The Effects of Market Structure on Uncertainty-Investment Relationship: Evidence from Turkish Manufacturing Industry[1]

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Abstract

The broad aim of this study is to examine the impact of uncertainty on investment in Turkey. Our particular aim is to test Caballero's (1991) theoretical claim that the negative relationship between investment and uncertainty is more pronounced in imperfectly competitive industries. With that aim in mind a panel of Turkish manufacturing industries for the years 1992-2001 is used to examine the effect of market structure on the investment-uncertainty relationship. Our estimation results show that uncertainty has a reductive effect on investment and that that effect becomes significantly stronger under imperfect competition conditions.

Keywords : Uncertainty, Investment, Market Structure, Turkish Manufacturing Industry, Dynamic Panel Data Methods.

JEL Classification Codes : E22, L60, L13, D81.

Öz

Bu çalışmanın genel amacı belirsizliğin yatırımlar üzerindeki etkilerini Türkiye için incelemektir. Özel amacımız ise Caballero (1991)'nun belirsizlik ile yatırım arasındaki negatif ilişkinin eksik rekabet koşullarında daha belirgin olacağı iddiasını test etmektir. Bu amaç doğrultusunda, belirsizlik-yatırım ilişkisinde piyasa yapısının etkisini inceleyebilmek için 1992-2001 dönemine ait Türk imalat sanayiinden elde edilen panel veriler kullanılmıştır. Sonuçlarımız belirsizliğin yatırımlar üzerinde azaltıcı etkisinin olduğunu ve bu azaltıcı etkinin eksik rakebet koşulları altında daha güçlü olduğunu göstermektedir.

Anahtar Sözcükler   :   Belirsizlik, Yatırım, Piyasa Yapısı, Türk İmalat Sanayii, Dinamik Panel Veri Yöntemi.

1. Introduction

Earlier modern investment theories have shown that increased uncertainty can raise investments under the assumption of constant returns to scale and perfect competition. On the other hand, according to the real options theory, which is based on the irreversible feature of investments and perfectly competitive markets, uncertainty can reduce investments. However, Caballero (1991) has shown that the positive relationship between uncertainty and investment may turn out to be negative only under imperfect competition conditions and/or decreasing returns to scale.

Empirical analyses of the effects of uncertainty on investment have also attracted considerable interest, but the evidence from these studies is mixed. Among these studies Bulan (2005), Henley et al. (2003), Böhm et al. (2000) and Guiso and Parigi (1999) support the results of Caballero (1991); uncertainty decreases investments under imperfect market conditions. On the other hand, Ghosal and Loungani (1996) and Maioli (2005) show that under imperfect competition the impact of uncertainty on investment is indeterminate.

The main aim of the paper is to provide an empirical analysis of the impact of price uncertainty on investment under different market structures by using panel data for Turkish manufacturing industries. A panel of four digit Turkish manufacturing industries for the years 1992-2001 is used to examine the relationship between uncertainty and investment. In order to analyze the impact of uncertainty on investment, price uncertainty is measured by using the standard deviation method and then an investment equation including the price uncertainty among all other variables is estimated by using the system GMM method. Our model focuses on the investment-uncertainty relation while taking into account the effect of market structure and the irreversibility feature of investment.

Although there already exists some studies investigating the effect of uncertainty on investment in Turkey, to the best of our knowledge this study represents the first to examine the impact of market structure on the investment-uncertainty relation for Turkey. In that sense, unlike the other empirical studies, it is also the first study that provides a test of Caballero's (1991) hypothesis for a developing country.

This paper is organized as follows. Part 2 provides a brief account of the theoretical and empirical literature on the uncertainty-investment relation with special reference to market structure. Trend of investment as well as uncertainty level, as proxied by price uncertainty, and market structure in Turkish manufacturing industry are briefly evaluated in Part 3. Data, methodology and the empirical model of the study are presented in Part 4. In part 5, we use a panel of Turkish manufacturing industries for the years 1992-2001 to examine the effect of market structure on the investment-uncertainty relationship. Our findings for the econometric estimates of different investment equations are presented in this

section. The last section concludes the analysis and evaluates our empirical results from a policy perspective.

