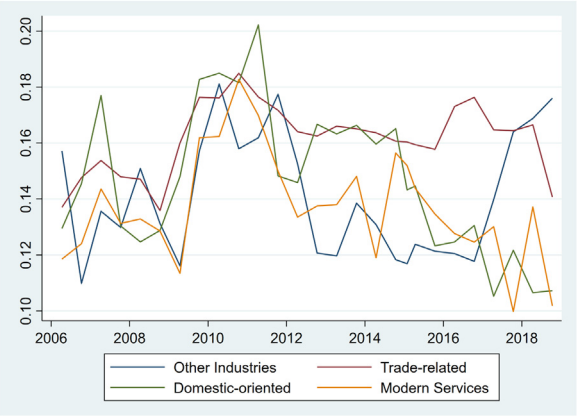

Fig. 5. Median value of *Cash* for all Sectors, 2006–2019.

given that the impact of *Low Debt2* in Table 6, while statistically significant around at 0.6 to 0.7 bps, is however small in economic terms.

Unlike all other sectors, the trade-related sector is not significantly impacted by *Low Cash*. This finding is consistent with Fig. 5, which shows the trade-related sector having the highest median value for *Cash* over most of the sample period, especially from 2012 to 2018. Both *Low Leverage* and *Low Liquidity* however have a significant impact on the trade-related sector's response to monetary policy surprises on the MAS monetary policy announcement date. Stock returns fall by about 1.3 bps with *Low Liquidity* and 0.9 bps with *Low Leverage*. The result with *Low Liquidity* is consistent with Fig. 4, which shows the trade-related sector having the lowest median value of *Liquidity* among all sectors. While the trade-related sector also has the lowest median value for *Mktcap*, this result is not reflected in the findings in Table 7, since the interaction term is not statistically significant.

7. Conclusion

In this study, we examined the impact of monetary policy surprises on the stock price behaviour of a small developed economy, whose monetary policy is based on the exchange rate. The findings in this paper offer an interesting insight into how monetary policy surprises from different policy levers in a BBC regime impact stock returns. Our results consistently show that the monetary policy surprises associated with all contractionary policy levers have a negative and statistically significant impact on stock returns. We also observe a similar response from a neutral policy stance. However, in the case of expansionary policy, only monetary policy surprises associated with a downward re-centering has a positive and significant impact on stock returns. These results provide potentially useful information for the central bank, as it allows them to consider the effects of specific policy actions on stock market performance that could be used in conjunction with large macro-econometric models to better inform on the overall impact of monetary policy. Additionally, the recalibrated industry classification system proposed in this paper permits a closer inspection of the relationship between the real sector and the financial sector, since it combines the industry classification systems adopted by both the central bank and the investing community. As a result of the proposed system, all industries can also be classified into four broad sectors, which are shown to respond differently to monetary policy surprises. The domestic-oriented sector benefits the most from expansionary monetary policy surprises, largely from a downward re-centering of the policy band. In comparison, the trade-related sector experience the largest drop in stock returns from policy surprises associated with contractionary monetary policy.

Finally, we find that financial and liquidity constraints help explain each sector's response to monetary policy surprises. Among the constraints analyzed, only *Low Cash* has a significant impact on the stock price response to monetary policy surprises in the domestic-oriented and other industries sector. However, in the modern services and trade-related sector, the stock price response to monetary policy surprises is significantly impacted by both *Low Leverage* and *Low Liquidity*. We also find that *Low Mktcap* is the only constraint among the four, affecting the stock price behaviour of firms in the modern services sector. These results show how monetary policy surprises can have a significant impact on stock market performance by having a disproportionate effect on sectors that face financial and liquidity constraints.

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Conflicts of interest

None declared.

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