Is the working-capital channel important?

Melinda Suveg *†

July 12, 2019

Abstract

Using a novel firm-level dataset, which merges firm-level producer price (PPI) and balance sheet data, this study shows that the working capital channel is important for firms' price setting behaviour. The working capital channel introduces interest payments in the firm's marginal cost, which make producer prices increasing in the policy rate. This is the first empirical paper to show firm-level evidence of the working capital channel as it is used in workhorse New Keynesian models. The role of the working capital channel in standard New Keynesian models is to create a direct supply-side monetary policy transmission mechanism that can generate price responses consistent with the price puzzle observed in aggregate data. The empirical results show that the pass-through of a one percentage point interest rate change to the producer price via the working capital channel is 0.9 percentage point for the firm with average working capital holdings over a five month price setting horizon. The paper extends the traditional model of the working capital channel by differentiating between anticipated and unanticipated interest rate changes in order to examine how important unanticipated interest rate changes are for the firm's price setting behaviour. The theoretical framework predicts that unanticipated interest rate changes have a larger impact on prices than anticipated interest rate changes. The empirical results show that interest rate changes are fully unanticipated by the firm so it is sufficient to use actual interest rate changes to measure the supply-side policy rate pass-through.

Keywords: working capital, firm price setting, monetary policy, pass-through
JEL Codes: D84, E31, L11

*melinda.suveg@nek.uu.se, Uppsala University

†The author thanks Nils Gottfries, David Vestin and Daria Finocchiaro for the supervision and the outstanding dedication to improve this paper. I also thank the Department of Economics at Uppsala University and the Jan Wallanders and Tom Hedelius Scholarship fund for the financial support.

1 Introduction

Many researchers have argued that monetary policy affects the performance of the economy through both demand *and* supply. The supply-side propagation mechanism, or the working capital channel, states that a higher nominal interest rate increases the marginal cost firms face because the interest rate scales the total amount of money firms need to spend in order to pay for their factors of production before sales are realised and payments are received. Workhorse New Keynesian models use the working capital channel to explain the price puzzle (Christiano, Eichenbaum and Evans (2005)); and the absence of more pronounced deflationary pressures during the Great Recession (Christiano, Eichenbaum and Trabandt (2015)).

This paper develops a theoretical framework based on the New Keynesian model to derive a structural equation that can be used to identify the working capital channel in firm-level data. First, the theory introduces the working capital channel into a basic New Keynesian model following (Christiano, Eichenbaum and Evans (2005)) to explain the effect of a repo rate change on firm-level price inflation. Then, the theoretical model is extended to show that anticipated and unanticipated interest rate changes have different effects on producer prices via the working capital channel. Absent price rigidities, only unanticipated interest rate changes impact firms' prices. The extent to which anticipated changes matter relative to unanticipated changes is determined by the structure of expectations the firm has, and the level of price stickiness. Nominal rigidities prevent firms from incorporating anticipated interest rate changes into current prices which makes anticipated interest rate changes matter less for current price changes.

To identify the working capital channel, this study uses a unique firm-level panel dataset containing detailed information on firm characteristics and monthly prices. The dataset includes firm-specific balance sheet and producer price data for 2,151 Swedish firms for the period 1997-2016. The working capital channel is identified by comparing the price response to an interest rate change of firms that have large working capital requirement to those firms that have little working capital requirement. The hypothesis is that firms who have a larger working capital requirement raise their prices more in response to an interest rate change because it increases their marginal cost by proportionately more. Working capital is defined as the sum of receivables and inventories net of payables and pre-payments from customers.

The variable, through which the transmission mechanism is measured, is the interaction between the economy-wide interest rate change and the firm-specific working capital to sales ratio. In the main specification, firm-level monthly price inflation is regressed on an interaction term between the working capital to sales ratio and the repo rate change, including relevant control variables. As a second step, interest rate changes are broken into anticipated interest rate changes and unanticipated interest rate shocks. The unanticipated interest rate changes used in this study are forecast errors derived from a Taylor-type forecast rule in which firms are modelled as econometricians who forecast interest rates based on their average price duration. Using anticipated and unanticipated interest rate changes as separate regressors in place of the repo rate changes helps examine the extent to which interest rate changes are unanticipated by firms.

The main result shows that the effect of a repo rate change on prices via the working capital is significant and economically non-negligible. Over a five months price setting horizon, the price rise from a one percentage point increase in the repo rate is around 1.4 percentage point higher for a firm whose working capital requirement equals its sales compared to a firm whose working capital requirement is zero. The predicted percentage price change upon a one percentage point change in the interest rate for the firm with average working capital holdings over the five month horizon is 0.9 percentage point; and the price change difference between the average firm and a firm with no working capital requirement is about 0.2 percentage points. The results show that the percentage price change from $p(t-1)$ to $p(t)$ is almost zero suggesting that prices are sticky and there is a delay in the price response.

The second set of regressions show that anticipated and unanticipated changes in the interest rate have the exact same effect which implies that the division of actual repo rate changes into anticipated and unanticipated components by the 'econometrician firms' is not a meaningful division. These results suggests that endowing firms with moderately sophisticated expectations, which assumes that firms monitor key macroeconomic processes, is not the correct specification for firms expectation formation. Firms expectations are likely to be much simpler and they are best described by static expectations where firm's forecast of the future interest rate is equivalent to the prevailing rate today. Therefore, using the actual repo rate change in a regression provide a sufficient statistic to understand the supply-side monetary policy pass-through via the working capital

channel.

To evaluate the reliability of the results, two additional measure of interest rate shocks are used in place of the forecast errors. The first measure of the interest rate shocks come from the Ramses II model of the Riksbank (Adolfson, Lasen, Christiano, Trabandt and Walentin (2013)). The results using these quarterly RamsesII shocks corroborate the conclusions from the main specification and show that unanticipated interest rate changes have non-negligible effects on firms' prices via the working capital channel. The second measure of interest rate shocks is calculated following Iversen and Tysklind (2017) who adapt the Kuttner (2001) method to Swedish data and derive the so called Kuttner-shocks using inter-bank lending rates. The shortcoming of the Kuttner-shock is that they are based on much more sophisticated information than the information firms use. Professional forecasters follow interest rate movements rigorously whereas firms have much less knowledge about interest rate movements so a significant fraction of the Kuttner-shocks can be considered measurement error from the firm's perspective. Despite this, using Kuttner-shocks lead to a positive price response upon an anticipated and an unanticipated increase in the policy rate via the working capital channel.

The contribution of this study is that it shows the existence of the working capital channel in micro-data. The identified pass-through of monetary policy via the working capital channel is non-negligible and it has considerable implications for firms' price setting behaviour. The results presented in this paper complement Barth and Ramey (2001)'s pioneering work that provides industry-level evidence about the cost channel. The closest to this paper, however, is Gaiotti and Secchi (2006). They use firm-level balance sheet data on Italian firms' working capital requirements and PPI price data to identify the cost channel. This study corroborates the findings of Gaiotti and Secchi (2006) in that the working capital channel is found to be important for firms' price setting behaviour. However, this study is different to Gaiotti and Secchi (2006) in two important ways. First, this paper focuses on the working capital channel as it is used in workhorse DSGE models, meaning that this study uses actual repo rate changes in the estimation whereas Gaiotti and Secchi (2006) use firm-specific interest rate changes. It is important to separate actual repo rate changes from firm-specific interest rate changes because the theoretical convention is to augment marginal costs with the policy rate; and because Gilchrist and Zakrajsek (2012) show that changes in corporate bond credit spreads and

monetary policy propagate the economy in different ways. Second, this paper examines the price response to anticipated and unanticipated interest rate changes. Separating anticipated and unanticipated interest rate changes helps understand the role of interest rate expectations in sticky price models.

2 Related Literature

The working capital channel has extensively been used in the literature. It is sometimes called the cost channel, first mentioned by Farmer (1984), Blinder (1987), and Fuerst (1992). Later Christiano and Eichenbaum (1992), Christiano, Eichenbaum and Evans (2005) and Ravenna and Walsh (2006) incorporate the working capital channel to the DSGE modelling framework. Christiano, Eichenbaum and Evans (2005) use the working capital channel to help generate the initial opposite response of inflation to monetary policy shocks, the 'price puzzle', which makes prices rise before they fall. Today, it is a general convention to use the working capital channel in DSGE models. Even central banks apply the working capital channel in their models, e.g. Sweden's Ramses II by Adolfson, Lasen, Christiano, Trabandt and Walentin (2013).

The working capital channel is widely used because aggregate data seems to support its role. Chowdhury, Hoffmann and Schabert (2006) estimate a New Keynesian Phillips curve for Canada, France, Germany, Italy, Japan, the UK, and the US augmented with a cost channel term and find a significant interest rate elasticity. Ravenna and Walsh (2006) estimate an augmented Phillips curve and build a model where a cost-push shock can arise endogenously through the cost channel in the New Keynesian model. They find that the cost channel is present and it has significant implications for optimal monetary policy. More recently, Tillmann (2008) estimates the role of the cost channel for inflation dynamics for the US, the UK, and the aggregate Euro area within a forward-looking Phillips curve framework; and confirms the importance of the cost channel. Tillmann (2009) examines the time-varying role of the cost channel in the US and finds that the cost channel was most important in the pre-Volcker period and that it is less important in the Volcker-Greenspan era.

However, there is also some evidence against the existence of a cost channel. For example, Mojon (2008) argues that the VAR-based stylised facts in support of the working

capital channel are fragile. Specifically, the fact that exogenous monetary policy shocks have a delayed, persistent, hump-shaped effect on inflation disappears when the estimation period is restricted to a period that does not include large shifts in the level of inflation. Rabanal (2007) finds that the demand-side effects of monetary policy dominate the supply side effect so a higher interest rate does not increase inflation. Gabriel and Martins (2010) argue that the cost channel effect is poorly identified in a single-equation framework and zero interest rate effects cannot be ruled out.

Barth and Ramey (2001) are the first to use industry-level data to test the importance of the working capital channel and the supply-side monetary policy transmission. Barth and Ramey (2001) find that it is an important monetary policy transmission channel that exists in the disaggregated data. Following Barth and Ramey (2001), the only empirical study that uses firm-level data to examine the working capital channel is that of Gaiotti and Secchi (2006). They find evidence in support of the working capital channel. Specifically, they find that the mean ratio of working capital to annual operating cost is 0.33, which implies that firms on average hold four month worth of operating costs as working capital. The effect they identify ranges between 0.3 and 1, meaning that a one percent rise in the annualised interest rate induce an increase in prices between 10 and 30 basis points. They conclude that the effect of interest rate changes on firms' price setting via the working capital channel is statistically significant and economically non-negligible.

3 Theoretical framework

3.1 Model

This model describes the working capital channel and shows how anticipated and unanticipated changes in the interest rate affect firm-level price inflation via the working capital channel. The model features staggered price changes a lá Calvo because price rigidity is observed in the firm-level data. Using staggered prices, the model shows that the level of price rigidity affects the extent to which firms incorporate anticipated and unanticipated interest rate changes into their price. The main prediction of the model is that an unanticipated interest rate change has a larger effect on prices than an anticipated interest rate change.

In the New Keynesian model, the firm sets its optimal price ($p^*_{i,t}$) according to

$$p^*_{i,t} = \mu + (1 - \theta\beta) \sum_{k=0}^{\infty} (\theta\beta)^k E_{i,t}[\widetilde{mc}^n_{i,t+k|t}] \tag{1}$$

where $\widetilde{mc}^n$ is the firm's nominal marginal cost in logs. The details of the derivation of equation (1) is in appendix (A.1).

Now introduce the working capital channel by assuming that the firm pre-funds its wage bill W_t, akin to Christiano, Eichenbaum and Evans (2005), and define nominal marginal costs as

$$\widetilde{MC}^n_{i,t} = \frac{(1 + i_t)^{\delta_i} W_t}{(\partial Y_t / \partial N_t)} = \frac{(1 + i_t)^{\delta_i} W_t}{A_t(1 - \alpha) N_t^{-\alpha}} = \frac{(1 + i_t)^{\delta_i} W_t N_t}{Y_t(1 - \alpha)} \tag{2}$$

Equation (2) says that the firm's marginal cost is a function of the interest rate i. Including the interest rate in the marginal cost establishes the working capital channel that provides a direct transmission mechanism of monetary policy to firm-prices. The parameter δ_i captures inter-period compound interest payments spent on pre-funding wages. δ_i bears subscript i because it differs across firms. δ_i is the firm-specific time delay between paying for inputs and receiving payments for the output. The longer the firm has to wait to get paid, the higher δ_i is. This formulation of the working capital channel explicitly accounts for firm-level differences in the time lag between payments for inputs and receiving payments for products sold. The definition in (2) can be used to express log marginal costs as a linear function of firm-specific interest payments and the marginal input cost such that

$$\widetilde{mc}^n_{i,t} = \delta_i R_t + mc^n_t \tag{3}$$

where $R_t \equiv ln(1 + i_t)$ and $mc^n_t = ln(W_t N_t / (Y_t(1 - \alpha)))$ is the log nominal marginal input cost common to all firms.