2. Investment, Uncertainty and Market Structure

Traditional investment theories such as Fisher's, Jorgenson's, Tobin's models, and even Keynes's investment theory ignore the effects of uncertainty on investment as well as the irreversibility feature of investment. Modern investment theories which analyze systematically the effect of uncertainty on a firm's investment decisions were initially developed by Hartman (1972) and Abel (1983). These studies showed that greater uncertainty can increase the investment of a risk-neutral competitive firm. Under the assumption of constant returns to scale and the marginal revenue product of capital is a convex function of the price, they have shown that greater uncertainty increases investment by raising the marginal value of one additional unit of capital.

Another strand of modern investment theories focuses on the irreversibility feature of investment. Real options theory developed by Bernanke (1983), Dixit and Pindyck (1994), McDonald and Siegel (1986) and Pindyck (1988) suggests that uncertainty over future demand has a negative effect on investment. According to real options theory, firms delay their investment decisions due to the high cost of waiting and this cost increases with uncertainty. Therefore, increased uncertainty reduces current investment.[3]

Although irreversibility is an important variable in the investment-uncertainty relationship, it is not the sole determinant of this relationship. Other factors such as competition level, availability of credit markets, attitude towards risk, returns to scale and firm size are also influential in this relationship.[4] As far as the relationship between competition level and uncertainty is concerned, Abel and Eberly (1994) have shown that, as long as perfect competition is valid, uncertainty has a nonnegative effect on investment even when irreversibility exists. Another study, Caballero (1991) which also focuses on the competition level asserts that the positive relationship between uncertainty and investment may turn to be negative under imperfect competition conditions. According to Caballero (1991), the competition level in the product markets plays a key role in the uncertainty investment relationship. In the perfect competition case, the uncertainty investment relationship may be positive or less negative relative to the imperfect competition case. The intuition behind this conclusion is that a firm that operates in the competitive conditions does

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[3] *See Carruth et al. (2000) for detailed evaluation of theoretical and empirical literature on the uncertainty-investment relationship.*

[4] *Guiso and Parigi (1999), Temple et al. (2001) and Lensink et al. (2005) analyze the importance of the availability of credit markets, Nickell (1978) and Zaira (1990) examine firm's attitude towards risk, Lensink et al. (2000), Ghosal and Loungani (2000), Joaquin and Khanna (2001), Lensink et al. (2001), Bulan (2005) and Lensink et al. (2005) analyze the role of firm size on the investment-uncertainty relation. Since our study focuses on the uncertainty-investment relation within the context of market structure, the results of these studies are not presented here.*

not have a chance to wait because of the pressure to invest before their rivals. Therefore, competition may lessen the negative effects of uncertainty or turn the relationship positive. However imperfect competition may strengthen the negative effect of uncertainty on investment. Since a monopolistic firm has an opportunity to decide about the timing of the investment, investment decisions can easily be postponed in the case of uncertainty. The same argument is valid for oligopolistic firms. In short, imperfect competition conditions may turn the uncertainty investment relationship negative (Abel & Eberly, 1994; Lambrecht & Perraudin, 2003; Ninh, 2003).

Although a large number of theoretical and empirical studies have examined the relationship between uncertainty and investment, the numbers of empirical studies that have explored the impact of market structure on the uncertainty-investment relationship are limited. Ghosal and Loungani (1996) find that the negative relationship between investment and uncertainty is more pronounced in more competitive industries. They find that uncertainty has no effect on current investment if all industries are taken together. But when industries are classified as competitive and non-competitive industries, it is concluded that uncertainty has a negative and significant impact on highly competitive industries' investment. On the other hand uncertainty has a smaller impact on investment for non-competitive industries. However this effect is not statistically significant.

By using industry level data from a panel of French two digit manufacturing industries and Herfindhal index as a proxy for competition, Maioli (2005) obtained similar results to Ghosal and Loungani (1996). She found that uncertainty has a negative and highly significant effect on investment. However, when the irreversibility and market structure are taken into account simultaneously, the reductive effect of uncertainty decreases in imperfectly competitive industries. According to these two studies, under imperfect competition the impact of uncertainty on investment is indeterminate. The net effect of uncertainty depends both on the irreversibility and the strategic interaction among firms in the industry (Ghosal & Loungani, 1996; 217). Atella et al. (2003) examine the effect of exchange rate volatility on investment for the period 1989-1994 by using Italian manufacturing firms' data. Their results can be summarized as follows: (i) exchange rate fluctuations reduce investment, particularly through imported inputs; (ii) The effect of volatility on investment is purely linked to monopoly power, but it depends on the kind of sector.

