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LIQUIDITY CONSTRAINTS AND THE BALANCE SHEET CHANNEL OF MONETARY POLICY TRANSMISSION

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ABSTRACT

The balance sheet channel used to be perceived as a minor channel of monetary policy transmission but has become important since the interest rates faced the zero lower bound. This paper analyzes monetary policy impact on the relation between liquidity and fixed asset investments of the US non-financial companies in the decade between 2005 and 2014. Two hypotheses were proposed: 1) tight monetary policy limited companies' access to liquidity, and 2) quantitative easing influenced the level of fixed asset investment. Three random effects and three fixed effects models were constructed for each hypothesis, controlling for size and the level of financial leverage. It was found that, firstly, relative tightening of monetary policy seemed unrelated to liquidity constraints. A company's size and its debt-to-equity ratio determined its ability to raise external funds. Secondly, the validity of the balance sheet channel could not be dismissed when considering unconventional monetary policy. The results corroborated the existence of a positive correlation between the liquid asset ratio and fixed asset investments.

Keywords: monetary policy, fixed asset investment, liquidity constraints, balance sheet channel.
JEL Classification: E52, E58, G310

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INTRODUCTION

Transmission of monetary policy shocks to the real economy has been highly debatable in recent years. The underlying reason for this has been dubious effectiveness of unconventional methods implemented by the Federal Reserve and other central banks in advanced economies. Given the scarcity of readily available liquidity and introduction of the zero lower bound on the federal funds rate the usual monetary transmission mechanisms seemed impaired.

Theoretically, there are several major channels through which a central bank can impact the economy. Until very recently the balance sheet channel was perceived as a minor mechanism that might help shape firms' investment decisions. The proponents of this mechanism argued that the difference between external and internal financing costs – or the external finance premium – given the existence of imperfect financial markets and flawed information flows, correlated negatively with a firm's net worth (Bernanke, Gertler, 1989). Assuming that net worth changes pro-cyclically, it implies that investment moves pro-cyclically as well. This in turn leads to accelerator effects that increase the amplitude and force of economic cycles.

As long as the central bank's interest rates face zero lower bound, the main transmission channel is restricted. This limits the central bank's ability to influence the economy. In such an environment, existence of an alternative way through which monetary policy shocks could influence the real economy is indispensable.

This paper offers an empirical analysis of monetary policy effects on the relation between liquidity and fixed assets investment of the U.S. non-financial firms in 2005–2014. During this timeframe, the U.S. monetary policy reached to extremes – in June 2004, when the federal funds rate stood at 1.03%, the Fed began, for the first time since January 1999, to tighten monetary conditions so that in July 2006 the effective federal funds rate reached 5.25% (Board of Governors of the Federal Reserve System (US), Effective Federal Funds Rate, Federal Reserve Bank of St. Louis). For the next twelve months it oscillated around that level. In mid-2007 the Fed began what was to become a long process of far-fetched monetary expansion in hopes of containing the financial crisis, providing liquidity to fast-drying financial markets, and finally boosting the lagging output. If quantitative easing did impact the real economy, the balance sheet channel may have served as the primary transmission mechanism. The study follows the approach presented in Angelopoulou and Gibson (2009), and later adapted by Masuda (2015). In the first part of the analysis the impact of contractionary monetary policy shocks on fixed investments is investigated; the second part sheds some light on the effects of quantitative easing on liquidity constraints faced by U.S. firms and fixed investments.

The paper is structured as follows: Section 2 offers a brief literature review, Section 3 explains the tested hypotheses and provides an in-depth description of data construction process, Section 4 presents and discusses the results of our analyses, and the implications from the robustness check are discussed in Section 5.

1. LITERATURE REVIEW

Imperfect substitutability of external and internal financing sources implies the existence of a financing structure in which internal sources are perceived as more advantageous than external ones. There are at least two sources of imperfect substitutability: informational asymmetry and negative selection problems. Both appear during the process of raising external funds, be it debt or equity. This gives rise to a classic principal-agent problem as described by Jensen and Meckling (1976), Jensen (1986), and Eisenhardt (1989). Agency costs further increase the cost of raising equity. Incurring higher debt in place of raising equity does not solve the problem in the longer run. Not only does it increase a company's financial costs and debt-to-equity ratio but also, due to informational asymmetries and increasing screening costs, financial intermediaries might raise the cost of credit and make it unavailable to a firm (Stiglitz and Weiss, 1981).

The dependence of investment on financing structure is one of implications of imperfect substitutability of financing sources which will be explored further in this paper. When financially constrained companies face an investment opportunity, the level of their investment is positively correlated with their cash flows. However, cash flow is insignificant for investment decisions of financially unconstrained firms (Fazzari, Hubbard, and Petersen, 1988).

