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A Dynamic Managerial Theory of Corruption and Productivity Among Firms in Developing Countries

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Abstract

In this paper, a simple dynamic model of efficient firm-level managerial resource allocation to two uses, one involving productivity activities and another one involving corruption activities to "get things done" was developed. The model follows the optimal control theory process. Two operational equations are derived representing firm growth and shadow-price behavior. Firm-level interview data on surrogates for the firm's inputs was used for domestically owned firms in developing economies covering two time periods. The SUR method was used to estimate jointly the two equations. Overall, the model fit the data quite well. It was found that the managerial surrogates; namely, capacity utilization, formal worker training, and the time spent dealing with government regulations, were positive and significant predictors of firm output growth and the shadow-price of its capital with a few negative exceptions. Implicitly, there appears to be a trade-off between managerial resources used for growth and those used for the shadow price. Policy implications were discussed briefly.

Keywords: Firm, Corruption, Dynamic, Growth, Shadow Price, Developing Countries
JEL Classification: C51; D81; E60; K49; M29

1. Introduction

The purpose of this paper is to take a managerial resource microeconomic perspective on corruption (or bribery) payments by the business firm to government officials for the purpose of "getting things done" in order to carry out its business of producing and selling products. The paper develops a simple dynamic managerial resource allocation model to show how managerial resources are allocated efficiently to two alternative uses, one use to improve the productivity of the firm's production and selling activities and another use to spend time and money to bribe government officials to obtain licenses, permits, fees and tax reductions and the like to "get things done." The model is quite general in that it can be applied to firms in either developed or developing economies. In this paper, the model is applied to developing economies as a matter of preference and also because of the availability of suitable firm-level micro data. The basic two-part question addressed by the paper is, What role does firm management have in the corruption and productivity process? and Can this role be measured?

The literature on the economics of corruption in general is quite voluminous and a survey of it is beyond the scope of this paper. Useful surveys of this literature include the work by Aidt (2003), Lambsdorff (1999 and 2007), Bardhan (1997), and Rose-Ackerman (1975, 1978, 1999, and 2010), to name only a few. Aidt, in particular, discusses four different analytical approaches to the economics of corruption. Lambsdorff focuses mainly on institutional problems related to corruption practices, sociological aspects, and prevention. Rose-Ackerman focuses on cross-country corruption and the research thereof and the need to change the legal structure of countries.

Closer to the micro-level approach used in the present paper is the work by Ades and Di Tella (1999), which focuses on the individual firm and the role of its market structure (or competition) in affecting the amount of corruption engaged in by the firm. Another useful market structure approach to modeling the price and cost of corruption is the work by Shleifer and Vishny (1993). Kaufmann and Wei (1999) use firm-level data in regression analyses on corruption and the time firm managers spend with bureaucrats in order to "get things done." Also, related to the present paper at least in terms of the type of data used is the study by Hellman, et al. (2000) that uses interviews of some 3,000 firms in 20 developing countries to produce profiles of corruption across countries. Their survey-type questions are similar to those used in the Enterprise Surveys of the World Bank Group (2010) to gather firm-level data on corruption, which is used in the present study. More directly related to the present paper is the study by Gander (2011) that uses data from the Enterprise Surveys to examine the microeconomics of firm corruption behavior in developing economies, using a single-equation regression on firm size and other variables.

In spite of the volume and topics covered by the literature on corruption, both at the country-wide level and the micro-firm level, there does not appear to be any micro analytical literature directed specifically at the internal allocation of the firm's managerial resources to the activities used in the present paper. Consequently, there appears to be a gap in the relevant micro literature. Hopefully, the present paper will help to fill this gap.

It is important at the outset to emphasize that conceptually the dynamic model developed here uses managerial variables, the direct data for which are not easily available from accessible sources. To get around this problem, micro-level surrogates must be used. The surrogates measure the effect side of managerial activities. Even the well-known large compilation of corruption data by Kaufmann et al. (2009) uses micro-level data from several sources but it is aggregated to the country level. It gives a useful macro profile across countries and over time, but it is not designed for a firm-level micro study. One final caveat relates to the dynamic model. As will be shown shortly, the model produces two, in effect, dynamic mathematical equations. The corresponding econometric equations are estimated statically but are, in effect, quasi-dynamic, since the dependent variables are rates of change and log values and dependent on a time variable.