On the other hand Guiso and Parigi (1999), Böhm et al. (2000), Henley et al. (2003) and Bulan (2005) support the theoretical claim of Caballero (1991). Guiso and Parigi (1999) investigate the impact of uncertainty on investment using a sample of Italian manufacturing firms. They find that the negative effect of uncertainty is stronger for firms which have considerable market power. Based on a German panel data set and standard deviation, and using the GARCH method to measure uncertainty, Böhm et al. (2000) conclude that there is a negative effect of uncertainty on investment and that that negative effect is closely related to degree of market competition. Henley et al. (2003) investigate the impact of uncertainty on investment using both firm and industry data. While firm specific uncertainty has a positive effect on fixed investment, industry wide uncertainty depresses investment. This

negative effect is stronger in the more concentrated markets. Bulan (2005) arrive at similar results to the above mentioned studies by using a firm-level panel data set for the US economy, and by using volatility of firm's equity returns as the uncertainty measure. As a result one can say that the majority of the studies focusing on the uncertainty-investment relationship within the context of market structure conclude that the reductive effect of uncertainty is more pronounced in imperfectly competitive industries. An important characteristic of these studies is that they mainly focus on industrialized countries. With that in mind, the main purpose of this study is to examine the impact of market structure on the investment-uncertainty relation for the Turkish case. To the best of our knowledge this represents the first study to examine the impact of market structure on the investment-uncertainty relation for Turkey.[5] At the same time, this study also provides a test of the Caballero's (1991) hypothesis for a developing country case.

3. Investment, Uncertainty and Competition in Turkish Manufacturing Industry
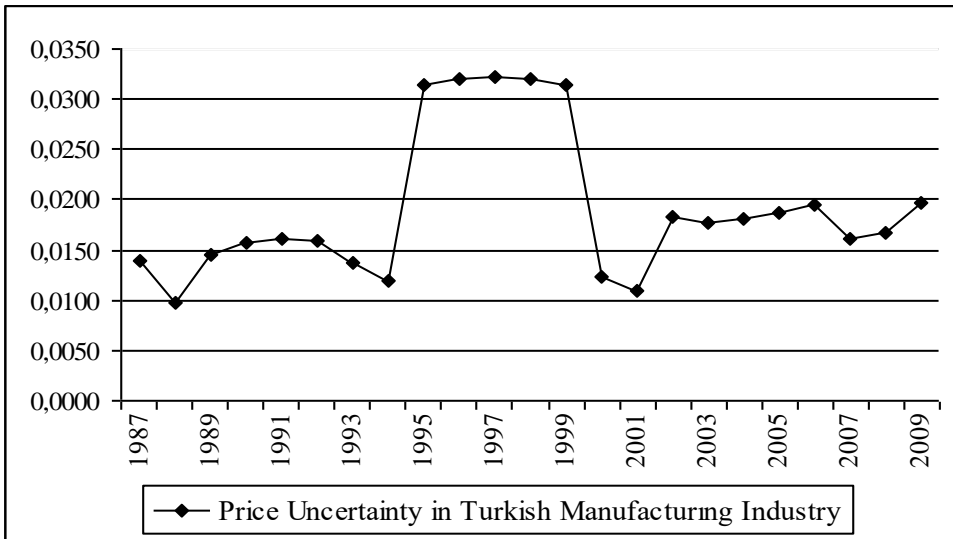
An inward looking development strategy in Turkey was replaced with an outward looking and export oriented strategy after 1980. This transformation in the Turkish economy has affected both the level and structure of investments in Turkey. The ratio of total fixed investment to GDP declined from 22 per cent in 1979 to 17 per cent in 2001 (State Planning Organization, SPO). There was also a decrease in the average growth rate of total fixed investment after the 1980s. While the average rate of growth of total fixed investment was 8.6% between the years 1948-1979, it was only 2.7% after 1980 (SPO, 2010). Share of manufacturing investment in total investment fluctuated to a great extent during the years 1963-2005, and decreased after the 1980s. Therefore, it can be said that another important feature of investment in this period is the change in the composition of investment away from manufacturing industry investment. Although the average share of manufacturing investment was 35% between the years 1975-1979, this share decreased to 20% during the years 2000-2003.

Our study time period, 1992-2001, was also subject to economic and political crises. The Turkish economy suffered from severe economic crises in 1994, 1997 and 2001. In addition, an increase in political instability during this time period also contributed to rise in uncertainty. Another important factor that increased the price uncertainty was a high inflation rate during this period of time. The average inflation rate was 70 per cent during the 1992-2001 period.

