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The Substitutability of Investment and Innovation in the Context of Corruption —Research Based on Micro-Enterprise Data

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Abstract. This study examines whether access to credit and physical investment facilitated by corruption substitutes for corporate R&D. The static model describes how to allocate the constrained administrative budget between innovation and rent-seeking. The empirical analysis uses the survey data of manufacturing enterprises in 120 cities of China conducted by the World Bank in 2005 to measure corruption related expenditure by the proportion of entertainment and travel expenses in sales. Capital intensity reflects the motivation difference of enterprises to obtain preferential financing. The main regression contains 11,296 observations. Higher capital intensity is associated with higher corruption related expenditures. The interaction between capital intensity and corruption expenditure is negative in R&D regression and positive in the instrumental-variable investment regressions. The term of office and replacement of the municipal Party secretary are used as instrumental variables of corruption expenditure and its interaction with capital intensity. The regression of collateral requirements provides limited evidence for credit channels, and this evidence is sensitive to the model setting. The interaction patterns are consistent with a relative shift toward physical investment as capital intensity rises, rather than a uniform decline in R&D or increase in investment. A causal interpretation remains conditional on instrument validity.

Keywords: Corruption Expenditure, Research and Development, Investment, Capital Intensity

1. Introduction

China's anti-corruption action has raised a question about the source of enterprise growth: will the cancellation of preferential treatment in resource acquisition inhibit investment or guide enterprises to turn to innovation? Credit can support both physical capital accumulation and R&D, but when enterprises allocate scarce resources between productive innovation and rent-seeking, this complementary relationship may not be established. This study examines how capital intensity affects that allocation.

The "lubricant" view holds that in an environment of institutional rigidities, corruption may help firms bypass institutional constraints, thereby facilitating resource access and economic activities [1-

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3]; the rent-seeking theory emphasizes that corruption will cause firms to invest resources in activities for special treatment, distort resource allocation and slow economic growth [4-6]. The difference between the two views lies in whether the firm-level benefits obtained by firms through corruption can offset the resource consumption and efficiency loss caused by rent-seeking activities. Empirical research has documented the adverse effects of corruption on economic growth, investment and international capital flows [7-15], but there is also evidence that the beneficial effects or impacts depend on the specific situation [16-18]. Svensson [19] reviewed this broader debate. These different conclusions suggest that to understand the economic consequences of corruption, it is necessary to further distinguish the institutional conditions under which corruption operates from different dimensions of firm decision-making: the improvement of resource access conditions may promote investment, but may not enhance innovation incentives at the same time. Regional evidence from China also shows that there is a link between corruption and firm productivity [20]. On this basis, investigating how firms allocate resources between physical investment and R&D will help to understand the specific mechanism of corruption affecting economic growth from the micro decision-making level.

Following Cai et al. [21], this study takes entertainment and travel costs (ETC) as the proxy variable of corruption related expenditure. Since such expenses may also include normal operating expenses, ETC should be understood as an indirect indicator reflecting corruption related activities, rather than a direct measure of corruption. This paper analyzes the interaction term between ETC and capital intensity to investigate whether firms with different capital intensity show different investment and innovation reactions, and estimates it combined with the instrumental variables based on the tenure and turnover of the municipal Party secretary. The research on the incentive mechanism for local officials and China's institutional structure provides a basis for understanding the institutional environment in which firms obtain resources [22-24]; the research on the Municipal Party secretary tenure and regional corruption provides a reference for investigating the political network and its changes [25, 26]. These studies help to explain the selection logic of instrumental variables, but their validity still depends on whether the relevance condition and exclusion restriction can be established. The research on the relationship between entertainment expenditure and firm orders [27] further extends the discussion to the link between firm expenditure and the acquisition of operating resources. Based on the above literature, this study brings corruption related expenditure, physical investment and R&D into the same resource allocation framework, and focuses on whether the financing and resource advantages obtained by corruption are likely to promote physical capital expansion rather than innovation, so as to provide firm level evidence for understanding the possible substitution relationship between investment growth and innovation incentives.