To analyse the effect of anticipated and unanticipated interest rate changes, consider a large group of firms with a specific value of price stickiness (θ) and a specific value of pre-funding requirement (δ). For this group, price inflation is given by

$$\pi_t \equiv p_t - p_{t-1} = (1 - \theta)(p^*_t - p_{t-1}) \tag{4}$$

where p_t^* is given by equation (1). Note that p_{t-1} can be written as the joint probability that the firms were able to change the price in $t-1$ and that they had not changed the price for τ periods

$$p_{t-1} = (1-\theta)\sum_{\tau=0}^{\infty}\theta^{\tau}p_{t-1-\tau}^{*} \tag{5}$$

It is possible to rewrite the equation for price inflation in (4) using p_t^* from equation (1), the definition of marginal costs in (3) and the definition of the previous period's price from (5) such that

$$\begin{aligned}\pi_t = (1-\theta)(1-\theta\beta)\Bigg[E_t\sum_{k=0}^{\infty}(\theta\beta)^k\delta(R_{t+k}+mc_{t+k}^{n}) \\ -(1-\theta)\sum_{\tau=0}^{\infty}\theta^{\tau}E_{t-1-\tau}\sum_{k=0}^{\infty}(\theta\beta)^k\delta(R_{t-1-\tau+k}+mc_{t-1-\tau+k}^{n})\Bigg]\end{aligned} \tag{6}$$

Considering an unanticipated change in the interest rate ∂R_t^U means that the firm did not change any of its previous prices so the second term in square brackets is zero, and the price change with respect to an unanticipated change in the interest rate is

$$\frac{\partial\pi_t}{\partial R_t^U} = (1-\theta)(1-\theta\beta)\left[E_t\sum_{k=0}^{\infty}(\theta\beta)^k\delta\left(\frac{\partial R_{t+k}^U}{\partial R_t^U}+mc_{t+k}^{n}\right)\right] \tag{7}$$

Considering an anticipated interest rate change, however, means that the firm was able to incorporate a discounted fraction of the anticipated interest rate change into its price so

$$\begin{aligned}\frac{\partial\pi_t}{\partial R_t^A} = (1-\theta)(1-\theta\beta)\Bigg[E_t\sum_{k=0}^{\infty}(\theta\beta)^k\delta\left(\frac{\partial R_{t+k}^A}{\partial R_t^A}+mc_{t+k}^{n}\right) \\ -(1-\theta)\sum_{\tau=0}^{\infty}\theta^{\tau}E_{t-1-\tau}\sum_{k=0}^{\infty}(\theta\beta)^k\delta\left(\frac{\partial R_{t-1-\tau+k}^A}{\partial R_t^A}+mc_{t-1-\tau+k}^{n}\right)\Bigg]\end{aligned} \tag{8}$$

with perfect foresight $\partial R_t^A = E_{t-1-\tau}\partial R_t^A$.

Comparing equations (7) and (8) shows that the effect of unanticipated interest rate changes is larger than the effect of anticipated interest rate changes

$$\frac{\partial\pi_t}{\partial R_t^U} > \frac{\partial\pi_t}{\partial R_t^A} \tag{9}$$

3.2 Predictions of the model with and without price stickiness

The flexible price model has clear predictions for the effect of anticipated and unanticipated interest rate changes. The flexible price model prescribes that $\theta = 0$ which means that firms are free to set their optimal price every period, so ceteris paribus prices and interest rates change one to one weighted with the pre-funding requirement

$$\frac{\partial \pi_t}{\partial R_t} = \delta \frac{\partial R_t}{\partial R_t} = \delta \tag{10}$$

In a flexible price environment, it is not necessary for the firm to forecast so $\partial R_t = \partial R_t^U = \partial R_t^A$.

If prices are sticky, either of equations (7) and (8) can be true depending on whether firms anticipate interest rate changes or not. It is important to note that price stickiness interacts with both anticipated and unanticipated interest rate changes so price stickiness is not decisive for whether firms anticipate interest rate changes or not. Rather, stickiness determines the size of the response in (7) and (8). If θ and price stickiness is high, then the probability of changing the price $(1 - \theta)$ is low so $\partial \pi_t / \partial R_t^U$ will be lower and the second term in $\partial \pi_t / \partial R_t^A$ will be smaller. If changes are unanticipated, price stickiness leads to a pass-through that is less than one to one. If changes are anticipated, price stickiness leads a pass-through that is less than one to one *and* it also prevents firms from incorporating anticipated interest rate changes into their previous prices.

3.3 Reduced form regression specification

Equation (7) showed that price changes are determined by interest rate changes interacted with the firm's working capital requirement keeping other things constant. For the first exercise, assume that the entirety of the interest rate change is a surprise and equation (7) holds. This would be the appropriate assumption if firms expectations were simplistic and their best forecast of future interest rates was today's prevailing interest rate. Within this framework, the working capital channel is identified by comparing the effect of interest rate changes on firms that have large working capital holdings relative to sales with firms that have little working capital holdings relative to sales. In other words, the price response of firms that wait a longer time to receive payments are compared with firms that wait a shorter time upon a change in the interest rate. The hypothesis is that firms with

longer waiting times have larger interest payments; and therefore they are more likely to change their price after an interest rate change. To account for firms that produce in more than one product group, the estimation uses clustered standard errors on the firm-level. k regressions for $k \in [0, 9]$ horizons described in equation (11) are estimated according to

$$p_{i,t+k} - p_{i,t-1} = \omega_k \left(\left(\frac{\overline{W_i}}{S_i} \right) \times \Delta R_t \right) + \alpha_k + \delta_k(\eta_t \times \zeta_j) + \xi_{1,k}(\overline{S_i} \times \Delta R_t) + \beta_{i,k} + \sum_s^S \xi_{s,k} \left(\left(\frac{\overline{W_i}}{S_i} \right) \times D_s \right) \tag{11}$$

where the firm has index i and it is in industry j. Subscript t refers to months between 1997m1-2016m12; and s is the months of the financial crises between 2008m10-2009m6. $p_{i,t+k} - p_{i,t-1}$ is the log change in the firm-specific Home Market Price Index (HMPI) from a month before ($p_{i,t-1}$) to k months ahead. ΔR are interest rate changes. The coefficient ω can measure the difference in the price response to a one percentage point anticipated interest rate change between a firm with zero working capital to a firm whose working capital requirement equals its sales. $\left(\frac{\overline{W_i}}{S_i} \right)$ is the variable of interest, the time-average of the working capital to sales ratio for each firm i. $W_{t,i}$ is the firm's working capital, defined as the sum of inventories and receivables net of payables and prepayments from customers[1]. The regression uses the time-invariant firm-average working capital to sales ratio because this ratio prevents the cyclical and endogenous response of working capital to changes in the economy, such as a response to a simultaneous change in demand. The time-average represents business-as-usual behaviour; and ensures the exogeneity of working capital to contemporaneous changes in demand and other shocks.

The control variables include η_t, time-fixed effects, and ζ_j, industry-fixed effects, so the term $\tau_t \times \zeta_n$ controls for time-industry fixed effects. It takes value one when the firm is present in industry j at time t. Controlling for time-industry fixed effects ensures that time and industry-specific conditions, such as cyclical and industry specific variation in demand and input prices are removed from the error term. Firm-fixed effects β_i remove the time-invariant unobserved heterogeneity from the error term, for example market

[1]Barth and Ramey (2001) and Giaotti and Secci (2006) use inventories and receivables to measure the firm's working capital requirement so this measure is more complete

power. Further control variables include the interaction term $\bar{S}_i \times R_t$, where $\bar{S}_i$ is net sales. $\bar{S}_i \times R_t$ takes into account that larger firms respond to shocks differently than smaller firms. The regression also includes dummies D_s for the months of the financial crises (2008m10-2009m6) interacted with the time-invariant working capital to sales ratio. These control variables address the generic turbulence during the financial crises.

As a second step, the interest rate changes are broken into anticipated and unanticipated interest rate changes to test the importance of monetary policy surprises according to

$$p_{i,t+k} - p_{i,t-1} = \gamma_{1,k} \left(\left(\frac{\overline{W_i}}{S_i} \right) \times \Delta R_t^A \right) + \gamma_{2,k} \left(\left(\frac{\overline{W_i}}{S_i} \right) \times \Delta R_t^U \right) + \alpha_k + \delta_k(\eta_t \times \zeta_j) + \xi_{1,k}(\overline{S_i} \times \Delta R_t) + \beta_{i,k} + \sum_s^S \xi_{s,k} \left(\left(\frac{\overline{W_i}}{S_i} \right) \times D_s \right) \tag{12}$$

where ΔR^A are anticipated and ΔR^U unanticipated changes in the interest rate at time t. The main measure of unanticipated interest rate changes is estimated using a simple Taylor-type forecasting rule. $\gamma_{1,k}$ and $\gamma_{2,k}$ are the coefficients measuring the transmission of anticipated and unanticipated interest rate changes to prices via the working capital channel. The coefficient γ_1 and γ_2 can measure the difference in the price response to a one percentage point anticipated and unanticipated interest rate change between a firm with zero working capital to a firm whose working capital requirement equals its sales.

3.4 Identification

The cross-sectional variation identifying the effect of interest rate changes on prices come from the difference in time firms have to wait to get paid for their sold products. To identify the working capital channel, it is important that the measured working capital to sales ratio and the repo rate changes do not correlate with the error term.

Exogeneity of working capital The main criterion for an unbiased estimation is the exogeneity of firms' working capital requirements to firm-specific demand and other unobserved firm characteristics. Barth and Ramey (2001) argue that firms want to decrease their inventories and accounts receivable in response to a monetary contraction. They

claim that it is well known that aggregate inventories and accounts receivable rise relative to sales in response to a monetary contraction. For the purpose of this exercise, an increase in aggregate demand, that leads to both an interest rate and a price increase for all firms, is not a concern as long as it does not affect high and low working capital firms in a differentiated way. In other words, it will not bias the estimates if all firms off-load the same fraction of inventories when demand drops. Contemporaneous level changes in demand and prices are not problematic if they do not interact with the working capital requirement of the firm relative to its sales. However, to take all precautions and ensure that working capital does not react to contemporaneous changes in demand, the regression uses the time-averages of the working capital to sales ratio and it controls for the interaction of sales with interest rate changes.

Exogeneity of interest rate changes There is substantial difference between the exogeneity of monetary policy shocks in a DSGE model and the exogeneity of interest rate changes in a (partial equilibrium) model of the firm. The unanticipated interest rate change in this study can be considered as a monetary policy shock that the firm is unable to foresee. Expected changes in the interest rate are those interest rate movements that the firm can forecast with precision. From the individual firm's perspective, both anticipated and unanticipated changes in the interest rate are exogenously imposed on the firm so reverse causality, i.e. the process that price movements cause interest rate changes, cannot occur. Another issue is whether underlying demand can drive both prices and interest rates. This would only be a problem if both aggregate interest rate and firm-level prices moves because of changes in firm-level demand. Since demand for an individual firm's goods does not have a significant effect on the economy-wide interest rate this is not a threat to identification. To ensure that variation in firm-level demand and other remaining unobserved firm-level differences do not bias the results, the regression uses firm and time-industry fixed effects as well as an interaction term between firm-sales and interest rate changes.

4 Data

This study merges three datasets: the firm-level monthly (HMPI) price index data (1992m1-2017m12), the firm-level annual balance sheet data (1985-2017) and the monthly

interest rate shocks and anticipated changes that are construct for the period 1997m1-2017m12). The years between 1992-1996 are excluded because Sweden underwent large economic adjustments during 1992-1996[2] and Sweden's low inflation regime starts in 1997. The final dataset consists of a series of monthly price indices, monthly interest rate changes and annual balance sheet items for 2,217 firms for the period 1997m1-2017m12.

The final dataset excludes observations below the bottom one percentile and the top 99 percentile of the log price change distribution are excluded. This is because extreme price changes are not plausible; and they likely represent reporting mistakes by the firm. The final dataset only includes those firms with a positive amount of inventories and receivables in order to exclude missing values that were coded as zeroes. The study focuses on firms in the manufacturing sector, meaning that 89% of the available total sample of firm-level price indices is utilised. The total sample includes firms in other sectors such as mining or agricultural production which are excluded in this study. Appendix A.3 shows the distribution of firms and observations across the 15 sub-industries within the manufacturing sector that are the focus of this study.

Table (1) shows the summary statistics of the main variables: working capital to sales, sales, receivables, inventories, payables and advance payments from customers. The mean working capital to sales ratio is 0.2; and most firms have very little prepayments from customers. The average value of receivables (170 mSEK) and payables (164 mSEK) is very similar in magnitude, implying that firms both receive and give trade credit.

[2]These economic changes include the banking crises and recession in '92, the introduction of the floating interest rate in '92 and interest rate targeting in '93 as well as joining the European Union in '94.

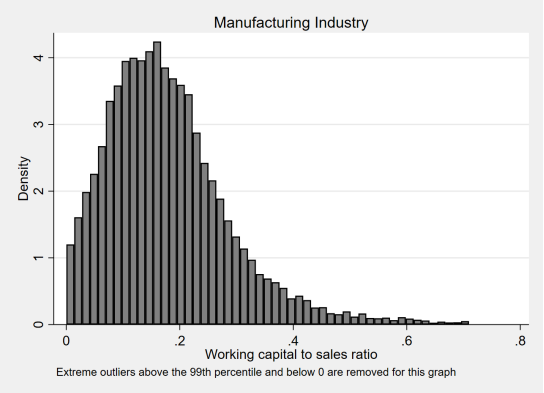
Table 1: Summary Statistics

	mean	sd	min	max
Working capital to sales ratio	.2004054	.7981873	-9.825784	44.65825
Receivables (mSEK)	169.8525	1002.205	.001218	52833
Inventories (mSEK)	198.0158	648.931	.000276	11136.07
Payables (mSEK)	163.6192	810.4752	0	40960
Prepayments (mSEK)	22.71159	226.6982	0	6373.133
Sales (mSEK)	1730.224	6826.474	0	130528.8
Avg nr of employees	464.7899	1293.431	0	20492
Value added (mSEK)	414.3671	1636.001	-15603.16	39204.99
Total tangible assets (mSEK)	343.0522	1166.156	-.005508	20837.19
Total current assets (mSEK)	764.9212	3119.699	-434.3072	65122
Liabilities (mSEK)	1743.981	10016.7	.536628	292523
Observations	157770			

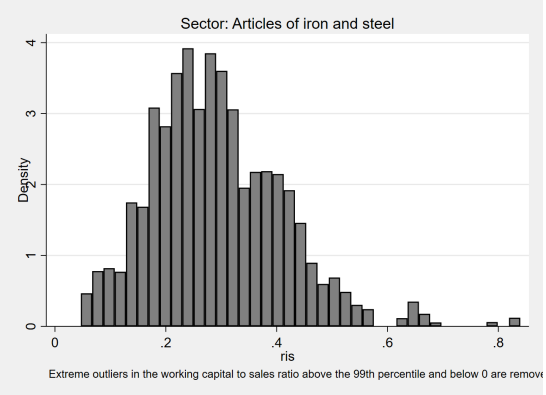
4.1 Working capital

The average working capital to sales ratio is 0.2 which means that firms on average keep an equivalent of 2.5 month of sales in the form of inventories, receivables net of prepayments and payables. This implies that the average firm experiences a 2.5 months delay in payments. If all firms had one month delay in payments the ratio would be 1/12, if the payment was delayed by two months it would be 2/12 and so on. In comparison, Barth and Ramey (2001) find a much larger stock of receivables and inventories in their industry-level US data, equivalent to 5.6 quarters of final sales in the manufacturing industry. This difference is partly because the average measurement in table (1) is net of prepayments and payables.