The hypothesis stating that a firm's financial constraints are relevant to the sensitivity of investment to changes in cash flow has been challenged by both theoretical and empirical research. Results of major theoretical works give ground to reason that financial constraints are not linked with an elevated sensitivity of investment to cash flow fluctuations (Tirole, 2006; Gomes 2001). Cleary (1999, 2006) suggests a different kind of relationship, namely that investment's sensitivity to cash flow increases as a company becomes less financially constrained. Also, it could be argued that investments correlate with cash flow related to financial constraints. Traditional classification criteria are applicable, such as firm's size and age, its dividend policy and relationships with financial intermediaries as well as debt-to-equity ratio. Angelopoulou and Gibson (2009) claim that assuming the above were true and that the statistical significance of the cash flow variable were the result of factors other than those related to financial constraints, one could estimate that same model for different subsamples with different characteristics regarding financing structure and the results would not yield any systematic differences in estimated coefficients. Since such differences appear, it seems reasonable to claim that cash flow investment sensitivity relates to the existence of financial constraints. The whole problem may be more complex than it originally appeared. It is possible that this relationship becomes more pronounced in periods of tight monetary policy. On the other hand, more sophisticated financial system infrastructure might mitigate it.

Another problem that relevant literature touches upon, is the application of Tobin's q in econometric modeling. Due to possible measurement errors which may differ across subsamples of companies classified a priori as financially con-

strained (or not), estimated coefficients of the cash flow variable may be unstable and biased. Gilchrist and Himmelberg (1995) claim, using the Tobin's q parameter, that the cash flow variable is statistically significant in this context. Erikson and Whited (2000) suggest that the issue is debatable. However, the authors selected a relatively short timeframe (1992-95) during which the U. S. economy was growing steadily. Difficulties in raising capital and incurring debt may have been less pronounced and thus seemingly irrelevant.

Using disaggregated data, Oliner and Rudebusch (1996), analyzed the influence of tight monetary policy on investment in the U.S. non-financial sector in the period between 1959 and 1992. Their results suggest that restrictive monetary policy may elevate the level of investment sensitivity regarding changes in a company's internal liquidity levels. This, however, holds true only for firms classified as small. The problem with Oliner and Rudebusch's research may lie in the quality of the data used in modeling. Although they used disaggregated data, better results could have been obtained, had they had access to firm-level data.

Guariglia's (1999) research centered on inventory investment in the United Kingdom in 1968-1999. Her results imply that for companies with either low coverage ratios or increased debt ratios, sensitivity of investment to changes of these parameters is higher during periods of tight monetary policy or during recessions.

Bougheas, Mizen, and Yalcin (2006) researched the existence of the balance sheet channel of monetary policy transmission in the 1990s in the United Kingdom. Using a large sample of companies, they proved that a company's idiosyncratic features determined its debt level and financing structure. The influence of these characteristics changes as the monetary policy strategy becomes more or less restrictive. Authors treat this finding as a proof that the balance sheet channel does exist, at least for the selected timeframe and country.

Using firm-level data for the British non-financial sector in 1971–1992, Angelopoulou and Gibson (2009) also verified the existence of the balance sheet channel of monetary policy transmission. Their results imply that the level of fixed capital investment is positively dependent on cash flow. The correlation strengthens in periods of tight monetary policy – cash flow sensitivity of investment is decidedly more pronounced for financially constrained companies than for unconstrained ones. This is particularly true for companies classified a priori as financially constrained according to criteria such as size, dividend policy and financial leverage. These findings suggest that the balance sheet channel might have been especially significant in the transmission of monetary policy shocks to the real economy.

In a similar vein, K. Masuda (2015) conducted research focused on Japanese manufacturing sector. However, in this study, financial constraints were replaced with liquidity constraints. The author assumed that the higher available liquidity, the easier it is for a company to raise capital externally, be it debt or equity. Masuda used the liquid asset ratio instead of net cash flow to measure a firm's net worth. This makes his reasoning slightly debatable, since liquid asset ratio

expresses the level of readily available liquidity and should not be equaled with a company's net worth. Masuda then broadened the scope of his study to capture possible effects of quantitative easing on the real sector. Nomenclature issues notwithstanding, the results of his study have two implications. Firstly, monetary policy tightening strengthens liquidity constraints. Secondly, quantitative easing may actually mitigate the problem, but only for large companies. This suggests that quantitative easing influenced the real economy via the balance sheet channel. This conclusion has been challenged numerous times, especially in light of Lyonnet and Werner's (2012) results regarding the Bank of England large-scale asset purchases and their impact on the real economy. Earlier, Werner and Voutsinas (2011) focused on how financial constraints, and especially fluctuations of credit supply, correlate with a firm's capital structure. Their chosen timeframe encompassed periods of economic instability including the asset bubble of the 1980s and an ensuing credit crunch in the 1990s in Japan. The results of their study imply that decisions regarding a company's financial policy are largely influenced by monetary policy decisions and the availability of debt. This was particularly true for companies classified as small, which face greater financial constraints during recessions.

