

Essays in Law and Economics

by

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Dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Department of Economics
in the Graduate School of Duke University
2009

ABSTRACT
(Economics)

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Abstract

This dissertation comprises of three essays in law and economics. The first chapter, a joint work with my advisor, Marjorie McElroy, examines the longly debated effect of the liberalized divorce laws in the United States on the divorce rates during 1956-1989. In our paper, we distinguish between the change in the *ground for divorce*, which includes grounds such as irreconcilable differences or living separate and apart for a considerably shorter period, and the change in the *property rights to divorce* from a mutual consent to a unilateral divorce. Using our independently researched divorce laws, we perform a spline linear regression and conclude that divorce grounds such as irreconcilable differences or living separate and apart for less than 2 years are likely to increase the divorce rates. A switch from a mutual consent to a unilateral divorce, however, does not have a statistically different effect on the divorce rates.

Chapter two and three are two related papers on the theoretical and empirical analysis of bribery. In chapter two, I develop a generalized Nash bargaining model of bribery that simultaneously determines the incidence of bribery and the level of bribe. The paper discusses a number of advantages of a cooperative game theoretic modeling of bribery and emphasizes on the role of risk aversion of agents on the effectiveness of various anti-bribery measures . A number of testable implications and contributions to the literature include the effect of the degree of risk aversion, the probability of detection, the level of penalty, and public compensation reform on bribery.

In chapter three, I use firm level data on bribery from The Business Environment and Enterprise Performance Survey (BEEPS) in 2005 to analyze the empirical determinants of the incidence of bribery and the level of bribe. The estimation methodology follows a standard discrete choice estimation for the incidence of bribery and a least square regression for the level of bribe. I also perform two robustness analyses: an *endogeneity correction* using an instrumental variable method for variables such as profit and a *survey response bias correction* for bribe-giving firms that may not reveal the truth in the survey. The estimation produces statistically significant estimates whose signs are consistent with the conjecture. In addition, I found that an increase in the judicial quality as perceived by firms significantly reduces the bribery incidence as well as the amount of bribe in the executive branch. The findings suggest that bribery is more rampant among emerging business entrepreneurs and that an effective judiciary tends to provide a good check and balance that deters the corruption within the executive branch in the country.

To my parents

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Introduction

This dissertation comprises of three chapters. The first chapter examines the longly debated effect of divorce laws on divorce rates in the U.S.A. during 1956-1989. Chapter two and chapter three are two related essays on the theoretical and empirical analyses of bribery. While the two topics, divorce and bribery, are seemingly unrelated issues, the underlying tool that I use to analyze these subjects are the same, that is, they are both treated as outcomes that result from a cooperative game between economic agents. In particular, divorce, in the spirit of [27], resulted when the utility possibility frontier from marriage falls below what the spouses would gain after the divorce. Similarly, bribery occurred when the utility possibility frontier of the bribe giver and the bribe taker is outside their *status quo* utility.

The first chapter is a joint work with my advisor, Marjorie McElroy. In particular, we seek to answer whether the steep rise in U.S. divorce rates from the late 1960's through the early 80's due to contemporaneous sweeping changes in state laws governing divorce. And if so, since divorce laws have changed little since then, what accounts for the decline and leveling off of divorce rates since the early 1980's? Among others, three successive AER articles attempted to determine whether unilateral divorce laws contributed to the early rise. From article to article the answers flip-floped between 'yes' and 'no' with the no's interpreted as corroborating the Coasean world in which the efficiency of a divorce is independent of the property rights to divorce, and the yes's interpreted as contradicting it.

Using state panel data, this paper uses a unified framework to explain the variation in divorce rates within states over time. We model divorce costs under fault regimes as the cheaper of two options, waiting separate and apart for the legally mandated minimal length of time, or proving fault in court. Similarly, for no-fault regimes, the cost of divorcing is the cheaper of waiting separately and apart for the legally mandated period of time, or the cost of getting a no-fault divorce. This model yields a straightforward measure of the seemingly-complicated, successive, state-specific liberalizations of grounds for divorce. This model also leads to a non-linear econometric specification that fully accounts for the state-specific changes in waiting times as well as the passage of no-fault laws and of unilateral divorce laws.

Our study has four advantages over earlier studies. First, we integrate the separate effects of three dimensions of divorce laws on existing marriages, namely waiting times that are sufficient grounds for divorce, whether grounds for divorce are fault or no-fault and whether (property) rights to divorce require mutual consent or belong unilaterally to each spouse. Secondly, we account for the indirect effect of legal changes on the quality of the stock of marriages over time. Third, we allow for correlated structure in the state-specific error terms as did [18]. Lastly, following [18] we mark the beginning of legal changes with implementation dates, not passage dates.

