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Cash-Flow and Investment: A Panel Quantile Approach

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Abstract: The investment behaviors of firms are affected mainly by financial climate and conditions of economic environment in which they operate. Besides, macro variables such as real interest rates, firms carefully evaluate their balance sheet items in their investment decisions. Classical regression analysis provides the possible impact of explanatory variables on the mean value of investment. Although, in some cases, it is very important to know how the mean level of investment is affected by the variables, it could be much more important to know, especially for policy makers, how each quantile of investment is affected by the variables. Based on effects of the variables on quantiles, different policy options can be produced and advised. In this study, a panel quantile regression approach has been used to analyze the effect of real interest rates, currency rates, cash flows and sales on investments by using a data set from Turkey.

Keywords: Cash-flow, Investment, fixed-effect, Panel Quantile, Correlated Random Effect

JEL Classification Number: D22, C21, C23

1. Introduction

Investment decision of firms is one of the most critical subjects in firms' lives, since that investment can destroy firm values leading to bankruptcy or add a positive value leading to a better company. For the importance of the subject a critical economic analysis is needed for those firms planning investment for the future. Since investment behavior is affected by the methods of investment financing, it becomes important to know the source of investment financing in order to make an accurate analysis. Investment financing may not be a major problem for those firms whose net worth is adequate or for the ones which are large and well known. But this may not be true for small firms that need external financing for their investment spending. Can they find external financing as easily as the large and well-known firms? Can they find external financing with the same conditions as the large and well known firms? Shortly, answers of these questions are "no".

Based on the assumptions of complete financial markets and without any transaction and information costs, The Modigliani-Miller theorem (Modigliani and Miller (1958)) states that debt used for firms' investment spendings does not affect the expected return of that investment. However, Akerlof (1970), expressing the effects of information asymmetry between buyers and sellers, showed that a market could be completely locked with this information asymmetry. Similarly, in financial markets an information asymmetry about the real return of the project related with that investment spending may occur and because of this information asymmetry, external financing becomes more costly than internal financing. Due to the difficulty of finding external financing with an acceptable cost, firms are forced to finance their investments internally. With such a financial constraint, these firms are defined as "financially constrained". Many empirical and theoretical studies showed that (Fazzari and the others (1988), Bernanke and the others (1999), Gertler and Gilchrist (1993), Gertler and Gilchrist (1994), Cooley and Quadrini (2006), Gilchrist and Himmelberg (1995) and (1999), Haan and Sterken (2006), Morgan (1991), Carpenter and Petersen (2002)) the financial constraints which affect firms' activities are mainly caused by information asymmetries and agency problems.

For a well-defined explanation of investment behavior, it is necessary to identify the factors that affect investment at a firm level as well as the macroeconomic level. Through the macroeconomic environment, real interest rate and exchange rate have direct effects on investment (Bernanke and Gertler (1995), Gilchrist and the others (2005)). Whereas at a firm level cash flow plays critique role. The cash flow is associated by financing imperfections and "financially constrained" (Fazzari and the others 1988). Beginning from Fazzari and the others (1988), there is a huge literature on financially constrained firms which face high costs of external financing. Financially constrained firms will mostly finance their investment by internal funds and there will be a high correlation between cash flow and investment.

Although changes of some economic activities affect the firms in different degrees, the mostly used approach is to ignore these differences. The classic regression analysis shows the impact of explanatory variables on the mean level of investment. Although it may be very important to know how the mean level of investment is affected by the variables, it is much more important, especially for policy makers, how each quantile of investment is affected by the variables. In order to see the differences of an effect of a shock, a generally used method is quantile regression. Based on effects of the variables on quantiles, different policy options can be executed.

One of the main problems in investment financing is the information asymmetry between the borrowers and lenders (in our case lenders are banks (firms)). This asymmetry may occur in financial conditions, net worth and investment capability of the firm and may

result with an adverse selection problem. Because of this adverse selection problem, there occurs a wedge between the cost of external and internal funds. This wedge is called external finance premium and those firms which need external financing must pay this external finance premium which contains all the costs related with information asymmetry and agency costs.

