Asian Academy of Management Journal, Vol. 23, No. 1, 101–115, 2018

PROFIT, OUTPUT MARKET UNCERTAINTY, AND CORPORATE INVESTMENT: EVIDENCE FROM VIETNAM

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Published online: 29 June 2018

To cite this article: Le, K.N., Huynh, H.T., and Tu, P.A. (2018). Profit, output market uncertainty, and corporate investment: Evidence from Vietnam. *Asian Academy of Management Journal*, *23*(1), 101–115. https://doi.org/10.21315/aamj2018.23.1.5

To link to this article: https://doi.org/10.21315/aamj2018.23.1.5

ABSTRACT

This paper empirically investigates how the variation of profits affects the relationship between the degree of output market uncertainty and firm investment. Using a primary dataset of 667 firms randomly selected in Vietnam, the empirical results indicate that higher profits mitigate the negative impact of the degree of output market uncertainty on investment by those firms. Specifically, as profits go beyond a certain benchmark, output market uncertainty even triggers investment. Given the results, this paper proposes recommendations that enable firms to make better investment decisions, thereby avoiding over-investment that may lead to debt burden (even bankruptcy) as output markets somehow turn worse. More importantly, the implication of this paper is to help the government devise better policies for moderating competition, containing monopoly, and mitigating corruption.

Keywords: investment, irreversibility, profit, Vietnam, uncertainty

INTRODUCTION

Investment is key to firm establishment and growth. Making wise investment decisions will contribute to improving performance, therefore helping firms grow fast. Mistakes in making investment decisions that lead to over-investment will confront firms with hardships due to output market uncertainty, among others.

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Over-investment may occur as prior investments have brought about high profits, inducing firm to invest more regardless of output market uncertainty (Lin, Hu, & Chen, 2005; Aggarwal & Samwick, 2006; Deltas, 2006; Pinheiro, 2008; Fu, 2010; Liu & Jiang, 2012). Thus, if output markets go down (for instance, as a result of economic crisis), firms may go bankrupt because of being unable to sell out products as a consequence of over-investment. This episode seems to be prevalent as to firms in Vietnam but few studies have dealt with it.

Vietnam is considered as an institutionally weak transition economy where the government still maintains a tight grip on the economy, especially regarding bank loans, business formation, investment magnitude, and finance (De Jong, Tu, & van Ees, 2012). In such a context, building close relationships (network) with government officials is crucial since it helps firms tackle constraints imposed by bureaucratic procedures, obtain investment (business) licenses, and win contracts, thereby improving performance. Then, bribery can be regarded as an inevitable investment of firms (Peng & Heath, 1996).

The aim of this paper is to examine the impact of profits on the relationship between output market uncertainty and investment by firms in Vietnam, using a primary data set of 667 firms randomly selected from the Mekong River Delta of this country. Findings of this paper shed further light on investment decisions of firms under output market uncertainty and give recommendations for firm managers to make good investments in order to improve performance and boost growth.

LITERATURE REVIEW AND EMPIRICAL MODEL

Capital is an indispensable factor to firm investment since investment depends primarily on the capital that firms have. Jorgenson (1963) assumes that capital markets are perfect, so using either internal or external funds make no difference for firms. In fact, capital market is basically imperfect due to asymmetric information between borrowers and lenders that results in default risk, among others. Hence, to minimise that risk, credit institutions eventually ration credit after raising interest rates up to a reasonable level, as pointed out by Stiglitz and Weiss (1981). If that is the case, firm investment should depend on internal funds, mainly profits (Guariglia, 2008; Engel & Middendorf, 2009).

Meanwhile, when making investment decisions, firm managers do face output market uncertainty because of being unable to know the exact future sales. Market uncertainty stems from the skill of firm managers in terms of gathering relevant

information. As time elapses, new information arrives and firm managers take it into account to adjust activities, including investment decisions, so as to make use the most of the socio-economic condition that constantly changes, for instance due to the sovereign cost of borrowing embedded in government bonds (Dergiades, Milas, & Panagiotidis, 2015). Indeed, as government bond yields hike up, the country will face a burden if having borrowed in international markets, and its ability to roll existing debt over at low cost is in fact squeezed. The fact that the country has to roll its debt over at high interest rates is detrimental to its fiscal prospect, making default more likely and the socio-economic condition more unstable.