In what follows, the dynamic model is developed in the next section. Then, the data and econometric models are discussed in the following section. The statistical results are presented and discussed in the next section. The final section has a summary and conclusions.

2. A Simple Dynamic Corruption Model

The basis of the model is optimal control theory and analogous to a previous model on managerial resources and firm growth (See, Gander, 2010). The objective of the firm can be specified a number of ways, maximize utility at every instant of time, t, or profit, or the rate of growth of the firm's output. The model here uses the rate of growth of the firm's output, $G = (\partial Q/\partial t)/Q(t)$, at every instant of time, t. This choice is due to the availability of the data. The output growth function is simplified to contain only capital, K (firm size), which is the state variable, and managerial resources, M1, used in a technical efficiency sense to increase production and selling activities and ultimately the rate of growth, G, of the firm's output. The G(.) function is assumed to be positive and increasing in both arguments but at a diminishing marginal rate for each input. The K in G(.) increases by the differential equation, $dK/dt = \Phi(K(t), M2(t))$, which is simplified to $dK/dt = K(t)g(M2(t))$, where g(.) is the rate of growth of capital, K(t) and assumed to be positive and increasing in M2 but at a diminishing marginal rate. The key control variable is M2, representing managerial time and money spent on public officials to "get things done" (for the "grease" effect, see, Méon and Weill, 2010). This simplification reduces the complexity of the model and its behavior.

The managerial constraint function is given by $M(t) = M1(t) + M2(t)$ and assumed binding at every instant of time, t. By assumption, the growth of M(t) is exogenous and given by $M(t) = M(0)e^{st}$, where s is the given rate of growth of M(t). Again, this specification simplifies the model. The resulting Hamiltonian function to be maximized is given by

(1) $$H = e^{-rt}[G(K(t), M1(t)) + \mu(t)K(t)g(M2(t)) + l(t)(M(t) - M1(t) - M2(t))],$$

where r is the discount rate (exogenous), the co-state variable $\mu(t)$ is the current shadow price (in terms of G units) of the state variable K(t), and the $l(t)$ is the current (in G units) marginal opportunity cost of managerial resources. The first-order conditions for the maximization of (1) at each instant of time t in current value terms are given by

(2) (a) $\partial G/\partial M1 - l(t) = 0$

(b) $\mu(t)K(t)(\partial g(M2(t))/\partial M2) - l(t) = 0$

(c) $M(t) - M1(t) - M2(t) = 0,$

where at an instant of time, t, $\mu(t)$ and K(t) are given, and managerial resources, M1, are employed such that for (2a) the marginal rate of output growth is equal to the marginal cost of managerial resources and M2 in (2b) is employed to the point where the marginal value of capital formation (the dK/dt) is equal to $l(t)$, all subject to (2c).

In other words, the marginal current output rate of growth ($\partial G/\partial M1$) in equilibrium is equal to the marginal value of capital formation ($\mu(t)K(t)(\partial g(M2(t))/\partial M2)$.

In effect there is a trade-off between M1 (which affects G) and M2 (which affects dK/dt). If the firm were to allocated more managerial resources to increasing the rate of growth of current output, it would sacrifice some capital formation for now and into the future. So, while the current output growth increases, the future stock of capital is forever less and thus the future rate of growth of output would be less. On the other hand, a small sacrifice (of output growth rate) today brings about relatively more capital and output growth now and forever into the future. This after all is the essence of dynamic capital theory.