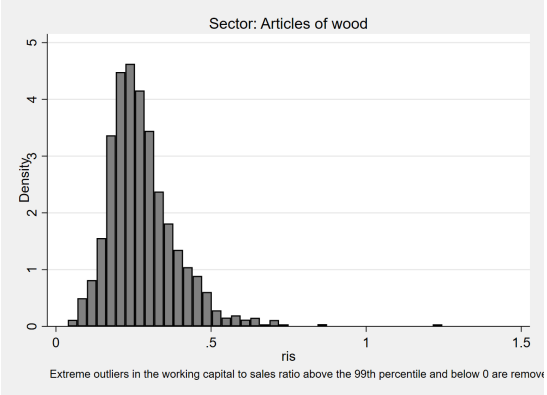
The working capital to sales ratio displays large cross-sectional within-sector variation. Figure (1a) shows the distribution of firms' working capital to sales ratio in the manufacturing industry as a whole. Figures (1b) and (1c) show the variation across industries. The estimation uses the within-industry variation as between-sector variation is removed by the time-industry fixed effects.



(a)



(b)



(c)

Figure 1: Variation in the working capital to sales ratio

Variation in inventories, receivables, payables and sales overtime is depicted in figure (2). Variation in inventories is mostly driven by cyclical changes in demand so sales and inventories show a high level of synchronised co-movement. Receivables and payables are trade credit given and received by the firm. Giving and receiving trade credit fluctuate for a number of reasons. Firms use trade credit to help credit constrained downstream firms overcome financing impediments and as a substitute for bank credit during periods of monetary tightening and financial crises[3]. Large, high-credit-quality suppliers may give trade credit because they have a comparative advantage in obtaining outside finance and pass on this advantage to small, credit-constrained buyers (Boissay and Gropp (2013))[4].

[3]See Demirguc-Kunt and Maksimovic (2001); McMillan and Woodruff (1999); Marotta (2001), Choi and Kim (2005); Love, Preve and Sarria-Allende (2007), Burkart and Ellingsen (2004).

[4]Trade credit terms can also be used by suppliers as a screening mechanism to mitigate buyer default risk. For example, sellers can reduce payment risks through longer payment terms based on instalments (Mian and Smith (1992); Ng, Smith and Smith (1999). It is also a way for suppliers to engage in price discrimination by giving favoured or more important clients longer terms (Wilner (2000); Fisman and Raturi (2004); Van Horen (2007); Giannetti, Burkart and Ellingsen (2011)). Delay in payments gives the buyers time to assess the quality of the supplied goods so relatively untrusted suppliers may choose to extend longer terms to buyers to guarantee product quality. See Klapper, Laeven and Rajan (2012); Lee and Stowe (1993); Long, Malitz and Ravid (1993); Antrs and Foley (2015)

Trade credit, therefore, responds to the firm's cost and credit shocks and the buyers' credit conditions because of firms' interlinkages within the supply chain.

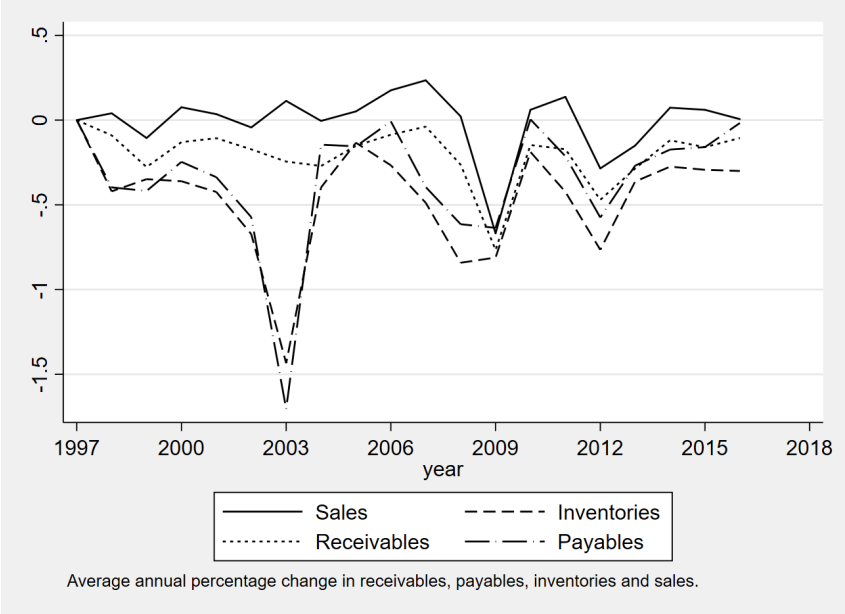


Figure 2: Average annual percentage changes in sales, inventories and receivables

To show how other characteristics of the firm vary with the working capital to sales ratio, figure 3 plots the mean value of total production value, total liabilities, number of employees, and value added of the firms across the distribution of the working capital to sales ratio. This graph helps examine whether interest rate changes affect the high working capital firms differently to the low working capital firms because of some underlying, unobserved characteristic, such as size or market power, that is strongly correlated with the choice of working capital holdings. We can see that the firm's size, which can be defined by either of its production value or number of employees, does not systematically correlate with the working capital to sales ratio between the 10th and 90th percentiles. However, there is a mechanical relationship between size and working capital: very large firms have a relatively smaller share of working capital. To control for this size effect, the regression interacts the size of sales with interest rate changes.

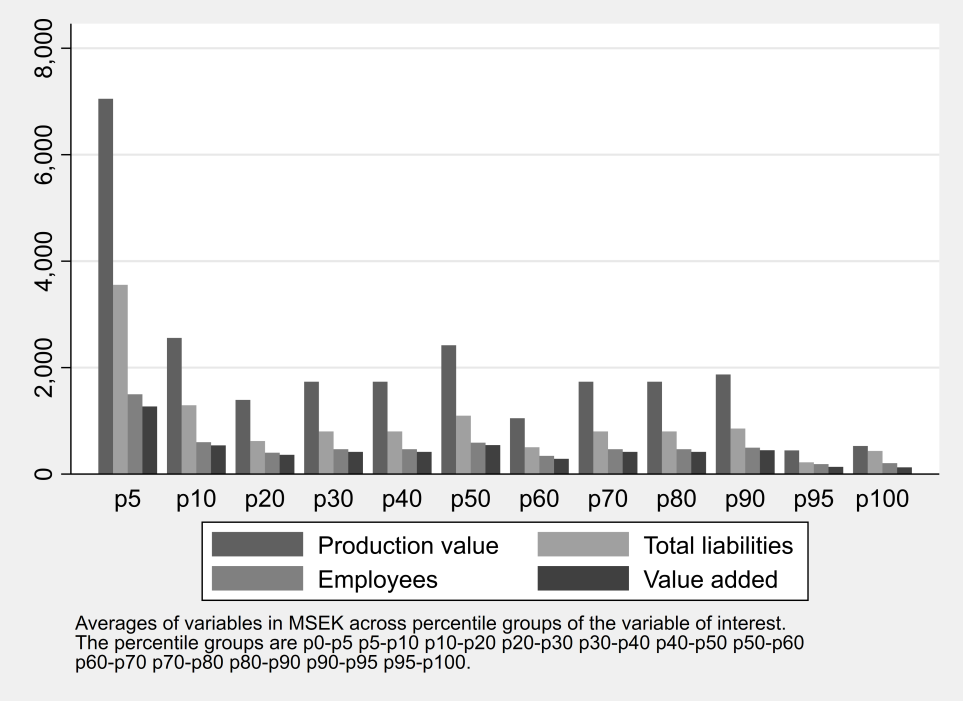


Figure 3: Averages of balance sheet variables across the percentiles of the working capital to sales ratio

4.2 Prices

The price data is a monthly dataset that includes five firm-specific index series. These are the Domestic/Home Market Price Index (HMPI), Export Price Index (EXPI), Import Price Index (IMPI), Producer Price Index (PPI), and Price Index for domestic supply (ITPI)[5]. The analysis in this paper only considers the HMPI price index series because the EXPI and the PPI series contain some measurement error. The EXPI and the PPI series use monthly average exchange rates to convert the prices reported in foreign currencies[6]. The HMPI index series, however, represent actual price changes and exclude price movements due to exchange rate fluctuations so it is the most suitable price index series for this analysis. The HMPI index is also meant to exclude changes to the price that result from a change in quality (SCB (2018)). The unit of price observation is on the level of the firm-product pair to account for the firms that produce in different product groups. The 2,151 firms in the final dataset may produce in numerous product categories, but

[5]The indices are constructed as a chain index with yearly links of the Laspeyres type.

[6]The statistics office exchanges the prices declared by the firms using current exchange rates based on a monthly average rate. The currency rates Statistics Sweden uses are monthly exchange rates from the Swedish Customs Authority (Tullverket). As a result, export price index changes, and therefore PPI changes which are a composite of export and home prices, do not only reflect price changes caused by firms' active decisions but also relative changes in the exchange rate.

85% of the firms produce in one product group and 11% produce in two product groups. The remaining 3% of firms produce in two to six product groups.

Graph (4) shows the average number of non-zero price changes across all firms. Firms change prices 4.6 times a year; which gives a 2-3 months average price duration. Most firms either change prices very often or very seldom. The implied probability of keeping the price unchanged is $1/(1-\theta) = 3$ with $\theta = 2/3$ in the Calvo-model for a firm that changes its price three times a year. The corresponding probability of changing its price $1 - \theta = 1/3$.

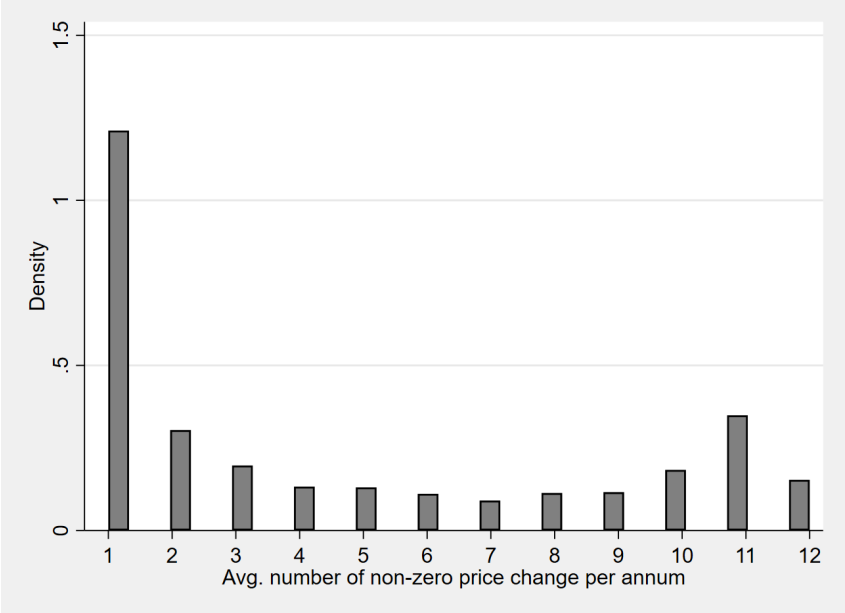


Figure 4: The average number of price changes in a year

The HMPI distribution plotted in figure (5) supports the view that there is a price change distribution with a spike at zero which indicates nominal price rigidities.

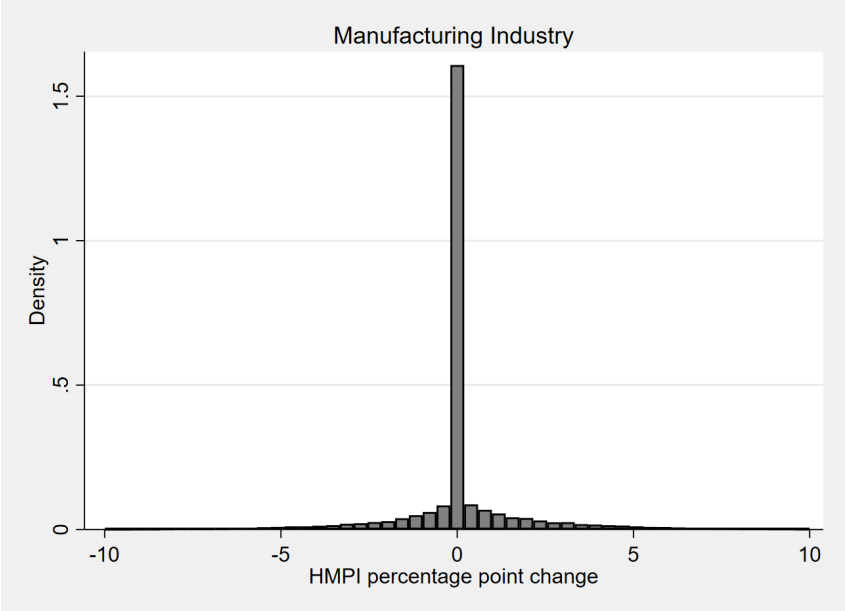


Figure 5

4.3 Anticipated and unanticipated interest rate changes

From the firm's point of view, an actual interest rate change can be divided into an anticipated and an unanticipated component. Anticipated interest rate changes are those changes in the repo rate that the firm can forecast with precision. They can be calculated as the difference between the repo rate change and the unanticipated component such that

$$\Delta R_t^A = \Delta R_t - \Delta R_t^U \tag{13}$$

where ΔR_t^A is the anticipated component and ΔR_t^U is the unanticipated component of the interest rate change. The unanticipated interest rate change can be seen as a monetary policy shock that the firm is unable to forecast. What matters for the firm is not that the unanticipated interest rate change is an exogenous shock to the economy but whether it is a change that the firm is unable to foresee. Since the firm does not choose the policy rate, both anticipated and unanticipated changes in the interest rate are exogenous from the individual firm's perspective. It is not crucial therefore that the unanticipated interest rate changes are "exogenous monetary policy shocks", i.e. orthogonal to other macroeconomic processes, as they are understood in DSGE models.

