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Interest Rates and Aggregate Corporate Investment

- An empirical study of the deterministic variables behind aggregate corporate
investment

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Abstract

Using Swedish data between 1988 and 2014 we investigate if the real corporate borrowing interest rate has a significant effect on corporate investment. We find no proof of a connection between the change in investment and the fluctuations in the interest rate. However, our results indicate a relationship between present and expected demand and the rate of corporate investment. According to these results, the common belief among policy makers that lower interest rates increases capital expenditures is incorrect.

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Introduction

Corporate investment is the engine of growth, so understanding what makes firms invest is both an important and interesting subject. Policy makers and central banks have followed the same path for years, assuming that the interest rate has a direct effect on aggregate corporate investment. Indeed, in theory the interest rate is one of the most powerful levers to convince firms to commit to an investment. In short, the framework used by the Swedish Riksbank conventionally postulates that interest rate cuts lead to a higher level of aggregate investment as external means to finance capital gets cheaper and easier to obtain (Hopkins, Lindé & Söderström, 2009). However, interest rate cuts are often carried out in times when the economy is facing or expecting a forthcoming period of low inflation. In this situation companies may refrain from investing as new capital will not be needed to meet the low demand on the market. Consequently, in this paper we investigate the possibility of aggregate corporate investment being driven by demand and expectations rather than by the interest rates and the cost of capital.

Supporting the hypothesis, Kothari et. al (2014) find a positive relationship between discount rates and aggregate corporate investment, i.e., in times of higher discount rates the level of aggregate corporate investment is found higher, contradicting the theoretical framework used by the Riksbank. As a potential explanation they present the possibility of interest rates and aggregate corporate investment both being driven by expectations of future economic activity.

In the literature stock prices have great support for being a strong predictor of corporate investment. Barro (1990) finds that high values of stock prices are closely correlated with high levels of investment which is supported by Blanchard, Rhee and Summers (1993). These findings do to some extent support our hypothesis as high stock market values are often observed in times with high economic output, coinciding with high interest rates.

Fazzari, Hubbard and Petersen (1988) on the other hand argues that the access to internal capital is important for investment, especially for firms that face financial constraints with difficulties to access external capital. The relationship can be seen as a double sided coin. On one side, greater demand should logically lead to greater profits which can be used as internal funding for investment. On the other side, high demand often coincides with high interest rates, effectively leading to reduced accessibility for external capital. The reversed relationship can be considered in times of low economic activity. However, Myers & Majluf

(1984) argues that due to the pecking order theory, internal financing is considered to have significant cost-advantages over external financing and is therefore desirable.

Von Ungern-Sternberg (1980) argues that in order to increase profits and maintain an advantageous position in the market firms may want to reduce price and increase quality. This will effectively result in a positive effect on the rate of research and development investments made by firms.

In times when the Riksbank unexpectedly lower the nominal base rate, they may send a distress signal to the market, increasing uncertainty and thus lowering investment. If the policy uncertainty related to the expansionary monetary policy has a greater negative effect on corporate investment than the positive effect the nominal base rate has, then aggregate firm investment will decline despite the lower interest rate. Gulen & Ion (2013) find that two thirds of the 32% drop in corporate investments during the crisis 2007-2009 in the United States was due to policy uncertainty. Given this result, policy uncertainty created by the central bank may very well have a bigger negative impact on corporate investment than interest rates directly, however the exact relationship is subject for further research. Furthermore, under high policy uncertainty firms choose to hold significantly more cash and issue significantly less debt, postponing investment further (Gulen & Ion, 2013).

In our study we find no direct effect of the interest rate on aggregate real corporate investment. We do however see signs pointing towards a positive relationship between aggregate investment and expectations of future demand. There are also certain indications of a positive relationship between current demand and aggregate investment.

In this paper we investigate the possibility of aggregate corporate investment being driven by demand and expectations, contradicting the theoretical framework used by the Riksbank. The first section starts with a review of the neoclassical and Tobin's Q investment theory which is based on an optimization problem of the capital stock to meet current demand. In order to understand how policy induced interest rate changes transcends into the economy we will in the second section tie these theories to the framework used by the Riksbank. The third section presents the model and data used in this paper. In the fourth section we present the results of the model followed by an analysis in order to determine what variables affects aggregate corporate investment. The paper ends with a conclusion.

Theoretical background

Much of the modern theories regarding investment stem from the classical capital theory work of Keynes and Fisher (Kuh, 1963) based on investments being made up until the point where the value of the future marginal expected revenue is equal to the opportunity cost of capital (Fischer 1930; Keynes 1936). Therefore, as long as the expected revenue from an investment is higher than the opportunity cost of capital, investment will be worthwhile and undertaken by the firm.

There is a fundamental difference between the Keynesian view and Fisher's view of investments. Keynes argued that there is no optimal stock of capital that firms work towards obtaining, and therefore no equilibria to adjust towards. Fisher, did however see investment theory as an optimisation progress towards an optimal capital stock (Fischer, 1930). Investment theory seen as Keynes formulated it is instead heavily influenced by expectations, these being irrational as they depend on the "animal spirits" of agents, making equilibria impossible to obtain (Keynes, 1936).

Investment Theory

Neoclassical investment theory

An evolution of the work by Fisher is the neoclassical investment theory developed by Jorgenson in 1963 that draws its fundamentals from the maximisation of utility and wealth over time for a firm (Eklund, 2013). The production function and profit function is optimized in order to maximise the discount flow of all future profits (Jorgenson 1963). In the neoclassical model adjustment costs are assumed to be absent, moreover it assumes that future net worth of investments can be calculated, perfect competition on the market and well-behaving production functions (Fazzari & Mott, 1986). These assumptions enable decision makers to equal the interest rate with the marginal rate of return on an investment. As corporations can predict the future, the optimal stock of capital will depend on output, price of output and the user cost of capital (Weintraub, 2015), which creates the following commonly known relationship;

$$K^* = \frac{\alpha(Y)}{C_k^\sigma} \quad (1)$$

where K^* is the desired level of capital stock, Y is the level of output, C_k is the user cost of capital, α is a function of capital and labour and other factors, and σ is the elasticity of substitution parameter between inputs in the production function (Ashworth & Davis, 2001).