The shadow price of capital K(t), μ(t), has the behavioral function given by

(3) $d\mu/dt = (r - g)\mu - (\partial G/\partial K)$,

where $(r - g) > 0$ and $(\partial G/\partial K) > 0$, by assumption. The marginal output growth rate with respect to K $(\partial G/\partial K)$ could very well be zero, then μ(t) would definitely grow at a positive rate of growth over time. If it were negative, μ(t) would still definitely grow at a positive rate of growth over time. As assumed, with a positive marginal growth rate of return to K(t), then it would have to be small enough for μ(t) to still grow at a positive rate. It would seem counter-intuitive to have μ(t) declining over time. In a more complicated model not attempted here, the decline could occur. With an infinite horizon implied by the simple model, the presumption is that μ(t) will continue to rise over time.

The marginal shadow price (marginal opportunity cost) for managerial resources, l(t), has the dynamic behavior given by $d(le^{-rt})/dt = -\partial H/\partial M$, implying that $dl(t)/dt = (r-1)l(t)$, where $(r - 1)$ is most likely negative. Thus, the solution for l(t) is given by $l(t) = l(0)e^{it}$, where $i = (r-1) < 0$. The l(t) is positive but decreasing over time. In other words, the marginal value of managerial resources falls as the system expands over time.

For future use in the econometric section, the simple solution to (3) when $(\partial G/\partial K) = 0$ is in log terms, $\log\mu(t) = \log\mu(0) + (r - g)t$. The first-order conditions give the optimal (or equilibrium) M1(t)* and M2(t)* implicitly as functions of the state and co-state variables, K(t) and $\mu(t)$. Substituting these functions into equation (3) and the differential equation for K(t) implicitly gives the optimal time paths for K(t)* and $\mu(t)$*. Putting these back into equation (2) gives the optimal time paths for M1(t)* and M2(t)*, subject to the managerial constraint. In effect, these equilibrium values are the variables that make up the operational functions developed shortly.

Direct measures of the variables included in the simple dynamic model, in particular, the managerial resource components, are not readily available in the data set being used (nor apparently in any other data set). As indicated earlier, it will not be possible to find direct measures of the managerial resources, so surrogates reflecting the effects of the variables must be used. This lack of data is also true for the firm's size variable, K, so the number of workers employed is used as a surrogate. Also, the shadow price needs a surrogate.

3. Data and Econometric Models

Data:

The sample data consist of two sets of data, one covering the 2002-2005 time period and the other covering the 2006-2010 time period. Both data sets were produced by face-to-face personal interviews with company officials using a standard set of questions for each interview. The interview responses are subjective. The defense of the survey technique to gather data on corruption is discussed by Reinikka and Svensson (2006). The data are contained in the Enterprise Surveys, conducted by private contractors for the World Bank Group and are available on the web site of the World Bank (2010). Only the responses of domestically owned firms are used in the regression analysis. Adding a dummy variable for foreign owned firms did not produce significant results.

Each company, establishment, business, enterprise, or firm was interviewed only once for a given country and given year. There are no yearly repeats. There are 151 developing countries involving samples of some 43,707 firms for 2002-2005 and 71,789 firms for 2006-2010. The sample sizes for the actual responses selected as the surrogates and then when finally used in the regressions are considerably smaller, due to missing values. The sample sizes in the table of results will reflect this. Each interview is unique unto itself by country, by year, and by industrial sector. It is noted that while the surveys consisted of several hundred questions, only those relevant to analyzing firm-level dynamic corruption and feasible for statistical analysis were selected.

Econometric Models:

Since the dynamic model has two related equations, the rate of growth of the firm's output function and its shadow price function, the seemingly unrelated regression (SUR) technique is used. The operational equation for the rate of growth of output as a function of time, the optimal values of K(t)*, and the optimal values of M1(t)* and M2(t)* as discussed earlier is given by

(4) GRQ = a + b1*K + b2*t + b3*X + e,

where the dependent variable, rate of growth of output, GRQ, has the proxy given by the firm's annual sales growth in percent for one year ago, coded c2511y in the 2002-2005 data set and by e3, whether sales of the main product increased, remained the same, or decreased, recorded as 1, 2, and 3, in the 2006-2010 data set. While M2(t)* was not part of equation (2a) for simplification, it is included in the statistical model. Here and elsewhere the reverse order of the data is noted. The interpretation of the results with respect to the signs of the relevant coefficients will be based on the reverse order.

