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MONETARY POLICY AND FIRMS' INVESTMENT IN MALAYSIA: A PANEL EVIDENCE

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ABSTRACT

This study examines the effects of monetary policy on firms' balance sheets, with a particular focus on the effects upon firms' fixed-investment spending. It uses a dynamic panel system GMM estimation proposed by Blundell and Bond (1998). The focal point concerns the two main channels of monetary policy transmission mechanism, namely the interest rates and broad credit channels in affecting firms' investment spending. By estimating the firms' investment model using a dynamic neoclassical framework in an autoregressive distributed lagged (ARDL) model, the empirical results tend to support the relevance of interest rates and broad credit channels in transmitting to the firm balance sheet condition, that is, firms' investment spending. The results also reveal that the effect of monetary policy channels to the firms' investment are heterogeneous, in that the small firms which faced financial constraint responded more to monetary tightening as compared to the large firm (less constrained firms). Thus, the monetary authority has to consider the microeconomic aspects of firm behaviour in formulating their monetary policy.

JEL Classification: E22, E52, C33

Key words: Monetary policy, Financial constraint, Firm investment, Dynamic panel data

1. INTRODUCTION

This paper explores the role of the monetary policy transmission mechanism on firms' investment spending through interest rates and broad credit channels by using disaggregated publicly listed companies' data set. For this purpose, the following research designs have been employed in examining the relevance of both monetary policy channels; Firstly, the interest rates channel of monetary policy is identified through the firm user cost of capital proposed by Chirinko, Fazzari and Meyer (1999), Mojon, Smets and Vermeulen (2002), and Chatelain et al. (2003b). Secondly, the broad credit channel of monetary policy is measured through the firms' liquidity, which is proxied by the cash flow to capital stock ratio. Thirdly, the disaggregated firm-level investment function has been estimated using the dynamic neoclassical model, which links firm-level investment spending to firm sales growth, the cash flow to capital stock ratio (broad credit channel), and more importantly the growth of user cost of capital (interest rates channel). Fourthly, in order to explore the heterogeneous of monetary policy effects, the sample of firms has been divided into two size categories, which are small and large firms.

In examining the channels of monetary policy, the existing literature has mainly relied on using macro level data. However, the mechanism through which monetary policy influences the economy is still debatable. Previous literatures have identified two main channels such as interest rates and credit channels in transmitting to real sector economy at macro level.[1] As argued by Chirinko, Fazzari and Meyer (1999), studying in the aggregate level commonly fail to find an economically significant relationship between investment spending and the firm user cost of capital. This failure was caused by biased estimates due to problems of simultaneity, capital market frictions and firm heterogeneity. Therefore, by using micro panel data set, it is possible to handle all related problems in macro level data set. In addition, by using micro panel data set it also permits to measure the firm's specific variables such as user cost of capital, sales and cash flow in estimating the determinants of firm investment spending.

Monetary policy has been commonly thought to influence firm investment spending through two main channels, that is through the interest rate and credit. Firstly, the interest rates channel refers to the

direct impact of interest rate changes through the user cost of capital on firms' investment activity. According to this channel, firms adjust their level of capital stock until the marginal productivity of capital equals the cost of funds given a perfect capital market. Secondly, changes in interest rates affect the net cash flow (i.e., cash flow after interest payments) available to a firm. Given imperfect capital markets due to information asymmetry, the availability of net cash flow will have a direct effect on investment. This mechanism is generally referred to as the 'broad credit channel'. The existence of a credit channel would imply that monetary policy affects not only current interest rates, but also the size of the external finance premium through reduced current and expected future profits, lowering equity prices and hence collateral, which in turn amplifies the monetary policy effect on firms' investment. Therefore, under asymmetric information, the sensitivity of investment to cash flow should be different across firms. For instance, the effects on investment by small firms which have information problems are likely to be severe. This suggests that investment by small firms should be more sensitive to the cash flows than by large firms.

This paper contributes to the existing literature by extending the analysis of the transmission mechanism of monetary policy in several important aspects. Firstly, this study provides new empirical evidence using micro level data in investigating the monetary policy transmission channels, namely, the interest rates and broad credit channels in a small open emerging market economy, i.e., Malaysia. Secondly, by studying the effect of monetary policy on firm-level investment, the paper also investigates the relevance of the firm's balance sheet conditions in the monetary transmission mechanism. Thirdly, this study contributes to the existing literature by estimating the determinants of firm investment using an augmented dynamic neoclassical model in an autoregressive distributed lagged (ARDL) model. Using the neoclassical model allows us to link the firm-level investment spending to the growth of user cost of capital (interest rates channel), cash flow to capital stock ratio (broad credit channel), and sales growth. Fourthly, this study investigates the heterogeneous effects of monetary policy by splitting the sample according to firm size (small and large firms). Finally, this study uses the panel data technique, that is the generalized method of moment (GMM) proposed by Arellano and Bond (1991), Arellano and Bover (1995), and recently extended by Blundell and Bond (1998). This technique

has an advantage for addressing the Nickell (1981) bias associated with the fixed effects in short panels (for example, bias due to the presence of the lagged dependent variable and bias due to the endogeneity of other explanatory variables).

Several interesting features have emerged from this study. Firstly, this paper shows that the monetary policy transmission mechanism works through both interest rate and broad credit channels in influencing firms' investment spending in the Malaysian economy. Secondly, monetary policy has heterogeneous effects in respect of firm size, that is the investment by small firm is very sensitive to tight monetary policy as compared to the large firm.

The rest of the paper is structured as follows. Section 2 provides the literature review about firm investment, and the channel of monetary transmission. Section 3 describes the theoretical framework, and section 4 explains the econometric framework. Section 5 presents the empirical results, and finally section 6 summarizes and concludes.

2. LITERATURE REVIEW

Most of the literature on transmission mechanism of monetary policy has focused on the macro level in investigating the main channel of the monetary policy transmission mechanism.[2] However, there are a few studies that have examined the transmission mechanism of monetary policy by using firm-level data (disaggregated data set), in particular to investigate the relevance of the two main channels of monetary transmission on firm balance sheet variables such as investment spending. For example, Chatelain et al. (2003b) supported the relevance of the two monetary policy channels in transmitting to firm-level investment in the Euro area. Specifically, with the cash flow to capital stock ratio in the investment model, they find that the user cost of capital has a significant long-run effect upon firm investment in Germany, Italy, Belgium and Luxembourg, but no significant effect in France, Spain and Austria. This finding suggests that monetary policy plays a significant role on corporate investment through the interest rates channel. The cash flow to capital stock ratio as a proxy for broad credit channel is also statistically significant in influencing the firm investment in all countries except Luxembourg. The effect of cash flow to capital stock ratio to the firm investment spending is also heterogeneous by

firm characteristics. For instance, in France and Germany, firms with poor credit ratings show higher cash-flow sensitivity. In Italy and Belgium, small firms are more sensitive to cash flow. Small services firms in Belgium and equipment manufacturers in France are found to be more sensitive to the cash flow. This finding indicates that internal funds (cash flow) are a crucial determinant of firms' investment in the Euro area, specifically the effect is stronger for the firms that are more likely to face financial constraints. Therefore, the broad credit channel is operative in the Euro area.