2. AIM AND METHODOLOGY

TESTED HYPOTHESES AND DATA CONSTRUCTION

It is postulated that monetary policy shocks affect the real economy via the balance sheet channel. If so, on the basis of Bernanke and Gertler (1989, 1995) it is presumed that contractionary monetary policy can negatively affect fixed investment of firms. Moreover, decline sholud be more palpable for firms which are more constrained and whose net worth plummets most. Although Bernanke and Gertler used cash flows to identify fluctuations in net worth, here the problem is analyzed in terms of liquidity. Hence,

H1: Tight monetary policy was an important factor limiting companies' access to liquidity during the period from 2005 to 2014, specifically after the recent global crisis.

The effectiveness of quantitative easing conducted in the USA and UK between 2008 and 2013 has remained questionable, especially regarding its influence on the real economy. By providing large quantities of easily accessible liquidity to the financial market, the central bank should theoretically mitigate financial constraints faced by companies at that time. If it were so, unconventional monetary policy would be transmitted to the real economy via companies' balance sheets. The existence of this channel during the global financial crisis has been debatable. However, literature has not provided sufficient evidence to claim this transmission mechanism as invalid yet. Hence, the second hypothesis,

H2: Quantitative easing influenced fixed asset investments during the period between 2008-2014.

DATA CONSTRUCTION

Panel data set was constructed using annual financial data from 187 companies listed on U.S. stock exchanges (such as: New York Stock Exchange, NASDAQ) with the sample period from 2005 to 2014. The sample size is restricted by the limited (at the time of conducting this research) availability and comparability of financial data provided by the Infinancials and the Securities Exchange Commission databases. The chosen timeframe encompasses both months of contractionary and ultra-expansionary monetary policy.

Since net worth correlates negatively with financial constraints it can be assumed that larger companies may raise more external financing more easily. Firstly, larger entities pay lower external finance premiums, because they have access to better collateral and thus their risk of defaulting is minimized. Secondly, such firms can appear more reliable to potential investors and creditors. Therefore, it can be expected that the external finance premium will in part depend on a company's net liquidity, and so will the level of fixed asset investment.

Empirical studies emphasize the importance of splitting the sample of companies based on their innate likelihood of facing financial constraints. This division could happen along certain characteristics, such as size (Audretsch and Elston, 2002), age (Chirinko and Schaller, 1995), and various leverage indicators (Guariglia, 1999). Due to the limited size of the sample it was not divided into groups of relatively large (likely unconstrained) and small (likely constrained) firms. Instead, three control variables were introduced: 1) firm's relative size, expressed as a percentage, is calculated by dividing a firm i's total assets by total assets of the largest firm in the sample, 2) the level of financial leverage measured as the debt-to-equity ratio, and 3) Tobin's q, a parameter that controls for the changes in the market value of a company and captures its future profitability.

It is hypothesized that the greater values of these variables, the easier access of a company to external financing and the higher the level of its fixed investment. Moreover, it is expected that the level of financial leverage is likely to be more sensitive to contractionary monetary policy decisions due to mounting financial costs. As mentioned before, a higher debt-to-equity ratio generates higher financial and agency costs. Hence, *D*/*E* coverage might influence fixed investment negatively. In the course of estimation a debt-to-equity ratio dummy was introduced that takes the value of one if a company's ratio exceeds the 75th percentile and 0 otherwise. It was used to replace the traditional *D*/*E* ratio in an attempt to divide the sample into two clearly separated groups. This did not yield satisfactory results invalidating somewhat the idea of such a simplified sample division according to leverage[1].

Recent empirical work (eg. Angelopoulou and Gibson, 2009) advocates net cash flow as a proxy for a company's net worth. However, the preliminary calcu-

[1] Estimation using a *GLS* and *LSDV* estimators; results of both are available upon request.

lations including estimation of two random effects models did not perform satisfactorily[2]. On the basis of Masuda (2015), net cash flow was replaced with a liquid assets ratio defined as the sum of a company's liquid assets relative to its total assets (LIQ). This, however, shifts the focus from a company's net worth to its net liquidity. From a technical standpoint, the measurement error of this indicator is relatively lower when compared to the variable based on net cash flow. It is assumed that the greater company's level of readily available liquidity, the lesser its risk of defaulting on its debts. Therefore, it may raise external funds more easily, even in periods of tight monetary policy. Moreover, firms holding more liquid assets may draw on them when bank financing is scarce. Taking this into consideration, it is expected that the coefficient of the variable *LIQ* will be significantly positive.