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[5] *Conway (1991), Uygur (2000), Ozatay (1997), Guncavdi and Mckays (2003), Erdal (2001), and Sile (2003) are the studies, among others, that examine the effect of uncertainty on investment in Turkey. Although the earlier studies examine this relationship at the macro level, more recent studies are at industry level. The majority of the studies reach the conclusion that uncertainty has a negative impact on investment in Turkey.*

In order to answer the question whether price uncertainty increased during our study time period, we measured the price uncertainly for the years 1987-2009. Figure 1 plots the price uncertainty variables for the years, 1987-2009.

Figure: 1
Price Uncertainty in Turkish Manufacturing Industry, 1987-2009

Source: based on authors' calculations.

Figure 1 shows that price uncertainty fluctuated to a great extent during this time period and increased sharply during economic crises years. It increased at to a considerable degree during economic crisis of 1994 and this high uncertainty continued up to 1999. It started to escalate again after economic crisis of 2001.

As far as the market structure of the manufacturing industry is concerned, one can say that the Turkish manufacturing industry exhibits an imperfectly competitive market structure. In year 2000, the concentration ratio was very high in 23 manufacturing industry sectors (CR4≥70%), 16 sectors had a high concentration ratio (50% ≤CR4≤ 70%), 25 sectors were characterized by a medium concentration ratio (30% ≤CR4 ≤ 50%) and 20 sectors had low concentration ratios (CR4<%30). The average concentration ratio (CR4) was 51% percent in 1981, 55% in 1985, 56 % in 1990, 57% in 2001, and 54 % in 2006 (TurkStat, 2010). These figures point out two facts. More than half of the industries exceed the critical level of concentration and the market structure of the manufacturing industry has not changed drastically since 1980s.

While the factual evidence on the pattern of investment and price uncertainty shows the fluctuations in the manufacturing investment and increased price uncertainty during the

study period, empirical analysis is needed to clarify the impact on uncertainty on the manufacturing industry. This analysis is also important when we take into account the imperfectly competitive structure of Turkish manufacturing industry.

4. Data, Methodology and Empirical Model of the Study

The analyses in this study are based on the data from the Annual Manufacturing Industry Surveys collected by TURKSTAT (Turkish Statistical Institute). Annual Manufacturing industry Surveys are collected from approximateley 11.000 firms that employs more than 25 labor. Our sample is unbalanced panel. It includes both public and private firms. Even though 86 industries are listed in ISIC REV 2 four digit level, it was only possible to construct the whole data set for all variables for 60 industries. Manufacturing industry data is based on ISIC REV 2 classification covering the years 1992-2001. The data limitations do not allow us to use more recent time period. There is a significant problem on transformations of industry classifications between ISIC REV 2 and ISIC REV 3 that is used after the year 2001. Although there is a time period problem, 1992-2001 period is important since there was high inflation and price uncertainty during this period. The main priority of the new government after 2001 was to combat high inflation. Accordingly inflation reduced to single digits, volatility of prices decreased and, therefore, price uncertainty decreased after 2001. Additionally, there has been no dramatic change in the imperfectly competitive structure of Turkish manufacturing industry after year 2001. In year 2010, the concentration ratio was still very high or at least high in 104 out of 224 sectors.

The broad aim of this study is to examine the impact of uncertainty on investment in Turkey. Our particular aim is to test the theoretical claim that the negative relationship between investment and uncertainty is more pronounced in noncompetitive industries. Following Ghosal and Loungani (1996), equation (1) is used as a baseline equation to estimate the relationship between uncertainty and investment. The investment model in equation (1) is an accelerator model extended by including an uncertainty variable.

$$\left(\frac{I}{K}\right)_{it} = \alpha + \beta_1 UNCER_{it} + \beta_2 \left(\frac{S}{K}\right)_{it} + \beta_3 CU_{it} + \beta_4 \left(\frac{I}{K}\right)_{i,t-1} + u_{it} \tag{1}$$

Consistent with the empirical literature on investment our dependent variable, investment, is defined as the ratio of investment to capital stock (Lensink and Sterken, 2000; Ghosal and Loungani, 1996, 2000 and Maioli, 2005). Investment and capital stock data are obtained from *Annual Manufacturing Industry Statistics*, provided by TurkStat (2010) and Taymaz et al. (2008) respectively and deflated by using sectoral price indices.