Another study by Mojon, Smets and Vermeulen (2002) examined the effects of the interest rates and sales on firms' investment in the Euro area by using an error correction framework in the dynamic neoclassical model. By identifying the interest rates using the user cost of capital, they also found a significant negative effect of the user cost of capital upon firms' investment spending in Germany, France, Italy and Spain. This finding indicates that the interest rates channel of monetary policy is operative in the Euro area. Additionally, although the average interest rate on debt is generally higher for small firms than for large firms, there is no evidence that the effects of the interest rates channel on small firms' investment are stronger than for large firms.

For Japan, Nagahata and Sekine (2005) examined the effect of monetary policy on firm investment after the collapse of asset price bubbles. The empirical findings stated that monetary policy in Japan worked through the interest rates channel; however, the effect of monetary policy through the credit channel was blocked due to the weakening in the Japanese firms' balance sheet. In fact, the investment by non-bond issuing firms is more affected by monetary policy through interest rates channel than bond-issuing firms. However, the effect of cash flow to capital stock ratio is not significant in influencing firm investment. This indicates that a broad credit channel is not operative in transmitting to firm-level investment spending.

A recent study by Guariglia and Mateut (2006) examined the credit and trade credit channel on inventory investment in the UK manufacturing firms. By estimating the error correction inventory investment equations augmented with the coverage ratio and trade credit (for example, accounts payable) to assets ratio, they found that both the credit and the trade credit channel operate in the UK, which suggests that the trade credit channel tends to dilute the role of the

traditional credit channel. As a result, if firms also have access to the trade credit, they can avoid the external financing constraint in the period of monetary tightening by increasing trade credit as an alternative to the bank and market financing.

Only a limited number of studies have investigated the channels of the monetary policy transmission mechanism in the context of a small open economy using micro level data. For example, Agung (2000) has estimated the firm investment model in Indonesia by using Tobin's-*q* and the Euler equation investment model, and found evidence of the existence of financial constraints and agency costs for the listed firms in raising external funds. This study also indirectly supports the existence of the broad credit channel of monetary policy in Indonesia. Another study by Rungsomboon (2005) using Tobin's-*q* investment model supported the existence of the balance sheet channel in Thailand and also found that the firms have faced greater liquidity constraints due to the financial crisis. In addition, small firms and non-bond-issuing firms are found to have been more adversely affected by the financial crisis than large and bond-issuing firms. However, Agung (2000) and Rungsomboon (2005) did not take into account the role of the interest rates channel (user cost of capital) in their investment model. As noted before, the interest rates channel plays a vital role in influencing firms' investment spending in Japan and the Euro area.

In the Malaysian context, the few studies that have been undertaken relating to issues of the monetary policy transmission mechanism have focused on macro level data. For example, Azali and Matthews (1999) found that during the pre-liberalization period, the bank credit shock had more impact compared to the money shock in explaining output variability. In contrast, during the post-liberalization period, money as well as credit innovations were significant in explaining output shocks. Ibrahim (2005) examined the sectoral effect of a monetary policy shock, and supported the real effect of monetary policy shocks across sub-sector of economy. Tang (2006) examined the relative importance of the monetary policy transmission mechanism channels (interest rates, credit, asset price, and exchange rate channels), and concluded that the interest rates channel plays a pivotal role in influencing output and inflation. A recent study by Ang (2009) examined the effects of three financial policies (interest rate restraints, directed credit programs, reserve and liquidity requirements) on private investment in Malaysia at the

macro level. By estimating the neoclassical investment model in a time series ARDL model, he found that interest rate restraints appear to have a positive and statistically significant effect on private investment. This means that by controlling the interest rate, the Bank Negara Malaysia (BNM), i.e., the Central bank of Malaysia can stimulate the capital formation in the private sector. In addition, the directed credit programs has a negative and significant effect on private sector capital formation, whereas, higher reserves and liquidity tend to encourage private investment.

To the author's best knowledge, so far there is no empirical study that has investigated the transmission mechanism of monetary policy at the micro level, in particular examining the role of interest rates and broad credit channels in transmitting to the firm-level fixed investment spending in a small open economy such as Malaysia. In addition, there is also no empirical study in Malaysia that has examined the heterogeneity effects of monetary policy channels by firm size (small and large firms). Therefore, based on this backdrop, this study makes a novel contribution to the existing literature by exploring the issue of the monetary policy transmission mechanism via interest rates and broad credit channels upon investment spending by using a disaggregated firm-level data set.

3. THEORETICAL FRAMEWORK

Most of the empirical studies, for example Mairesse, Hall and Mulkay (1999), Chirinko, Fazzari and Meyer (1999), Chatelain et al. (2003b) and Bond et al. (2003) have used a neoclassical demand for capital in investigating the determinants of investment using firm level data.[3]

3.1 NEOCLASSICAL INVESTMENT MODEL

According to the neoclassical theory, the demand for capital is derived from the firm's production function. By assuming a constant elasticity of the substitution (CES), the neoclassical production function can be parameterized as;

$$(1)\quad F\left(L_{it,}K_{it}\right)=TFP_iA_t\left[\beta_i L_{it}^{\frac{\sigma-1}{\sigma}}+\alpha_i K_{it}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}\upsilon},\ \alpha_i+\beta_i=1,$$

where, σ is the elasticity of substitution between capital (K) and labor (L), υ represents returns to scale, and TFP_iA_t is total factor productivity. The first-order condition for a firm's optimization problem leads to the equality between the marginal product of capital (F_K), and the user cost of capital (UC_{it}) as follows;

(2) $F_K\left(L_{it,}K_{it}\right)=UC_{it}$

By substituting the marginal productivity of capital in equation (2) into the production function in equation (1), the first order conditions of firm profit maximization are;

$$\log K_{it}=\theta\log Y_{it}-\sigma\log UC_{it}+\log H_{it}$$

or

(3) $k_{it}=\theta y_{it}-\sigma uc_{it}+h_{it}$

where, k_{it} is log of capital stock, uc_{it} is log of user cost of capital, h_{it} is log of firm specific variables, $\theta=\left(\sigma+\frac{1-\sigma}{\upsilon}\right)$ and $h_{it}=\log\left[\left(TFP_iA_t\right)^{\frac{\sigma-1}{\upsilon}}\left(\upsilon\alpha_i\right)^{\sigma}\right]$. Equation (3) states that the stock of capital (k_{it}) firm i at time t is determined by three factors: firm output or sales (y_{it}), firm user cost of capital (uc_{it}), and total factor productivity. The variable h_{it} depends on the time-varying term A_t and the firm-specific term TFP_i.[4]

In order to estimate equation (3), the new specification in terms of autoregressive distributed lag model (ARDL) is used in this study. The dynamic neo-classical investment model have been estimated by Mairesse, Hall and Mulkay (1999), Mojon, Smets and Vermeulen (2002), Chatelain et al. (2003a), Bond et al. (2003) and Nagahata and Sekine (2005). For example, the dynamic neoclassical investment model in $ARDL(2,2)$ can be written as follows;

$$(4)\quad \begin{aligned} k_{it} &= \alpha_1 k_{i,t-1} + \alpha_2 k_{i,t-2} + \phi_1 y_{it} + \phi_2 y_{i,t-1} + \phi_3 y_{i,t-2} + \sigma_1 uc_{it} \\ &\quad + \sigma_2 uc_{i,t-1} + \sigma_3 uc_{i,t-2} + \theta_1 h_{it} + \theta_2 h_{i,t-1} + \theta_3 h_{i,t-2} \end{aligned}$$