Such a situation induces Credit Rating Agencies (CRAs) to downgrade the debt rating of the country or assign an increased probability of its default on debt obligations, implying higher borrowing costs in international markets (Boumparis, Milas, & Panagiotidis, 2017). Since both corporate and sovereign debts are subject to the same country-specific macroeconomic risk factors, international creditors would handle their overall exposure to the country irrespective of whether lending is channelled to the public or to the private sector. Consequently, a rise in government debt pushes corporate borrowing costs higher for firms. For those reasons, firms facing market uncertainty for their output tend to postpone investment so as to fetch more relevant information to avoid the risk of failing, if not having to invest to preempt competitors (Dixit & Pindyck, 1995; Guiso & Parigi, 1999; Le, Hermes, & Lanjouw, 2004; Mason & Weeds, 2010; Nishide & Yagi, 2016).

Nevertheless, although firms will invest less as the degree of output market uncertainty increases, the higher the internal funds (profits) firms have, the lower the negative impact of the uncertainty on investment (Minton & Schrand, 1999; Ghosal & Loungani, 2000; Peeters, 2001). Specifically, if profits go beyond a certain threshold, firms will raise investment. Such behaviour is due to two reasons. First, as profits are higher, it is easier for firms to diversify investments, thereby better managing risks. Second, higher profits make firm managers more ambitious in making breakthroughs and optimistic about future business prospects so that they tend to take risk regardless of output market uncertainty. This trend strengthens itself as successes have been previously achieved.

Given the above argument, the empirical model used to investigate the impact of profits on firm investment under output market uncertainty reads as follows:

$$INV_i = \beta_0 + \beta_1 UNCER_i + \beta_2 UNCER_i \times PRO_i + \beta_3 PRO_i + \varepsilon_i \quad (1)$$

In Model (1), INV_i is the ratio of planned investment to current total fixed assets of firm *i*. $UNCER_i$ is the degree of output market uncertainty, measured by the coefficient of variation (CV) of expected sales of firm *i* (Guiso & Parigi, 1999; Lensink, Van Steen & Sterken, 2005). According to those studies, the higher the coefficient of variation of expected sales, the higher the output market uncertainty. Coefficient β_1 is expected to be negative since the theory postulates that output market uncertainty has negative impact on firm investment.

PRO_i is the ratio of after-tax profits to total assets of firm *i*. Le et al. (2004), Le (2008), and Engel and Middendorf (2009) argue that firm investment is closely related to profits because it is difficult for firms to get access to external funds (for instance, bank credit) due to information asymmetry and limited liability, among others. Therefore, coefficient β_3 is supposed to be positive.

$UNCER_i \times PRO_i$ is an interaction of $UNCER_i$ and PRO_i, which is employed to examine the impact of profits on the relationship between output market uncertainty and investment of firm *i*. As just mentioned, several studies (for instance, Minton & Schrand, 1999; Ghosal & Loungani, 2000; Peeters, 2001) identify that the negative impact of output market uncertainty on high-profit firms is less severe than that on low-profit ones. Specifically, as profits go beyond a certain threshold, output market uncertainty triggers firm investment. This argument is clarified by Model (1). Taking the first derivative of INV_i with respect to $UNCER_i$ gives:

$$\frac{\partial INV_i}{\partial UNCER_i} = \beta_1 + \beta_2 PRO_i \tag{2}$$

Expression (2) divulges that if profits are low ($PRO_i \rightarrow 0$), output market uncertainty has negative impact on investment (since $\beta_1 < 0$) but that impact decreases in magnitude if profits go up. Specifically, as profits get over a certain benchmark (namely, $PRO_i > -\beta_1/\beta_2$), this relationship turns positive. If that is the case, β_2 should be positive.

To be complete, the empirical model should include other determinants of investment decisions identified by previous studies (for instance, Guiso & Parigi, 1999; Engel & Middendorf, 2009; Polder & Veldhuizen, 2012) such as the irreversibility of used assets, growth rate of sales, degree of competition, bribes, and field of specialisation. Therefore, the empirical model is augmented to become:

$$\begin{aligned} INV_i = \; & \beta_0 + \beta_1 UNCER_i + \beta_2 UNCER_i \times PRO_i + \beta_3 PRO_i \\ & + \beta_4 IRR_i + \beta_5 RISK_i + \beta_6 DSAL_i + \beta_7 COMP_i \\ & + \beta_8 COMP_i^2 + \beta_9 BRI_i + \beta_{10} BRI_i^2 + \beta_{11} MANU_i \\ & + \beta_{12} SERV_i + \varepsilon_i \end{aligned} \tag{3}$$