Two ways of calculating the unanticipated interest rate changes are presented below. The first calculation estimates firm-specific forecast errors, based on the assumption that

firms possess less information than professional forecasters when forecasting repo rate changes. The second approach calculates Kuttner-shocks, based on the assumption that a firm's information set is equivalent to that of a professional forecaster who follow central bank announcements and closely monitor interest rate movements. The Kuttner-shocks derived this way are claimed to be orthogonal to other processes in the economy so they are the best estimates of exogenous shocks from the economy's perspective. It is reasonable to believe that applying equation (13) to the Kuttner-shock leads to an estimate of the anticipated interest rate change that is much larger than the actual forecast of a firm. From the firms perspective, Kuttner-shocks are measured with measurement error, which will likely lead to attenuation in the estimated price response.

Forecast errors are constructed for the one month, four month and the six months forecast horizons. The forecast errors for one month, four month and the six months forecast horizons are estimated as predicted residuals from a Taylor-type forecasting rule in regression (14).

$$i_t = \beta_1 \Delta GDP_{t-k,t-k-3} + \beta_2 i_{t-k} + \beta_3 \Pi_{t-k,t-k-3} \tag{14}$$

where $k = [1, 4, 6]$ and t is months. The regression results and the details of the estimation are in appendix (A.4). As an example, three forecast error series are depicted in figure (6) to show that as information gets less precise the size of the shocks increase.

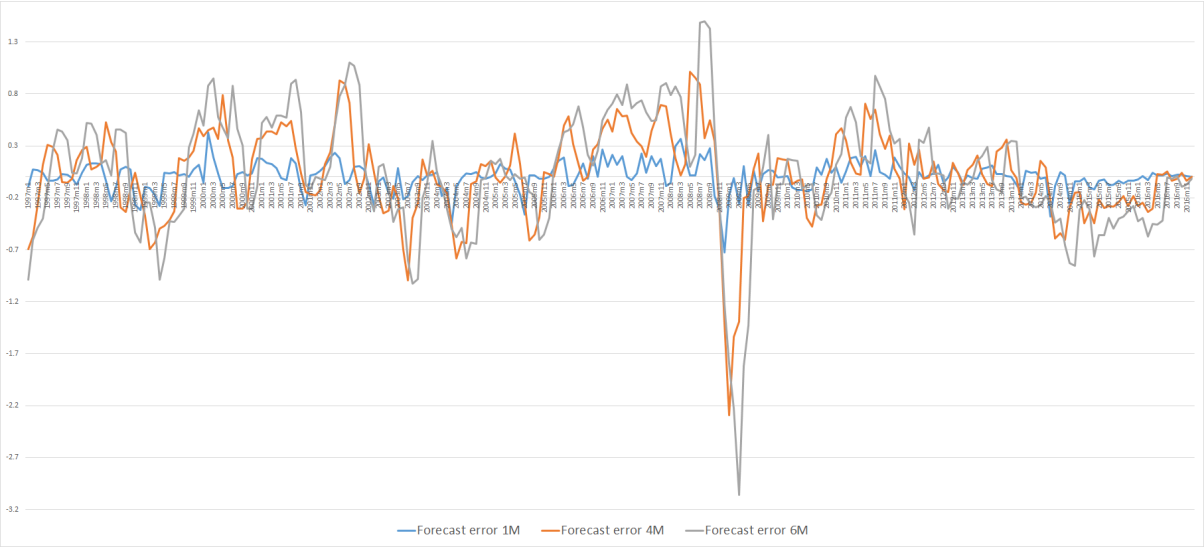


Figure 6: Firms' forecast error (1997m1-2016m12) based on information 1 month, 4 months and 6 months ago

Matching all firms in the sample with the same forecast errors implies a specific probability of price change that is relevant for the economy. For example, a four month forecast horizon presumes that firms change prices three times a year, implying that the economy-wide probability of keeping prices unchanged is 2/3.

To account for firm-level differences in the average price duration, it is possible to construct firm-specific forecast errors. Firm-level forecast errors are estimated based on each firm's average price duration that can be inferred from the data. The monthly price data allows the construction of 12 groups of firms with forecast horizons that span one month, two months, three months etc. up to 12 months, so $k = [1, ..., 12]$ in regression (14). Then, each firm is assigned to one of the 12 groups based on the firm's average price duration; and the corresponding anticipated and unanticipated interest rate changes are matched to the firm.

The second set of shocks are the Kuttner-shocks by Kuttner (2001). The estimation of these shocks follow the procedure outlined in Iversen and Tysklind (2017) who adapt the Kuttner-method to Sweden. Iversen and Tysklind (2017) estimate unexpected repo rate changes using the Swedish overnight indexed swap (OIS) rate with one month maturity, Stina1M, for the period between 2002m9-2015m12. The details of this estimation is explained in appendix (A.6). Since the Stina1m rate is only available since 2002, this study estimates an auxiliary set of Kuttner-shocks using the Stibor1M (Stockholm Interbank Offered Rate with 1 month maturity) as the underlying interest rate, which is available for the whole sample between 1997m1-2017m12. Figure (7) depicts the Kuttner-shocks and the forecast errors based on a one month forecast horizon. The graph shows a strong correlation between forecast errors and Kuttner-shocks on the negative side; and little correlation between them on the positive side. Note that this graph includes monthly forecast errors even in months when there was no policy rate change, emphasising that a firm's forecast is less less sophisticated than a banks forecast.

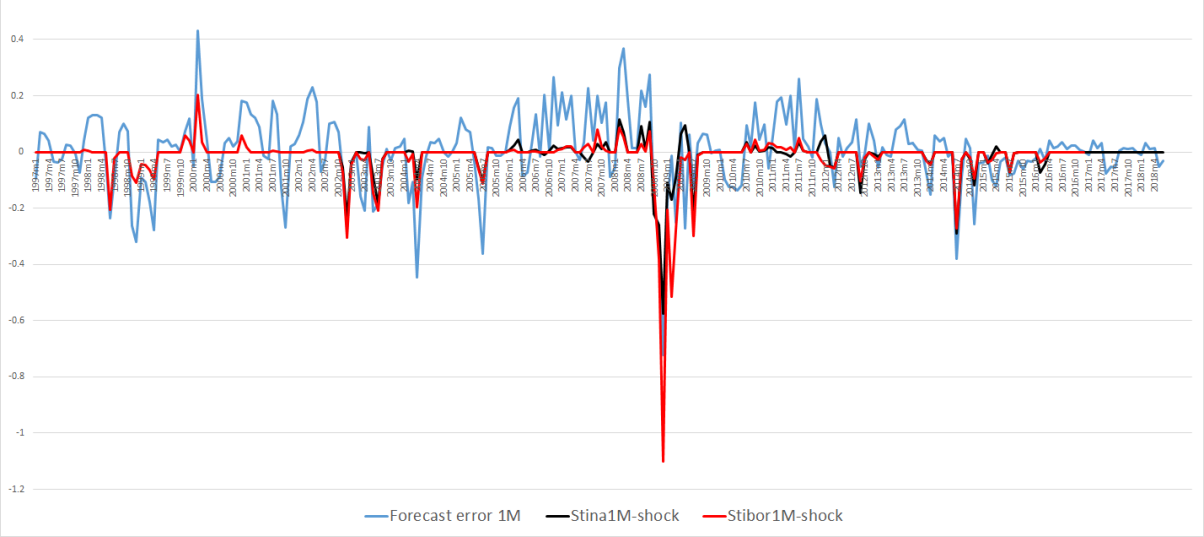


Figure 7: Kuttner-shocks (1997m1-2016m12) based on Stina1M and Stibor1M rates and the firm's forecast error based on information available one month ago

To show robustness, an additional measure of exogenous monetary policy shocks are used as well. These shocks are the identified policy rate innovations from Ramses II, the DSGE model of the Sveriges Riksbank. The details of how Ramses II shocks are estimated are in appendix (A.5). The shortcoming of using Ramses II shocks is that they are quarterly in frequency so an estimation based on them discards within-quarter variation in prices.

5 Results

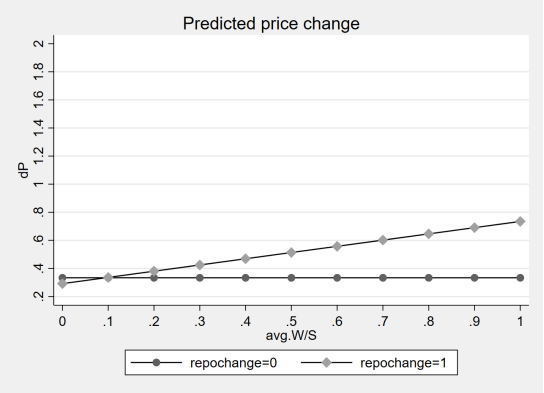
The effect of actual repo rate changes via the working capital channel Table (2) shows the effect of a repo rate change on prices via the working capital channel for k price setting horizons. Using actual repo rate changes in the regression assumes that firms treat the entirety of the actual repo rate change as a surprise. This specification corresponds to assuming that firms have static expectations and they think that their best guess of future interest rates is equivalent to the prevailing rate today. The first result from table (2) is that repo rate changes have no concurrent effect on prices. The percentage price change from $p(t-1)$ to $p(t)$ is almost zero suggesting that prices are sticky. Considering longer price setting horizons, the effect of a repo rate change on prices via the working capital channel varies between 0.3 and 1.3.

Table 2: The transmission of actual repo rate change via the working capital channel - static expectations

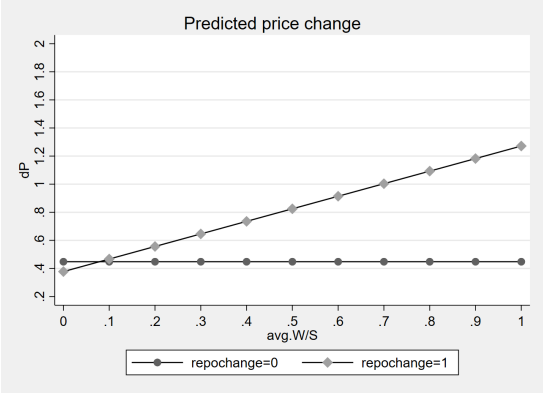
	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # dR	-0.0631	0.295+	0.443*	0.894*	1.099*
	(0.102)	(0.171)	(0.215)	(0.403)	(0.470)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	154072	151337	148591	145852	143131
	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S # dR	1.301*	1.021+	1.096	0.990	1.170
	(0.626)	(0.613)	(0.729)	(0.878)	(1.142)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayments. S is sales. The same control variables are used in each regression. These control variables are the interaction of sales and the repo rate change between $t-1$ and t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6. The tables with all coefficients can be found in appendix (A.7).

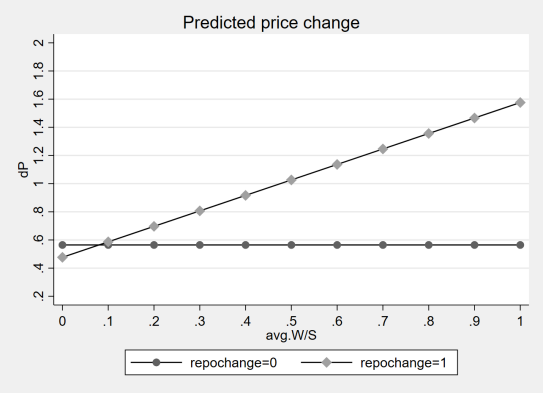
Graphs in figure (8) help interpret the regression coefficients on the interaction term of two continuous predictors. Figure (8a) depicts the price change from $t-1$ to $t+2$ upon an interest rate change at t. The firm whose working capital equals its sales raises its price by 0.8 percentage point after a one percentage point increase in interest rates. The price rise of this firm is $0.8 - 0.3 = 0.5$ percentage point higher than the price rise of a firm that has zero working capital. Over the five months horizon, depicted in figure (8d), the price rise from a one percentage point increase in the repo rate is around 1.4 percentage point higher for a firm whose working capital requirement equals its sales compared to a firm whose working capital requirement is zero. The predicted percentage price change for the firm with average working capital holdings (0.2) over the five month horizon is 0.9 percentage point; and the price change difference between the average firm and a firm with no working capital requirement is about 0.2 percentage point.



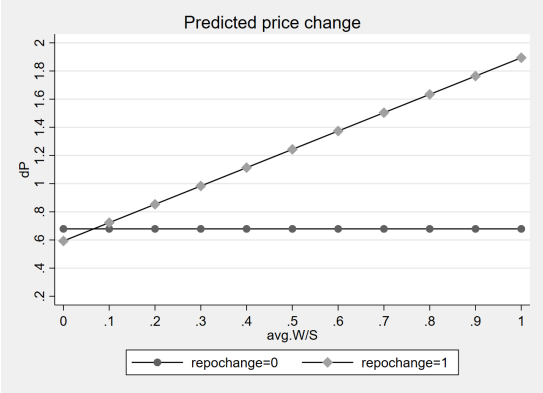
(a) p(t+2)-p(t-1)



(b) p(t+3)-p(t-1)



(c) p(t+4)-p(t-1)



(d) p(t+5)-p(t-1)

Figure 8: Predicted price change of firms with different levels of working capital holding

The effect of anticipated and unanticipated interest rate changes via the working capital channel Table (3) shows the effect of an anticipated and an unanticipated repo rate change on prices via the working capital channel for k price setting horizons. The table comprises of three parts, each of which use forecast errors derived from a different forecast horizon. Specification 1 matches all firms with forecast errors based on information available to the firm in the previous month. Specification 2 assigns to all firms the forecast errors based on information available to the firm four months ago; and specification 3 imposes forecast errors based on information available to the firm six month ago.