Relevant literature suggests that the level of a company's internationalization could be captured by either single-variable measures or by a more complex index measure (D. Sullivan, 1994). The concept of either of them seems dubious according to Ramaswamy, Galen Koeck, and Renforth (1996). Based on Dorrenbacher (2000)'s review of different approaches I introduced a dummy controlling for the ratio of domestic revenues to total revenues (US_REV%). The variable takes the value of 1, if a company's domestic revenues constitute more than 50% of its total revenues; and the 0 value otherwise.

To eliminate possible outliers, the gathered data were transformed by setting all the outlying observations to the 99th percentile of the data. This procedure was also applied to the 1st percentile of the data and checked for robustness. Since it did not influence the estimation results, they are omitted to keep the discussion in Section 4 concise.

Following Masuda (2015) and Angelopoulou and Gibson (2009), monthly dummy variables were introduced reflecting monetary policy decisions made each month during the selected timeframe. The dummies take the value of 1 in months during which the Fed decided to tighten monetary policy (Eq. 1) or engage in quantitative easing (Eq. 2).

$$M_{MON_{TIGHT}} = \begin{cases} 1 - \textit{monetary policy tightening} \\ 0 - \textit{other decisions} \end{cases} \tag{1}$$

$$M_{QE_{i,t}} = \begin{cases} 1 - \textit{decisions involving quantitative easing} \\ 0 - \textit{other decisions} \end{cases} \tag{2}$$

To annualize monthly dummy variables and match them to annual firm-level data, they were averaged as follows (Masuda, 2015, p. 13):

$$MON\_TIGHT_{i,t} = \frac{\sum_{1}^{12} M_{MON\_TIGHT_{i,t}}}{12} \tag{3}$$

[2] Results are available upon request.

$$QE_{i,t} = \frac{\sum_{1}^{12} M_{QE_{i,t}}}{12} \tag{4}$$

$MON\_TIGHT_{i,t}$ and $QE_{i,t}$ denote annualized averaged dummies identifying periods of contractionary and expansionary monetary policy for company i in year t. Depending on the number of months of either tight or expansionary monetary policy during a fiscal year, both take values between 0 and 1.

Following Masuda (2015), these variables were introduced as cross terms for the liquid asset ratio variable. Another cross term was added for the ratio of a company's domestic revenues to total revenues. Introduction of these interaction terms allowed to capture two phenomena. Firstly, supposing that the balance sheet channel is a valid monetary transmission mechanism, it will be possible to identify its influence on liquidity constraints and, indirectly, on fixed investment. Secondly, since the impact of the monetary policy on general economic conditions cannot be dismissed, an interaction term for a firm's domestic revenues dummy was include. It was assumed that firms whose revenues came in greater part from the U.S. market would be more sensitive to changing monetary conditions.

Fixed investment rate series is constructed as a difference in total fixed assets between periods t and $(t - 1)$ divided by an average book value of total assets at the end of periods t and $(t - 1)$.

Table 1 below summarizes the variables constructed for the analysis.

Table 1. Description of variables

Variable	Description	Abbreviation
Fixed investment	investment in tangible fixed assets relative to total assets	$INV_{i,t}$
Liquid assets ratio	measured as company i's securities, cash, bills, and accounts receivables relative to its total assets.	$LIQ_{i,t}$
Financial leverage	financial leverage measured as the ratio of the company i's total debt to equity	$D/E_{i,t}$
Tobin's q	measured as company i's market value to its book value; controls for the changes in a company's market value and its future profitability	$Q_{i,t}$
Revenues ratio	measured as company i's domestic revenues relative to its total revenues	$US\_REV\%_{i,t}$

Contractionary monetary policy	calculated according to Eq. 1	$MON\_TIGHT_{i,t}$
Quantitative easing	calculated according to Eq. 2	$QE_{i,t}$
Industry	denotes industry in which company *i* operates	$industry_i$
Size	company *i*'s total assets relative to the total assets of the largest firm	$size_{i,t}$

3. EMPIRICAL RESULTS AND DISCUSSION

BALANCE SHEET CHANNEL OF MONETARY POLICY TRANSMISSION

The significance of the balance sheet transmission mechanism was investigated using a random effects model estimated by a generalized least square estimator (GLS). This decision was based on the outcome of the Hausman specification test, according to which the null hypothesis that the company-specific effects do not correlate with the regressors could not be rejected. A fixed effects approach was used in the robustness check in Section 5. Lagged explanatory variables were introduced for two reasons. Firstly, monetary policy shocks take time to affect the real economy. Secondly, a one-year lag may help to avoid a possible endogeneity problem, as noted in Angelopoulo and Gibson (2009, pp. 681–682). This might not be sufficient to eliminate the issue of endogeneity but introduction of variables lagged by two or more periods would reduce the number of observations and so obtained results could be relatively more biased than in the original estimation process. The panel GMM estimator (Arellano, Bond, 1991) might provide a solution to this problem. The decision whether to apply that methodology would depend on the outcome of the Sargan test of over-identifying restrictions.