Price uncertainty is chosen as a measure of uncertainty in our study because the period of our study, 1992-2001 was subject to a high price increases and therefore volatility of prices was substantial during this time period. At the same time this uncertainty variable is consistent with other seminal theoretical studies (Hartman, 1972; Abel, 1983; Dixit & Pindyck, 1994). As was noted in the previous section, even though the theoretical literature

on investment is inconclusive about the sign of the uncertainty effect on investment, the majority of empirical studies on this issue conclude that uncertainty has a negative impact on investment.

Uncertainty variable, $UNCER_{it}$ denotes price uncertainty is calculated by using the standard deviation model based on equation (2). That method assumes that firms use the information on previous year's prices to forecast the current year price (Ghosal and Loungani, 1996; Maioli, 2005). Within this context, it is assumed that firms forecast prices based on the second order autoregressive model in equation (2).

$$p_{it} = a_0 + a_1 t + a_2 p_{i,t-1} + a_3 p_{i,t-2} + u_{i,t} \qquad (2)$$

In this equation p_{it} shows the logarithm of industry product price and t shows the linear trend. The standard deviation of the residuals obtained from equation (2) is used as a measure of uncertainty. Following, Ghosal and Loungani (1996) and Maioli (2005) the rolling regression method is employed to measure uncertainty. The Wholesale Price Index at industry level, obtained from Turkish Statistical Institute (TurkStat, 2010), is used for the calculation of price uncertainty.

In the literature, different variables are used as a proxy for the accelerator effect. In this study, we follow Ghosal and Loungani (1996) by using ratio of industrial sales to capital stock (S/K) as the proxy for the accelerator effect. Lagged value of the industrial sales to capital stock is used in the equation and the expected sign of this variable is positive.

In order to capture economy wide influences on investment we follow Price (1995, 1996), Bell and Campa (1997), Driver et al. (2004), Ghosal and Loungani (1996), and Temple et al. (2001) by using capacity utilization ratio (CU) as an indicator of investment environment. Lagged value of the capacity utilization is used in the equation and since capacity utilization increases during recovery times, that variable is expected to have a positive influence on investment. Capacity utilization and sales data at industry level are obtained from TurkStat (2010).

Lagged value of investment expenditure (I/K)$_{i,t-1}$ are also employed as an explanatory variable in the equation so as to reflect the dynamic nature of the investment variable (see also Calcagnini & Saltari, 2000; Serven, 1998, 2003; Ghosal & Loungani, 1996, 2000; Price, 1995, 1996; Henley et al., 2003). The expected sign of this variable is positive.

Since the main aim of this study is to analyze the impact of uncertainty on investment while taking into account the market structure, a measure of the extent of competition in product market is also needed. With that in mind, a dummy variable is constructed that takes

the value 1 if the four-firm concentration ratio (CR4) is over 75% and 0 otherwise.[6] Additionally, in order to differentiate the impact of uncertainty under different market structures, the manufacturing industries are also divided into competitive and noncompetitive industries and investment equations are estimated for these two groups of industries.

To explore the empirical relation between uncertainty and investment, the system GMM estimation method is used due to the dynamic characteristics of the investment equation (1). To estimate dynamic equation like equation (1) by using panel data difference GMM estimator proposed by Arellano and Bond (1991) is typically used. In order to test the validity of selected instruments we also applied two diagnostic tests. Namely, the test for second or higher order autocorrelation and Hansen test for correlation between instruments and the error term. An unbalanced panel of 60 Turkish manufacturing industry sectors for the years 1992-2001 is used to estimate the investment equation in (1).[7]

5. Estimation Results

In order to examine the impact of uncertainty on investment in Turkey two sets of regressions are estimated. The first set of regressions is the base line regressions focusing on the investment-uncertainty relation while taking into account the effect of market structure and the irreversibility feature of investment (Table 1). The second sets of regressions are presented as alternative investment equations to test the effect of market structure on the investment-uncertainty relation. That is achieved by, following Maioli, including interaction terms in equation (1) (Table 2). Table 1 shows the estimation results obtained by using the system GMM for the investment model of equation (1). Three different estimation results are presented in the Table 1.[8] Column (1) of Table 1 shows the results of our main investment equation estimation result (Equation 1). The coefficient of the price uncertainty variable (-0.8934) is statistically significant and shows that uncertainty variable has a negative effect on investment. This result supports the claim that uncertainty leads to lower investment. Sales, capacity utilization ratio and lagged value of investment variables carry the expected sign and they are all statistically significant.