2. Model

2.1. Model settings

A firm chooses R&D intensity s, rent-seeking activity e and output y. The unit cost of rent-seeking is q, the fixed administrative expense is $\bar{x}$ and the proportion of administrative expense budget to sales is m. The capital intensity of the industry is expressed in θ. The optimization problem of firm is:

$$\max_{s,e,y}[P(y,s)-c(e,\theta)]y, s+qe+\underline{x}\leq m \tag{1}$$

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Product price falls with output and rises with innovation. The separable price function is P(y,s)=R(y)+W(s), with a positive but diminishing return to R&D. Capital k and labor l produce one unit at minimum cost:

$$c(e,\theta) = \min_{k,l}[r(e,\theta)k + wl], F(k,l;\theta) \geq 1 \tag{2}$$

Rent-seeking lowers the capital rental rate r, while wages w are unaffected. Constant returns imply total production cost c(e,θ)y. The problem separates into output choice and allocation of administrative resources:

$$\max_y[R(y) + h(q,\theta)]y \tag{3}$$

$$h(q,\theta) = \max_{s,e}[W(s) - c(e,\theta)], s + qe + \underline{x} = m \tag{4}$$

The first-order condition equates marginal returns per unit of spending:

$$W_s(s) = -\frac{c_e(e,\theta)}{q} \tag{5}$$

Equations (1)-(5) capture the trade-off: R&D raises product value, whereas rent-seeking lowers financing-related production costs. The model abstracts from R&D subsidies obtained through rent-seeking.

2.2. Comparative statics and testable implications

Under the curvature assumption of the model, the reduction of rent-seeking cost will increase rent-seeking activities. Its impact on R&D depends on the capital intensity: when the capital intensity exceeds the threshold in the model, the reduction of rent-seeking cost will reduce R&D. Higher capital intensity will enhance rent-seeking motivation and weaken innovation motivation. The prediction is: capital-intensive firms have more rent-seeking expenditure; with the increase of rent-seeking activities related expenditure, compared with firms with low capital intensity, their R&D response is weaker, while the response of physical investment is stronger.

3. Empirical research design

3.1. Data and variables

The investment environment survey of the World Bank in 2005 covered 12,400 manufacturing firms in 30 provinces or equivalent jurisdictions and 120 cities in China, including their business information in 2004. The manager questionnaire describes the business environment, innovation and external relations; the financial and personnel questionnaire provides financial and employment indicators. These data were matched by city and the records of the Secretary of the municipal Party committee from 2000 to 2013 collected from open sources. The main estimated sample contains 11296 observations.

ETC is entertainment and travel expenses divided by sales. R&D and investment are the proportion of R&D expenditure and new fixed asset investment in sales respectively. CapInt adopts the median ratio of industry capital to sales, and takes the industry with the lowest capital intensity as the benchmark for centralized treatment. The control variables include government help, early tax burden, relationship between customers and suppliers, lagged employment, enterprise age,

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ownership structure and sales outside the province. Table 1 reports the results of descriptive statistics.

3.2. Estimation and instruments

The baseline equation tests whether capital intensity can predict ETC, and then examines the difference between R&D and investment reactions through cross-sectional OLS regressions containing interaction terms, followed by IV estimation. These are not difference-in-differences regressions, since no before-and-after treatment comparison is specified:

$$\mathrm{ETC}_i = \alpha_0 + \alpha_1 \mathrm{CapInt}_i + \alpha_2 X_i + \varepsilon_i \tag{6}$$

$$\mathrm{RD}_i = \beta_0 + \beta_1 \mathrm{ETC}_i + \beta_2 \mathrm{CapInt}_i + \beta_3 \mathrm{ETC}_i \mathrm{CapInt}_i + \beta_4 X_i + \varepsilon_i \tag{7}$$

$$\mathrm{Investment}_i = \gamma_0 + \gamma_1 \mathrm{ETC}_i + \gamma_2 \mathrm{CapInt}_i + \gamma_3 \mathrm{ETC}_i \mathrm{CapInt}_i + \gamma_4 X_i + \varepsilon_i \tag{8}$$