As we can see, the interest rate plays a role in the theory as it affects the user cost of capital which has a connection to the optimal stock of capital, as well as output. Accordingly, a lower cost of capital or and a higher output would lead to the optimal capital stock increasing, thus increasing the demand for investment.

Tobin's Q Investment Theory

The neoclassical theory has one major drawback as it does not incorporate expectations in the model. James Tobin (1969) works around this problem with the introduction of the "Q-investment theory". The aggregate (average) Q in Tobin's model is defined as;

$$Q = \frac{\text{Market value of firms}}{\text{Replacement cost of capital}} \quad (2)$$

Market value of firms incorporates future expectations the model is appealing. If the market value of firms is greater than the replacement cost of capital firms will choose to invest until the value of capital equals the replacement cost, thus optimising capital stock (Tobin, 1969; Brainard & Tobin, 1968). Hence, the most simple investment equation can be visualised as

$$I = \beta Q \quad (3)$$

where β is a strictly positive parameter. Following the same reasoning as above, if $Q > 1$ investment should be undertaken. However, the model implies that if $Q < 1$, the capital stock should actually be reduced. Nevertheless, this may in practice not be plausible as much of capital should logically be assumed to be, at least partial, irreversible.

If Tobin's Q is introduced in firms' optimisation problem, the firms' investment decision is dependent on the level of marginal Q which is defined as the future marginal returns on

investment over the current marginal costs of investment. Following the same reasoning as before, if marginal $Q > 1$, investment should be undertaken by the firm (Abel, 1980; Hayashi, 1982; Lucas & Prescott, 1971).

Interest Rates as a Mean to Affect Corporate Investment

Monetary policy and investment theory is closely linked as monetary policy is meant to affect determining variables in the investment theories. Monetary policy affects the aggregate corporate investment through various “channels” in the monetary transmission mechanism framework¹ adopted by the Riksbank (Hopkins, Lindé & Söderström). In this section we link some of these transmission channels to the investment theory in order to get an understanding of what effect monetary policy has on investment.

Interest Rate Channel

The primary channel in the monetary transmission mechanism is the *interest rate channel* (Kuttner & Mosser, 2002). As the central bank lowers the short term nominal rates, the long term nominal rates will decline due to removal of arbitrage possibilities by the market. As prices are sticky, the lower nominal interest rate will effectively induce a lower real interest rate through the Fisher equation² (Fisher, 1930). With lower interest rates, firms’ cost of capital decreases. If we consider the investment theories in the previous section we see that a decrease in cost of capital will induce a higher optimal capital stock in the neoclassical investment theory and decrease the replacement cost of capital in Tobin’s Q investment theory, thus theoretically leading to a higher rate of investment. Furthermore, when the interest rate is lowered consumers face lower interest rate for their savings and consumption will increase. This leads to increased domestic demand and output for firms, effectively increasing Q and optimal capital stock. (Mishkin F. S., 1996)

¹ For an overview of these channels see Mishkin (1995)

² For more information about real interest rate and its connection to monetary policy see Lagervall (2008)

Exchange Rate Channel

In open economies, real effects of an expansionary policy will affect the economy through the *exchange rate channel* (Kuttner & Mosser, 2002). If the domestic interest rate decreases, the domestic exchange rate relative to foreign exchange rates will decrease through the uncovered interest rate parity. Domestic companies will therefore experience an increase in foreign demand stemming from a greater demand of their relatively cheaper products. A depreciation of the currency also leads to greater demand from domestic consumers, as the relative price of imported goods increases (Mundell 1963). The effect of the exchange rate channel in case of an interest rate cut thus has a positive effect on output in the neoclassical investment theory and the market value of firms in Tobin's Q investment theory.

Credit Channel

Long-term assets such as bonds and stocks are affected when interest rates fluctuate over time. In case of an interest rate decline, the value of such assets will increase due to the inverse relationship between interest rates and price of long term assets (Shiller, 2007). In presence of adverse selection and moral hazard between lender and borrower, the premium that companies need to pay for external finance declines as the companies' collateral increases in value (Bernanke, Gertler, & Gilchrist, 1996). Higher collateral value of firms consequently increase the accessibility of external finance to a lower cost. As a result, firms afford to invest more, amplifying the effect of interest rate policy decisions (Ashworth & Davis, 2001). This is often referred to as the financial accelerator or the *broad credit channel* (Kuttner & Mosser, 2002). The accelerator effect is considered having a greater impact on the investment of small firms than it has on larger firms (Guariglia, 1999).

Lastly we will shortly review the *narrow credit channel*. As the interest rate declines, the commercial banks will increase their lending as buying bonds to now lower interest rate is less desirable as a source of revenue than before. As banks increase their lending, companies will have easier access to capital at a lower price and therefore increase their borrowing to finance investments (Hörngren, 1995).

Empirical Analysis

Economic Model and Data

The econometric model that will be used in this paper to investigate whether or not the changes in the interest rate affects corporate investment is a multivariable OLS- regression, based on quarterly data between 1988 and 2014.