As indicated earlier, size K(t) has the proxy given by the average number of permanent employees for one year earlier than the interview year and coded c262aly in the 2002-2005 data set and labeled simply Size. For the 2006-2010 data set, Size is based on employment classified as small (< 20), medium (20 to 99 workers), and large (100 or more workers), recorded respectively as 1, 2, and 3. The t is for the year and labeled Year for both data sets, although the legal code for Year is a14y in the later data set. The X variable represents the managerial resource proxies. The e is the error term. Throughout the paper, the actual data codes are given along with the verbal labels to facilitate any future use of the same data set. In the table to follow, only the verbal labels are used.

The shadow price equation for (3) is operationalized by

(5) $\log\mu(t) = A + B1*K + B2*t + B3*X + e,$

where the time derivative of $\log\mu(t)$ is equal to B2, an estimate of $(r - g)$ in equation (3).

The shadow price $\mu(t)$ of K has the proxy given by whether the price of the main product increased, remained the same, or decreased, recorded as 1, 2, and 3 respectively and labeled e4 in the 2006-2010 data set (note the reverse order), and by c252, the percent of net profit reinvested in the firm in the 2002-2005 data set. The e is the error term.

The X's for equations (4) and (5) vary with the data set period. For the 2006-2010 data set independent variables include, c24d, internet used to do RND on new products and services—a proxy for M1 managerial uses and coded yes =1 or no = 2 (the 2 is changed to 0 to run the regressions) but later dropped due to too many missing values; f1, the percent of capacity utilized by the firm in 2007, again a proxy for M1 uses; j2, the percent of managerial time spent dealing with government regulations—a proxy for M2 use of managerial resources; and j7a, the percent of sales used to make informal payments to officials to "get things done," a proxy for M2.

The X's for the 2002-2005 data set represent a similar set of survey questions but they use different variable labels. The X's include c256, whether the firm's technology compared to its main competitors is less, the same, or more advanced, recorded as 1,2, and 3, respectively and used as a proxy for M1 managerial uses; c250, percent of annual capacity utilization last year, another proxy for M1; c267a, Does the firm offer formal training for permanent employees?, coded yes = 1 and no = 2 (again converted to 0), another proxy for M1; c2583, Was there an initiative in the last three years to under take new technology?, yes = 1 and no = 2 (converted to 0), a proxy for M1 uses; and c238, the percent of managerial time spent dealing with government regulations, a proxy for M2 uses to "get things done."

4. Statistical Results

At the outset, it is important to note that for reasons of missing values and insignificant coefficients, not all of the surrogate variables relating to M1 and M2 were finally used in obtaining the statistical results presented in the table. For some combination of X's the number of missing values was considered too large with insignificant coefficients, so the variables were not used. Other combinations of X's did not unduly affect the number of missing values, although some of the coefficients may not have been significant but were still used in order to have some representation of both M1 and M2 in equations (4) and (5). In all cases, the best judgment was used in selecting the X variables and reporting the statistical results.

Table 1 allows for a side-by-side comparison of the SUR two-equation (4 and 5) results for the two time periods. As indicated earlier, not all the surrogates for M1 and M2 are exactly the same for each time period. The table shows the variables in verbal labels (the technical codes were given earlier). To review the main differences, the equation (4) dependent variable, the GRQ, is the rate of growth of sales (a proxy for output) for the earlier time period and changes in the level of sales (increased, the same, decreased) for the later time period. The dependent variable for the shadow-price equation ($\log\mu(t)$), equation (5), is the surrogate, the log of the percent of net profit reinvested in the firm for the earlier time period and the log of the change (increased, the same, decreased) in the product price for the later time period. Other X-variable differences are indicated in the table.