In equations (6)-(8), RD denotes R&D intensity, i indexes firms and X denotes controls. The expected interaction term is negative in the R&D equation and positive in the investment equation. In order to deal with the potential reverse causality, the tenure and turnover of the Secretary of the municipal Party committee in 2004 are taken as the instrumental variables of ETC, and the interaction between the two and CapInt is taken as the instrumental variable of ETC × CapInt. This paper selects these instrumental variables because the official turnover may break the existing political relationship network, and a longer tenure may promote the formation of these relationships. The research on officials' incentives, institutional environment and tenure provides a basis for this selection logic [22-26]. However, the validity of instrumental variables also requires that after controlling other factors, the tenure and official turnover can only affect enterprise R&D and investment through ETC and its interaction with CapInt. If officials also influence enterprise decisions through local policies or credit allocation and other channels, it may violate this exclusion restriction. The IV model in this paper controls the characteristics of cities and industries, and adopts the clustering standard error at the city industry level. But these treatments can not guarantee the effectiveness of instrumental variables. Thus, the IV estimation results can be interpreted as causal effects only if the recognition assumptions such as correlation and exclusivity restrictions are tenable.

Table 1. Descriptive statistics

Variable	Mean	SD	Min.	Max.	N
R&D / sales	1.022	2.948	0	64.341	11296
ETC	1.117	2.391	0	71.429	11296
CapInt	.328	.374	0	7.858	11296
Government help	.565	1.121	0	9.99	11301
Lagged tax burden	.004	.005	0	.115	11301
ln(Relationship)	2.345	.313	1.099	2.708	11296
ln(Lagged labor)	5.522	1.477	0	11.700	11296
ln(Age)	2.276	.794	1.099	7.602	11296
Private share	39.880	44.967	0	100	11296
Foreign share	13.992	31.214	0	100	11296

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Table 1. (continued)

Other-province sales	.771	.420	0	1	11296
Investment / sales	.081	1.029	-.095	97.141	11296
Collateral ratio	544.25	450.623	0	1000	11296
Collateral dummy	.507	0.500	0	1	11296
Tenure	1.868	1.461	0	6	11296
Turnover	.184	.388	0	1	11296

Notes: Government help and lagged tax burden are city-industry medians. Relationship is the logged sum of years with major customers and suppliers. Ownership shares are percentages. Tenure and turnover refer to the municipal party secretary in 2004.

4. Empirical results

4.1. Corruption expenditure and capital intensity

Table 2 shows that capital intensity is positively associated with ETC. CapInt alone could explain the same degree of variation as the original control variable ($R^2 = 0.14$); After including both CapInt and the controls, R^2 increases to 0.19. The coefficient of capital intensity is still significant at 1%, which is consistent with the expectation that capital-intensive firms have stronger rent-seeking motivation.

Table 2. Corruption expenditure and capital intensity

Variable	ETC (1)	ETC (2)	ETC (3)
CapInt		1.475 (5.11)**	1.518 (5.28)**
Government help	-0.010 (0.29)		-0.007 (0.22)
Lagged tax burden	122.471 (8.97)**		117.171 (8.68)**
ln(Relationship)	0.026 (0.32)		0.152 (1.90)
ln(Lagged labor)	-0.202 (9.08)**		-0.220 (9.89)**
ln(Age)	0.015 (0.47)		-0.059 (1.94)
Private share	-0.001 (1.74)		0.000 (0.01)
Foreign share	-0.001 (1.73)		-0.001 (1.11)
Other-province sales	0.314 (6.43)**		0.296 (5.96)**
Constant	1.417 (6.47)**	0.633 (6.90)**	0.879 (3.95)**
R^2	0.14	0.14	0.19
N	11,296	11,296	11,296

Notes: t-statistics in parentheses; standard errors clustered by city-industry. * $p < 0.05$; ** $p < 0.01$.

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4.2. Corruption expenditure and R&D

The R&D regression results are reported in Table 3. In the model with interactive terms, the CapInt × ETC coefficients of columns (3) and (4) are − 0.030, which are significant at the level of 5%. The corresponding IV estimates are − 0.154 and − 0.110, both significant at the 1% level. Thus, with the increase of capital intensity, the estimated association between corruption expenditure and R&D becomes more unfavorable to R&D, which is consistent with the substitution mechanism in the model.