The model has been specified as follows:

$$\begin{aligned} \Delta \ln(\text{Investments}) = & \alpha + \beta_1 \Delta \ln y_{t-1}^{\text{Germany}} + \beta_2 \Delta \ln y_{t-1}^{\text{Sweden}} + \beta_3 \Delta \ln y_{t-1}^{\text{USA}} + \\ & \beta_4 \left(\frac{\text{Confidence indicator}_{t-1}}{100} \right) + \beta_5 \Delta \ln(\text{Profits}_{t-1}) + \beta_6 r_{t-1} + \beta_7 \Delta \ln(\text{TCW}_{t-1}) + \\ & \beta_8 \Delta \ln(\text{Investments}_{t-1}) + \beta_9 \Delta \ln(\text{Investments}_{t-2}) + \varepsilon_t \end{aligned}$$

Where $\Delta \ln(\text{Investments})$ is the percentage change in companies' realized real investments during the period, α is an intercept, y_t^{Germany} is the percentage change in constructed GDP for Germany in chained prices. The GDP is constructed as the combined West and East German GDP, enabling us to rely on the pre 1990-data. The percentage change in GDP for Sweden and the United States are denoted as y_t^{Sweden} and y_t^{USA} respectively.

The Confidence indicator is an index consisting of companies' present and expected demand for their goods and services. It has been divided by 100 to ease the comparability of the coefficients in the model.

$\Delta \ln(\text{Profits})$ is the percentage change in profits for Swedish companies, r_t is the interest rate that companies face (real corporate borrowing rate). $\Delta \ln(\text{TCW})$ is the percentage change in the TCW-index.

Lastly, $\Delta \ln(\text{Investment})$ is a lagged dependent variable to help us see effects of previous periods investments on the current investment ratio.

The GDP-variables are indicators on the current financial situation, an increase in GDP should increase the demand for the company's products, as many industries are sensitive to business cycle fluctuations (Berman & Pfleeger, 1997).

The confidence indicator is an index published by the Swedish Institute of Economic Research, where the data is collected through a survey conducted quarterly among 6000 Swedish firms³, asking them about their current demand, their stock of goods and their future expected demand. The index is standardized with a mean of 100 and a standard deviation of 10 (National institute of economic research, 2015). Logically, the confidence indicator should be positively correlated with investments. Expectations of good times to come leads to companies investing to cope with increased demand.

TCW (total competitive weights) is an exchange rate index, measuring the Swedish Krona's value against a basket of other currencies. The weights of the currencies in the basket are determined by the amount of trade Swedish firms' has with said country. An increase in the value means that the Swedish Krona has depreciated. (Statistics Sweden, 2015). Intuitively it should be positively correlated with our investments, as a higher value of TCW is beneficial to the export sector.

Profits lead to companies having the option of re-investing their own capital³, it is therefore likely that profits should have a positive relationship with investment.

The real interest rate is calculated using the nominal company borrowing rate (Economics, 2015), adjusted with the companies' own inflation expectations⁴.

We will run the model using a one-period lag amongst our variables as realized investments today most likely is based on information from previous periods.

We have five major events in our data that could affect the results and therefore we run the test with five different time periods, one between 1988 and 2014, one between 1988 and 2008, one for 1995-2008, one for 1995-2014 and one for 2008-2014. These major economic events in chronological order start with the unification of Germany in 1990, as it might be significant to the Swedish export-industry. The following is the financial crisis in Sweden from 1990 to 1994 and the abolition of the fixed exchange rate and the introduction of the inflation target policy in 1992 and 1995 respectively. The last two policy changes has

³ The discussion about whether or not they do, or should do so, is not addressed in this paper, for some further reading see (Dobrovolsky, 1945).

⁴ Using the Fisher Equation as proposed by Irving Fisher(1930).

significant impacts on the effects of monetary policy and how it can be conducted (Sohmen, 1969). Thirdly the global financial crisis of 2008 and the drastic shifts in the global economy it gave rise to. Lastly we have the zero percent nominal interest rate implemented by the Swedish Riksbank in 2014. The results of the last of these major events might not be apparent yet in our data and therefore we will not draw any conclusions about the zero interest rate and its impact on investments.

All data has been collected using Thomson Reuters Datastream, where the original data comes from Statistics Sweden, the Swedish Institute of Economic Research, the Swedish Riksbank, Oxford Economics, the German Federal Statistical Office and the Bureau of Economic Analysis.

Illustrative Data

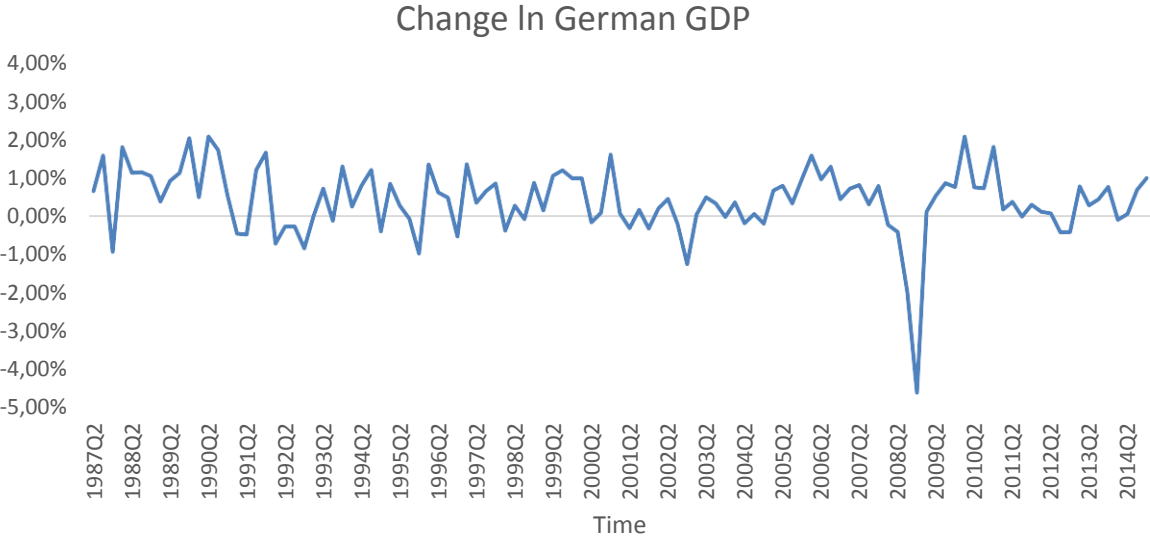


Figure 1; Percentage change of German GDP

We can see relatively high volatility in the German output growth the following years after the unification in 1990. Between 2001 and 2002 the aftermath of the dot-com bubble can be observed. Furthermore, the financial crisis is clearly visible in 2008 and 2009.