External finance premium is related with both firm's financial conditions and bank's credit supplies. The firms which are financially healthy and whose net worths are high, face a low external finance premium. With an information asymmetry, the external finance premium is determined by the balance sheet of the firms. If a tightening monetary policy is applied, the cost of short term lending increases. Consequently with the rising interest rates, both the expected rate and level of profits decrease, which results with a decrease in firm's credibility and an increase in external finance premium. Since the balance sheet of a firm behaves procyclically, the effects of the monetary and real shocks are amplified in such a case and this is called financial accelerator mechanism (Lünnemanve and Matha, 2001). The financial accelerator mechanism not only amplifies the effects of monetary shocks but also forces the firms to finance their investments through internal funds. As mentioned in Hubbard (1998), several empirical studies showed that financial constraints are the key components of the investment behavior of small firms.

Fazzari and the others (1988) strongly emphasize the financial hierarchy between internal and external finance in which the elasticity of substitution is very weak and internal finance is more advantageous than external finance. In such a situation investment is dependent on financial structure which is summarized by the cash flow of the firm. In their (Fazzari and the others (1988)) study investments of financially constrained firms have strong correlation with the cash flow parameter.

According to the Neoclassical Theory, if sales increase, firms' investment increases and if sales decrease, firms' investment decreases (Hall and Jorgenson (1967)). Chirinko (1993) says that sales strongly determine the level of investment compared to other variables. So following these theoretical results we use sales in the investment function.

This paper tries to find the determinants of investment in Turkey by employing a panel quantile regression approach. For that purposes, real interest and currency rates, cash flows and sales on investments are used as variables. We include the interest rate as in the study of Gertler and Gilchrist (1994) and include the exchange rate following Benavente et. el. (2003). Our contribution is to use a new data set that never been used for stated purposes.

With this introduction and a relevant short literature review, Section 2 sets up the empirical model. Section 3 evaluates data and empirical results and finally Section 4, we provide some implications.

2. Econometric Model

Introduced by Koenker and Basset (1978), the quantile regression is an extension of the classical regression model to estimate conditional quantile functions. In conditional quantile functions, quantiles of the conditional distribution of the response variables are expressed as functions of observed covariates (Koenker and Hallock (2001)).

We use the quantile approach since our aim is to identify the effects of investment determinants in different quantiles rather than obtaining mean effects of those variables. With this method we will be able to analyze the effects of the same independent variable in different quantiles, especially in the lower and upper quantiles. The quantile regressions can be stated as:

$$(I/K)_{i,t} = \beta_0 + \beta'_{\theta K} Y_{K,i,t} + z_{\theta i,t} \tag{1}$$

or

$$\text{Quant}_\theta\left(\frac{(I/K)_{i,t}}{Y_{K,i,t}}\right) = \beta'_{\theta K} Y_{K,i,t} \tag{2}$$

where $(I/K)_{i,t}$ is the investment of firm i in period t ; Θ is the quantiles; $\beta'_{\theta K}$ is the parameter of each investment determinant in each quantile; $Y_{K,i,t}$ is the vector of investment determinants specified by real interest rates r_t , real exchange rate $\Delta r_{er,t}$, sales (S/K) and cash flow (CF/K) normalized with capital stock of the firm; $z_{\theta i,t}$ is the error; $\text{Quant}_\theta\left(\frac{(I/K)_{i,t}}{Y_{K,i,t}}\right)$ is the quantile of the dependent variable $(I/K)_{i,t}$, which is conditionally related with the independent variables $Y_{K,i,t}$.

$$Y_{K,i,t} = \{r_t; \Delta r_{er,t}; \left(\frac{S}{K}\right)_{i,t}; (CF/K)_{i,t}\} \tag{3}$$

The quantiles we will use are specified as¹:

$$\Theta = \{10, 25, 35, 45, 50, 65, 75, 85, 90\} \tag{4}$$

In our investment equation, r represents the traditional interest rate that affects investment with an expected negative sign. Unlike widely used definition of real exchange rate², in our case an increase in real exchange rate means appreciation of Turkish Liras, while a decrease means depreciation. The effects could be either positive or negative. A positive effect implies that investment expenditures due to an import mechanism becomes cheaper with appreciation while opposite effect is also true. A negative effect is triggering an export mechanism. Since the domestic products become cheaper and this will result with an

¹Estimation can be done using more quantiles. However, this will increase computer time without providing more depth analysis.

²By defining the exchange rate as 1/TL, we could obtain widely used version of the real Exchange rate. However we choose use the variable as provided by the source.

increase in exports and consequently the income of the firms will increase. As a result of this process firms will increase their investment expenditures. The end result will be determined by summing up the negative and positive effects. Finally the signs of last two variables of sales and cash flow are expected to be positive.