Table 3. Corruption expenditure and enterprise R&D

Variable	OLS (1)	OLS (2)	OLS (3)	OLS (4)	IV (5)	IV (6)
CapInt	0.743(4.57)**	0.709(4.33)**	0.670(4.18)**	0.622(3.86)**	0.367(2.23)*	0.473(2.54)*
ETC			0.158(4.70)**	0.162(4.79)**	0.769(4.95)**	0.534(2.64)**
CapInt × ETC			-0.030(2.11)*	-0.030(2.09)*	-0.154(5.12)**	-0.110(3.01)**
Government help		0.121(3.06)**		0.122(2.88)**		0.147(3.63)**
Lagged tax burden		0.343(3.19)**		16.825(1.59)		17.165(0.65)
ln(Relationship)		0.003(2.89)**		0.236(2.69)**		0.298(3.21)**
ln(Lagged labor)		0.001(4.85)**		0.153(5.83)**		0.237(5.52)**
ln(Age)		-0.001(1.28)		-0.054(1.17)		-0.054(1.28)
Private share		-0.000(0.01)		-0.000(0.02)		-0.001(1.13)
Foreign share		-0.000(3.78)**		-0.005(3.68)**		-0.003(2.94)**
Other-province sales		0.004(5.54)**		0.321(5.10)**		0.356(5.06)**
Constant	0.008(13.78)**	-0.008(3.36)**	0.006(11.03)**	-0.948(3.95)**	0.001(0.82)	-1.908(6.37)**
R^2	0.13	0.14	0.14	0.15	.	0.01
N	11,296	11,296	11,296	11,296	11,296	11,296

Notes: t-statistics in parentheses; standard errors clustered by city-industry. * $p < 0.05$; ** $p < 0.01$. IV specifications control for city and industry characteristics. Blank cells indicate omitted regressors; "." reproduces an unreported R^2.

The negative interaction term reflects the different responses under different capital intensity. The interaction coefficient is negative, indicating that the relationship between ETC and R&D varies with capital intensity. The estimated marginal association between ETC and R&D is $\beta_1 + \beta_3 CapInt$. A negative interaction coefficient means that this marginal association gradually weakens with the increase of capital intensity, but it does not mean that it is negative for all enterprises. Thus, when comparing enterprises with different capital intensity, it is necessary to combine the positive coefficient of ETC with the negative coefficient of interaction term.

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4.3. Corruption expenditure and physical investment

Table 4 replaces the dependent variable with the proportion of new fixed asset investment in sales revenue from R&D. The interaction coefficient is not significant in columns (1) - (2), but is significantly positive in the IV estimation. The estimated marginal association between ETC and investment is $\gamma_1 + \gamma_3$CapInt. Since the coefficient of ETC in the IV estimation is negative and the coefficient of interaction term is positive, it does not mean that the marginal association between ETC and investment is positive for all enterprises. Combined with table 3, these results are consistent with the relative transfer of resource allocation to physical investment rather than R&D with the increase of capital intensity, provided that the hypothesis of instrumental-variable is tenable.

The comparison between tables 3 and 4 is informative. It distinguishes two uses of enterprise resources. In OLS and IV specifications, R&D interaction is negative, while investment interaction is only significant in IV norms. Thus, the investment interpretation depends more strongly on the identification hypothesis. This difference links the investment literature [7, 13] with the concern that rent-seeking will weaken productive incentives [5], and does not prove that expenditure is directly transferred from R&D to investment.

Table 4. Corruption expenditure and corporate investment.

Variable	OLS (1)	OLS (2)	IV (3)	IV (4)
CapInt	0.738 (1.87)	0.759 (1.86)	0.941 (0.89)	0.770 (0.77)
ETC	-0.008 (1.20)	-0.007 (1.14)	-1.866 (2.47)*	-1.763 (2.32)*
CapInt × ETC	-0.006 (0.48)	-0.006 (0.49)	0.493 (9.29)**	0.473 (7.11)**
Government help		0.002 (0.95)		-0.009 (0.21)
Lagged tax burden		-3.397 (1.07)		201.181 (1.94)
ln(Relationship)		0.018 (0.33)		0.290 (2.04)*
ln(Lagged labor)		0.007 (2.11)*		-0.289 (1.68)
ln(Age)		-0.055 (1.97)		-0.070 (1.50)
Private share		0.001 (1.38)		0.001 (0.60)
Foreign share		0.000 (0.33)		-0.001 (0.93)
Other-province sales		-0.005 (0.34)		0.396 (1.83)
Constant	-0.149 (1.30)	-0.125 (0.69)	1.573 (2.97)**	1.397 (1.89)
R^2	0.08	0.08	.	.
N	11,296	11,296	11,296	11,296

Notes: t-statistics in parentheses; standard errors clustered by city-industry. * $p < 0.05$; ** $p < 0.01$. IV specifications control for city and industry characteristics.