Table 3: The transmission of anticipated and unanticipated interest rate changes via the working capital channel - simple firm forecasts

Specification 1 - errors from 1 month forecast horizon					
	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S#error1m	-0.0467	0.331+	0.483*	0.898*	1.091*
	(0.116)	(0.187)	(0.221)	(0.410)	(0.491)
avg.W/S#Exp1m	-0.209	-0.0373	0.0645	0.858	1.189*
	(0.157)	(0.235)	(0.369)	(0.553)	(0.539)
	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S#error1m	1.273*	0.990	1.046	0.938	1.173
	(0.647)	(0.642)	(0.781)	(0.974)	(1.230)
avg.W/S#Exp1m	1.613*	1.346+	1.580+	1.448+	1.147
	(0.698)	(0.737)	(0.845)	(0.788)	(0.746)
Specification 2 - errors from 4 months forecast horizon					
	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S#error4m	-0.0760	0.300+	0.433*	0.875*	1.078*
	(0.113)	(0.165)	(0.170)	(0.366)	(0.445)
avg.W/S#Exp4m	-0.107	0.311	0.412**	0.829**	1.026*
	(0.151)	(0.205)	(0.154)	(0.311)	(0.433)
	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S#error4m	1.293*	0.983+	1.040+	0.926	1.180
	(0.613)	(0.542)	(0.618)	(0.753)	(1.011)
avg.W/S#Exp4m	1.274+	0.887*	0.904*	0.781	1.201
	(0.660)	(0.446)	(0.407)	(0.500)	(0.749)
Specification 2 - errors from 6 months forecast horizon					
	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S#error6m	-0.0745	0.302*	0.462**	0.912*	1.119*
	(0.107)	(0.154)	(0.179)	(0.389)	(0.461)
avg.W/S#Exp6m	-0.0940	0.314*	0.495**	0.944*	1.154*
	(0.122)	(0.144)	(0.153)	(0.398)	(0.499)
	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S#error6m	1.331*	1.037+	1.087+	0.972	1.204
	(0.625)	(0.540)	(0.602)	(0.721)	(0.976)
avg.W/S#Exp6m	1.387*	1.066*	1.072*	0.945+	1.254+
	(0.692)	(0.487)	(0.446)	(0.506)	(0.751)

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayments. S is sales. The same control variables are used in each regression. These control variables are the interaction of sales and the repo rate change between $t-1$ and t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6. The tables with all coefficients can be found in appendix (A.8).

The results across all specifications show that the coefficient on anticipated and unanticipated interest rate changes are very similar in magnitude. This pattern implies a

simple relationship between interest rate changes and prices:

$$\begin{aligned} \Delta p_t &= \beta \Delta R_t^A + \beta \Delta R_t^U \\ &= \beta(R_t^A + \Delta R_t^U) = \beta \Delta R_t \end{aligned} \tag{15}$$

It also suggests that endowing firms with moderately sophisticated expectations, which assumes that firms monitor key macroeconomic processes, is not the correct specification for firms expectation formation. The results in (3) suggest that firms use less sophisticated forecasts; implying that firms have static expectations when forecasting interest rate changes. Static expectations mean that firms expect the current interest rate to prevail in future periods; and their best guess is that the interest rate in the next period will be around its current level.

The regression in (4) imposes an even more sophisticated information structure on firms. This information structure assumes that firms listen to central bank announcements, know when the policy rate will be raised, and they also know their own average price duration. Table (4) shows results for the regression using firm-level interest rate shocks. In this regression, each firms receives an interest rate shock according to its own average price duration. The estimated coefficients from this regression confirm the results in (3). The coefficients on anticipated and unanticipated interest rate changes are very similar in magnitude, so this regression confirms that firms have less sophisticated expectations.

Table 4: The transmission of anticipated and unanticipated interest rate changes via the working capital channel - moderately sophisticated firm forecasts

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # shockR	-0.0953	0.239	0.371+	0.858*	1.049*
	(0.102)	(0.167)	(0.210)	(0.413)	(0.477)
avg.W/S # expR	-0.00101	0.399*	0.572**	0.958*	1.188**
	(0.111)	(0.165)	(0.206)	(0.373)	(0.444)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	154072	151337	148591	145852	143131
	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S # shockR	1.262*	0.912	0.964	0.887	0.980
	(0.635)	(0.607)	(0.729)	(0.878)	(1.143)
avg.W/S # expR	1.369*	1.208*	1.320+	1.168	1.471
	(0.603)	(0.597)	(0.704)	(0.873)	(1.120)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayments. S is sales. The same control variables are used in each regression. These control variables are the interaction of sales and the repo rate change between $t-1$ and t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6. The tables with all coefficients can be found in appendix (A.8).

In summary, tables (3) and (4) show that dividing actual interest rate changes into anticipated and unanticipated changes is not how firms think about actual interest rate changes. The results suggest that firms expectations are much simpler and they are best described by static expectations. The results support the view that the firm's forecast of future interest rates is the prevailing current rate so using actual repo rate changes in a regression is sufficient for measuring the effect of interest rate changes on firm-prices. Therefore, the results in table (2) are already based on the most likely model of firms' expectation structure and these coefficients provide sufficient statistics to understand the supply-side monetary policy pass-through via the working capital channel.

6 Robustness

6.1 Alternative measures of interest rate shocks

Ramses II shocks Table (5) shows the results with quarterly Ramses II monetary policy shocks that are common to all firms. Using aggregate Ramses II policy innovations in place of the firm-level forecast errors show that unanticipated interest rate changes matter more for firm's price setting behaviour, so these results corroborate the main findings.

Table 5: The transmission of interest rate changes using RamsesII shocks

	p(t+3)-p(t-1)	p(t+6)-p(t-1)	p(t+9)-p(t-1)	p(t+12)-p(t-1)
avg.W/S # shockRamses	0.344*	1.140**	1.510*	1.814
	(0.150)	(0.378)	(0.685)	(1.125)
avg.W/S # expRamses	0.0270	0.185	0.291*	0.290
	(0.0611)	(0.112)	(0.135)	(0.182)
avg. S # repochange	5.65e-12	-3.43e-11	-5.17e-11	-4.02e-11
	(7.09e-12)	(2.43e-11)	(4.13e-11)	(3.46e-11)
avg(W/S)*2008q4	0.275	2.949***	2.074*	2.172
	(0.339)	(0.784)	(1.020)	(1.151)
avg(W/S)*2009q1	0.975	2.185***	3.515***	3.396**
	(0.518)	(0.608)	(0.745)	(1.047)
avg(W/S)*2009q2	-0.0982	1.062	0.494	-0.265
	(0.844)	(1.252)	(1.955)	(1.914)
Constant	0.306***	0.592***	0.910***	1.223***
	(0.00328)	(0.00777)	(0.0161)	(0.0248)
Observations	45345	41501	39186	37107

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayment. S is sales. The control variables are the interaction of average sales and the change in the repo rate from $t-1$ to t, time-industry fixed effects, and the financial crises dummies for the quarters of the financial crises 2008q4, 2009q1 and 2009q2.

Kuttner-shocks Using monthly Kuttner-shocks instead of forecast errors replaces the expectations of moderately sophisticated firms with the expectations of financial markets and professional forecasters. From the firms perspective, these interest rate shocks are

likely to be measured with large measurement error which reshuffles most of the "true shock" to the anticipated component. This measurement error attenuates the coefficient on the shock component and affects the other coefficients in convoluted ways. Table (6) shows that the effect of anticipated changes on prices is larger in magnitude (between 1.1-1.7 percentage points) than the effect resulting from an unanticipated change. The variation in anticipated changes is likely driven by the measurement error so this result is not really meaningful.

Table 6: The transmission of interest rate changes using Stibor1M based Kuttner shocks

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S#shock	0.00774	1.346	0.334	0.314	0.605
	(0.388)	(1.272)	(0.461)	(0.659)	(0.808)
avg.W/S#exp	-0.0952	-0.183	0.493	1.160*	1.320*
	(0.190)	(0.439)	(0.342)	(0.553)	(0.518)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	154072	151337	148591	145852	143131
	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S#shock	0.355	-0.219	-0.0569	0.510	1.072
	(1.062)	(1.330)	(1.512)	(1.552)	(2.146)
avg.W/S#exp	1.723**	1.570**	1.599**	1.198	1.213
	(0.601)	(0.517)	(0.614)	(0.969)	(1.153)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6. The tables with all coefficients can be found in appendix (A.9).

Controlling for interim interest rate changes One claim is that inter-period interest rate changes may also affect price changes, and therefore the regression in table (2) suffers from omitted variable bias. For example, if a price change from $t-1$ to $t+1$ is not only caused by an interest rate change at t but also by the interest rate change at $t+1$ and these interest rate changes are correlated, then not including ΔR_{t+1} as a control variable

will lead to biased estimates. To test whether interest rate changes are correlated, the regressions include inter-period repo rate changes as control variables. Table (7) shows that the coefficients do no change significantly compared to those in table (2).

Table 7: The transmission of actual repo rate change via the working capital channel - static expectations

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # dR	-0.0631	0.323*	0.432*	0.550*	0.865*
	(0.102)	(0.136)	(0.209)	(0.274)	(0.420)
avg. S # dR	8.69e-13	-2.11e-12	-5.78e-12	-8.92e-12	-1.06e-11
	(3.30e-12)	(5.52e-12)	(8.29e-12)	(1.08e-11)	(1.25e-11)
avg.W/S # F.dR		-0.0984	0.434+	0.524**	0.551+
		(0.111)	(0.262)	(0.201)	(0.323)
avg.W/S # F2.dR			-0.463**	-0.101	-0.0719
			(0.174)	(0.160)	(0.188)
avg.W/S # F3.dR				-0.575*	-0.142
				(0.268)	(0.259)
avg.W/S # F4.dR					-0.793*
					(0.311)
avg. S # dR	x	x	x	x	x
Firm FE	x	x	x	x	x
Time-Industry FE	x	x	x	x	x
FC dummies	x	x	x	x	x
Observations	154072	148984	144244	139784	135531

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayments. S is sales. The same control variables are used in each regression. These control variables are the interaction of sales and the repo rate change between $t-1$ and t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

7 Conclusion

This paper develops a theoretical framework based on the New Keynesian model to derive a structural equation that can be used to identify the working capital channel in firm-level data. First, the theory introduces the working capital channel into a basic New Keynesian model following (Christiano, Eichenbaum and Evans (2005)) to explain the effect of a repo rate change on firm-level price inflation. Then, the theoretical model is extended to show that anticipated and unanticipated interest rate changes have different effects on producer prices via the working capital channel. The empirical results show that the pass-through of a one percentage point interest rate change to the producer price

via the working capital channel is 0.9 percentage point for the firm with average working capital holdings over a five month price setting horizon. The second set of regressions show that interest rate changes are fully unanticipated by the firm so it is sufficient to use actual interest rate changes to measure the supply-side policy rate pass-through.

8 References

References

Adolfson, M., S. Lasen, L. Christiano, M. Trabandt, and K. Walentin, "Ramses II - Model Description," Technical Report, Sveriges Riksbank 2013.

Antrs, Pol and C. F. Foley, "Poultry in Motion: A Study of International Trade Finance Practices," *Journal of Political Economy*, 2015, *123* (4), 853–901.

Barth, III Marvin J. and Valerie A. Ramey, "The Cost Channel of Monetary Transmission," *NBER Macroeconomics Annual*, 2001, *16* (1), 184–240.

Bernanke, Ben S. and Mark Gertler, "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *The Journal of Economic Perspectives*, 1995, *9* (4), 27–48.

Blinder, Alan S., "Credit Rationing and Effective Supply Failures," *The Economic Journal*, 1987, *97* (386), 327–352.

Boissay, F. and R. Gropp, "Payment Defaults and Interfirm Liquidity Provision," *Review of Finance, Vol. 17 Issue 6, p1853-1894. 42p*, 2013.

Burkart, Mike and Tore Ellingsen, "In-Kind Finance: A Theory of Trade Credit," *The American Economic Review*, 2004, *94* (3), 569–590.

Choi, Woon G. and Yungsan Kim, "Trade Credit and the Effect of Macro-Financial Shocks: Evidence from U.S. Panel Data," *Journal of Financial and Quantitative Analysis*, 2005, *40* (4), 897–925.

Chowdhury, Ibrahim, Mathias Hoffmann, and Andreas Schabert, "Inflation dynamics and the cost channel of monetary transmission," *European Economic Review*, 2006, *50* (4), 995–1016.

Christiano, Lawrence J. and Martin Eichenbaum, "Liquidity Effects and the Monetary Transmission Mechanism," *The American Economic Review*, 1992, *82* (2), 346–353.

Christiano, Lawrence J, Martin Eichenbaum, and Charles L Evans, "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, 2005, *113* (1), 1–45.

Christiano, Lawrence J., Martin S. Eichenbaum, and Mathias Trabandt, "Understanding the Great Recession," *American Economic Journal: Macroeconomics*, 2015, *7* (1), 110–167.

Demirguc-Kunt, Asli and Vojislav Maksimovic, *Firms as Financial Intermediaries: Evidence from Trade Credit Data*, S.l.: World Bank, Washington, DC, 2001.

Farmer, Roger E. A., "A New Theory of Aggregate Supply," *The American Economic Review*, 1984, *74* (5), 920–930.

Fisman, Raymond and Mayank Raturi, "Does Competition Encourage Credit Provision? Evidence from African Trade Credit Relationships," *The Review of Economics and Statistics*, 2004, *86* (1), 345–352.

Fuerst, Timothy S., "Liquidity, loanable funds, and real activity," *Journal of Monetary Economics*, 1992, *29* (1), 3–24.

Gabriel, V. J. and L. F. Martins, "The Cost Channel Reconsidered: A Comment Using an Identification-Robust Approach," *Journal of Money, Credit and Banking*, 2010, *42* (8), 1703–1712.

Gaiotti, Eugenio and Alessandro Secchi, "Is There a Cost Channel of Monetary Policy Transmission? An Investigation into the Pricing Behavior of 2,000 Firms," *Journal of Money, Credit and Banking*, 2006, *38* (8), 2013–2037.

Gertler, Mark and Peter Karadi, "Monetary Policy Surprises, Credit Costs, and Economic Activity," *American Economic Journal: Macroeconomics*, 2015, *7* (1), 44–76.

Giannetti, Mariassunta, Mike Burkart, and Tore Ellingsen, "What You Sell Is What You Lend? Explaining Trade Credit Contracts," *The Review of Financial Studies*, 2011, *24* (4), 1261–1298.

Gilchrist, Simon and Egon Zakrajsek, "Credit Spreads and Business Cycle Fluctuations," *The American Economic Review*, 2012, *102* (4), 1692–1720.