IRR_i is the irreversibility of used assets of firm *i*. To construct this variable, the manager was asked to evaluate the possibility to resell used assets to create variable $IRR1_i$, which takes a value of 1 if the answer is "easy" and 0 if the answer is "not easy." We also use information about the expected resell value of used assets to create variable $IRR2_i$ (i.e., the ratio of the expected resell value of used assets to their replacement costs). Since $IRR1_i$ and $IRR2_i$ are correlated, the factor analysis technique is used to combine them into one common factor (namely, $IRR_i = w_1 IRR1_i + w_2 IRR2_i$, with w_1 and w_2 are factor scores) to proxy for the possibility to resell used assets of firm *i*. According to studies (Dixit & Pindyck, 1995; Guiso & Parigi, 1999), most investment decisions are irreversible because of constraints on reselling used assets. Therefore, if it is easier to resell and/or obtain higher values of resold assets, firms tend to invest more. Coefficient β_4 is thus supposed to be positive.

$RISK_i$ is used to measure risk attitude of the top manager of firm *i*. To construct this variable, the manager was asked to choose between two cases: (1) investing a certain amount of money to earn 10% profit for sure, or (2) investing the same amount of money to earn 20% profit with a probability of 50% or nothing with the remaining probability of 50%. The answers are used to measure risk attitude of firm manager $RISK_i$, which takes a value of 0 (risk-averse) for the manager who chooses case (1) and 1 (risk-loving) for the one choosing case (2). Andrade and Stafford (2004) contend that risk-loving managers tend to invest more compared to risk-averse ones since they are more self-confident in own competence, especially in controlling market risk. Therefore, coefficient β_5 is supposed to be positive.

$DSAL_i$ is the annual growth rate of sales by firm *i* (%). Fast growth of sales means better prospects for firms, so they may make more investment to capture opportunities and expand market shares (Guiso & Parigi, 1999; Guariglia, 2008; Engel & Middendorf, 2009; Yang, Koveos, & Barkley, 2015). As a result, coefficient β_6 is expected to be positive.

$COMP_i$ is the degree of competition facing firm *i*, measured by its profit elasticity (PE_i). PE were coined by such as Boone (2000) and further developed by Boone (2008), and Polder and Veldhuizen (2012). According to those studies, the degree of competition can be identified by the ratio of percentage change of profit (π) to percentage change of marginal cost (MC), which means:

$$PE_i = \frac{\Delta\pi_i / \pi_i(\%)}{\Delta MC_i / MC_i(\%)} \tag{4}$$

Since it is often difficult to measure MC, researchers replace it by average cost (AC). In addition, the average cost of firms that operate in different sectors will be the ratio of total cost (TC) to total revenue (TR), because it is not plausible to add up the quantity of different goods (Polder & Veldhuizen, 2012). In sum, PE_i can be written as follows:

$$PE_i = \frac{\Delta\overline{\pi}_i / \overline{\pi}_i(\%)}{\Delta AC_i / AC_i(\%)} < 0,\ \overline{\pi}_i = \pi_i / TR_i \tag{5}$$

As explained earlier, fierce competition may squeeze PE_i. Thus, in order to make it easier to grasp the impact of competition on investment, we use $COMP_i = |PE_i|$. Higher value of $COMP_i$ means higher degree of competition facing firm i. $COMP_i^2$ is used to reveal the presence of an inverted U-shaped ($\cap$) relationship between the degree of competition and investment by the firm. Nielsen (2002), Moretto (2008), Akdogu and MacKay (2008), and Polder and Veldhuizen (2012) assert that firms operating in a less severely competitive environment often have high costs due to moral hazard that results in inefficiency. As competition pressure strengthens, firms are forced to raise investment to mitigate costs, enhance efficiency, and preempt competitors so as to tackle the risk of squeezed market share. Yet, if competition pressure goes beyond a certain point, it becomes too fierce, market niche evaporates and the benefit from investing is no longer promising, firms will then scale down investment. Therefore, coefficient β_7 is expected to be positive and β_8 negative.