$$INV_{i,t} = \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 LIQ_{i,t-1} + \alpha_3 (MON\_TIGHT * LIQ)_{i,t-1} + \alpha_4 year + \\ + \alpha_5 (D/E)_{i,t-1} + \alpha_6 (US\_REV\% * MON\_TIGHT)_{i,t-1} + \alpha_7 size_{i,t} + \\ + \alpha_8 industry_i + \alpha_9 group_i + \varepsilon_{i,t} \tag{5}$$

where variables and capture other aggregate macroeconomic shocks such as interest rate changes, exchange rate changes, inflation, fiscal policy.

Table 2 below reports the results obtained from the first model (Eq. 5).

Column 1 reports results before controlling for a company's leverage and the impact of contractionary monetary policy on liquidity. Variables $LIQ_{i,t}$ and $Q_{i,t}$ are statistically significant and greater than zero at the 1% significance level, as expected. After including the debt-to-equity ratio to investigate the sensitivity of fixed investment to financial leverage (as shown in column 2), results improved in terms of

Table 2. Estimation results using a GLS estimator

Variable	1	2	3
$Q_{i,t}$	0.0177*** (4.91)	0.0993*** (5.62)	0.0915*** (5.15)
$(MON\_TIGHT * LIQ)_{i,t-1}$			0.0946 (0.202)
$LIQ_{i,t-1}$	1.5885*** (6.24)	1.6637*** (6.98)	1.7917*** (7.00)
$(D/E)_{i,t-1}$		0.0019 (0.204)	0.0019 (1.32)
$(US\_REV\% * MON\_TIGHT)_{i,t-1}$	–0.0019 (–0.0105)	0.0952 (0.503)	0.0146 (0.0809)
$Size_{i,t}$	–0.3917 (0.197)	0.9920*** (3.05)	0.9881*** (3.27)
$Industry_i$	–0.0003 (–0.809)	0.0011 (0.397)	0.0009 (0.751)
Constant	–0.1618 (–0.451)	–0.3035 (–1.52)	–0.3883* (–1.79)
R^2	0.0727	0.0648	0.0787

*Notes: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively; 2. Estimation using robust standard errors; 3. T-statistics reported in the parentheses are heteroscedasticity-consistent.*

statistical significance. The variable controlling for relative size is statistically significant at the 1% level. The coefficients on the *LIQ* and *Q* variables changed visibly, rising by 4.5% and 82% respectively. Column 3 reports the estimation results after the introduction of the composite variable identifying the impact of contractionary monetary policy on liquidity. While the introduction of the debt-to-equity variable improved the overall quality of the model, the presence of the cross term seems of little importance. Its influence may reflect on the value of the coefficient on the *LIQ* variable, which rose by 7%. The signs of the coefficients on the significant variables remained as expected, regardless of the gradual expansion of the model.

On the basis of obtained results it can be assumed that investment in fixed assets is sensitive to changes in a firm's Tobin's q and liquidity levels. The latter could be partly explained by financial market imperfections and asymmetrical information which restrict companies' access to external funding and force them to rely more on their internal liquid assets. The former corroborates an intuitive claim that the greater future profitability of a company as measured by Tobin's q, the higher its level of investment. Contrary to previous analyses, tight monetary policy influence on fixed investment via its impact on the liquid assets ratio

could not be confirmed. Although contractionary monetary policy may well strengthen liquidity constraints, there seems to be no direct translation of this impact on the relationship between the liquid asset ratio and fixed investment. This implies that the transmission of monetary policy shocks through firms' balance sheets may have been limited. In line with my earlier presumption, a company relative size – measured in each case by two and three separate variables respectively – proved to be an important factor influencing fixed investment. The more assets a firm holds and the greater their market value, the easier its access to external funding. It follows that such companies face weaker financial constraints and their net liquidity – as measured by the liquid asset ratio – is less dependent on monetary policy decisions.

There may be several reasons why the study failed to capture the impact of contractionary monetary policy on fixed investment. During the chosen timeframe investor optimism and elevated asset prices across market sectors did not yield to the Fed's attempts to cool the economy. Moreover, this finding validates the claim that financial and thus liquidity constraints weaken with rising levels of market sophistication as mentioned in Angelopoulou and Gibson (2009, p. 698). With the benefit of hindsight it may be conjectured that U.S. investors did not perceive the central bank's actions as forceful and decisive enough to counteract the augmenting financial disequilibria and systemic risk.