In order to transform equation (4) into a neoclassical investment model, we need to take the first difference of equation (4) and use the approximation of capital stock, $k_t - k_{t-1} = \frac{I_t}{K_{t-1}} - \delta$.[5] In addition, replacing year-specific productivity growth $(\Delta \log A_t)$ by time dummies (λ_t), firm-specific effect productivity growth $(\Delta \log TFP_i)$ by firm-specific effects (η_i), and adding a random term υ_{it}, yields;

$$(5)\quad \begin{aligned} \left(\frac{I_{it}}{K_{i,t-1}}\right) &= \alpha_1 \left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \alpha_2 \left(\frac{I_{i,t-2}}{K_{i,t-3}}\right) + \phi_1 \Delta y_{it} + \phi_2 \Delta y_{i,t-1} + \phi_3 \Delta y_{i,t-2} \\ &\quad + \sigma_1 \Delta uc_{it} + \sigma_2 \Delta uc_{i,t-1} + \sigma_3 \Delta uc_{i,t-2} + \lambda_t + \eta_i + \upsilon_{it} \end{aligned}$$

where in equation (5), λ_t is unobservable time-specific effects, η_i is unobserved firm-specific effects and υ_{it} is the remainder stochastic disturbance term, which is assumed to be independent and identically distributed with mean zero and variance σ_υ^2.

3.2 USER COST OF CAPITAL (UC)

According to the neoclassical model, monetary policy through a change in interest rate will alter the user cost of capital. For example, monetary policy tightening through an increase in interest rate will increase the firm user cost of capital. Therefore, the relevance of the traditional interest rates channel in monetary policy transmission mechanism can be examined through the firm user cost of capital. Most of the previous studies have derived the firm user cost of capital by using the Hall and Jorgenson (1967) approach. Following Mojon, Smets and Vermeulen (2002) and Chatelain et al. (2003b), the firm user cost of capital (UC_{it}) based on the accounting proportions of debt and equity can be expressed as follows;

$$(6)\ UC_{it} = \frac{P_{st}^{I}}{P_{st}} \frac{\left(1 - itc_t - \tau_t z_s\right)}{\left(1 - \tau_t\right)} \left[\begin{array}{l} AI_{it}\left(\frac{D_{it}}{D_{it} + E_{it}}\right)\left(1 - \tau_t\right) \\ + \left(LD_t\right)\left(\frac{E_{it}}{D_{it} + E_{it}}\right) - \left(1 - \delta_s\right)\frac{\Delta P_{st+1}^{I}}{P_{st}^{I}} + \delta_s \end{array} \right]$$

where, s is the sector-specific index, p_{st} is the price of final goods, p_{st}^{I} is the price of capital goods of sectors, τ_t is the corporate income tax rate, z is the present value of depreciation allowances and itc is an investment tax credit. AI is the apparent interest rates, measured as interest payment (interest expense) over gross debt, LD is the long-term debt rate used as a proxy for the opportunity cost of equity, E is the book value of equity, D is the book value of debt and δ_s is the industry-specific rate of economic depreciation. However, it is very difficult to verify the price of capital goods (p_{st}^{I}) and the price of final goods (p_{st}) in Malaysian firm level data. Therefore, in this study the Producer Price Index (PPI) has been used as a proxy for the price of investment goods and the Consumer Price Index (CPI) as a proxy for the price of final goods. In Malaysia, the present value of depreciation allowance (z) and investment tax credit (itc) are very difficult to estimate. Therefore, z and itc are assumed to be zero.

3.3 MONETARY POLICY, FINANCIAL CONSTRAINTS, AND BROAD CREDIT CHANNEL

Besides the traditional interest rates channel, monetary policy can also influence firm-level investment spending through the broad credit channel. According to the broad credit channel theory, the credit market imperfections are not limited to the market for bank loans but also connected to all credit markets in the economy such as bond and equity markets. The problem of asymmetric information between borrowers (for example, firms), and the lenders (banks) in the credit market will create a wedge between internal and external financing, that is, the firm faces a different interest rate depending on its risk premium. This wedge arises because of agency costs

associated with information asymmetries, and the ability of lenders to costlessly monitor borrowers. As a result, cash flow and net worth become important in affecting the cost, availability of finance, and the level of investment spending. Bernanke, Gertler and Gilchrist (1996) list three empirical implications of the broad credit channel. Firstly, external finance is more expensive for borrowers than internal finance. Secondly, because the cost differential between internal and external finance arises from agency costs,[6] the gap should depend inversely on the borrower's net worth. For example, a fall in net worth raises the costs of external finance. Thirdly, adverse shocks to net worth should reduce borrowers' access to finance, thereby reducing their investment, employment, and production.

Under the broad credit channel, agency costs increase during recessions and in response to the tightening of monetary policy. For example, monetary policy tightening (an increase in interest rates) lowers asset values and the value of collateral, increasing the cost of external funds relative to internal funds. Since agency problems are likely to be more severe for small firms than large firms, the linkage between internal sources of funds and investment spending should be particularly strong for small firms after monetary contractions. In contrast, agency costs are usually assumed to be smaller for large firms because of the economies of scale in collecting and processing information about their situation. As a result, large firms can more easily obtain financing directly from the financial market and are less dependent on banks. For example, Gertler and Gilchrist (1994) argued that small manufacturing firms in the US economy are more sensitive than large firms in response to the tightening of monetary policy over the business cycle. Small firms account for a highly disproportionate share of declines in sales, inventories and short-term debt following monetary tightening. They argued that the small firms are likely to face larger barriers to outside finance than large firms because asymmetric information creates agency problems between the small firms and banks.

Most of the empirical studies have linked the broad credit channel with the firm financial constraints, which is proxied by cash

flow. Fazzari, Hubbard and Peterson (1988), and several other recent empirical studies on fixed-investment found that smaller firms are more likely to be financially constrained. Therefore, the investment by small firms may be sensitive to the cash flow or net worth if the agency cost associated with imperfect information or costly monitoring create a wedge between the cost of internal and external finance. Based on this analysis, in order to examine the relevance of the broad credit channel in transmitting to the firm-level investment in Malaysia, the cash flow to capital stock ratio $\left(\frac{CF_{it}}{K_{i,t-1}}\right)$ has been used as a proxy for the broad credit channel or financial constraints. The cash flow (CF_{it}) has also been scaled by the beginning-of-period capital stock $(K_{i,t-1})$. Therefore, the augmented version of the neoclassical investment model in estimating the firm-level investment functions can be expressed as;

$$\begin{aligned}\left(\frac{I_{it}}{K_{i,t-1}}\right) &= \alpha_1\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right) + \alpha_2\left(\frac{I_{i,t-2}}{K_{i,t-3}}\right) + \phi_1\Delta y_{it} + \phi_2\Delta y_{i,t-1} \\ &+ \phi_3\Delta y_{i,t-2} + \sigma_1\Delta uc_{it} + \sigma_2\Delta uc_{i,t-1} + \sigma_3\Delta uc_{i,t-2} \\ &+ \theta_1\left(\frac{CF_{it}}{K_{i,t-1}}\right) + \theta_2\left(\frac{CF_{i,t-1}}{K_{i,t-2}}\right) + \theta_3\left(\frac{CF_{i,t-2}}{K_{i,t-3}}\right) + \lambda_t + \eta_i + \upsilon_{it}\end{aligned} \tag{7}$$