BRI_i is the ratio of bribes that firm i paid to government officials to its total assets. BRI_i^2 is included to detect the non-monotonic relationship between bribes and investment by the firm. If bribed, bureaucratic officials are greased to provide better services to firms, enabling them to take up available investment opportunities. However, despite being bribed, corrupt officials deliberately stay intact so as to urge firms to bribe more later on. If forced to bribe too much, expected profits from investment projects would go down and firms reduce investment accordingly. Thus, there exits an inverted U-shaped relationship between bribes and firm investment as well as growth (Svensson, 2005; Le, 2008). If so, β_9 is expected to be positive and β_{10} to be negative.

$MANU_i$ and $SERV_i$ are included to test for the possible gap in investment among firms in different sectors (i.e., manufacturing, trade, and services). $MANU_i$ takes a value of 1 for manufacturing firms and 0 otherwise. $SERV_i$ takes a value of 1 for service firms and 0 otherwise. Coefficients β_{11} and β_{12} can be either positive or negative, depending on the environments in which firms operate.

RESEARCH METHODOLOGY

Primary data used in this paper are directly collected from 667 non-state firms in the Mekong River Delta (Vietnam) in 2014. Based on a list of firms operating provided, we randomly select 200 non-state firms in Can Tho city and 100 firms in each of other provinces of the region to interview their top managers, using a questionnaire prepared in advance and corrected after several pilot surveys. Due to unexpected reasons (for instance, such as unable to contact the manager and missing information), we are able to get information from just 667 firms, consisting of 42 in An Giang province (accounting for 6.3% of the total number of the surveyed firms), 24 in Bac Lieu (3.6%), 22 in Ben Tre (3.3%), 44 in Ca Mau (6.6%), 194 in Can Tho (29.1%), 43 in Dong Thap (6.5%), 53 in Hau Giang (7.9%), 43 in Kien Giang (6.5%), 52 in Long An (7.8%), 44 in Soc Trang (6.6%), 24 in Tien Giang (3.6%), 25 in Tra Vinh (3.7%), and 57 in Vinh Long (8.5%).

The data collected include information about general characteristics, performance, actual investment in 2013, and planned investment in 2015 by the firms, among others. To give a full picture of the performance and investment of the surveyed firms, we use descriptive statistics. Then, Tobit model is utilised to estimate the impact of profits on the relationship between output market uncertainty and investment by the surveyed firms.[1]

FINDINGS

Characteristics of the Surveyed Firms

According to the survey, the average age of the firms is 10 years and their average assets in 2013 is VND146,913 million. A majority of them are liability-limited (accounting for as much as 34.6% of the total number of the surveyed firms), joint-stock (28.9%), and sole proprietorship firms (27.0%). The number of firms that export products accounts for 23.1% of the total number of the firms, in which 87.7% of them operate in both domestic and foreign markets.

Average sales of the surveyed firms in 2013 is VND210,402 million (increasing by 17.4% compared to that in 2012). Their average profit is VND16,761 million (increasing by 6.8% compared to that in 2012) and returns on sales (ROS) is 8.0%. However, the average cost went up markedly (by 18.4% compared to that in 2012). All this implies that the firms had reasonable growth rates but did not utilise resources well, so the cost is high.

Table 1
General information about the surveyed firms (2013)

Indicators	Mean	Standard deviation	Min	Max
Age (year)	10	9	2	52
Total assets (VND million)	146,913	492,392	130	6,750,400
Sales (VND million)	210,402	539,048	50	5,450,131
Profit (VND million)	16,761	77,904	–705,087	1,200,000
Investment (VND million)	14,402	60,835	0	793,000

Source: Authors' own survey in 2014

About 46.3% of the surveyed firms paid bribes and the average bribe per firm is as much as VND192.2 million per year. Bribing seems to be pervasive as 45.6% of the firms did it on purpose and 48.5% deem it as an implicit norm while doing business in Vietnam. Types of bribes that firms use are gifts (accounting for 56.0% of the total number of firms), travel (54.3%), or in cash (52.8%).