We find that divorce grounds that allow for incompatibility in the marriage or living separate and apart for less than two years significantly increases the divorce rates. This effect, via the reduction in the cost to divorce as opposed to the old regime where couples must prove to the court that faults have been committed, a relatively costly process. As opposed to previous empirical studies such as [16] and [45] who do not distinguish between a no-fault mutual consent and a no-fault unilateral divorce law, we find that the unilateral law does not *increase* the divorce rates. In particular, we find that a unilateral divorce law, controlled for the change in the cost to divorce, does not have any significant effect on the divorce rates up to

approximately six years after the law was passed. We however find that the law has a negative and significant effect on the divorce rates about six to ten years after the passage of the law, before this effect begins to subside. The finding is in coherent with the predicted selection effect of the unilateral divorce law, which increases the matching quality of the spouses and thereby reduces the divorce rates.

The second chapter proposes a generalized Nash bargaining model of bribery between an official and a firm. While the game theoretic model of corruption and bribery has received attention from economists and political scientists for many decades (see, for example, [36], for her pioneering work in the economics of corruption), the role of risk aversion of agents on the prevalence of bribery and the equilibrium level of bribe has been left relatively unexplored. In my model, as opposed to previous models by [9] and [30] with risk neutral agents, the degree of risk aversion of related agents in the bribery game is shown to play a crucial role in determining the effectiveness of some anti-corruption policies such as the public compensation reform.

The model yields a generalized result of the the well known proposition in [9] and [30] that a public wage reform will induces a trade-off between a reduction in the prevalence of bribery and an increase in the equilibrium bribe among officials who continue to take bribe. In particular, I argue that such trade-off may not exist when the initial wage of the official is relatively high. This justifies, for example, a relatively large wage gap between high and low ranking officials in one of the most corruption-free countries such as Singapore. In addition, I also show how an effective judicial system may be an effective anti-corruption measure that is able to reduce the incidence of bribery as well as lower the equilibrium bribe. Other main predictions of the model are that the prevalence of bribery is decreasing in the severity of the penalty imposed on either player, the gain from bribery, the initial status quo profit of the firm, an increase in the degree of risk aversion of the player, the probability

that bribery is detected, and the morality of the official. The equilibrium bribe is decreasing in the penalty imposed on the firm and the degree of risk aversion of the official, but increasing in the penalty imposed on the official and the degree of risk aversion of the firm. The effect of the probability of detection, the gain from profit, and the salary of the official must however be empirically determined.

The last part of the chapter discusses the role of the state in coping with corruption. I analyze the response of the firm toward the bribe, i.e. how the quantity of goods produced is altered by the bribe payment to the official and show that, depending on the penalty scheme imposed on the agents involved in bribery, the presence of bribery does not necessarily reduce the level of goods produced compared to that in the absence of bribery. In a world where the state adopts a teleological perception towards bribery, i.e. when the economic outcome resulting from bribery rather than the act of bribery *per se* is a matter of concern, I also discuss the tax-like effect of bribery and show how bribery, with an appropriately designed penalty scheme, can be used to deter unwanted commodities, such as illegal drugs, prostitution, and gambling. The chapter concludes with an optimal penalty scheme that minimizes the level of bribe in the presence of bribery.

The last chapter is an empirical analysis of the determinants of the prevalence of bribery and the level of bribe. The chapter aims to test some of the testable implications of the model developed in chapter two. As is well known, the lack of reliable corruption related surveys is not uncommon due to the nature of corruption that normally precludes the respondents from truthfully the information. Most empirical studies of corruption must therefore rely on surveys of expert's opinions. Conclusions drawn from these studies are as a result subject to a number of measurement errors.

A notable exception to the aforementioned practice is [40] who conducts a private survey of the bribe experience of Ugandan firms in 2003. He finds that firms with higher profit per employee significantly pay more bribe, a result consistent with his

conjecture that officials are able to extract larger rent in terms of bribe payment from larger firms. In this chapter, I acquire firm-level data from BEEPs 2005, a publicly available data conducted by the World Bank that covers a number of Eastern European countries including former Soviet Union states, and test a number of conjectures derived from the model of bribery developed in chapter two. The survey contains a detailed information of the characteristics of the firm such as type of ownership of the firm, the number of years the firm has operated, financial characteristics including profit, and various types of cost, as well as some corruption-related information such as whether and how much firms pay in unofficial payment.