QUANTITATIVE EASING AND THE BALANCE SHEET TRANSMISSION MECHANISM

The second hypothesis investigates the existence of the balance sheet transmission mechanism during the periods of quantitative easing. If it were true, the central bank would be able to ease liquidity constraints and stimulate investment by providing companies with unlimited access to liquid funds. Moreover, companies' net liquidity as proxied by the liquid assets ratio should be less sensitive to the central bank's decisions during periods of ultra-easy monetary policy. To verify this statement a model similar to the one presented in the previous section was estimated. The variable identifying quantitative easing periods $(QE^{*}LIQ)_{i,t}$ was introduced Assuming that unconventional monetary policy mitigated liquidity constraints faced by firms in the analyzed timeframe, the coefficient of the newly entered variable would be significantly negative and the coefficient of the liquid assets ratio – significantly positive.

$$\begin{aligned} INV_{i,t} &= \alpha_0 + \alpha_1 Q_{i,t-1} + \alpha_2 LIQ_{i,t-1} + \alpha_3 (QE * LIQ)_{i,t-1} + \alpha_4 year + \\ &+ \alpha_5 (D/E)_{i,t-1} + \alpha_6 (US\_REV\% * QE)_{i,t-1} + \alpha_7 size_{i,t} + \alpha_8 industry_i + \\ &+ \alpha_9 group_i + \varepsilon_{i,t} \end{aligned} \quad (6)$$

Notations are the same as in the previous equation (Eq. 5). *QE* stands for the annualized monetary policy dummy (Eq. 4). Table 3 below reports the regression model estimation results (Eq. 6).

Table 3. Estimation results using a GLS estimator

Variable	1	2	3
$Q_{i,t-1}$	0.0937*** (5.33)	0.0992*** (5.62)	0.0920*** (5.17)
$(QE * LIQ)_{i,t-1}$			–2.4284* (–1.80)
$LIQ_{i,t-1}$	1.4753*** (6.25)	1.6554*** (6.96)	2.0914*** (7.75)
$(D/E)_{i,t-1}$		0.0019 (1.27)	0.0019 (1.28)
$(US\_REV\% * QE)_{i,t-1}$	–0.1441 (–0.527)	–0.1070 (–0.243)	–0.0778 (–0.184)
$Size_{i,t}$	–0.4474 (–1.36)	0.9895*** (3.03)	1.0337*** (3.40)
$Industry_i$	0.00002 (0.0141)	0.0012 (0.910)	0.001 (0.796)
Constant	–0.0370 (–0.247)	–0.2415 (–1.57)	–0.4458*** (–2.93)
R^2	0.0599	0.0648	0.0806

*Notes: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively; 2. Estimation using robust standard errors; 3.T- statistics reported in the parentheses are heteroscedasticity-consistent.*

Columns 1 and 2 present results before and after the introduction of the debt--to-equity ratio, respectively. The basic model (column 1) performance is satisfactory, confirming the positive relationship between a firm's fixed investment and its Tobin's q and liquidity levels. Both *Q* and *LIQ* are statistically significant at the 1% level. When *D*/*E* variable was included, the overall quality of the model changed visibly. Although the presence of the new variable seems to have little impact on the *Q* parameter, the coefficient on the liquid assets ratio rose by slightly more than 10%. Apart from this, the variable controlling for a company's relative size became statistically significant at the 1% level. This mirrors the development observed in the case of Eq. (5). The $size_{i,t}$ variable seems to affect investment only when combined with financial leverage, regardless of the statistical significance of the latter. The results shown in column 2 remained unchanged in terms of statistical significance after the cross term identifying quantitative easing periods was introduced (column 3). The composite variable is significant at the 10% level; the negative coefficient on *QE*LIQ* suggests that the sensitivity of a firm's net liquidity is lower during periods of easy monetary policy. The presence of the composite variable affected the coefficients on the *Q* parameter and the liquidity ratio. The former has reduced slightly, while the latter has risen by 20%.

While there is no apparent link between contractionary monetary policy and the relationship between the liquid asset ratio and fixed investment (as shown in Table 2), quantitative easing may shape, to a certain extent, the relation between these two variables. These results imply that large-scale asset purchases conducted by the central bank may have had an impact on the real economy via the balance sheet transmission channel. In doing so, they seem to have mitigated liquidity constraints faced by U.S. non-financial companies during the selected period. Monetary policy notwithstanding, the relative size of a firm, if considered in connection to a variable controlling for the debt-to-equity coverage, remains an important factor in its access to external funding and fixed investment decisions.

4. ROBUSTNESS CHECK

As a robustness check, both hypotheses were investigated and both sets of models (for Eq. 5 and Eq. 6) were re-estimated using fixed effects estimators. The calculations are given in tables 4 and 5 below. Like in the previous section, columns 1, 2, and 3 present the results before and after the inclusion of the variables controlling for a company's financial structure and identifying the monetary policy.