3. Data and Empirical Results

We use a data set, running from 1992 to 2008, obtained from Central Bank of Turkey Main features of our data set, which is balanced with 88 firms for 17 years, are given in Table-1.

Table 1: Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Minimum	Maximum
Real Interest Rate	0.067	0.073	-0.111	0.157
Change in Real Exchange Rate	0.018	0.083	-0.149	0.147
Investment/Capital Stock	0.35	0.19	0	0.92
Sales/Capital Stock	11.64	28.14	0.11	735.29
Cash Flow/Capital Stock	0.99	1.59	-19.01	27.23

To set up a benchmark for our quantile regression, we first estimate a fixed effects panel model. The estimation results of fixed effects panel model is given in Table 2.

As seen in Table 2, all of the variables are statistically significant at %5 significance level.³ The sign of the real interest rate is consistent with the theoretic literature. There is a negative relationship between the real interest rates and investments; an increase in real interest rates leads to a decrease in investments. The real exchange rate affects investment negatively such that an increase in the real exchange rate, which means there is an appreciation in Turkish Liras, leads to a decrease in firms' investments. This result is also consistent with the literature; an appreciation causes a decrease in firms' exports, consequently a decrease in sales and finally a decrease in investment expenditures.

Another indicator of investment is the sales and its sign is positive as expected. The last determinant of investment in our study is the cash flow variable, which is also a strong indicator for financially constrainedness. The coefficient of cash flow is positively correlated with investment and this relation clearly implies that firms are financially constrained and choose internal financing instead of external sources. This may occur due to the imperfect capital market mechanism, so that firms' access to external financing is limited and/or costly.

³Koc and Sahin (2015) use the full data set which is unbalanced. Their Hausman test results indicate a fixed effects model. We follow this path in our study.

Table 2: Fixed Effects Panel Data Estimation Results

Investment (I/K)	Coefficients	Standard Error	P> t
Real Interest Rate	-0.47347	0.06837	0
Change in Real Exchange Rate	-0.13364	0.06011	0.026
Sales (S/K)	0.0015757	0.0002576	0
Cash Flow (CF/K)	0.0079669	0.0038422	0.038
Constant	0.3577726	0.0075365	0
Number of Obs.	1496		
Number of Groups	88		
F(4,1404)	33.96		
Prob> F	0		
R ²	within	between	overall
	0.0882	0.025	0.073

According to our panel data estimation results, we can conclude that firms in our study are financially constrained. But is it really the case for all the firms? In order to answer this question we use a quantile regression approach. For that purposes first we estimate a fixed effects panel quantile model. The results are given in Table 3. Compared with Table 2, we see that in some quantiles, coefficients are not statistically significant. For example the coefficient of the real interest rate is not significant at above 75th quantile which implies that the real interest rate has no effect on investment expenditures of these firms. Firms which operate at upper quantiles can be classified as aggressive investors.

Those firms which invest aggressively compared to their capital stock do not consider the real interest rate in their investment. The situation is similar in cash flow parameter. Cash flow becomes statistically meaningful starting from 50th quantile. Below this quantile (which means that investment behavior is not as aggressive as the upper quantiles) cash flow is not statistically significant. Combining this result with the real interest rate, we see that at the quantiles that real interest rate is not statistically significant, cash flow is statistically significant. This shows that if firms are financially constrained and investing very aggressively, the main determinant of investment is cash flow. In such a case, firms neglects the opportunity cost of investment and does not care to assess the real interest rate while investing. In fixed effects panel data analysis we cannot distinguish such a case, but with quantile regression, it becomes possible to see that the effects of monetary policies have different impacts on firms. The coefficient of Sales is statistically significant at above 45th quantile supporting the case for cash flow except for 85th quantile.