3.4 INTEREST RATES AND BROAD CREDIT CHANNELS

The inclusion of the user cost of capital growth (Δuc), and cash flow to capital stock ratio $\left(\frac{CF_{it}}{K_{i,t-1}}\right)$ in equation (7) permits both interest rates and broad credit channels for the transmission of monetary policy to be analyzed. The short-run effects of interest rates channel can be tested by checking the signs and significance of the coefficients on the user cost of capital growth that is σ_1, σ_2 and σ_3. The expected sign is negative for their sum of coefficient

because an increase in interest rates will increase the user cost of capital, and subsequently decrease firms' investment spending. Similarly, the short-run effects of the broad credit channel can be tested by checking the coefficients θ_1, θ_2 and θ_3. The expected sign is positive for their sum of coefficient and significant for the small firm (constrained firm) relative to the large firm (unconstrained firm). This indicates that the small firm is heavily reliant on internal funds as a cheaper source of funds and has some difficulties in accessing external financing.

In equation (7), the long-run elasticity of firm investment with respect to sales growth, user cost of capital growth and cash flow to capital stock can also be identified. The long-run elasticity of investment with respect to sales growth is given by $\phi = \left(\frac{\phi_1 + \phi_1 + \phi_2}{1 - \alpha_1 - \alpha_2} \right)$, the long-run elasticity of investment with respect to user-cost of capital growth is $\sigma = \left(\frac{\sigma_1 + \sigma_2 + \sigma_3}{1 - \alpha_1 - \alpha_2} \right)$, and the long-run elasticity of investment with respect to cash flow to capital stock ratio is $\theta = \left(\frac{\theta_1 + \theta_2 + \theta_3}{1 - \alpha_1 - \alpha_2} \right)$.

4. ECONOMETRIC METHODOLOGY

4.1 DATA/ SAMPLE SELECTION

This study uses annual firm balance sheet data spanning from 1990 up to 2008 (19 years). The firms in this study are main board publicly listed companies, which cover an average 650 firms in various sub-sectors of the economy. The data set has been collected from Thompson Datastream. Few firms have been listed continuously since 1990, but many firms are listed in the main board at some later point. Therefore, the data constitute an unbalanced panel. For the estimation analysis, the following sample selections

are applied. Firstly, this study just considered non-financial firms. This means that all financial firms are removed from the sample. This is because financial firms have high cash flow but low investment. Therefore, excluding these firms removes the effects of influential outliers on the sample. Secondly, firms were selected that were consecutively present in the sample for at least five years in order to have sufficient number of lags as an explanatory variable. This is important to avoid data reduction due to the data transformation process and for adoption of lagged values in the model estimations (for example, in this study, the maximum lag order is two for all explanatory variables). Third, in order to eliminate outliers, following Nagahata and Sekine (2005), firms with a negative value for the user cost of capital have been dropped from the sample. Finally, after cleaning the data set, this study have unbalanced panel of 332 firms, which is equivalent to 2035 firm-year observations or an average 6.13 observations per group.

In order to explore the heterogeneity of monetary policy effects, the sample of firms has been divided into two size categories, i.e., small and large firms. As mentioned previously, the broad credit channel stated that the small firms are subject to greater informational problems and will be affected more strongly by a monetary policy tightening. Therefore, the small firms rely more heavily on internal financing (for example, cash flow) due to their limited access to external financing. In comparison, the large firms have greater access to external finance and are not heavily dependent on internal financing. For that reason, the firms have been segmented by using their total assets as proposed by Laeven (2002) and Rungsomboon (2005). In order to segment the firms, firstly, the average (mean) of total assets has been computed for each firm. Secondly, the grand median of the averages is then computed to segment firms into small and large category. The firm is considered large if their mean assets is greater than the grand median and small if their mean is less than or equal to the grand median. Specifically, there are 165 firms in large category and 167 firms in small category.

4.2 VARIABLES DEFINITIONS

In order to estimate the baseline neo-classical investment model in equation (7), this section briefly discusses the specific definitions of the variables used in this study.

4.2.1 INVESTMENT (I_{it})

This refers to the current-period investment spending for firm *i* at time *t*, which includes the capital expenditure on property, plant and equipment taken from firms' uses of funds statement. The capital expenditure is measured in Malaysian Ringgit (RM) in current market prices. Capital expenditure has been used as a proxy for investment by many researchers such as Kaplan and Zingales (1997), Chirinko, Fazzari and Meyer (1999), Bhagat, Moyen and Suh (2005), Love and Zicchino (2006), and Moyen (2004).

4.2.2 CAPITAL STOCK (K_{it})

The capital stock refers to net firm fixed assets, which excludes depreciation. It includes property, plant and equipment at period *t* less accumulated reserves for depreciation, depletion and amortization, and measured in the Malaysian Ringgit.

4.2.3 CASH FLOW ($CF_{i,t}$)

Cash flow is defined as operating income after tax earning plus depreciation. The cash flow is also measured in the Malaysian Ringgit. The depreciation includes total depreciation, amortization and depletion. This variable is used as a measurement of the degree of market imperfections caused by financial constraints. Under asymmetric information, the sensitivity of a firm's investment to the cash flow is likely to be different across firms. In fact, the relationship between cash flow (financial constraint) on investment

spending can also be related to the relevance of the broad credit channel in monetary policy transmission mechanism.

4.2.4 SALES (y_{it})

This refers to the net sales or revenue that is calculated at the year-end-period of sales in a particular year, which is measured in the Malaysian Ringgit. The inclusion of this variable is also consistent with the financial accelerator theory, which postulates that there is a positive relationship between sales and investment. For example, an increase in sales growth is associated with more capital expenditure, and increases the rate of investment.

4.2.5 USER COST OF CAPITAL (UC)

As mentioned before, the derivation of user cost of capital is based on the methodology proposed by Mojon, Smets and Vermeulen (2002) and Chatelain et al. (2003b). The user cost of capital can help to identify the relevance of interest rates channel of the monetary policy transmission mechanism.

4.3 DYNAMIC PANEL GMM ESTIMATION

The inclusion of the lagged dependent variables in the baseline neo-classical investment model in equation (7) implies that there is correlation between the regressors and the error term since the lag of investment ratio $\left(\frac{I_{i,t-1}}{K_{i,t-2}}\right)$ depends on $\varepsilon_{i,t-1}$. Therefore, due to this correlation, the dynamic panel data estimation in equation (7) suffers from Nickell (1981) bias, which disappears only if T is larger or approaches infinity. In order to deal with the endogeneity issue, this study used the generalized method of moments (GMM) estimators developed by Anderson and Hsiao (1982), Arellano and Bond

(1991), Arellano and Bover (1995), and recently extended by Blundell and Bond (1998).