Table 4. Estimation results using a LSDV estimator

Variable	1	2	3
$Q_{i,t-1}$	0.0829 (0.863)	0.0869 (0.971)	0.0787 (0.826)
$(MON\_TIGHT * LIQ)_{i,t-1}$			–0.8839 (–1.03)
$LIQ_{i,t-1}$	4.6845*** (3.19)	3.1922*** (2.69)	3.45*** (3.38)
$(D/E)_{i,t-1}$		0.0021*** (2.20)	0.0021** (2.03)
$(US\_REV\% * MON\_TIGHT)_{i,t-1}$	–0.0891 (–0.552)	0.0226 (0.121)	–0.0761 (–0.468)
$Size_{i,t}$	–0.3770 (–0.55)	4.7260 (0.152)	4.8603 (1.48)
$Industry_i$	0.0083*** (2.90)	0.0091*** (2.64)	0.0115*** (3.16)
Constant	–0.8550* (–0.061)	–1.0838** (–1.96)	–1.3212** (–2.32)
R^2	0.277356	0.2577448	0.3114957

*Notes: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively; 2. Estimation using robust standard errors;3. T-statistics reported in the parentheses are heteroscedasticity-consistent.*

Column 1 reports results of the regression estimation before the debt-to-equity ratio was introduced. Such a model performs well, suggesting that the relationship between liquidity constraints and fixed investment is stable. As assumed in Section 3, a company's size, although in this case expressed as its debt-to-equity ratio, remains a significantly positive factor when considering its level of fixed investment (as shown in column 2). The statistical significance of the liquid asset ratio remained unchanged relative to the dependent variable. On the other hand, its impact seems slightly diminished with the coefficient on the ratio falling by 31%. The presence of the cross term had little impact on the basic results besides lowering slightly the statistical significance of the D/E variable. It strengthened the influence of the liquid assets ratio on investment and raised its coefficient by 34%. It was found that the industry variable was statistically significant at the 1% level regardless of the monetary policy interaction term. As noted before, the results using a LSDV estimator are fairly in line with the ones reported in Section 4. Neither case confirms the influence of tight monetary conditions on companies' access to liquidity and their investment decisions. The supposed lack of such a link can be ascribed to either high level of market sophistication or the measurement errors in relevant parameters.

Table 5. Estimation results using a LSDV estimator

Variable	1	2	3
$Q_{i,t-1}$	0.0910 (1.02)	0.0876 (0.982)	0.0821 (0.861)
$(QE * LIQ)_{i,t-1}$			–0.3288 (–0.225)
$LIQ_{i,t}$	2.9941** (2.52)	3.1997*** (2.70)	4.6224*** (3.68)
$(D/E)_{i,t-1}$		0.0020** (2.16)	0.0021** (2.03)
$(US\_REV\% * QE)_{i,t-1}$	–0.4304 (–1.14)	–0.7168 (–1.41)	–0.5417 (–1.06)
$Size_{i,t}$	–0.5054 (–0.777)	4.7305 (1.44)	4.9439 (1.51)
$Industry_i$	0.0063** (2.31)	0.0100*** (2.65)	0.0121*** (3.04)
Constant	–0.7036 (–1.50)	–1.1471** (–1.98)	–1.6205*** (–2.64)
R^2	0.2295	0.2588	0.3104

*Notes: 1. ***, **, and * denote 1%, 5%, and 10% significance levels, respectively; 2. Estimation using robust standard errors; 3. T-statistics reported in the parentheses are heteroscedasticity- consistent.*

Table 5 reports the estimation results of the Eq. (6). The basic model confirms the significance of the relationship between a firm's liquid assets ratio and its fixed investment. The variable controlling for industry is statistically significant at the 5% level. When the debt-to-equity ratio was entered (column 2), the quality of the model has improved. In the case of ultra-easy monetary policy, there seems to be a positive correlation between a company's debt-to-equity coverage and investment decisions. The impact of the liquid assets ratio on the dependent variable has strengthened by around 6%. In light of the estimation results shown in column 3, the previously proven impact of quantitative easing on the real economy becomes debatable. The coefficients of the liquid asset and the debt-to-equity ratios remained positive and statistically significant at the 1% and 5% levels, respectively. Moreover, the presence of the cross term boosted the coefficient on the *LIQ* variable by 30%. The financial structure of liabilities continues to influence investment decisions irrespective of the monetary policy. Results shown in column 3 invalidate the supposed balance sheet transmission mechanism when considering liquidity constraints and their impact on fixed investment in the chosen sample period. It implies that, contrary to theoretical assumptions, ultra-easy monetary policy might not have lessened liquidity constraints of non-financial companies during the recent crisis.

CONCLUSIONS

Liquidity constraints can limit a firm's access to external funding sources due to their negative impact on credibility and default risk,. Such companies are more sensitive to adjustments in monetary policy, and the strength of their reaction depends on their financial structure. This provides the central bank with a mechanism of transmission of its policy decisions and thus allows it to shape the real economy to a certain extent.