Real exchange rate behaves very similar to the real interest rate. It is statistically significant below the 75th quantile. Beginning with 75th quantile it loses its statistical significance which means that firms which are investing aggressively does not value the real exchange

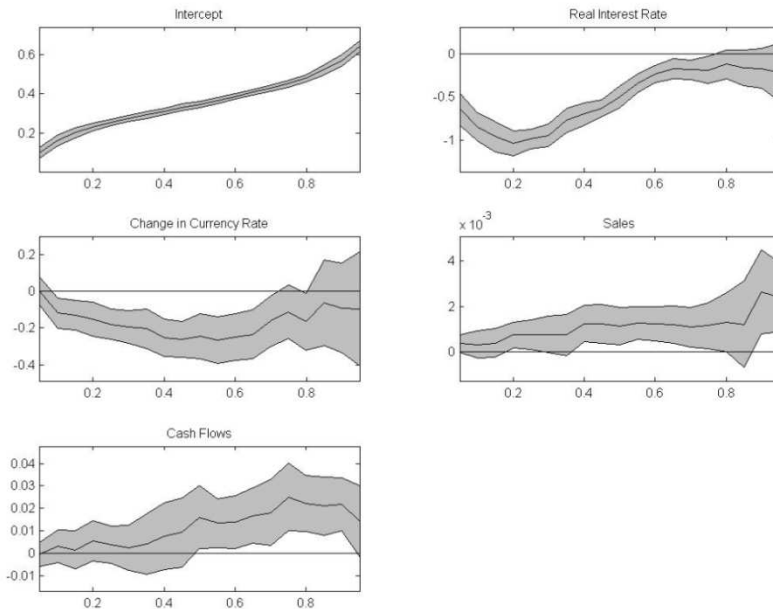
rate as it is expected. We can reach a conclusion that if a firm is financially constrained and investing aggressively, the only determinant of investment is cash flow. In Figure-1 the movements' of explanatory variables can be seen.

Table 3: Fixed-Effects Quantile Regression Estimation Results

Variables	Coefficients in different Quantiles								
	10%	25%	35%	45%	50%	65%	75%	85%	90%
Constant	0.164 (0.000)	0.254 (0.000)	0.293 (0.000)	0.331 (0.000)	0.346 (0.000)	0.407 (0.000)	0.451 0.000	0.523 0.000	0.567 0.000
Real Interest Rate	-0.854 (0.000)	-0.990 (0.000)	-0.771 (0.000)	-0.630 (0.000)	-0.495 (0.000)	-0.169 (0.017)	-0.186 0.052	-0.162 0.204	-0.168 0.224
Change in Real Exchange Rate	-0.120 (0.017)	-0.180 (0.000)	-0.205 (0.002)	-0.263 (0.000)	-0.246 (0.001)	-0.235 (0.004)	-0.112 0.208	-0.064 0.652	-0.091 0.541
Sales/Capital Stock	0.0003 (0.360)	0.001 (0.055)	0.001 (0.174)	0.001 (0.017)	0.001 (0.020)	0.001 (0.016)	0.001 0.057	0.001 0.289	0.003 0.018
Cash Flow/Capital Stock	0.003 (0.489)	0.004 (0.443)	0.004 (0.617)	0.009 (0.327)	0.016 (0.060)	0.017 (0.026)	0.025 0.006	0.021 0.007	0.022 0.003

Note: Figures in the parentheses indicate p values.

Figure 1: Fixed-Effect Quantile Regression



As mentioned in Wooldridge (2013) if unobserved heterogeneity is correlated with any explanatory variables, it is a convenient way to use a correlated random effects (CRE) model. The CRE models lead to simple, robust tests of correlation between heterogeneity and covariates. Also average partial effects can be identified by CRE models. Following Wooldridge (2013) we assume a simple linear relationship:

$$\beta_i = \alpha + \gamma \bar{Y}_i + r_i \tag{5}$$

where we assume that r_i is uncorrelated with each Y_{it} . Since \bar{Y}_i is a linear function of Y_{it} we can write:

$$\text{COV}(\bar{Y}_i, r_i) = 0 \tag{6}$$

Equation (5) and (6) together show that β_i and \bar{Y}_i are correlated if $\gamma \neq 0$. Together with (1) and (5) the following equation holds:

$$(I/K)_{i,t} = \alpha + \beta'_{\theta K} Y_{K,i,t} + \gamma \bar{Y}_i + r_i + z_{\theta i,t} \tag{7}$$

CRE quantile regression result of equation (7) is given in Table-4. As seen in Table-4, in correlated random effects quantile regression the movements and the signs of the coefficient are almost the same with the fixed effects model. The reel interest rate is insignificant beginning with the 75th quantile. The same explanations of fixed effects quantile regression are valid in CRE quantile regression. In CRE reel exchange rate is significant below the 85th quantile. One good news is that the coefficient of sales parameter is significant for all the quantiles and this is major a difference with FE quantile regression. Cash flow is significant above the 50th quantile in %10 confidence interval.