In order to remove the firm-specific effects (η_i), Arellano and Bover (1995) proposed forward orthogonal deviation transformation or forward Helmert's procedure. This transformation essentially subtracts the mean of future observations available in the sample from the first *T*-1 observations and its main advantage is to preserve sample size in panels with gaps. First-difference transformation has a weakness where if some explanatory variable (x_{it}) is missing, then both $\Delta x_{i,t}$ and $\Delta x_{i,t+1}$ are missing in the transformed data (Roodman, 2009). However, under orthogonal deviations, the transformed $x_{i,t+1}$ will not be missing. This procedure can be expressed as follows:

$$(8)\quad x_{i,t+1} = c_{it}\left[x_{it} - \frac{1}{T_{it}} \sum_{s>t} x_{is} \right]$$

where, T_{it} is the number of time-series observations on firm *i*, c_{it} is the scale factor, that is, $\sqrt{\frac{T_{it}}{T_{it}+1}}$ and $\sum_{s>t} x_{is} = x_{it} + x_{i,t+1} + ... + x_{iT}$. As noted by Hayakawa (2009), by using a Monte Carlo simulation study, he found that the GMM estimator of the model transformed by the forward orthogonal deviation tends to work better than transformed by the first difference. Therefore, this study has used forward orthogonal deviation transformation in order to eliminate the firm-specific variable.

However, by transforming using forward orthogonal deviation, it introduces a new bias that is the correlation between the transformed error terms with the transformed lagged dependent variable. Similarly, the transformed explanatory variables, that is, the sales growth (Δy_{it}), the growth of user cost of capital (Δuc_{it}) and cash flow-capital ratio $\left(\frac{CF_{it}}{K_{i,t-1}}\right)$ also potentially become endogenous

because they are related to the transformed error term. Therefore, three assumptions can be made regarding the explanatory variable. For instance, the explanatory variable can be a predetermined variable that is correlated with the past error term and the endogenous variables are potentially correlated with the past and present error terms. In contrast, strictly exogenous variable is uncorrelated with either current, past or future error terms. Specifically, X_{it} is said to be predetermined if $E[X_{it}\varepsilon_{is}] \neq 0$ for $s < t$ but $E[X_{it}\varepsilon_{is}] = 0$ for all $s \geq t$. In addition, X_{it} is assumed exogenous if $E[X_{it}\varepsilon_{is}] \neq 0$ for $s \leq t$ but $E[X_{it}\varepsilon_{is}] = 0$ for all $s > t$, and X_{it} is said to be strictly exogenous if $E[X_{it}\varepsilon_{is}] = 0$ for all *t* and *s*.

Arellano and Bover (1995) and Arellano and Bond (1991) recommend that the lagged levels or untransformed regressors are used as instruments for the transformed variables. This refers to the difference GMM. However, Alonso-Borrego and Arellano (1999) and Blundell and Bond (1998) show that in the case where lagged dependent and explanatory variables are nearly a random walk, the lagged levels of these variables are weak instruments for the regression equation in differences. This happens either as the autoregressive parameter (α) approaches unity, or as the variance of the individual effects (η_i) increases relative to the variance of the transient shocks (ε_{it}). Hence, to decrease the potential bias and imprecision associated with the difference estimator, Blundell and Bond (1998) have proposed the system GMM approach by combining both regression in differences and regression in levels. In addition to the regression in differences, the instruments for the regression in levels are the lagged differences of the corresponding instruments.

However, as noted by Roodman (2009), the system GMM can generate moment conditions prolifically. Too many instruments in system GMM overfits endogenous variables even as it weakens the Hansen test of the instruments joint validity. Previous researchers, for example, Beck and Levine (2004), Calderon, Chong and Loayza (2002), Cardovic and Levine (2005), and Roodman (2009) have practiced two main techniques in limiting the number of instruments

such as using only certain lags instead of all available lags for instruments, and combining instruments through addition into smaller sets by collapsing the block of instrument matrix.

In addition, this study also applies both estimators, that is, one-step and two- step estimators in the system GMM. As argued by Baltagi (2008), both parameters are asymptotically similar if the ε_{it} is *i.i.d*. However, Bond (2002) stated that the one-step result is more favored than the two-step results. This is because his simulation studies have shown that the two-step estimator is less efficient when the asymptotic standard error tends to be too small or the asymptotic t -ratio tends to be too big. Therefore, Windmeijer (2005) has provided a bias correction for the standard error in the two-step estimators. As noted by the author, the two-step GMM performs somewhat better than the one-step GMM in estimating the coefficient, with lower bias and standard errors. In fact, the reported two-step standard errors with the correction are quite accurate; therefore, the two-step estimation with corrected standard errors seems modestly superior to cluster robust one-step estimation.

The success of the GMM estimator in producing unbiased, consistent and efficient results are highly dependent on the appropriate adoption of the instruments. Therefore, there are three specifications test suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1998). Firstly, the Sargan or Hansen test of over-identifying restrictions, which tests the overall validity of the instruments by analyzing the sample analogue of the moments conditions used in the estimation process. If the moment condition holds, then the instrument is valid and the model has correctly been specified. Secondly, the serial correlation test, that is, there is no serial correlation among the transformed error terms. Finally, to test the validity of the extra moment's conditions on the system GMM, the difference in Hansen test is used. This test measures the difference between the Hansen statistic generated from the system GMM and the difference GMM. Therefore, failure to reject the three null hypotheses gives support to the estimated model.

5. ESTIMATION RESULTS[7]

This section discusses the empirical results of estimating the baseline augmented dynamic neoclassical investment model in equation (7). The main results are from the system GMM in the one-step and two-step estimations. The focal points are to examine the role of interest rates and broad credit channels in transmitting to the firm-level investment spending for the whole sample (Table 1) and sub-sample analyses according to firm size, that is small firm (Table 2) and large firm (Table 3). In addition, the long-run elasticity of firm investment spending with respect to sales growth, user cost of capital growth, and cash flow to capital stock ratio are also discussed in Table 4.

5.1 THE FULL SAMPLE

In Table 1, the estimation results by using the system GMM in the one-step and two-step estimations show that the interest rates channel, which is proxied by user cost of capital has contemporaneous and statistical significance in influencing the firm investment. For example, in the one-step estimation, a 1% increase in the user cost of capital growth causes the investment spending (investment ratio or net growth capital stock) to decrease by 0.191%. However, the lagged effect of user cost of capital growth is statistically insignificant in influencing firm investment. In the two-step estimation, the contemporaneous effect of user cost of capital on investment is smaller than that found in the one-step estimation, which is, investment has decreased by 0.159% in response to a 1% growth in the user-cost of capital. However, the total coefficient of the user cost of capital is quite similar in both estimations and statistically significant at least at the 1% significance level. For instance, investment has decreased by 0.222% (one-step) and 0.216% (two-step) in response to a 1% growth in the user cost of capital. The significant and negative effect of the user cost of capital growth on firm investment in Malaysia supports the relevance of the interest rates channel in monetary transmission. This finding is also consistent with previous studies in the Euro area and Japan as mentioned previously.