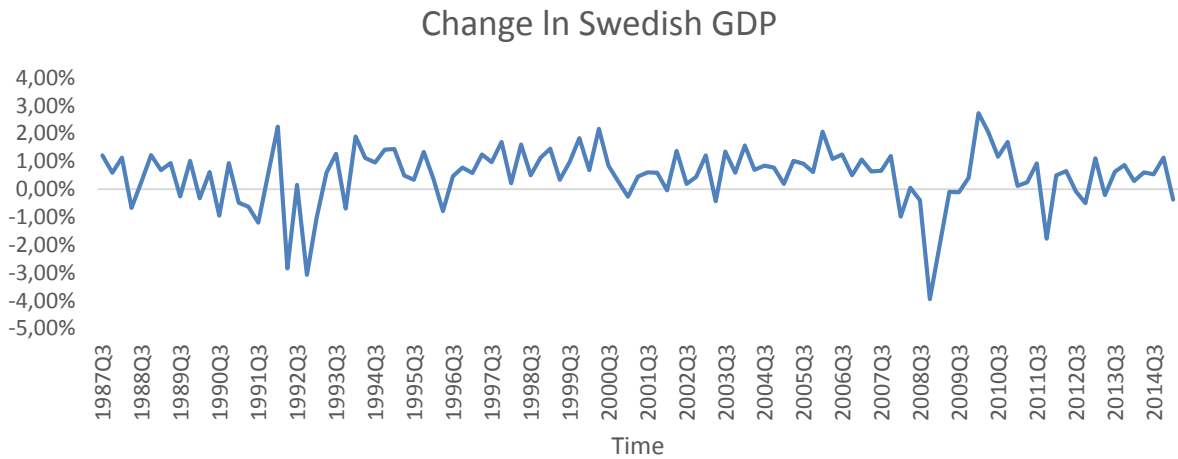


Figure 2: Percentage change of Swedish GDP

Notable in Swedish output growth is that the financial crisis in combination with the abolition of fixed exchange rate in created relatively high volatility in the early 1990's. Worth pointing out is that all the post 1992 and 1995 data most likely are affected by these major monetary policy changes, however no long run trend can visually be observed. The financial crisis can clearly be identified in 2008.

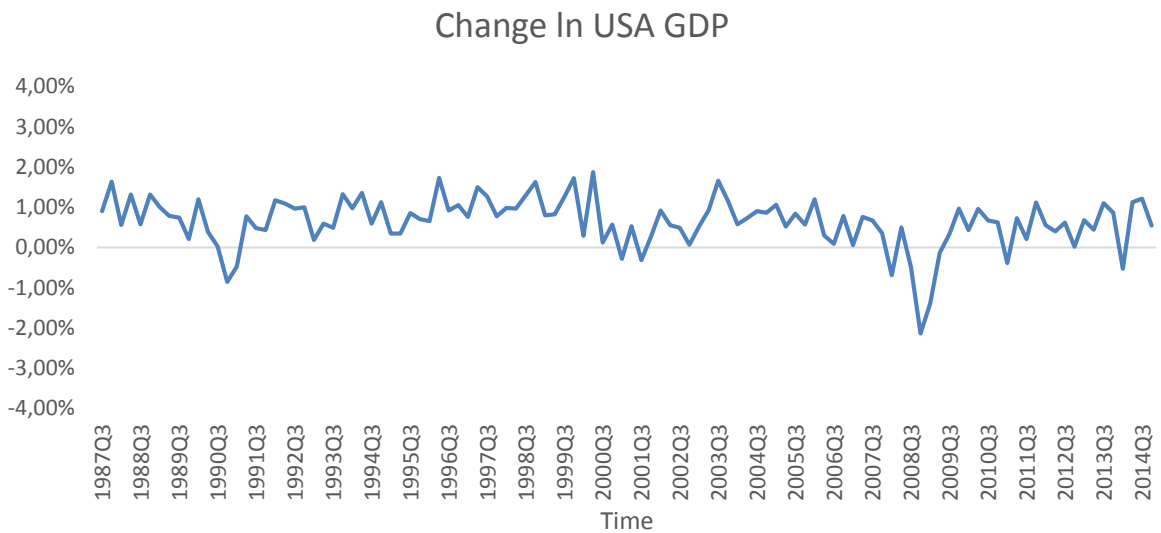


Figure 3: Percentage change in USA GDP

Most notable in the United States GDP growth is the financial crisis in 2008 and the low GDP growth following the bust of the dot-com bubble in the early 2000's.