In addition to model 1, the investment model in the Column (2) investigates the effect of market structure on investment by using dummy variable (*DUMCR4*). *DUMCR4* takes the value of 1 if the industry CR4 has a higher value than 75% *DUMCR4*, otherwise it takes the value of 0. According to the Model 2, *DUMCR4* is statistically significant and has a negative effect on investment. The reductive effect of uncertainty on investment increases

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[6]   *Maioli (2005) also defined an industry as concentrated if the average value of the HHI was lying at or above the 75th percentile or the top 25th percentile (Maioli, 2005: 27).*

[7]   *It is not possible to extend the period of study beyond 2001 since there is no data available after 2001 consistent with the previous years due the changes in the classification system of manufacturing industry data.*

[8]   *The estimations were carried out in Stata.*

after the introduction of the market structure variable. This result shows that investments decrease in highly concentrated markets.

As a next step, in order to control for the effect of irreversibility on investment, (following Maioli, 2005) we use the ratio of investment on machinery and equipment to total investment as a proxy for irreversibility and then we constructed the *DUMIRREV* variable which takes the value of 1 if industry has an irreversibility ratio that is in the top 25th percentile and zero otherwise. Column (3) of Table 1 shows the effects of irreversibility on investment. Although the sign of the irreversibility variable *(DUMIRREV)* is negative, this variable is not statistically significant. On the other hand after we introduce the irreversibility variable into the model, the sign of the *UNCER* variable does not change and the value of this variable is even higher than the value of the same variable in other models in Table 1.[9]

The increase in the coefficient of the uncertainty variable after the introduction of variables representing the market structure and irreversibility of investment suggests the possibility that those two variables might have an indirect effect on investment via uncertainty. In order to explore that possibility, equation (1) is estimated by using the interaction terms between uncertainty and irreversibility as well as uncertainty and market structure.

Table: 1
The Effects of Uncertainty on Investment

Equation	Model 1	Model 2	Model 3
(Dependent variable= *I/K*)			
Constant	0.0659*	0.0768***	0.0453
	(0.038)	(0.038)	(0.030)
UNCER	-0.8934**	-0.9359**	-1.1126**
	(0.439)	(0.439)	(0.447)
$\left(\frac{S}{K}\right)_{t-1}$	0.0039*	0.0040*	0.0047**
	(0.002)	(0.002)	(0.002)
CU_{t-1}	0.0007*	0.0006*	0.0007*
	(0.0002)	(0.0002)	(0.0002)
$\left(\frac{I}{K}\right)_{t-1}$	0.0982**	0.0951*	0.1095**
	(0.050)	(0.050)	(0.050)
DUMCR4		-0.0162**	
		(0.008)	
DUMIRREV			-0.0019
			(0.005)
Wald stat. (*p*-value)	0.000	0.000	0.000
Hansen Test (*p*-value)	0.423	0.416	0.441
1. AC (*p*-value)	0.001	0.002	0.000
2. AC (*p*-value)	0.614	0.717	0.795
Number of Obs.	531	531	523

*, ** and *** denote statistical significance at the 1%, 5% and 10% levels, respectively.*
Standard errors are in parenthesis.

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[9] *In order to reflect the effect of economic crises, dummy variables for the crisis years of 1994, 2000 and 2001 are included in all models in Table 1. Sign of the coefficient of dummy variables are negative and statistically significant.*

Table 2 presents the estimation results when the effects of irreversibility and market structure on investment are introduced by using interaction terms. There are four different models in the Table 2. Firstly, in order to test the role of irreversibility on the relationship between investment and uncertainty, we introduced an interaction term (*UNCER*DUMIRREV*) in the main investment equation.

$$\left(\frac{I}{K}\right)_{it} = \alpha + \beta_1 UNCER_{it} + \beta_2 \left(\frac{S}{K}\right)_{it} + \beta_3 CU_{it} + \beta_4 \left(\frac{I}{K}\right)_{i,t-1}$$
$$+ \beta_5 UNCER * DUMIRREV_{it} + u_{it} \tag{3}$$

In equation (3), β_5 represents the marginal effect of a change in uncertainty on investment for the most irreversible industries and $\beta_1 + \beta_5$ represents the total impact of a change in uncertainty on investment for such industries (Maioli, 2005:30).The reductive effect of uncertainty on investment is increasing with the increase in irreversibility when $\beta_1 < 0$ and $\beta_5 < 0$.