TABLE 1
System GMM Estimation - Whole Sample
(Forward Orthogonal Deviation Transformation)

Independent Variables	One-Step Estimation			Two-Step Estimation		
	Coef.	Robust Standard Error	*p*-value	Coef.	Corrected Standard Error	*p*-value
$\left(I_{t-1}/K_{t-2}\right)$	0.025	0.118	0.831	0.019	0.094	0.839
$\left(I_{t-2}/K_{t-3}\right)$	0.028	0.056	0.619	0.003	0.050	0.951
$\sum\left(I_{i,t-n}/K_{i,t-n-1}\right)$	**0.053**	**-**	**0.808**	**0.022**	**-**	**0.977**
$\Delta\log UCC_{i,t}$	-0.191	0.045	0.000***	-0.159	0.037	0.000***
$\Delta\log UCC_{i,t-1}$	-0.035	0.036	0.324	-0.038	0.025	0.133
$\Delta\log UCC_{i,t-2}$	-0.016	0.016	0.323	-0.019	0.015	0.210
$\sum\Delta\log UCC_{i,t-n}$	**-0.222**	**-**	**0.000*** **	**-0.216**	**-**	**0.000*** **
$\left(CF_{it}/K_{i,t-1}\right)$	0.001	0.002	0.655	0.001	0.001	0.408
$\left(CF_{i,t-1}/K_{i,t-2}\right)$	0.009	0.002	0.000***	0.008	0.001	0.000***
$\left(CF_{i,t-2}/K_{i,t-3}\right)$	0.017	0.015	0.263	0.033	0.021	0.114
$\sum\left(CF_{i,t-n}/K_{i,t-n-1}\right)$	**0.027**	**-**	**0.000*** **	**0.042**	**-**	**0.000*** **
$\Delta\log Sale_{i,t}$	0.150	0.032	0.000***	0.145	0.0281	0.000***
$\Delta\log Sale_{i,t-1}$	0.019	0.040	0.633	0.039	0.026	0.141
$\Delta\log Sale_{i,t-2}$	0.040	0.019	0.037**	0.046	0.019	0.016**
$\sum\Delta\log Sale_{i,t-n}$	**0.209**	**-**	**0.000*** **	**0.230**	**-**	**0.000*** **
Number of observations	2035			2035		
Observations per group	6.13			6.13		
Number of instruments	76			76		
Number of firms	332			332		
AR(2)- *p-value*	0.284			0.557		
Sargan test - *p-value*	0.967			0.967		
Hansen test - *p-value*	0.513			0.513		

Notes: ** Significant at the 5% percent level; *** significant at the 1% level. The *p*-value of the total coefficient is obtained by using the Wald statistic. The year dummy and constant are not included in order to save space. All *p*-value of the difference in Hansen tests of exogeneity of instruments subsets are also rejected at least at the 10% significance level, but not reported here. The full results are available upon request. Instrument for orthogonal deviation equation: Lags 2 to all available lags for all endogenous variables (lagged dependent variable), lags 1 to all available lags for all predetermined variables (cash flow-capital ratio and sales growth) and all lags for strictly exogenous variable (user cost of capital growth). The estimation also collapses the instruments matrix as proposed by Calderon et al. (2002) and Roodman (2009). The two-step estimations are based on Windmeijer (2005).

The contemporaneous effect of the cash flow to capital stock ratio on firm investment spending is statistically insignificant. However, the lagged effect of the cash flow-capital ratio on firm investment is statistically significant at the 1% level. In addition, the total coefficient of cash flow-capital ratio on investment is also statistically significant at least at the 1% level; however, the effect is relatively small. For example, the total coefficient is 0.027 and 0.042 in the one-step and two-step estimations, respectively. This means that, a 10% increase in the cash flow-capital ratio increases the investment rate by 0.27% in the one-step and 0.42% in the two-step estimations, respectively.

Sales growth has a substantial effect on firm investment either contemporaneously or with a lagged effect. For example, a 1% change in sales growth leads to a contemporaneous increase in investment rate by 0.150 in the one-step and 0.145 in the two-step estimations. In addition, the total coefficient of sales growth is 0.209 and 0.230 in the one-step and two-step estimations, which is statistically significant at least at the 1% level.

In addition, in the one-step and two-step estimations, both specification tests, that is, AR(2) for testing the serial correlation and the Sargan/Hansen test for testing the validity of the instruments adopted are also valid. For instance, as shown in Table 1, the *p*-value for AR(2) and the Sargan/Hansen test are higher, that is statistically insignificant at least at the 10% level. This implies that the empirical model has been correctly specified since there is no serial correlation (autocorrelation) found in the transformed residuals and the instruments (moments conditions) used in the models are valid. The validity of additional moment conditions such as difference in Hansen tests are also statistically insignificant in all models.[8]

5.2 SUB-SAMPLE RESULTS

The analysis of the whole sample results cannot explain the heterogeneity of monetary policy effects, in particular the different role of interest rates and broad credit channels in affecting firm-level investment according to firm size, which is the small and large firms. Under asymmetric information, small firms heavily rely on internal financing than external financing because external financing is more costly for small firms than large firms. Therefore, it is expected that the cash flow to capital stock ratio would play a more significant role in influencing investment by small firms. In addition, the effect of the user cost of capital growth is also expected to be higher in

relation to small firms than large firms because small firms face difficulties in accessing external financing.

Table 2 and 3 summarize the sub-sample analysis. As can be seen, the effect of the user cost of capital growth on firm investment spending is heterogeneous, which is, small firms behave strongly than large firms in response to the tightening of monetary policy. Interestingly, the user cost of capital growth has a contemporaneous and significant effect in influencing investment by both firms in the one-step and two-step estimations. For example, a 1% growth in the user cost of capital has contemporaneously decreased the small firm investment by 0.190% and 0.160% in the one-step and two-step estimations, respectively. In comparison, the contemporaneous effect of user cost of capital on large firm investment spending is relatively lower, for example, investment has decreased by 0.174% in the one-step estimation and 0.162% in the two-step estimation. As expected, the total coefficient of the user cost of capital growth on investment spending is relatively higher for the small firm compared to the large firm. For example, the total effect of the user cost of capital to small firm investment is -0.320% in the one-step estimation and -0.280% in the two-step estimation, whereas, the total effect for the large firm investment is -0.201% and 0.187% in the one-step and two-step estimations, respectively. The negative response of investment to the user cost of capital supports the existence of interest rates channel in the monetary transmission mechanism.

The results in Table 2 (small firm) and Table 3 (large firm) have indicated that the different role of cash flow-capital ratio in influencing the firm investment. For the small firm, the first period lagged cash flow-capital ratio is statistically significant in influencing the investment spending, whereas the contemporaneous and two-period lagged cash flow-capital ratio is insignificant in influencing the investment spending. In addition, the total effect of cash flow-capital ratio on investment is statistically significant at least at the 1% significance level for the small firm, while there is no significant effect to the large firm. However, the total effect of cash flow-capital ratio to small firm investment spending is relatively small, which is 0.012 and 0.020 in the one-step and two-step estimations, respectively. This finding implies that the small firm relies heavily on internal financing as a cheaper source of finance and cannot have access to the external financing which is more expensive. In contrast, the large firm is not highly dependent on internal financing because they can access external financing such as debt and equity market. Therefore, this finding tends to support the existence of broad credit channel in monetary transmission in Malaysia.