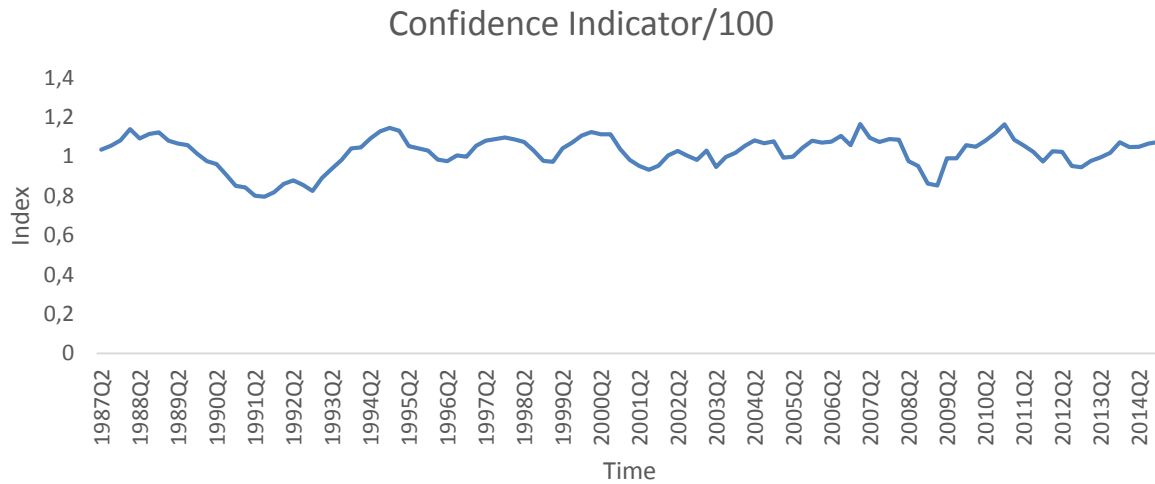


Figure 4; Confidence indicator / 100

Firms demand and expectations decreased the years prior the abolition of the fixed exchange rate in 1992. We can observe a decrease as the inflation target was introduced in 1995. If the decrease is due to the inflation target, or just normal cyclical fluctuations is subject for further research. Nevertheless, we can identify relatively big a drop in confidence during the financial crisis in 2008.

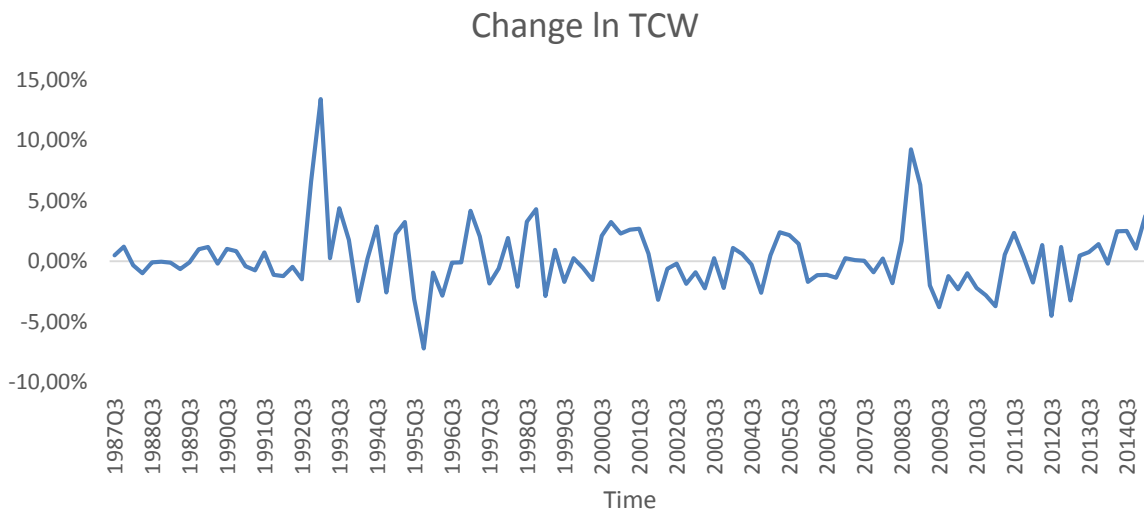


Figure 5: Percentage Change in TCW

The Swedish Krona depreciated in value relative our big export partners when the fixed exchange rate was abandoned in 1992 but appreciated when the inflation target was introduced in 1995. Furthermore we can identify a depreciation as a result of the financial crisis in 2008.

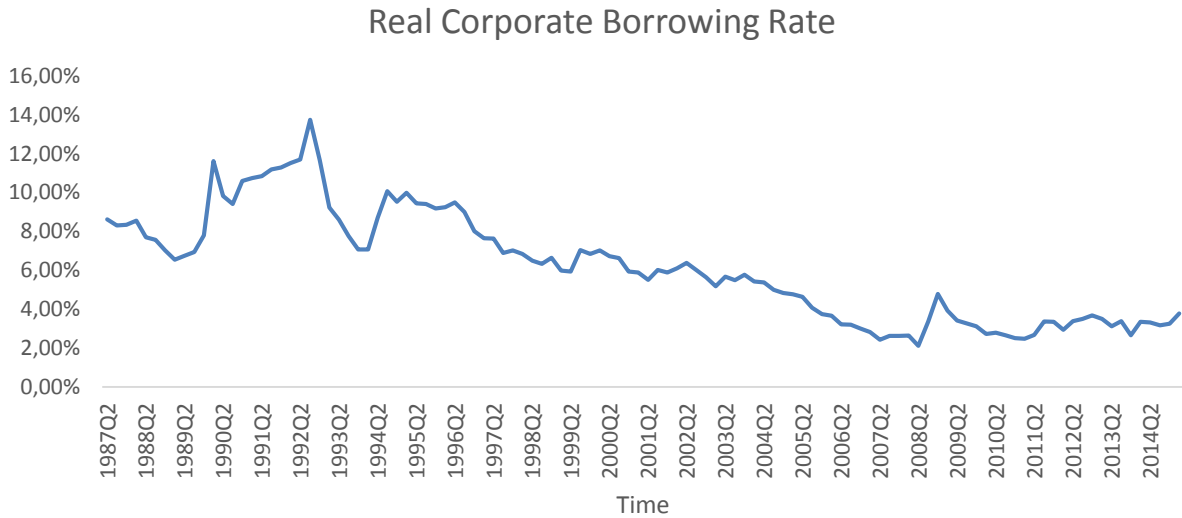


Figure 6: Real Corporate Borrowing Rate

Most notable in the real corporate borrowing rate is the drop witnessed at the same time as the abolition of the fixed exchange rate in 1992. Furthermore, we can see an increase leading up to the introduction of the inflation target in 1995. Moreover, an increase is identified in connection to the financial crisis in 2008.