On the other hand, according to Caballero (1991) the higher degree of concentration (low competition) accentuates the negative relationship between investment and uncertainty. To explore the effects of market structure the relationship between investment and uncertainty, the main investment equation is estimated by introducing another interaction term (*UNCER*DUMCR4*).

$$\left(\frac{I}{K}\right)_{it} = \alpha + \beta_1 UNCER_{it} + \beta_2 \left(\frac{S}{K}\right)_{it} + \beta_3 CU_{it} + \beta_4 \left(\frac{I}{K}\right)_{i,t-1}$$
$$+ \beta_6 UNCER * DUMCR4_{it} + u_{it} \tag{4}$$

The reductive effect of uncertainty on investment is increasing with an increase in the concentration level when $\beta_1 < 0$ and $\beta_6 < 0$. In this case, we can conclude that the sensitivity of investment to uncertainty is higher in noncompetitive industries than competitive industries (Maioli, 2005: 27).

Finally, in order to find out the effects of irreversibility and market structure on uncertainty-investment relationship simultaneously we introduce another interaction term (*INT3=UNCER*DUMCR4*DUMIRREV*). In all models of Table 2, uncertainty has significantly negative effect on investment. Sales, capacity utilization ratio and lagged value of investment are statistically significant and have the expected signs. Column (1) of Table 2 shows that coefficient of *UNCER*DUMIRREV* is statistically insignificant and, irreversibility has no effect on the uncertainty-investment relationship. This result is consistent with the other results obtained in the models given in the Table 1 where irreversibility is found to have no effect on investment in different models. On the other hand *UNCER*DUMCR4* is significant and has a negative sign (Column 2 of Table 2). This result together with the negative coefficient of the uncertainty variable in the same equation provides evidence that the reductive effect of uncertainty on investment becomes even

stronger under imperfect competition conditions. The simultaneous introduction of both interaction terms (column 3) did not change the results obtained in Model 1 and Model 2. The effect of uncertainty on investment in the case of the simultaneous presence of irreversibility and uncertainty is tested with the introduction of the interaction term (*UNCER*DUMCR4*DUMIRREV*) (Column 4). Since the negative coefficient of this variable is statistically significant, one can conclude that simultaneous presence of irreversibility and uncertainty increases the negative effect of uncertainty on investment. This result also shows that, for the Turkish case, irreversibility by itself is not one of main determinants of investment for all industries concerned, but it does influence investment behavior in imperfectly competitive industries.[10]

Table: 2
The Effects of Irreversibility and Market Structure on Uncertainty-Investment Relation

Equation	(Dependent variable= *I/K*)			
	Model 1	Model 2	Model 3	Model 4
Constant	0.0517** (0.021)	0.0721*** (0.015)	0.0822*** (0.0165)	0.0525* (0.021)
UNCER	-0.8956** (0.454)	-0.6668*** (0.135)	-0.4780** (0.278)	-1.1383** (0.261)
$\left(\dfrac{S}{K}\right)_{t-1}$	0.0038* (0.002)	0.0043 (0.004)	0.0043 (0.004)	0.0047** (0.003)
CU_{t-1}	0.0007** (0.0002)	0.0004** (0.0001)	0.0005** (0.0002)	0.0006 (0.0004)
$\left(\dfrac{I}{K}\right)_{t-1}$	0.0974* (0.050)	0.1159*** (0.017)	0.1157*** (0.019)	0.1071** (0.018)
INT1 (UNCER*DUMIRREV)	0.0140 (0.116)		0.0194 (0.053)	
INT2 (UNCER*DUMCR4)		-0.3117** (0.137)	-0.3361** (0.138)	
INT3 (UNCER*DUMCR4*DUMIRREV)				-0.4746* (3.508)
Wald stat. (*p*-value)	0.000	0.000	0.000	0.000
Hansen Test (*p*-value)	0.421	0.310	0.394	0.497
1. AC (*p*-value)	0.001	0.001	0.002	0.001
2. AC (*p*-value)	0.613	0.691	0.708	0.719
Number of Obs.	531	531	523	523

*, ** and *** denote statistical significance at the 1%, 5% and 10% levels, respectively. Standard errors are in parenthesis.