TABLE 2
System GMM Estimation - Small Firms
(Forward Orthogonal Deviation Transformation)

Independent Variables	One-Step Estimation			Two-Step Estimation		
	Coef.	Robust Standard Error	*p*-value	Coef.	Corrected Standard Error	*p*-value
$\left(I_{t-1}/K_{t-2}\right)$	0.047	0.164	0.773	0.033	0.176	0.849
$\left(I_{t-2}/K_{t-3}\right)$	0.020	0.036	0.584	0.055	0.045	0.223
$\sum\left(I_{i,t-n}/K_{i,t-n-1}\right)$	**0.067**	-	**0.7633**	**0.088**	-	**0.347**
$\Delta\log UCC_{i,t}$	-0.190	0.065	0.003***	-0.160	0.049	0.001***
$\Delta\log UCC_{i,t-1}$	-0.102	0.060	0.089*	-0.073	0.048	0.129
$\Delta\log UCC_{i,t-2}$	-0.028	0.018	0.121	-0.047	0.015	0.002***
$\sum\Delta\log UCC_{i,t-n}$	**-0.320**	-	**0.002*** **	**-0.280**	-	**0.000*** **
$\left(CF_{it}/K_{i,t-1}\right)$	0.002	0.002	0.199	0.002	0.002	0.156
$\left(CF_{i,t-1}/K_{i,t-2}\right)$	0.010	0.002	0.000***	0.009	0.002	0.000***
$\left(CF_{i,t-2}/K_{i,t-3}\right)$	0.018	0.033	0.578	0.002	0.035	0.964
$\sum\left(CF_{i,t-n}/K_{i,t-n-1}\right)$	**0.030**	-	**0.000*** **	**0.013**	-	**0.000*** **
$\Delta\log Sale_{i,t}$	0.155	0.054	0.004***	0.167	0.050	0.001***
$\Delta\log Sale_{i,t-1}$	0.043	0.032	0.178	0.048	0.030	0.111
$\Delta\log Sale_{i,t-2}$	0.064	0.024	0.007***	0.052	0.026	0.042**
$\sum\Delta\log Sale_{i,t-n}$	0.262	-	0.000***	0.267	-	0.002***
Number of observations	856			856		
Observations per group	5.13			5.13		
Number of instruments	41			41		
Number of firms	167			167		
AR(2)- *p-value*	0.642			0.316		
Sargan test - *p-value*	0.228			0.228		
Hansen test - *p-value*	0.500			0.500		

Notes: ** Significant at the 5% percent level; *** significant at the 1% level. The *p*-value of the total coefficient is obtained by using the Wald statistic. The year dummy and constant are not included in order to save space. All *p*-value of the difference in Hansen tests of exogeneity of instruments subsets are also rejected at least at the 10% significance level, but not reported here. The full results are available upon request. Instrument for orthogonal deviation equation: Lags 2 to all available lags for all endogenous variables (lagged dependent variable), lags 1 to all available lags for all predetermined variables (cash flow-capital ratio and sales growth) and all lags for strictly exogenous variable (user cost of capital growth). The estimation also collapses the instruments matrix as proposed by Calderon et al. (2002) and Roodman (2009). The two-step estimations are based on Windmeijer (2005).

TABLE 3
System GMM Estimation - Large Firms
(Forward Orthogonal Deviation Transformation)

Independent Variables	One-Step Estimation			Two-Step Estimation		
	Coef.	Robust Standard Error	*p*-value	Coef.	Corrected Standard Error	*p*-value
$\left(I_{t-1}/K_{t-2}\right)$	0.196	0.269	0.467	0.141	0.203	0.489
$\left(I_{t-2}/K_{t-3}\right)$	0.078	0.093	0.403	0.058	0.114	0.612
$\sum\left(I_{i,t-n}/K_{i,t-n-1}\right)$	**0.274**	-	**0.636**	**0.199**	-	**0.704**
$\Delta\log UCC_{i,t}$	-0.174	0.046	0.000***	-0.162	0.044	0.000***
$\Delta\log UCC_{i,t-1}$	-0.011	0.053	0.833	-0.006	0.055	0.918
$\Delta\log UCC_{i,t-2}$	-0.016	0.032	0.609	-0.019	0.034	0.574
$\sum\Delta\log UCC_{i,t-n}$	**-0.201**	-	**0.000*** **	**-0.187**	-	**0.002*** **
$\left(CF_{it}/K_{i,t-1}\right)$	0.040	0.098	0.687	0.039	0.052	0.454
$\left(CF_{i,t-1}/K_{i,t-2}\right)$	0.050	0.059	0.397	0.037	0.043	0.388
$\left(CF_{i,t-2}/K_{i,t-3}\right)$	0.013	0.017	0.450	0.016	0.016	0.322
$\sum\left(CF_{i,t-n}/K_{i,t-n-1}\right)$	**0.103**	-	**0.601**	**0.092**	-	**0.401**
$\Delta\log Sale_{i,t}$	0.148	0.039	0.000***	0.118	0.037	0.001***
$\Delta\log Sale_{i,t-1}$	0.007	0.064	0.912	0.016	0.027	0.558
$\Delta\log Sale_{i,t-2}$	0.001	0.034	0.976	0.022	0.025	0.361
$\sum\Delta\log Sale_{i,t-n}$	**0.156**	-	**0.004*** **	**0.156**	-	**0.006*** **
Number of observations		1179			1179	
Observations per group		7.15			7.15	
Number of instruments		41			41	
Number of firms		165			165	
AR(2)- *p-value*		0.217			0.337	
Sargan test - *p-value*		0.160			0.160	
Hansen test - *p-value*		0.644			0.644	

Notes: ** Significant at the 5% percent level; *** significant at the 1% level. The *p*-value of the total coefficient is obtained by using the Wald statistic. The year dummy and constant are not included in order to save space. All *p*-value of the difference in Hansen tests of exogeneity of instruments subsets are also rejected at least at the 10% significance level, but not reported here. The full results are available upon request. Instrument for orthogonal deviation equation: Lags 2 to all available lags for all endogenous variables (lagged dependent variable), lags 1 to all available lags for all predetermined variables (cash flow-capital ratio and sales growth) and all lags for strictly exogenous variable (user cost of capital growth). The estimation also collapses the instruments matrix as proposed by Calderon et al. (2002) and Roodman (2009). The two-step estimations are based on Windmeijer (2005).

Besides user cost of capital growth and cash flow-capital ratio, the firm investment (small and large firm) is also significantly influenced by sales growth, and the effect is relatively higher than user cost of capital growth and cash flow-capital ratio. Specifically, the sensitivity of investment to the sales growth is comparatively higher for the small firm as compared to the large firm. For example, the total coefficient of sales growth for small firm is 0.262 and 0.267 in the one-step and two-step estimations, whereas, for the large firm the total coefficient is 0.156 in the one-step and two-step estimations. This means that a 10% increase in sales growth leads to an increase in small firm investment by 2.62% in the one-step estimation and 2.67% in the two-step estimation, while investment by large firm has increased relatively lower at 1.56 percent in one-step and two-step estimation.