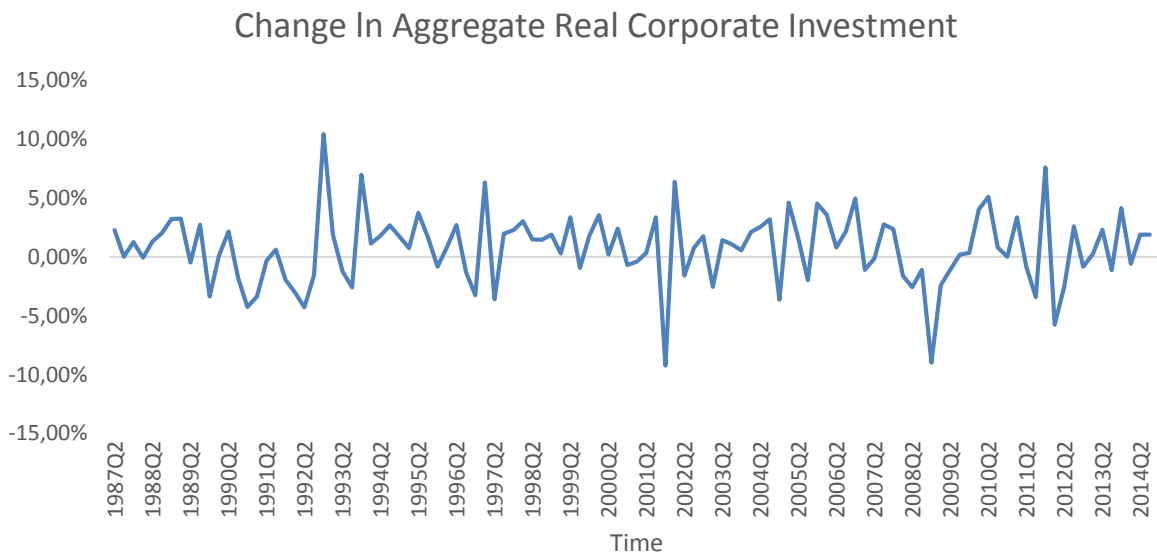


Figure 7: Percentage Change in Real Aggregate Corporate Investment

The aggregate real corporate investment increased following the adoption of flexible exchange rates in 1992 and decreased just after the bust of the dot-com bubble. The financial crisis is present in this data as we can identify a decline in 2008.

Analysis of Data

Test for Stationarity

In order to test for stationarity in our variables we use the Dickey-Fuller test as proposed by Dickey & Fuller (1979). Under the null hypothesis that the variable contains a unit root we get the following results;

Variable:	Δ GDP GER	Δ GDP SWE	Δ GDP USA	Δ Investment	Δ TCW	Δ Profit
T-stat	-7.78	-5.08	-7.15	-3.69	-7.71	-12.18
P-value	0.00***	0.00***	0.00***	0.03**	0.00***	0.00***

Table 1: Augmented Dickey-Fuller Test, ***, **, * stands for significance at the 1, 5 and 10% level respectively.

We can see that the null hypothesis can be rejected in all our variables, as we choose the 5% level of significance. Therefore it is safe to say that the variables are stationary

The interest rate⁵ and the confidence indicator are by definition generally considered as stationary and therefore it is not necessary to conduct said test on these variables.

⁵ It is debated whether or not the interest rate is by definition stationary, see Norrbin & Smallwood (2011) for further reading on the subject.

Regression Results

In the data, several big economic events occurred as discussed in the previous section. The model is therefore ran for five different time periods in order to avoid as much bias as possible. The regression results are presented in Table 2:

Time period:	(1)1988-2014	(2)1988-2008	(3)1995-2008	(4)1995-2014	(5)2008-2014
Δ GDP Germany (-1)	0.35 (0.28)	-0.27 (0.36)	0.28 (0.59)	0.81* (0.44)	1.13 (0.97)
Δ GDP Sweden (-1)	-0.32 (0.52)	-0.61 (0.58)	0.28 (0.73)	0.42 (0.55)	-1.86 (1.68)
Δ GDP USA (-1)	1.87*** (0.57)	1.19** (0.51)	0.17 (0.74)	1.1* (0.58)	1.81 (1.14)
Confidence Indicator (-1)	0.15*** (0.05)	0.16*** (0.04)	0.21 *** (0.07)	0.19*** (0.07)	-0.33 (0.27)
Δ Profits (-1)	-0.01 (0.05)	-0.02 (0.05)	-0.11 (0.11)	-0.08 (0.10)	0.43 (0.42)
Real Interest Rate (-1)	-0.01 (0.01)	-0.01 (0.01)	0.01 (0.01)	0.01 (0.01)	-0.07* (0.04)
Δ TCW (-1)	0.19 (0.13)	0.29 ** (0.13)	0.11 (0.15)	0.05 (0.13)	0.18 (0.33)
Δ Invest (-1)	-0.34*** (0.12)	-0.34 *** (0.12)	-0.73*** (0.16)	-0.63*** (0.12)	-0.38 (0.24)
Δ invest (-2)	-0.21** (0.09)	-0.22** (0.01)	-0.39*** (0.15)	-0.29** (0.11)	0.03 (0.27)
Number of observations	n = 108	n = 83	n = 55	n = 80	n = 23

*Table 2: Regression results with coefficients and (S.E), *, **, *** stands for 10, 5, 1 % significance respectively. In periods 1 and 2 the standard errors has been adjusted for heteroskedasticity. In period 3 the standard errors has been adjusted for auto correlation, see appendix for further information.*

A review of every time period will follow before we combine the results in order to draw a conclusion.