The GRQ equation (4) for the earlier time period has significant coefficients for two of the M1 proxies with positive signs. As capacity use and formal training increase, the rate of growth of sales increases, suggesting an efficient allocation of managerial resources. The coefficient for the M2 proxy (percent of management time spent on working with government regulations) was not significant, so its efficiency status could not be determined. The coefficient for the time variable (Year) is significant but with a negative sign, indicating that over time, the rate of growth of sales (output) was declining. This result, as suggested earlier, is the dynamic aspect of the estimated equation.

The results for the later period were mixed. The M1 coefficient and the Size coefficient were both significant. The negative sign for the M1 capacity-use coefficient means that as M1 increases, output goes from 3 (low) to 1 (high), increasing (due to the reverse order), suggesting an efficient allocation of managerial resources. The negative sign for the Size coefficient means that as Size increases, output also increases (due to the reverse order discussed earlier). The two M2 coefficients (for management time … and sales to pay off …) were not significant, so efficient allocation could not be determined. On the other hand, the Year coefficient was significant and positive in sign.

The shadow-price equation (5) for the earlier period with one exception has significant M1 (formal training … and new technology …) and M2 (for management time …) coefficients with positive signs, indicating that managerial resources allocated to M1 and M2 activities (in terms of the proxies) had a positive effect on the firm's shadow price, suggesting an efficient allocation of managerial resources. The Year coefficient was significant but negative in sign, indicating that over time the shadow price of capital (K) was declining as a trend. Of and by itself this result is not inconsistent with the diminishing returns to size assumption sometimes found in capital theory. As indicated in the theory discussion of the dynamic model, a declining shadow price is not inconceivable.

For the later period, one M1 (capacity use) coefficient and one M2 (for management time …) coefficient are both significant. The M1 coefficient was negative in sign, indicating that as capacity use increased, the shadow price of capital went from 3 (down) to 1 (up), thus increasing (again recognizing the reverse order of the way the data were recorded), suggesting again an efficient allocation of managerial resources. The Size coefficient was significant and also negative in sign, indicating that firm size had an increasing effect on the shadow price of capital (recognizing again the reverse order).

The significant and positive sign for the M2 coefficient (percent of management time spent on working with government regulations) indicates that this use of managerial resources had a negative effect (due to the reverse ordering of the price change) on the shadow price of capital. This surprise result would seem to suggest an inefficient use of managerial resources. The Year coefficient was significant and positive in sign, indicating that over time, the shadow price was increasing, controlling for the other factors.

As to the degree of fit of the equations to the data, the R-sq's are small but significant and not out of line from other studies using firm-level subjective data (for example, Kaufmann and Wei, 1999). As to the appropriateness of the SUR simultaneous equation approach, the Breusch-Pagan Chi2(1) was significantly different from zero (although the p value for the earlier time period is relatively high), indicating that the two equations are not independent of each other, but interdependent, regardless of the time period considered.

Having surveyed the relevant statistical results, the earlier stated two-part question, What role does firm management have in the corruption and productivity process? and Can this role be measured?, can now be addressed. The simple managerial dynamic corruption model by itself has been useful in providing the basis for describing at the firm level the managerial role in corruption and productivity. As to the link between the model and the data, considering the subjective nature of the firm-level data, the results were mixed within and between the two time periods.

Overall, for both time periods and both equations, there were fourteen surrogates used for M1 and M2 managerial activities. Of these, eight coefficients were statistically significant. For the earlier time period, based on the M1 and M2 surrogates, managerial resources were generally allocated efficiently 5 out of 8 times with respect to output growth and shadow price behavior. For the later time period, the efficient allocation score was 3 out of 6 times. All-in-all, these are good odds for accepting the link and the measurement of the managerial role in the corruption and productivity process. This is not to say that there are no unsettled questions. Future research can address these.