In addition, the serial correlation test stated that the GMM estimations are not serially correlated at the second order or AR (2). In fact, the Sargan and Hansen test have shown that the system GMM estimation are well specified and the instruments employed are valid because the *p*-value is greater than 0.1. The validity of additional moment conditions such as difference in Hansen tests are also statistically insignificant in all models, but not reported in order to save space.

5.3 LONG RUN EFFECTS

In Table 4, for the whole sample, the long-run coefficient of the user cost of capital growth, cash flow-capital ratio and sales growth on firm investment is relatively higher than the effect in the short run. The effect of interest rates channel (user cost of capital) is also relatively higher for the small firm as compared to the large firm. However, in the long-run the user cost of capital growth is only statistically significant in influencing the small firm investment, whereas insignificant in influencing the large firm investment. In addition, the cash flow-capital ratio is also statistically significant in influencing the small firm investment, whereas, insignificant in influencing the large firm.

TABLE 4
Long-Run Coefficient of User Cost of Capital, Cash-Flow and Sales on Firm Investment

	Whole Sample		Small Firms		Large Firms	
	One-Step	Two-Step	One-Step	Two-Step	One-Step	Two-Step
User cost of capital	-0.234 (0.138)**	-0.221 (0.128)**	-0.343 (0.177)**	-0.307 (0.132)**	-0.277 (0.195)	-0.233 (0.205)
Cash flow-capital ratio	0.029 (0.016)**	0.043 (0.015)***	0.032 (0.017)**	0.014 (0.008)**	0.142 (0.092)	0.115 (0.085)
Sales growth	0.221 (0.052)***	0.235 (0.046)***	0.281 (0.105)***	0.293 (0.104)***	0.215 (0.093)**	0.195 (0.081)***

Notes: The figures in parentheses are standard errors computed by the delta method.[9]
** Significant at the 5% percent level; *** significant at the 1% level.
The long-run effects of the explanatory variables are defined as the sum of the coefficients of the explanatory variables divided by one minus the sum of the coefficient on the lagged dependent variables.

6. SUMMARY AND CONCLUSION

The channels of monetary policy transmission mechanism using macro level evidence have been studied extensively by prior studies, but little attention has been given to investigating the micro level evidence of the monetary transmission mechanism. Therefore, to fill this gap in the previous literature, this study focuses on two main channels of monetary policy, namely the interest rates channel (derived from the user cost of capital), and the broad credit channel (cash flow to capital stock ratio) in affecting firm-level investment in a small open economy (i.e., Malaysia).

By estimating the dynamic version of an augmented neoclassical investment model in the ARDL model using the system GMM estimation, this study tends to support the relevance of interest rates and broad credit channels in monetary policy transmission to firm-level investment spending. Specifically, the firm-level investment spending is seen to be significantly influenced by the user cost of capital, and cash flow to capital ratio. In addition, monetary policy has heterogeneous effects, in that small firms are affected more

strongly by the interest rates channel as compared to large firms. Investment by small and large firms is also statistically significantly influenced by internal funds (the cash flow to capital stock ratio). However, the effect of the cash flow to capital stock ratio on firm investment is relatively higher for small firms as compared to large firms. As mentioned before, the higher response of small firm investment to the cash flow to capital stock ratio suggests that small firms rely heavily upon internal financing as a source of financing, which indicates that small firms experience financial constraints under imperfect financial markets. In contrast, large firms do not rely heavily on the cash flow to capital ratio, which indicates that they are not subject to liquidity constraints and can gain access to external financing such as short-term credit markets, bonds and financial instruments in the capital market.

This study has several implications for the implementation of monetary policy. Firstly, since the interest rates channel plays a significant role in influencing firms' investment, the monetary authority has a greater chance to stabilize investment by altering the monetary policy variables such as short-term interest rates or the interbank overnight rate. This is because the interbank overnight rate has a significant effect on firms' apparent interest rates. For example, the monetary authority can fine-tune the investment cycle by implementing an easy monetary policy during a slowdown in economic activity. Secondly, the existence of the broad credit channel implies that monetary policy is likely to be more effective when firms face tighter financial constraints, in particular for small firms. Therefore, small firms have to monitor closely their financial condition, in particular the cash flow as a cheaper source of financing. Thirdly, the empirical finding indicates that the response of the real sector economy to monetary policy shocks, in particular investment, depends on the degree of financial constraint, the segmentation of firm (by firm size), and the firm's balance sheet conditions. Therefore, the monetary authority has to monitor the microeconomic indicators of the firm in formulating their monetary policy. In addition, the monetary authority has also to observe the credit market conditions and liquidity in the financial market in order to ensure that the domestic liquidity is reasonable to support the business agenda.

ENDNOTES

1. For example, Bernanke and Gertler (1995) have identified two mechanisms through which the credit channel of monetary policy operates, such as the bank lending channel (BLC) and balance sheet channel (BSC). The BSC emphasizes on the impact of changes in monetary policy on the borrower's balance sheet, whereas BLC focuses on the possible effect of monetary policy actions on the supply of loans by the banking system. The interest rates channel is also known as money channel has been a standard feature in the traditional Keynesian model by using *IS-LM* framework.

2. An excellent literature survey about the monetary transmission mechanism can be found in Egert and Macdonald (2009).

3. An excellent review about modeling strategies, empirical results and policy implications relating on business fixed investment can be found from Chirinko (1993), and Bond and Reenen (1999).

4. The elasticity of capital to sales is unity $(\theta = 1)$ if the production function has constant returns to scale $(\upsilon = 1)$, or if the elasticity of substitution is unity $(\sigma = 1)$, that is in the Cobb-Douglas function.

5. $\Delta k_{it} = \log\left[\frac{K_{it}}{K_{i,t-1}}\right] = \log\left[1 + \frac{\Delta K_{it}}{K_{i,t-1}}\right] \cong \frac{\Delta K_{it}}{K_{i,t-1}} \cong \frac{I_{it}}{K_{i,t-1}} - \delta$, where, Δk_{it} is the net growth in capital stock (K), δ is the average depreciation rate and I_{it} is the investment of firm *i* in year *t*.

6. In the credit markets, the lender delegates to a borrower control over resources. Therefore, the inability to monitor the borrower's actions or to share the borrower's information gives rise to agency costs.

7. All models are estimated using the Arellano and Bond dynamic panel system GMM estimations by using the Stata xtabond2 command written by Roodman (2009).

8. The detailed results for the difference in Hansen test is not reported in order to save space. The full results are available upon request.

9. In order to compute the delta-method for standard error, I follow the procedure proposed by Papke and Wooldridge (2005). According to this procedure, first we need to estimate the gradient with respect to the parameters in the long-run effect, and then use the estimated gradient to

transform the particular explanatory variable, and then estimate the new transformed model. The estimated standard error of transformed lagged dependent variable is the standard error for long run coefficient. Then, the standard *t*-statistic can be used to test the significance of the particular variable by dividing the long run coefficient on the estimated standard error.

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