Period 1 (1988-2014)

The results from this time period indicate that the interest rate is not significant for the aggregate level of real corporate investment. Instead we see that GDP for the United States, the confidence indicator and investment conducted in quarter t-1 and t-2 are significant.

An increase in American GDP in the previous quarter has a positive effect on the level of aggregate real corporate investment. Since the United States is a major export partner of Sweden (Statistics Sweden, 2015), it is possible that a GDP growth leads to the United States importing more goods and services from their trade partners, one of which is Sweden. The Swedish companies will therefore have to invest in order to meet the increased demand⁶.

⁶ Optimal capital stock has increased.

The significance of the confidence indicator points us in the direction of investments depending on demand and expectations of demand. The confidence indicator in this test is positively correlated with investment. Since the confidence indicator is a measurement of present and expected demand, it gives an indication of what firms believe the demand for their goods and services will be in the future (National institute of economic research, 2015).

Previous investments are significant and negatively correlated with investments. Logically this could be derived from the intuition that if a firm invests in a durable good in period $t-1$, the need for that investment will not occur again in period t .

Period 2 (1988-2008)

As seen in the illustrative data, the financial crisis is present in all of our variables. In this test all data until the financial crisis hit in 2008 will be included in order to nullify potential biased results of the financial crisis. Nevertheless, the change from fixed to exchange rate and the introduction of the inflation target is still present in the data which potentially could impact the results.

The results are similar to the ones from the test conducted on period 1 with GDP for the United States, the confidence indicator and investments conducted in $t-1$ and $t-2$ being significant. All the coefficients have the same signs as before, positive for GDP-USA and confidence indicator, while it is negative for previous investments. Hence, the results indicates that even if we choose to exclude the happenings occurring after the financial crisis of 2008, the significance of the demand driven variables is still palpable.

In contrast to the test conducted on period 1, TCW is introduced as significant in this test with a positive coefficient, meaning that when the Swedish krona depreciates investments increase. Removing the crisis of 2008 and the fluctuations in exchange rate it has spawned might be a reason for why TCW is significant in the period (Kohler, 2010). The introduction of the exchange rate, and the relationship it has with investments through the exchange rate channel, helps further to imply that the interest rate is not the direct deterministic variable for corporate investment, but instead that it is driven by demand, in this case export demand.

Period 3 (1995-2008)

The third test excludes the change to flexible exchange rate, the introduction of the inflation target as well as the financial crisis. However the data is limited to 55 observations.

In difference to previous tests, GDP for USA is no longer significant. It is only the confidence indicator and previous investments that show signs of affecting the current aggregate investments. However trusting this test might be misleading as the number of observations is limited and the probability of getting misleading results increases (Babyak, 2004). Therefore it is not advisable to fully rely on the results based on this regression alone.

The regression does nevertheless indicate that the rate of investments does not depend on the short-term interest rate, but is instead dependent on current and expected demand of firms.

Period 4 (1995-2014)

The fourth test in this paper excludes the shift to the flexible exchange rate and the inflation target, but incorporates the financial crisis of 2008.

Again, GDP growth for USA, the confidence indicator and previous investments are significant. Unlike the other tests however, German GDP is significant in this time period. The introduction of German GDP with a positive coefficient is important. As earlier mentioned, economic growth among the major export partners leads to Swedish firms meeting a higher demand for their products (Taylor, 2000). Germany is the largest export partner of Sweden (Statistics Sweden, 2015), therefore fluctuations in German output should theoretically impact Swedish export. The GDP for the United States and the confidence indicator being significant, as well as previous investments follows the same reasoning as earlier.

As in the previous tests, there is a strong tendency towards investment being demand and expectations driven rather than by interest rates.

Period 5 (2009-2014)

The fifth test is conducted in order to account for the aftermath of the financial crisis and thus leaving out all events up until 2009. By shortening the time period substantially the test only includes 23 observations, and is potentially subject for bias (Babyak, 2004).

The results from this test differ from the previous four tests as none of the previous significant variables are significant. Instead we see that the real corporate borrowing rate is significant, indicating that the interest rate may be a deciding factor of aggregate real corporate investment as discussed in the theory chapter of this paper. Meanwhile the result is not unorthodox it is a contradiction to the previous tests.

Further Notes on the Results

If we combine the results from all tests conducted we find that, most notably, the real corporate borrowing rate is only significant in time period 5. The test shows a tendency towards interest rates having an effect on aggregate real corporate investment. However, the test does only contain 23 observations and therefore have a high likelihood of bias (Babyak, 2004), therefore we take this result very lightly.

The reason for the general insignificance of the interest rate may be a problem of simultaneity. The Swedish Riksbank generally loosens policy in times of weak output and tightens in times of high output. If we consider the neoclassical investment theory we realise that if output is high at the same time as we have high interest rates, high user cost of capital, the effect on the optimal capital stock in Equation 1 will potentially to some extent be nullified.

Strongly contradicting the result of time period 5, all other tests show significant demand and expectation variables, thus showing a strong tendency towards aggregate real corporate investment being driven by demand and expectations. In a majority of the other tests we find GDP among major export partners, the confidence indicator and previous investments being significant. Most notable is the strong significance of the confidence indicator throughout period 1 to 4. German GDP is only significant in time period 4. In the test containing data pre-

1995, Germany was still divided⁷. This might be a reason for why it is not significant in the other tests that includes an adequate amount of observations. TCW is significant in time period 2, suggesting that the exchange rate to some extent has an impact on the level of aggregate real corporate investment.