5. Summary and Conclusions

A simple dynamic model of efficient firm-level managerial resource allocation to two uses, one involving essentially productivity activities and another one involving activities associated with corruption to "get things done" was developed. The goal of the firm is to choose inputs capital and managerial resources to maximize at each instant of time t the rate of growth of the output of the firm. The model has two dynamic functions, one using the rate of growth of the firm's size (capital) and another one using the rate of growth of the shadow price of capital. Both of these functions are dependent on the capital input and the specified managerial uses. Together, they form the basis for two operational equations. The empirical part of the paper links firm-level subjective data on surrogates for the firm's capital and its managerial inputs to the two operational equations of the model, using domestically owned firms in developing economies. The SUR method was used to estimate jointly these equations. The fit of the operational equations and the overall statistical results were then discussed.

Considering the nature of the subjective data, overall, it can be concluded that there is some evidence to argue that the managerial surrogates do a reasonably good job in measuring the efficiency role of firm management in the corruption and productivity process. Of particular note are the surrogates, capacity use, formal training of workers, and management time spent on working with government regulations.

In general, M1 had a positive effect on firm growth and capital value, but not M2. This would by itself suggest that M2 managerial resource allocation was not an efficient use in terms of growth. But, when it comes to the value of capital, both M1 and M2 have a positive effect (with one exception for M2). To summarize, M1 use is expected to improve growth, but M2 is expected to improve capital value. So, implicitly there is a trade-off between growth and value and correspondingly between M1 and M2. Theoretically, this trade-off is controlled by the first-order conditions in equation (2). If there were direct, explicit measures of managerial resources for the sample involved, then more could be inferred about the trade-off and particularly about the behavior of the ratio of M1/M2. Unfortunately, such is not the case.

What policy implications are valid for the current results will depend on what weight one puts on the proxy approach and on managerial efforts to increase productivity versus managerial efforts to increase value. Looking down the road of time, corruption efforts will perhaps become less and less important as firms and developing countries move into the developed category and expenditures on corruption become, in effect, internalized into the market system and the cost of running the government and the firm.

If this conjecture turns out to be correct, then, the best long-run policy prescription would be for developing countries to focus on educational and technical efforts of all types and to encourage firms to focus on managerial efforts to increase technology and output productivity.

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Table 1. Dynamic SUR Corruption Results		
	TimePeriod	
	2002-2005	2006-2010
Dep. Variable (EQU 4)	%Sales Growth	Sales Change
Variables Constant	141603	-467
	(6.60)***	(-3.65)***
Size in Employment		-.169
		(-4.27)***
Ave Capacity Use—M1	.1800	-.005
	(1.77)*	(-3.69)***
Formal Train for Employ—M1	8.660	
	(2.22)**	
New Tech Initiative—M1	4.094	
	(1.04)	
% Mang Time on Gov Reg—M2	-.028	.0014
	(-0.19)	(1.22)
%Sales Inform Pay to Offs—M2		-.0056
		(-1.60)
Year	-70.70	.234
	(-6.60)***	(3.67)***
Dep. Variable (EQU 5)	Log(%Profit Reinvest)	Log(Price Change)
Variables		
Constant	541	-72.2
	(2.51)**	(-1.14)
Size in Employment		-.047
		(-2.39)**
Ave Capacity Use—M1	.0015	-.0019
	(1.45)	(-2.94)**
Formal Train for Employ--M1	.239	
	(6.09)***	
New Tech Initiative—M1	.069	
	(1.75)*	
%Mang Time on Gov Reg—M2	.0043	.0011
	(2.95)**	(2.04)**
%Sales Inform Pay to Offs—M2		-.0023
		(-1.30)
Year	-2.68	.042
	(-2.49)**	(1.32)

Sample Size (n)	2791	760
R-sq (EQU 4) (p)	.018 (.000)	.062 (.000)
R-sq (EQU 5) (p)	.023 (.000)	.028 (.000)
Breusch-Pagan Independ Test: Chi2(1)	2.712	69.724
Significance (p)	(.0996)	(.000)

Notes: The * indicates significant for $.05 < p < .10$, the ** indicates significant for $.01<p<.04$, and the *** indicates significant for $p < .000$. The (.) has z. All firms are domestic. A dummy variable for domestic ownership (1) and foreign ownership (0) was included in other runs not reported for it was never significant. Some 86 percent of the firms in the sample are domestic.