Horen, Neeltje Van, *Customer market power and the provision of trade credit: evidence from Eastern Europe and Central Asia*, S.l.: s.n., 2007.

Iversen, J. and O. Tysklind, "The effect of repo rate path changes on asset prices," Technical Report, Sveriges Riksbank 2017.

Klapper, Leora, Luc Laeven, and Raghuram Rajan, "Trade Credit Contracts," *The Review of Financial Studies*, 2012, *25* (3), 838–867.

Kuttner, Kenneth N., "Monetary policy surprises and interest rates: Evidence from the Fed funds futures market," *Journal of Monetary Economics*, 2001, *47* (3), 523–544.

Lee, Yul W. and John D. Stowe, "Product Risk, Asymmetric Information, and Trade Credit," *Journal of Financial and Quantitative Analysis*, 1993, *28* (2), 285–300.

Long, Michael S., Ileen B. Malitz, and S. A. Ravid, "Trade Credit, Quality Guarantees, and Product Marketability," *Financial Management*, 1993, *22* (4), 117–127.

Love, Inessa, Lorenzo A. Preve, and Virginia Sarria-Allende, "Trade credit and bank credit: Evidence from recent financial crises," *Journal of Financial Economics*, 2007, *83* (2), 453–469.

Marotta, G., "Is Trade Credit More Expensive than Bank Loans? Evidence from Italian Firm-Level Data," *Available at SSRN: https://ssrn.com/abstract=260064 or http://dx.doi.org/10.2139/ssrn.260064*, 2001.

McMillan, John and Christopher Woodruff, "Interfirm Relationships and Informal Credit in Vietnam," *The Quarterly Journal of Economics*, 1999, *114* (4), 1285–1320.

Mian, Shehzad L. and Clifford W. Smith, "Accounts Receivable Management Policy: Theory and Evidence," *The Journal of Finance*, 1992, *47* (1), 169–200.

Mojon, Benot, "When did unsystematic monetary policy have an effect on inflation?," *European Economic Review*, 2008, *52* (3), 487–497.

Ng, Chee K., Janet K. Smith, and Richard L. Smith, "Evidence on the Determinants of Credit Terms Used in Interfirm Trade," *The Journal of Finance*, 1999, *54* (3), 1109–1129.

OECD, "OECD Data: Inflation," Technical Report, OECD 2019.

Rabanal, Pau, "Does inflation increase after a monetary policy tightening? Answers based on an estimated DSGE model," *Journal of Economic Dynamics and Control*, 2007, *31* (3), 906–937.

Ramey, Valerie A., "Nonconvex Costs and the Behavior of Inventories," *Journal of Political Economy*, 1991, *99* (2), 306–334.

Ravenna, Federico and Carl E. Walsh, "Optimal monetary policy with the cost channel," *Journal of Monetary Economics*, 2006, *53* (2), 199–216.

SCB, "QUALITY DECLARATION Producer and Import Price Index (PPI)," Technical Report, Statistics Sweden 2018.

_ , "Statistical database: GDP: expenditure approach (ESA2010) by type of use, seasonally adjusted. Quarter 1980K1 - 2018K3," Technical Report, Statistics Sweden 2019.

Tillmann, Peter, "Do interest rates drive inflation dynamics? An analysis of the cost channel of monetary transmission," *Journal of Economic Dynamics and Control*, 2008, *32* (9), 2723–2744.

_ , "The time-varying cost channel of monetary transmission," *Journal of International Money and Finance*, 2009, *28* (6), 941–953.

Wilner, Benjamin S., "The Exploitation of Relationships in Financial Distress: The Case of Trade Credit," *The Journal of Finance*, 2000, *55* (1), 153–178.

A Appendix

A.1 Derivation of the firm's price setting

The core assumption of the New-Keynesian model is that in every period a set of firms in the economy cannot reoptimise their posted prices. Assume that the firm uses Cobb-

Douglas Technology

$$Y_{i,t} = A_t N_{i,t}^{1-\alpha} \tag{16}$$

to produce a differentiated good $i \in [0,1]$. $Y_{i,t}$ is the firm specific output, A_t is the economy wide technology and $N_{i,t}$ is the amount of labour the firm uses to produce good i. The firm's objective is to maximise profits, taking into account that prices are sticky. The firm's maximisation problem can be written as

$$max_{P_{i,t}^*} \sum_{k=0}^{\infty} \theta^k E_t \Big\{ Q_{t,t+k} \Big(\frac{1}{P_{t+k}} \Big) \big(P_{i,t}^* Y_{i,t+k|t} - TC_{i,t+k|t}^n (Y_{i,t+k|t}) \big) \Big\} \tag{17}$$

subject to the sequence of firm-specific demand constraints

$$Y_{i,t+k|t} = (\frac{P_{i,t}^*}{P_{t+k}})^{-\epsilon} C_{i,t+k} \tag{18}$$

Equation (17) states that the firm chooses the optimal price ($P_{i,t}^*$) that maximises the current market value of its profits. When reoptimising, the firm takes into consideration the households' discount factor ($Q_{t,t+k}$) and that the price remains effective for k periods with probability θ^k. Equation (18) states that the demand for output in period $t+k$ for a firm that sets its price in the period t is determined by the ratio of the optimal reset price and the price level in $t+k$, and consumption ($C_{i,t+k}$). The first-order condition can be written as

$$\sum_{k=0}^{\infty} \theta^k E_t \Big\{ Q_{t,t+k} Y_{i,t+k|t} \Big[(\epsilon - 1) - \epsilon \frac{MC_{i,t+k|t}^n}{P_{i,t}^*} \Big] \Big\} = 0 \tag{19}$$

Let $\Pi_{i,t}^* \equiv P_{i,t}^*/P_{i,t-1}$, $\Pi_{t+k,t} \equiv P_{t+k}^*/P_t$, $MC_{i,t}^r = MC_{i,t}^n/P_t$ and $\frac{\epsilon}{\epsilon-1} \equiv \mathcal{M}$. Divide by P_{t-1} and rearrange equation (19) the following way

$$\sum_{k=0}^{\infty} \theta^k E_t \Big\{ Q_{t,t+k} Y_{i,t+k|t} \Big[\Pi_{i,t}^* - \mathcal{M} MC_{i,t+k|t}^r \Pi_{t+k,t} \Big] \Big\} = 0 \tag{20}$$

The optimal price setting condition is log-linearised around the firm-specific perfect foresight zero inflation steady state where $Q_{t,t+k} = \beta^k$ and $\frac{P_{i,t}^*}{P_{t+k}} = \frac{P_{i,t}}{P_{t+k}} = 1$. Log-linearisation of the firm's optimal price setting condition yields

$$\bar{\Pi}_i \frac{ln\Pi_{i,t}^* - ln\bar{\Pi}_i}{1-\beta\theta} - \sum_{k=0}^{\infty} (\theta\beta)^k E_t \Big\{ \mathcal{M} \bar{MC}_i^r \Big[lnMC_i^r - \bar{MC}_i^r + ln\Pi_{t+k,t-1} - 0 \Big] \Big\} = 0 \tag{21}$$

Note that in steady state $\bar{\Pi}_i = \mathcal{M}\bar{MC}_i^r$. Let $ln\Pi_{i,t}^* \equiv \pi_{i,t}^*$ be the firm-specific optimal inflation rate, $ln\Pi_{t+k,t} \equiv \pi_{t+k,t}$ and $lnMC_{i,t}^r \equiv mc_{i,t}^r$ to get

$$p_{i,t}^* - p_{i,t-1} - \bar{\pi}_i = (1-\theta\beta)\sum_{k=0}^{\infty}(\theta\beta)^k E_t\Big\{mc_{i,t+k|t}^n - p_{t+k} - \bar{mc}_i^n + p_{t+k} - p_{i,t-1}\Big\} \quad (22)$$

Note that in steady state $\bar{\pi}_i = ln\mathcal{M} + \bar{mc}_i^r$ so that

$$p_{i,t}^* = \mu + (1-\theta\beta)\sum_{k=0}^{\infty}(\theta\beta)^k E_t[mc_{i,t+k|t}^n] \quad (23)$$

where $mc_{i,t+k|t}^n$ is the log nominal marginal cost and $\mu \equiv ln\mathcal{M} = ln\Big(\frac{\epsilon}{\epsilon-1}\Big)$ is the desired steady state markup. Equation (23) shows that the firm's *optimal reset price* is a function of the desired markup and the weighted average of current and expected nominal marginal costs with the weights being proportional to the probability of the price remaining effective at each horizon (θ^k).

A.2 HS2 product groups

01 Live animals. 02 Meat and edible meat offal. 03 Fish and crustaceans, molluscs and other aquatic invertebrates. 04 Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere specified or included. 05 Products of animal origin, not elsewhere specified or included. 06 Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage. 07 Edible vegetables and certain roots and tubers. 08 Edible fruit and nuts; peel of citrus fruit or melons. 09 Coffee, tea, mate and spices. 10 Cereals. 11 Products of the milling industry; malt; starches; inulin; wheat gluten. 12 Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal plants; straw and fodder. 13 Lac; gums, resins and other vegetable saps and extracts. 14 Vegetable plaiting materials; vegetable products not elsewhere specified or included. 15 Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal or vegetable waxes. 16 Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates. 17 Sugars and sugar confectionery. 18 Cocoa and cocoa preparations. 19 Preparations of cereals, flour, starch or milk; pastrycooks' products. 20 Preparations of vegetables, fruit, nuts or other parts of plants. 21 Miscellaneous edible preparations. 22 Beverages, spirits and vinegar. 23 Residues and waste from the food

industries; prepared animal fodder. 24 Tobacco and manufactured tobacco substitutes. 25 Salt; sulphur; earths and stone; plastering materials, lime and cement. 26 Ores, slag and ash. 27 Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes. 28 Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, of radioactive elements or of isotopes. 29 Organic chemicals. 30 Pharmaceutical products. 31 Fertilisers. 32 Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints and varnishes; putty and other mastics; inks. 33 Essential oils and resinoids; perfumery, cosmetic or toilet preparations. 34 Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial waxes, prepared waxes, polishing or scouring preparations, candles and similar articles, modelling pastes, "dental waxes" and dental preparations with a basis of plaster. 35 Albuminoidal substances; modified starches; glues; enzymes. 36 Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations. 37 Photographic or cinematographic goods. 38 Miscellaneous chemical products. 39 Plastics and articles thereof 40 Rubber and articles thereof 41 Raw hides and skins (other than furskins) and leather. 42 Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles of animal gut (other than silk-worm gut). 43 Furskins and artificial fur; manufactures thereof. 44 Wood and articles of wood; wood charcoal, 45 Cork and articles of cork. 46 Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork. 47 Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard. 48 Paper and paperboard; articles of paper pulp, of paper or of paperboard. 49 Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans. 50 Silk. 51 Wool, fine or coarse animal hair; horsehair yarn and woven fabric. 52 Cotton, 53 Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn. 54 Man-made filaments. 55 Man-made staple fibres. 56 Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof 57 Carpets and other textile floor coverings. 58 Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery. 59 Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable for industrial use. 60 Knitted or crocheted fabrics. 61 Articles of apparel and clothing accessories, knitted or crocheted. 62 Articles of apparel and clothing accessories, not knitted or crocheted. 63 Other made up

textile articles; sets; worn clothing and worn textile articles; rags. 64 Footwear, gaiters and the like; parts of such articles, 65 Headgear and parts thereof 66 Umbrellas, sun umbrellas, walking-sticks, seat-sticks, whips, riding-crops and parts thereof 67 Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles of human hair. 68 Articles of stone, plaster, cement, asbestos, mica or similar materials. 69 Ceramic products. 70 Glass and glassware. 71 Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad with precious metal and articles thereof; imitation, jewellery; coin. 72 Iron and steel. 73 Articles of iron or steel. 74 Copper and articles thereof 75 Nickel and articles thereof. 76 Aluminium and articles thereof 77 (Reserved for possible future use in the Harmonized System) 78 Lead and articles thereof 79 Zinc and articles thereof. 80 Tin and articles thereof. 81 Other base metals; cermets; articles thereof. 82 Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal. 83 Miscellaneous articles of base metal. 84 Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof 85 Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles, 86 Railway or tramway locomotives, rolling-stock and parts thereat railway or tramway track fixtures and fittings and parts thereof; mechanical (including electro-mechanical) traffic signalling equipment of all kinds. 87 Vehicles other than railway or tramway rolling-stock, and parts and accessories thereof. 88 Aircraft, spacecraft, and parts thereof. 89 Ships, boats and floating structures. 90 Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical instruments and apparatus; parts and accessories thereof 91 Clocks and watches and parts thereof. 92 Musical instruments; parts and accessories of such articles. 94 Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, not elsewhere specified or included; illuminated signs, illuminated name-plates and the like; prefabricated buildings. 95 Toys, games and sports requisites; parts and accessories thereof 96 Miscellaneous manufactured articles. 97 Works of art, collectors' pieces and antiques. 98 (Reserved for special uses by Contracting Parties) 99 (Reserved for special uses by Contracting Parties)

A.3 Industry decomposition

Table 8: Number of observations and firms within the manufacturing industry by sector

	Observations	Percent	Firms	Percent
Food Production	27.001	15.70	264	11.91
Beverages	1.366	0.79	13	0.59
Tobacco products	455	0.26	5	0.23
Textiles	2.54	1.48	44	1.98
Clothing	1.045	0.61	14	0.63
Leather, leather and leather goods	735	0.43	8	0.36
Wood and articles of wood, cork, rattan	11.629	6.76	188	8.48
Paper and paper goods manufacturing	11.074	6.44	104	4.69
Graphic production and recordings	2.333	1.36	55	2.48
Coal products and refined petroleum	828	0.48	12	0.54
Chemicals and chemical products	10.181	5.92	103	4.65
Pharmaceuticals	1.119	0.65	16	0.72
Rubber and plastic products	8.988	5.22	121	5.46
Other non-metallic mineral products	8.872	5.16	89	4.01
Steel and metal production	10.451	6.08	93	4.19
Metal products, exc. machinery, equip.	19.822	11.52	339	15.29
Computers, electronics and optics	5.933	3.45	100	4.51
Electrical equipment	4.774	2.78	77	3.47
Other machinery	18.101	10.52	244	11.01
Motor vehicles, trailers	11.097	6.45	121	5.46
Other means of transport	2.45	1.42	31	1.40
Furniture	4.868	2.83	65	2.93
Other manufacturing	3.1	1.80	53	2.39
Repair and installation of machinery	3.265	1.90	58	2.62
Total	172.027	100.00	2.217	100.00

A.4 Forecast errors

I estimate monthly forecast error using quarterly GDP from SCB (2019) and quarterly CPI from OECD (2019). The definition of the variables are

$$\Delta GDP_{t-k,t-k-3} = \frac{GDP_{t-k}}{GDP_{t-k-3}} - 1 \tag{24}$$

$$\Delta \Pi_{t-k,t-k-3} = \frac{CPI_{t-k}}{CPI_{t-k-3}} - 1 \tag{25}$$

where t is months. I use the Newey-West variance estimator with lag 3, which produces consistent estimates when there is autocorrelation in addition to possible heteroskedasticity. The results of the regression are in table (9).