The strong significance of the confidence indicator effectively means that current demand and expectations about future demand for Swedish corporations play a crucial role in the level of aggregate corporate investment. Expectations are incorporated in the Tobin's Q model of investment which may therefore be a good estimator of aggregate corporate investment with regard to our results. If we consider the neoclassical investment theory we propose that expectations of future demand should be included in the model such as;

$$K^* = \frac{\alpha(Y + Y_e)}{C_k^\sigma} \quad (4)$$

Where Y_e is a new variable accounting for expected demand. One could argue that expectations is already incorporated in the user cost of capital as expectations of future economic activity affect the real interest rate through the Fisher equation. However, as our results show that the interest rate does not affect investment we believe that the introduction of an independent output expectation variable is valid. Such model could potentially explain the effects of monetary policy on aggregate investment more accurate considering our results. Nevertheless, the feasibility of such model is subject for further research.

Profits should theoretically be an important determinant of corporate investment as corporations have access to more cheap internal funding when profits increase as proposed by Mayers & Majluf (1984). However, we find no proof of this relationship as profits are not significant in any of the time periods. On the other hand, the level of investment made in t-1 and t-2 is highly significant trough out period 1-4. Logically, if corporations invest in t-1 or t-2, they may not have the need to invest in period t.

Even though there is a clear tendency towards investment being driven mainly by demand and expectations, the Swedish output is not significant in any of the time periods and to some

⁷ The east part before the fall of the Berlin wall is considered a closed economy and therefore the constructed GDP-measure might not be an adequate measurement for export levels pre 1990.

extent conflicting with the hypothesis. If Swedish demand increases, corporations should invest in order to meet the new demand.

Conclusion

In this study we have investigated if the short term nominal interest rate has a direct significant impact on corporate investment as suggested by the channels of the monetary transmission mechanism used in the theoretical framework of the Swedish Riksbank. We find that the interest rate does not have an effect on aggregate corporate investment in our model⁸, hence cost of capital seems of less importance for the level of aggregate corporate investment. A possible explanation for this may be that we often face low interest rates in times when demand is low, and high interest rates in times when demand is high - effectively nullifying much of the interest rate effect given by the theories discussed in this paper.

On the other hand, we find GDP-growth for big export partners as well as the confidence indicator being of importance for corporate investment, effectively meaning that current demand and future demand expectations play a great role in the determination of aggregate corporate investment and strongly indicate corporate investment being driven by demand and expectations. We propose that expected demand should be included in the neoclassical investment model in order to account for the significant effects of demand expectations.

According to our results, the common belief among policy makers that lower interest rates increases capital expenditures is incorrect. Therefore there is a need for policy makers to reconsider the importance of interest rates as a mean to increase aggregate corporate investment.

⁸ One should keep in mind that the interest rates may affect other factors, such as aggregate demand, which in turn will have a second order effect on aggregate investment. The exact relationship is however subject for further research.

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Appendix

Test for Autocorrelation

When conducting studies involving time series data it is important to check the residuals for autocorrelation, this has been done for the regressions using the Breusch-Godfrey serial correlation test with LeGrange Multiplier as suggested by Godfrey (Godfrey, 1978). The more commonly used Durbin Watson test⁹ is invalid when we have a dynamic regression model with lagged dependent variables as estimators (Breusch, 1978). The test is conducted under the null hypothesis of no autocorrelation and a chi-square statistic. The statistics we receive from the Breusch-Godfrey test are shown in Table 4; As we can see, our tests show no proof, with the exception of the period 1995-2014, of being auto correlated at the 5% level. We have therefore adjusted the standard errors in that regression using the matrix proposed by Newey & West (1987).

Period	1987-2014	1987-2008	1995-2008	1995-2014	2009-2014
F-stat	1.607092	2.086511	1.132652	3.265253	1.052995
Prob.F	0.2058	0.1317	0.3316	0.0443	0.3816
Obs*R-square	3.498812	4.607514	2.752478	7.009754	3.695849
Prob. χ -square	0.1739	0.0999*	0.2525	0.0301**	0.1576

Table 3: **, * represents significance at 5 and 10% level respectively

As we can see, our tests show no proof, with the exception of the period 1995-2014, of being auto correlated at the 5% level. We have therefore adjusted the standard errors in that test using the matrix proposed by Newey & West (1987).

⁹ For more information see (Durbin & Watson, 1950)

Test for Heteroskedasticity

A test for heteroskedasticity is conducted to make sure the parameter estimates are efficient and that the covariance matrix estimates are consistent. The more generic test proposed by Halbert White (White, 1980) is used to check the residuals for non-consistent variance over the time series. The null hypothesis of homoscedasticity cannot be rejected in our tests, apart from the time period 1987-2014 and 1987-2008, therefore we choose to reject the alternative hypothesis of heteroskedasticity in all but those two tests¹⁰. We have chosen not to include the cross-terms of the regressors, and therefore limiting the test to a pure heteroskedasticity test.

Period	1987-2014	1987-2008	1995-2008	1995-2014	2009-2014
F-stat	5.622829	3.210819	0.786175	1.329740	1.853491
Prob.F	0.0000	0.0025	0.6302	0.2376	0.1511
Obs*R-square	36.77785	23.53821	7.472919	11.68037	12.92636
Prob. χ -square	0.0000***	0.0051***	0.5880	0.2319	0.1660

Table 4: *** significant at 1%.

¹⁰ Therefore the standard errors has been adjusted for heteroskedasticity using White (1980) standard errors in those two tests.