4.4. Instrument relevance

Table 5 shows the first stage regression results of ETC and CapInt × ETC. The reported F statistics were 10.67 and 59.75, respectively. The coefficients show that there is a relevance between instrumental variables and endogenous explanatory variables, which supports instrument relevance. However, the reported F-statistics alone do not establish instrument strength for the two endogenous

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regressors, and first-stage relevance does not establish the exclusion restriction. The IV estimates remain conditional on the identification assumptions in Section 3.2.

Table 5. Instrumental-variable first-stage results

Variable	ETC	CapInt × ETC
Tenure	-0.044 (1.67)	-0.157 (2.24)*
Turnover	-0.063 (0.73)	0.053 (0.59)
Tenure × CapInt	0.083 (2.71)**	0.397 (2.64)**
Turnover × CapInt	0.003 (5.56)**	0.024 (14.06)**
Constant	1.115 (19.40)**	0.394 (5.58)**
R^2	0.17	0.47
F statistic	10.67	59.75
N	11,296	11,296

Notes: t-statistics in parentheses; standard errors clustered by city-industry. * $p < 0.05$; ** $p < 0.01$.

4.5. Credit acquisition

Table 6 examines the collateral conditions. All CapInt × ETC coefficients are negative and significant in columns (3) - (4) of the IV specifications, but are no longer significant after adding control variables related to ETC in columns (5) - (6). Thus, the evidence supporting credit channels is more sensitive to the model setting. Existing estimates cannot prove that easier credit is the only explanation for the contrast between investment and R&D.

Table 6. Corruption expenditure and corporate credit acquisition.

Variable	OLS (1) Dummy	OLS (2) Ratio	IV (3) Dummy	IV (4) Ratio	IV (5) Dummy	IV (6) Ratio
CapInt	0.053(3.41)**	5.279(2.71)**	-0.013(0.70)	1.589(0.61)	-0.003(0.11)	4.158(1.13)
ETC	-0.006(1.97)	-0.763(2.58)*	0.049(2.63)**	5.458(2.52)*	0.035(0.86)	1.825(0.33)
CapInt × ETC	-0.002(1.94)	-0.189(1.42)	-0.013(3.85)**	-1.602(4.03)**	-0.010(1.36)	-0.956(0.96)
Government help					-0.007(0.58)	-1.635(1.88)
Lagged tax burden					-8.215(1.64)	-512.086(0.73)
ln(Relationship)					0.031(1.68)	2.767(0.94)
ln(Lagged labor)					0.071(8.74)**	5.264(4.51)**
ln(Age)					-0.013(1.57)	-1.125(0.92)
Private share					0.001(6.76)**	0.115(5.28)**
Foreign share					-0.001(3.52)**	-0.122(3.36)**
Other-province sales					0.111(6.93)**	9.738(4.20)**
Constant	0.498(54.73)**	50.905(44.28)**	0.465(21.53)**	45.978(17.37)**	-0.027(0.40)	8.648(1.01)
R^2	0.12	0.10	.	.	0.05	0.03

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Table 6. (continued)

N	11,296	11,291	11,296	11,291	11,296	11,291

Notes: t-statistics in parentheses; standard errors clustered by city-industry. * $p < 0.05$; ** $p < 0.01$. Dummy denotes the collateral indicator; Ratio denotes collateral value relative to the loan. IV specifications control for city and industry characteristics.

5. Conclusion

The model and firm-level estimates are consistent with a possible association between corruption-related expenditure and the composition of firm spending. Capital-intensive enterprises have more corruption related expenditure, and the interaction between corruption expenditure and capital intensity corresponds to a relatively weaker R&D association and a relatively stronger physical investment association in the IV estimates. These interaction patterns do not establish a uniformly negative effect on R&D or a uniformly positive effect on investment; causal interpretation depends on instrument validity. The regression of collateral conditions provides limited support for the mechanism of preferential credit. These findings help to explain why corruption may have different effects on investment driven expansion and innovation driven growth. The model suggests that reducing dependence on rent-seeking may encourage innovation, but this study does not directly estimate the effects of an anti-corruption policy.

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