Table 2
Investment by the firms

Financing sources	Investment in 2013		Planned investment in 2015		Change in 2015 compared to 2013 (%)
	Amount (VND million)	% of total	Amount (VND million)	% of total	
Equity	9,472.03	65.77	5,142.61	58.57	–45.71
Loans from joint-stock banks	2,976.26	20.66	2,169.25	24.71	–27.11
Loans from state banks	1,432.91	9.95	1,022.82	11.65	–28.62
Loans from foreign-owned banks	221.11	1.54	90.67	1.03	–58.99
Loans from government projects	30.58	0.21	19.34	0.22	–36.76
Others	269.51	1.87	335.13	3.82	24.35
Total investment	14,402.41	100.00	8,779.81	100.00	–39.04

Source: Authors' own survey in 2014

Table 2 shows that the average investment by the firms in 2013 is VND14,402.4 million. Due to economic downturn and suppressed market demand, planned investment of the firms in 2015 is just VND8,779.8 million (decreasing by 39.04% compared to that in 2013). Financing sources for investment by the firms are equity (mainly retained profits) and bank loans that are much less than retained profits. According to the survey, retained profits are the most important financing source

of investment by the firms. When making investment decisions, firm managers were also concerned with output market uncertainty. The coefficient of variation of the future sales of the firms is up to 37.7%. Trading and production firms seem to feel more uncertain about markets (with the coefficient of variation of sales of 0.388 and 0.379, respectively) compared to service firms (0.360).

Estimation Results

Before running the regression, we carefully check the assumptions of the regression model regarding multicollinearity and heteroscedasticity. The results show that all the coefficients between independent variables (r_{ij}) are smaller than 0.8 ($0.002 \leq |r_{ij}|$ 0.532). Moreover, since the relationship between $COMP_i$ and $COMP_i^2$ or between BRI_i and BRI_i^2 is nonlinear, this regression does not violate the multicollinearity assumption of the classical model (Gujarati, 2004). We have also performed the White test for heteroscedasticity and found this problem (p-value = 9.436×10^{-13}) . Therefore, we use the Robust estimation option of Stata to correct it.

The result in column 2 of Table 3 (Model 2a) shows that if not taking account of PRO_i and $UNCER_i \times PRO_i$, coefficient β_1 of $UNCER_i$ is negative (−0.124) at a significance level of 10%, implying that output market uncertainty alone has a negative impact on investment by the surveyed firms. Variable PRO_i is added in Model 2b (column 3 of Table 3) to empirically examine the dependence of investment on profits. Coefficient β_3 of this variable is 0.248 at a significance level of 1%, revealing that the higher the profits, the more firms tend to invest.

Model 2c is used to estimate the impact of profits on the relationship between output market uncertainty and firm investment (column 4 of Table 3). The result reveals that coefficient β_2 of the interactive term $UNCER_i \times PRO_i$ has a positive value of 0.610 at a significance level of 1% and coefficient β_1 of $UNCER_i$ has a negative value of –0.226 at a significance level of 1%. This is supportive evidence for the point of view that higher profits mitigate the negative impact of output market uncertainty on firm investment. Moreover, if profits go over a certain level (0.369),[2] firms tend to raise investment as output market uncertainty picks up.

Our finding is quite identical to those of several studies (for instance, Minton & Schrand, 1999; Ghosal & Loungani, 2000; Peeters, 2001), which divulged that the negative impact of output market uncertainty on high-profit firms is less severe than that on low-profit ones. Moreover, we found that as profits go beyond a certain threshold (0.369), output market uncertainty triggers firm investment, thereby adding interesting evidence to the investment literature.

Table 3
Estimation results

Dependent variable: INV_i – planned investment in 2015

	Model 2a	Model 2b	Model 2c
(1)	(2)	(3)	(4)
Constant C	–0.031	–0.075*	–0.032
$UNCER_i$	–0.124* (–0.047)	–0.127* (–0.049)	–0.226*** (–0.087)
$UNCER_i \times PRO_i$			0.610*** (0.236)
PROi		0.248*** (0.096)	
IRR_i	0.048*** (0.018)	0.048*** (0.019)	0.045*** (0.018)
$RISK_i$	0.102** (0.043)	0.089** (0.037)	0.101** (0.042)
$DSAL_i$	0.002*** (0.001)	0.002*** (0.001)	0.002*** (0.001)
$COMP_i$	0.004** (0.002)	0.005*** (0.002)	0.005*** (0.002)
$COMP_i^2$	0.000* (0.000)	0.000** (0.000)	0.000** (0.000)
BRI_i	8.849*** (3.385)	7.708*** (2.970)	7.339*** (2.833)
BRI_i^2	–64.419** (–24.640)	–61.337** (–23.634)	–55.166* (–21.296)
$MANU_i$	–0.025 (–0.009)	–0.022 (–0.008)	–0.024 (–0.009)
$SERV_i$	–0.052 (–0.019)	–0.051 (–0.019)	–0.058 (–0.021)
Observations	667	667	667
χ^2	51.240	77.370	78.710
Significance	0.000	0.000	0.000
Log likelihood	–346.585	–333.517	–332.847