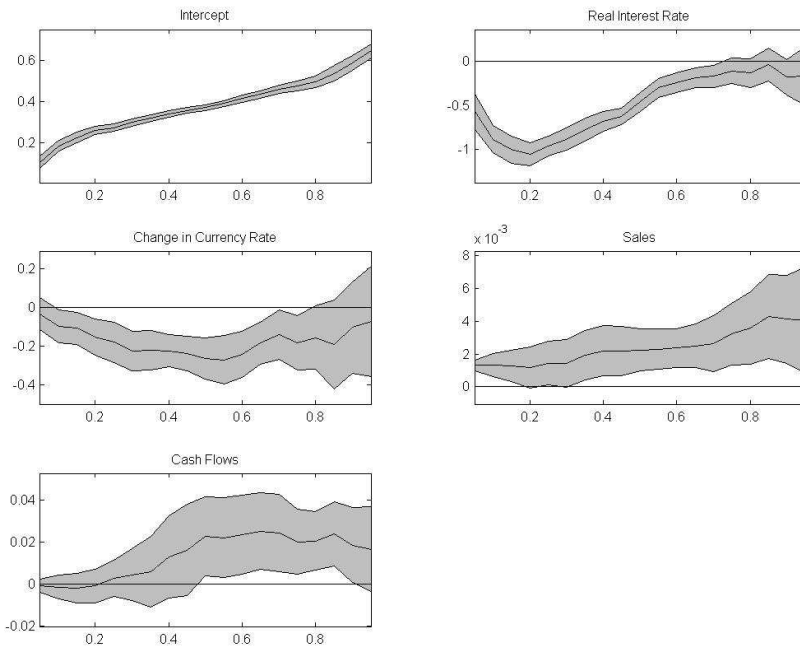
Table 4: Correlated Random Effects Quantile Regression Estimation Results

Variables	Coefficients in different Quantiles								
	10%	25%	35%	45%	50%	65%	75%	85%	90%
Constant	0.185 (0.000)	0.274 (0.000)	0.321 (0.000)	0.358 (0.000)	0.371 (0.000)	0.435 (0.000)	0.478 (0.000)	0.538 (0.000)	0.588 (0.000)
Real Interest Rate	-0.881 (0.000)	-0.956 (0.000)	-0.771 (0.000)	-0.621 (0.000)	-0.457 (0.000)	-0.186 (0.006)	-0.105 (0.234)	-0.035 (0.764)	-0.178 (0.146)
Change in Real Exchange Rate	-0.098 (0.060)	-0.180 (0.005)	-0.220 (0.000)	-0.238 (0.000)	-0.266 (0.000)	-0.185 (0.005)	-0.184 (0.030)	-0.191 (0.172)	-0.104 (0.469)
Sales/Capital Stock	0.001 (0.003)	0.001 (0.075)	0.002 (0.035)	0.002 (0.019)	0.002 (0.005)	0.003 (0.002)	0.003 (0.005)	0.004 (0.006)	0.004 (0.012)
Cash Flow/Capital Stock	-0.001 (0.673)	0.003 (0.605)	0.006 (0.557)	0.016 (0.223)	0.023 (0.045)	0.025 (0.022)	0.020 (0.034)	0.024 (0.010)	0.019 (0.084)

Note: Figures in the parentheses indicate p values.

The movements and behaviours of explanatory variables in Correlated Random Effect model are given in Figure 2. Figure 1 and Figure 2 provide a visual description of effect of each variable on investment.

Figure 2: Correlated Random Effects Quantile Regression



4. Conclusion

Same variables can have different effects on the levels of investments. While the classical regression approach gives the effect of the variables on the mean level of investment, a quantile regression approach provides more detailed effects. Our estimation results show that a variable has different effects on quantiles of investment. For that reason, a policy advice based on the classical regression results would probably produce an unsatisfactory result.

Another point of emphasis of this study is that for a firm having aggressive investments (the firm could be adopting a new technology, may make a change in production method or willing to target a different market in short term, may make a significant transformation in its production and commercial life) the impact of interest rates becomes meaningless and the internal funds are an extremely important determinant. Firm's limited finance as well as

the motivations listed above, may cause this result. Policy makers should develop their policy recommendations, stimulus packages etc. taking into account different quantiles, rather than putting forward policy suggestions depending on more general analysis.

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