Table 9: Results from firms' forecast using information 1, 4 or 6 months ago

	1 month reporate forecast	4 months reporate forecast	6 months reporate forecast
dGDP	7.926**	27.01**	34.73***
	(2.661)	(8.145)	(10.07)
reporate lag	0.992***	0.940***	0.891***
	(0.00860)	(0.0351)	(0.0503)
dCPI	4.059**	13.69*	13.69
	(1.498)	(6.137)	(7.901)
_cons	-0.0694**	-0.174*	-0.161
	(0.0242)	(0.0826)	(0.117)
R-squared	0.99	0.95	0.90
N	281	278	276

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

A.5 RamsesII monetary policy shocks

The RamsesII monetary policy innovations are estimated quarterly between 1995q2-2016q4 using the Taylor rule described in equation (26).

$$\begin{aligned} ln(\frac{R_t}{R}) = \rho ln(\frac{R_{t-1}}{R}) + (1-\rho)[ln(\frac{\bar{\pi}_t^c}{\bar{\pi}^c}) + r_\pi ln(\frac{\pi_{t-1}^c}{\bar{\pi}^c}) \\ + r_y ln(\frac{h_{t-1}}{h})] + r_{\Delta\pi}\Delta ln(\frac{\pi_{t-1}^c}{\pi^c}) + r_{\Delta y}\Delta ln(\frac{h_t^c}{h}) + \epsilon_{i,t} \end{aligned} \tag{26}$$

where $\bar{\pi}_t^c$ is the inflation target shock, h_t is hours worked instead of output as a measure of the utilization of resources. This monetary policy rule prescribes how the interest rate responds to inflation and hours worked. I consider $\epsilon_{i,t}$ to be a shock to monetary policy which is uncorrelated to economic activity, for example the central bank has a preference change because of a new board member, who expresses a different opinion.

A.6 Estimation of the Kuttner shocks

I use daily Stina swaps closing data to estimate the shocks. These overnight swaps have the STIBOR T/N interest rate as basis for the floating leg and are therefore called STINA swaps (Stockholm Tomnext Interbank Average) swaps. STINA Swaps are short-term interest-rate swaps, denominated in Swedish kronor, with a maturity of up to and

including one year. I use the Stina swap that refers to a one-month contracts because one-week contracts may be too short to capture the days of the announcement and the actual repo rate change. The unexpected change in the repo rate is calculated using the formula in (27)

$$\Delta repo_t^{unexpected} \approx \frac{[t_t^{STINA} - t_{t-1}^{STINA}(\tau_1 + \tau_2) - \Delta repo_t]}{\tau_2 - 1} \tag{27}$$

where t represents the announcement or publication date of the new repo rate, τ_1 is the number of days the contract has run before the implementation of the new repo rate and τ_2 is the number of days left of the contract's maturity after the implementation of the new repo rate.

To construct monthly shocks, I follow Gertler and Karadi (2015) and calculate a monthly average of the cumulated daily shock that is cumulated over the full sample over all d days. First, I cumulate shock over the full sample:

$$shock_d^{cumulated} = \sum_{s=1}^{d} shock_d \tag{28}$$

Then, make monthly averages:

$$ma_t = \frac{\sum_{d=d_t^1}^{d_t^T} shock_d^{cumulated}}{d_t^T} \tag{29}$$

where T is the number of trading days in month t. Finally, taking the difference in monthly averages gives the measure of monthly monetary policy shocks

$$Z_t = ma_t - ma_{t-1} \tag{30}$$

Z_t captures the unexpected change in the average policy rate between two subsequent months. A similar aggregation using the same formula can be done to derive quarterly Kuttner shocks.

A.7 Result tables - Repo changes

Table 10: The transmission of actual repo rate change via the working capital channel

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # dR	-0.0631	0.295+	0.443*	0.894*	1.099*
	(0.102)	(0.171)	(0.215)	(0.403)	(0.470)
avg. S # dR	8.69e-13	-7.78e-12	-2.40e-11	-4.02e-11	-4.98e-11
	(3.30e-12)	(1.01e-11)	(2.39e-11)	(3.04e-11)	(3.29e-11)
avg(W/S)*2008m10	0.0873	0.348	1.497**	2.273***	2.594***
	(0.194)	(0.387)	(0.547)	(0.651)	(0.711)
avg(W/S)*2008m11	0.109	1.490**	2.220***	2.813***	2.681***
	(0.246)	(0.474)	(0.564)	(0.670)	(0.597)
avg(W/S)*2008m12	0.573+	1.787***	2.182**	2.512***	2.788**
	(0.309)	(0.522)	(0.674)	(0.724)	(0.894)
avg(W/S)*2009m1	0.0819	0.711*	0.0490	0.412	1.752+
	(0.367)	(0.351)	(0.456)	(0.630)	(0.940)
avg(W/S)*2009m2	0.437*	-0.150	0.0255	0.986	0.924
	(0.210)	(0.543)	(0.701)	(0.991)	(1.277)
avg(W/S)*2009m3	-0.367	-0.0225	1.128	1.524	0.947
	(0.388)	(0.571)	(0.901)	(1.118)	(0.851)
avg(W/S)*2009m4	-0.0343	0.709	0.636	0.341	-1.595*
	(0.435)	(0.729)	(1.002)	(0.706)	(0.651)
avg(W/S)*2009m5	0.603+	0.574	0.502	-1.297*	0.385
	(0.330)	(0.645)	(0.321)	(0.655)	(0.719)
avg(W/S)*2009m6	-0.130	-0.544	-2.494**	-0.767	-1.260+
	(0.358)	(0.379)	(0.938)	(0.622)	(0.693)
Constant	0.105***	0.222***	0.330***	0.442***	0.558***
	(0.00100)	(0.00184)	(0.00207)	(0.00293)	(0.00365)
Observations	154072	151337	148591	145852	143131

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayments. S is sales. The same control variables are used in each regression. These control variables are the interaction of sales and the repo rate change between $t-1$ and t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 11: The transmission of actual repo rate change via the working capital channel

	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S # dR	1.301*	1.021+	1.096	0.990	1.170
	(0.626)	(0.613)	(0.729)	(0.878)	(1.142)
avg. S # dR	-4.84e-11	-5.03e-11	-5.96e-11*	-6.60e-11*	-6.68e-11*
	(3.09e-11)	(3.29e-11)	(2.95e-11)	(3.18e-11)	(3.26e-11)
avg(W/S)*2008m10	2.354***	2.267***	2.730**	2.748**	2.351*
	(0.522)	(0.668)	(0.874)	(0.986)	(0.941)
avg(W/S)*2008m11	2.815***	3.026**	3.178**	2.652*	1.670+
	(0.778)	(0.959)	(1.116)	(1.081)	(0.876)
avg(W/S)*2008m12	3.425**	3.184*	2.866*	1.708	2.757
	(1.098)	(1.302)	(1.284)	(1.062)	(1.839)
avg(W/S)*2009m1	1.766	1.018	-1.490*	0.760	0.322
	(1.342)	(1.082)	(0.666)	(1.776)	(1.802)
avg(W/S)*2009m2	0.618	-1.453*	0.202	-0.406	-0.355
	(0.975)	(0.597)	(1.416)	(1.259)	(1.275)
avg(W/S)*2009m3	-1.148+	0.830	0.340	0.109	-0.238
	(0.649)	(1.171)	(0.932)	(1.048)	(1.168)
avg(W/S)*2009m4	0.0152	-0.546	-0.537	-0.749	-0.863
	(1.116)	(1.007)	(0.975)	(0.917)	(0.851)
avg(W/S)*2009m5	-0.0826	-0.216	-0.541	-0.484	-0.314
	(0.657)	(0.645)	(0.697)	(0.629)	(0.737)
avg(W/S)*2009m6	-1.301+	-1.504+	-1.470+	-1.384+	-1.574
	(0.671)	(0.773)	(0.834)	(0.818)	(1.103)
Constant	0.673***	0.778***	0.887***	0.995***	1.102***
	(0.00426)	(0.00443)	(0.00460)	(0.00502)	(0.00526)
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; t is months. W is working capital, defined as receivables and inventories net of payables and prepayments. S is sales. The same control variables are used in each regression. These control variables are the interaction of sales and the repo rate change between $t-1$ and t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

A.8 Result tables - Forecast errors

Table 12: Forecast error based on information available 1 month ago

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S#error1m	-0.0467	0.331+	0.483*	0.898*	1.091*
	(0.116)	(0.187)	(0.221)	(0.410)	(0.491)
avg.W/S#ExpdR1m	-0.209	-0.0373	0.0645	0.858	1.189*
	(0.157)	(0.235)	(0.369)	(0.553)	(0.539)
avg. S # dR	8.62e-13	-7.80e-12	-2.40e-11	-4.02e-11	-4.98e-11
	(3.30e-12)	(1.01e-11)	(2.39e-11)	(3.04e-11)	(3.29e-11)
avg(W/S)*2008m10	0.0800	0.330	1.478**	2.271***	2.599***
	(0.193)	(0.386)	(0.544)	(0.657)	(0.716)
avg(W/S)*2008m11	0.0580	1.372**	2.086***	2.800***	2.714***
	(0.239)	(0.463)	(0.594)	(0.728)	(0.604)
avg(W/S)*2008m12	0.530+	1.688**	2.069**	2.501***	2.816**
	(0.296)	(0.542)	(0.702)	(0.752)	(0.867)
avg(W/S)*2009m1	0.0326	0.598	-0.0794	0.400	1.783*
	(0.392)	(0.379)	(0.474)	(0.579)	(0.880)
avg(W/S)*2009m2	0.382+	-0.275	-0.117	0.973	0.958
	(0.201)	(0.502)	(0.633)	(0.902)	(1.161)
avg(W/S)*2009m3	-0.418	-0.138	0.997	1.511	0.979
	(0.370)	(0.507)	(0.845)	(1.038)	(0.746)
avg(W/S)*2009m4	-0.0912	0.580	0.488	0.327	-1.560*
	(0.393)	(0.667)	(0.932)	(0.663)	(0.763)
avg(W/S)*2009m5	0.600+	0.567	0.494	-1.298*	0.388
	(0.328)	(0.642)	(0.319)	(0.662)	(0.712)
avg(W/S)*2009m6	-0.137	-0.561	-2.514**	-0.769	-1.255+
	(0.353)	(0.381)	(0.949)	(0.617)	(0.701)
Constant	0.105***	0.221***	0.328***	0.441***	0.558***
	(0.00153)	(0.00253)	(0.00275)	(0.00363)	(0.00438)
Observations	154072	151337	148591	145852	143131

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 13: Forecast error based on information available 1 month ago

	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S# error1m	1.273*	0.990	1.046	0.938	1.173
	(0.647)	(0.642)	(0.781)	(0.974)	(1.230)
avg.W/S#ExpdR1m	1.613*	1.346+	1.580+	1.448+	1.147
	(0.698)	(0.737)	(0.845)	(0.788)	(0.746)
avg. S # dR	-4.84e-11	-5.03e-11	-5.96e-11*	-6.59e-11*	-6.68e-11*
	(3.09e-11)	(3.29e-11)	(2.95e-11)	(3.18e-11)	(3.26e-11)
avg(W/S)*2008m10	2.371***	2.285***	2.756**	2.771**	2.350*
	(0.520)	(0.655)	(0.846)	(0.950)	(0.913)
avg(W/S)*2008m11	2.927***	3.142***	3.350***	2.814**	1.662*
	(0.738)	(0.874)	(0.989)	(0.912)	(0.822)
avg(W/S)*2008m12	3.523***	3.284**	3.012*	1.843+	2.750+
	(1.042)	(1.221)	(1.184)	(1.014)	(1.651)
avg(W/S)*2009m1	1.874	1.129	-1.325*	0.915	0.314
	(1.255)	(0.968)	(0.596)	(1.534)	(1.571)
avg(W/S)*2009m2	0.736	-1.330*	0.384	-0.234	-0.363
	(0.850)	(0.662)	(1.217)	(1.070)	(1.062)
avg(W/S)*2009m3	-1.038	0.944	0.509	0.268	-0.246
	(0.740)	(1.016)	(0.813)	(0.837)	(0.987)
avg(W/S)*2009m4	0.136	-0.419	-0.348	-0.570	-0.872
	(1.021)	(0.959)	(0.908)	(0.877)	(0.830)
avg(W/S)*2009m5	-0.0745	-0.208	-0.531	-0.475	-0.314
	(0.655)	(0.642)	(0.693)	(0.628)	(0.732)
avg(W/S)*2009m6	-1.285+	-1.487+	-1.445+	-1.360	-1.575
	(0.680)	(0.788)	(0.858)	(0.841)	(1.128)
Constant	0.674***	0.779***	0.889***	0.997***	1.102***
	(0.00504)	(0.00561)	(0.00647)	(0.00714)	(0.00666)
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 14: Forecast error based on information available 4 month ago