Source: Authors' own survey in 2014
Notes: Numbers in the first line of each rows are coefficient β_i. Numbers in the parentheses are $\partial INV/\partial X_i$.
*** 1% significance level; ** 5% significance level; * 10% significance level

Coefficient of IRR_i also has a positive value at a significance level of 1%, implying that the easier it is to resell used assets, the higher the level of investment is.[3] Likewise, coefficients of $RISK_i$ and $DSAL_i$ also have a positive value at the significance level of 5% and 1%, respectively. Coefficients of other variables (namely, $COMP_i$, $COMP_i^2$, BRI_i and BRI_i^2) have expected signs, except for $MANU_i$ and $SERV_i$.

Interestingly, we found the inverted U-shaped relationship between bribes and firm investment, meaning that bribes trigger investment but after a certain threshold that positive effect will deteriorate. As a matter of fact, institution plays a key role since it provides firms with guidance and certain routines, thereby reducing economic and market uncertainties (Uzzi, 1997; Graeff, 2005; North, 2005; Bruton, Ahlstrom & Obloj, 2008). However, firms in transition countries face many difficulties due to deficiencies of the legal system and financial markets (Scase, 1997). Therefore, networking turns out to be a common practice and political connections become extremely important for firms in those countries (Yiu & Lau, 2008). This relationship is meant to trigger bribery behaviour of firms in order to create and maintain networks, thereby enhancing the ability to grasp investment opportunities.

Although bribes brought about advantages for firms, after going beyond a certain point bribes may crowd out investments and corrode incentives for innovation (Luo, 2004). In addition, bribes do not necessarily guarantee good performances because firms that have paid bribes may face more severe demands by corrupt officials. As a result, the more bribes firms pay, the more inefficient resources allocation and lower investment would be (De Jong et al., 2012).

CONCLUSION AND RECOMMENDATIONS

Output market uncertainty is a key element that affects firm investment. Nevertheless, the relationship between investment and output market uncertainty depends on profits. Hence, this paper concentrates on empirically examining the impact of profits on the relationship between investment and output market uncertainty of 667 non-state firms in Vietnam using Tobit model. The findings show that most independent variables of the empirical model have coefficients that are statistically significant as predicted by the theory (for instance, output market uncertainty alone has a negative impact on investment of the firms). It is worth noting that higher profits are associated with reduced negative impact of output market uncertainty on investment of the firms. Especially, if profits go over

a certain level, an increase in the degree of output market uncertainty induce firms to invest more, so over-investment is very likely to occur.

In addition, the relationship of the degree of competition on investment of the firms has an inverted U-shaped, implying that low degree of competition stimulates investment but if competition pressure becomes too fierce, firms will scale down investment to avoid unexpected loss. The relationship between bribes on firm investment is also in the form of inverted U-shaped while higher growth rates of sales and higher reversibility of used assets do encourage firms to invest more. However, bribes seem to be costly for the firms, so those that have to pay too much bribes tend to invest less.

The findings give some thoughts that should be taken into account to enhance efficiency and ensure sustainable growth of firms. Firms need to set up a specialised department in charge of forecasting market tendency so as to have proper investment strategies that help avoid over-investment adversely induced by high profits. The government may pay more attention to moderate competition. When monopoly exists, it is desirable to remove barriers to firm entry to stimulate them to enter markets. When the level of competition is too fierce, the government may tight up regulations in terms of eliminating inefficient firms to ensure that markets operate effectively.

Moreover, in order to contain bribery phenomenon that seems to be pervasive, there is an urgent need to make administrative procedures transparent. More importantly, the government may reform the salary policy and re-allocate discretionary power to avoid power concentration that makes it difficult to manipulate or extort bribes. In addition, second-hand goods market should be established and endorsed in order to better price used assets of firms, thereby promoting their investment.

NOTES

1. We have also applied Ridge regression to the empirical model and come up with almost the same result.
2. Taking the first derivative of INV_i with respect to $UNCER_i$: $\partial INV/\partial UNCER = -0.087 + 0{,}236 \times PRO$. Let $\partial INV/\partial UNCER = 0 \Rightarrow PRO = 0.369$.
3. Factor analysis results show that IRR $- 0.609IRR1_i + 0.609IRR2_i$

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