The aim of this paper was to determine whether the monetary policy of the Fed in 2005–2014 influenced non-financial firms' fixed investments. If the first presented hypothesis were true, tight monetary policy would influence a company's net liquidity expressed as its liquid asset ratio and raise its external finance premium thus lowering fixed investment. On the other hand, as stated in the second hypothesis, quantitative easing and provision of easily accessible funds to the market could have alleviated liquidity constraints.

The analysis failed to provide enough grounds to support the first hypothesis stating that the balance sheet mechanism was a valid transmission channel of monetary policy in the selected timeframe. Relative tightening of the monetary policy seemed unrelated to companies' liquidity constraints and fixed investment. While this outcome was not entirely unexpected given the prevailing economic outlook and conditions in the chosen period, according to the relevant literature the link does exist. However, it might not manifest itself in the environment of ultra-easy monetary conditions. This issue remains controversial and, in light of

new developments in the U.S. financial market, requires further studies. In line with analyses published earlier, the size of a company, especially when combined with a variable controlling for its debt-to-equity coverage, was an important factor determining a company's ability to raise external funding.

Secondly, when considering unconventional monetary policy the importance of the balance sheet channel could not be entirely dismissed. It was assumed that when the central bank engaged in large-scale asset purchases, liquidity constraints faced by most companies diminished, at least to a certain extent. This proved to be true, however, results obtained using an alternative estimator did not corroborate wholly the baseline analysis. The existence of a positive relation between the liquid assets ratio and fixed investment was confirmed, yet the link between quantitative easing and these two variables remains dubious. In both cases either financial structure expressed by the D/E ratio or expected future profitability measured by a company's Tobin's q remained statistically significant factors influencing its investment decisions.

The issue of the effectiveness of the balance sheet channel has been controversial and it remains unresolved in recent empirical analyses. This research confirms that the link between a firm's liquid assets and its level of fixed investment is positive and statistically significant. This corroborates the mechanism of liquidity constraints. As expected, firm's financial structure and expected future profitability also positively influence investment decisions. According to the estimation results, there is no valid reason to state that monetary policy, either contractionary or expansionary, affects this relationship. Based on the results discussed in this paper at least three explanations for the lack of this link can be proposed. Firstly, regarding the ultra-easy monetary policy, the zero lower bound problem may impair monetary policy transmission mechanisms. Secondly, advanced financial market infrastructure may weaken or modify such relationships. It follows that the investigated phenomenon may well be non-linear, in which case more sophisticated econometrical modeling should be applied. Furthermore, the endogeneity problem may also influence the results. Future research should verify these issues and address them by applying an alternative – non-linear one if required – estimation method, and by using a larger sample and a longer timeframe.

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OGRANICZENIA W POZIOMIE PŁYNNOŚCI PRZEDSIĘBIORSTWA A ODDZIAŁYWANIE KANAŁU BILANSOWEGO TRANSMISJI POLITYKI PIENIĘŻNEJ

STRESZCZENIE

W czasie ostatniego kryzysu znaczenia nabrała transmisja impulsów polityki pieniężnej za pomocą kanału bilansowego, co było szczególnie ważne ze względu na nieczynny kanał stóp procentowych. Niniejszy artykuł analizuje wpływ polityki pieniężnej na związek płynności i poziomu inwestycji amerykańskich przedsiębiorstw sektora niefinansowego w okresie 2005–2014. Aby zbadać znaczenie tego kanału transmisji sformułowano dwie hipotezy: 1) restrykcyjna polityka pieniężna ograniczyła dostęp do płynności w badanym okresie i 2) ilościowe luzowanie oddziaływało na poziom inwestycji w aktywa rzeczowe w okresie 2008–2014. Dla każdej z badanych hipotez przeprowadzono estymację trzech modeli z wykorzystaniem efektów losowych i trzech z zastosowaniem efektów ustalonych. Ustalono, że po pierwsze, relatywnie zacieśnienie polityki pieniężnej wydaje się niezwiązane z ograniczeniem w dostępie do płynności. Mimo to rozmiar przedsiębiorstwa oraz poziom dźwigni finansowej okazały się istotnymi czynnikami determinującymi możliwość pozyskania finansowania zewnętrznego. Po drugie, uzyskane wyniki nie potwierdziły jednoznacznie istotności kanału bilansowego transmisji w kontekście niekonwencjonalnej polityki pieniężnej. Stwierdzono jednak pozytywną relację pomiędzy współczynnikiem płynności i poziomem inwestycji w aktywa trwałe.

Słowa kluczowe: polityka pieniężna, inwestycje, ograniczenie płynności, kanał bilansowy przedsiębiorstwa.
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