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # error 4m	-0.0760	0.300+	0.433*	0.875*	1.078*
	(0.113)	(0.165)	(0.170)	(0.366)	(0.445)
avg.W/S # ExpdR4m	-0.107	0.311	0.412**	0.829**	1.026*
	(0.151)	(0.205)	(0.154)	(0.311)	(0.433)
avg. S # dR	8.67e-13	-7.78e-12	-2.40e-11	-4.02e-11	-4.98e-11
	(3.30e-12)	(1.01e-11)	(2.39e-11)	(3.04e-11)	(3.29e-11)
avg(W/S)*2008m10	0.0750	0.352	1.489**	2.254***	2.573***
	(0.206)	(0.416)	(0.558)	(0.662)	(0.694)
avg(W/S)*2008m11	0.0941	1.495**	2.209***	2.791***	2.656***
	(0.260)	(0.487)	(0.596)	(0.654)	(0.583)
avg(W/S)*2008m12	0.574+	1.787***	2.183**	2.514***	2.790**
	(0.307)	(0.521)	(0.675)	(0.730)	(0.899)
avg(W/S)*2009m1	0.126	0.695+	0.0793	0.478	1.826+
	(0.381)	(0.410)	(0.529)	(0.773)	(1.061)
avg(W/S)*2009m2	0.463*	-0.160	0.0438	1.026	0.969
	(0.215)	(0.569)	(0.762)	(1.075)	(1.377)
avg(W/S)*2009m3	-0.350	-0.0287	1.140	1.549	0.976
	(0.400)	(0.585)	(0.949)	(1.176)	(0.923)
avg(W/S)*2009m4	-0.0248	0.706	0.642	0.355	-1.579*
	(0.431)	(0.727)	(1.017)	(0.733)	(0.636)
avg(W/S)*2009m5	0.596+	0.576	0.497	-1.307+	0.374
	(0.331)	(0.648)	(0.309)	(0.676)	(0.699)
avg(W/S)*2009m6	-0.134	-0.543	-2.497**	-0.773	-1.266+
	(0.360)	(0.383)	(0.949)	(0.618)	(0.699)
Constant	0.105***	0.222***	0.330***	0.441***	0.558***
	(0.00102)	(0.00179)	(0.00231)	(0.00342)	(0.00434)
Observations	154072	151337	148591	145852	143131

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 15: Forecast error based on information available 4 month ago

	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S # error 4m	1.293*	0.983+	1.040+	0.926	1.180
	(0.613)	(0.542)	(0.618)	(0.753)	(1.011)
avg.W/S # ExpdR4m	1.274+	0.887*	0.904*	0.781	1.201
	(0.660)	(0.446)	(0.407)	(0.500)	(0.749)
avg. S # dR	-4.84e-11	-5.03e-11	-5.96e-11*	-6.60e-11*	-6.68e-11*
	(3.09e-11)	(3.29e-11)	(2.95e-11)	(3.18e-11)	(3.26e-11)
avg(W/S)*2008m10	2.346***	2.229***	2.676***	2.688**	2.360**
	(0.505)	(0.614)	(0.780)	(0.880)	(0.838)
avg(W/S)*2008m11	2.806***	2.980***	3.112**	2.579**	1.681*
	(0.762)	(0.881)	(1.003)	(0.949)	(0.795)
avg(W/S)*2008m12	3.427**	3.189*	2.871*	1.709	2.757
	(1.104)	(1.310)	(1.287)	(1.062)	(1.834)
avg(W/S)*2009m1	1.794	1.156	-1.296	0.965	0.292
	(1.535)	(1.366)	(0.994)	(2.119)	(2.173)
avg(W/S)*2009m2	0.635	-1.369*	0.319	-0.283	-0.372
	(1.116)	(0.658)	(1.603)	(1.443)	(1.482)
avg(W/S)*2009m3	-1.137+	0.884	0.415	0.187	-0.249
	(0.610)	(1.290)	(1.050)	(1.169)	(1.290)
avg(W/S)*2009m4	0.0212	-0.516	-0.495	-0.706	-0.869
	(1.163)	(1.043)	(1.023)	(0.962)	(0.891)
avg(W/S)*2009m5	-0.0866	-0.237	-0.571	-0.517	-0.309
	(0.652)	(0.628)	(0.679)	(0.621)	(0.712)
avg(W/S)*2009m6	-1.304+	-1.517+	-1.489+	-1.404+	-1.571
	(0.676)	(0.784)	(0.854)	(0.830)	(1.118)
Constant	0.673***	0.777***	0.886***	0.994***	1.102***
	(0.00536)	(0.00553)	(0.00584)	(0.00609)	(0.00632)

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 16: Forecast error based on information available 6 month ago

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # error 6m	-0.0745	0.302*	0.462**	0.912*	1.119*
	(0.107)	(0.154)	(0.179)	(0.389)	(0.461)
avg.W/S # ExpdR6m	-0.0940	0.314*	0.495**	0.944*	1.154*
	(0.122)	(0.144)	(0.153)	(0.398)	(0.499)
avg. S # dR	8.69e-13	-7.78e-12	-2.40e-11	-4.02e-11	-4.98e-11
	(3.30e-12)	(1.01e-11)	(2.39e-11)	(3.04e-11)	(3.29e-11)
avg(W/S)*2008m10	0.0816	0.351	1.507**	2.282***	2.604***
	(0.196)	(0.393)	(0.544)	(0.645)	(0.696)
avg(W/S)*2008m11	0.0926	1.500**	2.248***	2.840***	2.711***
	(0.255)	(0.474)	(0.576)	(0.652)	(0.599)
avg(W/S)*2008m12	0.564+	1.793***	2.198***	2.527***	2.804**
	(0.310)	(0.530)	(0.664)	(0.719)	(0.888)
avg(W/S)*2009m1	0.101	0.700+	0.0180	0.382	1.717+
	(0.368)	(0.363)	(0.464)	(0.689)	(0.995)
avg(W/S)*2009m2	0.442*	-0.153	0.0174	0.978	0.914
	(0.210)	(0.548)	(0.713)	(1.009)	(1.301)
avg(W/S)*2009m3	-0.354	-0.0308	1.107	1.502	0.922
	(0.394)	(0.590)	(0.940)	(1.169)	(0.918)
avg(W/S)*2009m4	-0.00882	0.694	0.594	0.300	-1.641**
	(0.436)	(0.751)	(1.069)	(0.814)	(0.635)
avg(W/S)*2009m5	0.616+	0.566	0.481	-1.318*	0.362
	(0.333)	(0.655)	(0.353)	(0.603)	(0.776)
avg(W/S)*2009m6	-0.127	-0.546	-2.499**	-0.772	-1.265+
	(0.357)	(0.379)	(0.929)	(0.627)	(0.690)
Constant	0.105***	0.222***	0.330***	0.442***	0.558***
	(0.00103)	(0.00191)	(0.00228)	(0.00339)	(0.00429)
Observations	154072	151337	148591	145852	143131

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 17: Forecast error based on information available 6 month ago

	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S # error 6m	1.331*	1.037+	1.087+	0.972	1.204
	(0.625)	(0.540)	(0.602)	(0.721)	(0.976)
avg.W/S # ExpdR6m	1.387*	1.066*	1.072*	0.945+	1.254+
	(0.692)	(0.487)	(0.446)	(0.506)	(0.751)
avg. S # dR	-4.84e-11	-5.03e-11	-5.96e-11*	-6.60e-11*	-6.68e-11*
	(3.09e-11)	(3.29e-11)	(2.95e-11)	(3.18e-11)	(3.26e-11)
avg(W/S)*2008m10	2.369***	2.275***	2.726***	2.739**	2.367**
	(0.510)	(0.634)	(0.814)	(0.918)	(0.873)
avg(W/S)*2008m11	2.861***	3.050***	3.165**	2.628**	1.716*
	(0.773)	(0.857)	(0.968)	(0.898)	(0.784)
avg(W/S)*2008m12	3.449**	3.196*	2.858*	1.694+	2.786
	(1.083)	(1.252)	(1.199)	(0.986)	(1.712)
avg(W/S)*2009m1	1.710	0.989	-1.476+	0.785	0.276
	(1.435)	(1.227)	(0.828)	(1.955)	(1.994)
avg(W/S)*2009m2	0.603	-1.461*	0.206	-0.400	-0.365
	(1.006)	(0.603)	(1.455)	(1.296)	(1.317)
avg(W/S)*2009m3	-1.188*	0.810	0.350	0.127	-0.269
	(0.603)	(1.286)	(1.048)	(1.176)	(1.293)
avg(W/S)*2009m4	-0.0579	-0.583	-0.517	-0.714	-0.927
	(1.297)	(1.166)	(1.170)	(1.104)	(1.017)
avg(W/S)*2009m5	-0.119	-0.235	-0.532	-0.467	-0.344
	(0.690)	(0.709)	(0.757)	(0.665)	(0.801)
avg(W/S)*2009m6	-1.310+	-1.509*	-1.468+	-1.380+	-1.581
	(0.668)	(0.765)	(0.818)	(0.805)	(1.085)
Constant	0.674***	0.778***	0.887***	0.995***	1.102***
	(0.00521)	(0.00534)	(0.00551)	(0.00569)	(0.00588)
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

A.9 Result tables - Kuttner-shocks

Table 18: Price response to a Kuttner-shock derived from Stibor1M rate

	p(t)-p(t-1)	p(t+1)-p(t-1)	p(t+2)-p(t-1)	p(t+3)-p(t-1)	p(t+4)-p(t-1)
avg.W/S # shocks	0.00774	1.346	0.334	0.314	0.605
	(0.388)	(1.272)	(0.461)	(0.659)	(0.808)
avg.W/S # exp	-0.0952	-0.183	0.493	1.160*	1.320*
	(0.190)	(0.439)	(0.342)	(0.553)	(0.518)
avg. S # dR	8.70e-13	-7.76e-12	-2.40e-11	-4.02e-11	-4.98e-11
	(3.30e-12)	(1.01e-11)	(2.39e-11)	(3.04e-11)	(3.29e-11)
avg(W/S)*2008m10	0.0894	0.378	1.494**	2.256***	2.579***
	(0.190)	(0.396)	(0.550)	(0.659)	(0.710)
avg(W/S)*2008m11	0.127	1.744**	2.194***	2.673***	2.560***
	(0.235)	(0.641)	(0.597)	(0.648)	(0.584)
avg(W/S)*2008m12	0.649	2.923*	2.064**	1.885*	2.254*
	(0.479)	(1.365)	(0.757)	(0.736)	(1.062)
avg(W/S)*2009m1	0.0814	0.703*	0.0500	0.418	1.754
	(0.368)	(0.356)	(0.457)	(0.627)	(0.939)
avg(W/S)*2009m2	0.476	0.432	-0.0349	0.665	0.650
	(0.334)	(1.012)	(0.727)	(1.122)	(1.411)
avg(W/S)*2009m3	-0.359	0.101	1.116	1.456	0.888
	(0.412)	(0.684)	(0.905)	(1.141)	(0.878)
avg(W/S)*2009m4	-0.0390	0.640	0.643	0.380	-1.563*
	(0.429)	(0.673)	(0.998)	(0.702)	(0.667)
avg(W/S)*2009m5	0.595	0.447	0.515	-1.227	0.444
	(0.307)	(0.531)	(0.331)	(0.698)	(0.715)
avg(W/S)*2009m6	-0.131	-0.560	-2.493**	-0.759	-1.252
	(0.356)	(0.380)	(0.938)	(0.621)	(0.696)
Constant	0.105***	0.224***	0.329***	0.440***	0.557***
	(0.00102)	(0.00167)	(0.00225)	(0.00308)	(0.00396)
Observations	154072	151337	148591	145852	143131

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.

Table 19: Price response to a Kuttner-shock derived from Stibor1M rate

	p(t+5)-p(t-1)	p(t+6)-p(t-1)	p(t+7)-p(t-1)	p(t+8)-p(t-1)	p(t+9)-p(t-1)
avg.W/S # shocks	0.355	-0.219	-0.0569	0.510	1.072
	(1.062)	(1.330)	(1.512)	(1.552)	(2.146)
avg.W/S # exp	1.723**	1.570**	1.599**	1.198	1.213
	(0.601)	(0.517)	(0.614)	(0.969)	(1.153)
avg. S # dR	-4.84e-11	-5.04e-11	-5.97e-11*	-6.60e-11*	-6.68e-11*
	(3.09e-11)	(3.29e-11)	(2.95e-11)	(3.18e-11)	(3.26e-11)
avg(W/S)*2008m10	2.325***	2.228**	2.692**	2.732**	2.348*
	(0.523)	(0.678)	(0.885)	(0.982)	(0.940)
avg(W/S)*2008m11	2.584**	2.721*	2.893*	2.533*	1.646
	(0.814)	(1.064)	(1.234)	(1.109)	(0.979)
avg(W/S)*2008m12	2.403	1.843	1.619	1.190	2.650
	(1.463)	(1.928)	(1.973)	(1.646)	(2.631)
avg(W/S)*2009m1	1.770	1.022	-1.491*	0.760	0.321
	(1.341)	(1.084)	(0.669)	(1.778)	(1.803)
avg(W/S)*2009m2	0.0955	-2.138**	-0.435	-0.671	-0.409
	(1.155)	(0.714)	(1.712)	(1.369)	(1.567)
avg(W/S)*2009m3	-1.261*	0.679	0.197	0.0494	-0.250
	(0.630)	(1.243)	(0.999)	(1.075)	(1.205)
avg(W/S)*2009m4	0.0769	-0.466	-0.464	-0.719	-0.857
	(1.104)	(0.997)	(0.963)	(0.940)	(0.885)
avg(W/S)*2009m5	0.0293	-0.0716	-0.410	-0.429	-0.303
	(0.671)	(0.648)	(0.716)	(0.716)	(0.821)
avg(W/S)*2009m6	-1.287	-1.486	-1.454	-1.377	-1.572
	(0.674)	(0.778)	(0.843)	(0.828)	(1.119)
Constant	0.671***	0.775***	0.884***	0.994***	1.101***
	(0.00464)	(0.00477)	(0.00508)	(0.00657)	(0.00764)
Observations	140397	137657	134909	132160	129410

Notes: Clustered standard errors by firm are in parenthesis; significance levels $p < 0.05$; $p < 0.01$ $p < 0.001$; t is months. W is working capital, defined as receivables and inventories; and S is sales. The same control variables are used in each regression. These are the interaction of average sales and the change in the repo rate from $t-1$ to t, firm and time-industry fixed effects, and the financial crises dummies for the months of the financial crises between 2008m10-2009m6.