[10] *In order to ensure the robustness of our findings on the effect of market structure on the uncertainty-investment relation, we applied an alternative method. Following Ghosal and Loungani (1996) we divide the sample into two subgroups based on competition level (low competition industries CR4>50 and high competition industries CR4≤50) and equation (1) is estimated for these two different groups. We found that uncertainty has a reductive and significant effect on investment for these two groups, however this negative effect is higher amongst less competitive industries. The coefficient of uncertainty is -0.9281 for less competitive industries, and -0.3075 for more competitive industries. These findings are consistent with the results of the Caballero (1991), Guiso and Parigi (1999), Böhm et al. (2000), Bulan (2005) and Henley et al. (2003).*

6. Conclusion and Policy Implications

There is an extensive and rich body of research that focuses on the effects of uncertainty on investment. After the influential study of Hartman (1972) and Abel (1983), a sizeable number of theoretical studies have examined the uncertainty-investment relation with special reference to the irreversibility feature of investment as well as market structure. Parallel to the increase in the number of theoretical studies, empirical research on the uncertainty-investment relation with special focus on the impact of market structure have garnered substantial interest in recent years.

The general aim of this study has been to examine the impact of uncertainty on investment in Turkey. The specific aim has been to test the impact of market structure on the investment-uncertainty relation while taking into account the irreversibility feature of investment in the Turkish case. This also provides a test of Caballero (1991)'s hypothesis that the negative relationship between investment and uncertainty is more prominent in noncompetitive industries. We have used a panel of Turkish manufacturing industries for the period 1992-2001 to estimate the impact of uncertainty on investment in Turkey. Our estimation results show that uncertainty has a reductive effect on investment. This result is robust for different investment models estimations that take into account the irreversibility features of investment as well as the investment behavior in different market structures.

As far as the impact of market structure on the uncertainty-investment relation is concerned, the result of this study supports the findings of Caballero (1991): the negative effect of uncertainty on investment becomes significantly stronger under imperfect competition conditions. Our first group of estimations results shows that a proxy for market structure (*DUMCR4)* has a negative and statistically significant effect on investment. This result shows that investments decrease in markets with a high concentration ratio. Regression results obtained from the investment model where interaction terms are included to reflect the difference in market structure provide evidence in support of the claim that the negative effect of uncertainty on investment becomes stronger under imperfect competition conditions in the Turkish case. More explicit evidence for this hypothesis is provided by the estimation results for the two different groups of industries; namely, more competitive and less competitive industries. Estimation results show that uncertainty has a more reductive effect on investment in less competitive industries in Turkey. Another important result of the study is that irreversibility by itself is found to have no effect on investment in all industries, but it does influence investment behavior in imperfectly competitive industries. Our results also indicate that high uncertainty has negative effect on the investment of firms especially operating in imperfectly competitive industries.

Since our study shows that price uncertainty is detrimental to investment and this effect is more prominent in imperfectly competitive industries, one can conclude that price uncertainty effects both resource allocation and sectoral reallocation of investment among industries because of the differing sensitivity of competitive and noncompetitive industries' investment to price uncertainty. Therefore, the main policy implication of our findings is that macroeconomic policies emphasizing price stability will help to boost investments in

Turkey. Within this context, a commitment by the Central Bank to price stability and a stable monetary policy are important tools for increasing investment and, thereby, the productive capacity of Turkey. Similarly, in order to reduce price uncertainty, measures to increase the structural stability in the Turkish economy should be the primary aim of the macroeconomic policy.

In addition to these macro level policy implications, our empirical findings also point to the importance of redesigning competition policy in Turkey so as to decrease the imperfect competition conditions. In the same vein, policies that facilitate entry and exit should be promoted. For example, regulatory barriers to small entrants should be removed wherever possible (Bailey, 1981: 181). Within this context, in order to decrease the negative effect of imperfect comptetitive sturcture on investment, effective competition law policy needs to be implemented.

On the other hand, since the study also shows that the simultaneous presence of irreversibility and uncertainty increases the negative effect of uncertainty on investment, policies aimed at decreasing the level of irreversibility of investment will also help to increase investment in Turkey. Measures to handle sunk cost problems, such as encouragement of technical changes that replace technologies involving large sunk costs with technologies that offer more opportunity for mobility or shared use or the absorption of the sunk cost by the government or municipality (Bailey, 1981: 179, 182), will help to reduce level of sunk costs. Similarly, in order to decrease the sunk cost, encouragement of the leasing market as well as the establishment of the active second-hand market for capital (Kessides, 1990: 612) represent important policy measures for Turkey.

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