As opposed to the previous specification a la [40], I attempt to differentiate between two types of profit: the profit that the firm gains *after* the bribe and the profit that the firm gains *before* the bribe. Although the survey contains no explicit information that would allow ones to distinguish between the two, I conjecture that firms normally pay bribe to increase their sale revenues through secured government contract or to lower tax payment. The sale reported by the firm in the survey is then used as a proxy variable for the profit after the bribe and other firm's characteristics such as firm size and the labor cost is used as proxy variables for the *status quo* profit of the firm. The survey also contains the information related to the perception of the firm towards the judicial quality of the country in which the firm operates, a variable used as a proxy variable for the probability that the agents involved in bribery is found guilty and subsequently punished.

The model is initially estimated using two separate equations: a probit equation for the incidence of bribery and an ordinary least squares for the level of bribe, with profit, firm size, the perception of the firm towards the judicial quality, and other controlled variables. The estimated coefficients are highly significant, and the signs are all in accord with the theory, i.e. the prevalence of corruption is decreasing in the level of profit, the size of the firm, and the effectiveness of the judiciary as

perceived by the firms. The level of bribe is increasing in the profit but decreasing in the firm size, a result coherent with the gain from cooperation and the threat point conjecture. An increase in the judicial quality also significantly decreases the amount of bribe, which confirms that a strong check and balance system between the judiciary and the executive is an effective anti-corruption policy.

I perform two robustness analyses: the endogeneity correction and the survey response bias correction. Some explanatory variables such as profit are endogenous by construction, that is, firms gain higher profit after they pay bribe. Indeed, the profit is found to be endogenous while the size of the firm and the labor cost are not. This supports the previous conjecture that the former is a suitable proxy for the profit after the bribe while the latter is an appropriate proxy for the status quo profit. The endogeneity problem is corrected using standard procedures of instrumental variable regression, which yields estimation results similar to the previous findings.

As the nature of bribery may induce some bribe-giving respondents to lie, I correct for the survey response bias using the method of maximum likelihood under the assumption that some respondents who report no bribe experience may lie while those who report incidence of bribery truthfully report the amount of bribe paid. The results found after this correction are consistent with the previous ones. The findings suggest that bribery is more rampant among emerging business entrepreneurs and that an effective judiciary tends to provide a good check and balance that deters the corruption within the executive branch in the country.

The Dimensions of Divorce Laws

1.1 Background

In 1969, Governor Ronald Reagan of California signed the Family Law Act that allowed for a law that has become known as the no-fault unilateral divorce law. In essence, the act has replaced the traditional fault grounds for divorce such as adultery, cruelty, and desertion by irreconcilable difference between the spouses. In addition, it also allows one spouse to file for divorce without the mutual consent of the other. The law was originally enacted as a mean to restore the sanctity of the law since many unhappy couples are willing to pay a high price to end the doomed marriages, even if ones must commit perjury in court. In the United States before 1950, the so-called fault era of divorce law since divorces were granted only on fault grounds, perjury was almost foreseen in the family court. According to an interesting remark by Judge Henry Fenn in 1911, ‘there is probably no tribunal in the country in which perjury is more rife than in the Divorce Court, which has been known in some quarters as the playground of perjurers’. In New York, where divorce at that time was practically limited to adultery, the following adultery charade, as was

vividly retold by [17], was common in the court. The plaintiff, typically the wife, would present to the court photographs of her husband taken in bed with another woman, who was hired by the couples' lawyer to fabricate an evidence of adultery. In California before 1969, where cruelty was a popular ground, the court scenario was captured by Justice Stanley Mosk of the California Supreme Court as follows:

Every day, in every superior court in the state, the same melancholy charade was played: the 'innocent' spouse, generally the wife, would take the stand and, to the accompanying cacophony of sobbing and nose-blowing, testify under the deft guidance of an attorney to the spousal conduct that she deemed 'cruel'.

Many states followed California and liberalized their divorce laws in the 1970s in one way or another. Some states, such as Colorado, immediately allowed for grounds such as incompatibility in the marriages, irreconcilable differences, and irretrievable breakdown (hereafter referred to as an III ground) and unilateral divorce at the same time. Some, such as Delaware, only allowed for an III ground but retained the mutual consent requirement of both spouses to file for divorce. And some, such as Virginia, chose not to pass any new grounds for divorce but instead reduced the time the couples were required to separate in order to file for divorce on living separate and apart ground. As shown in Figure, the divorce rates at the national level markedly increased during the early 1970s, reached their peak in the early 1980s, the time after which an urge to relax the divorce laws finally subsided, and started to decline afterwards.

There continue to be a heating debate whether the rise is due to the change in the divorce laws. But what laws, if any, actually attribute to the increase in the divorce rates? It is important to emphasize the distinction between a *unilateral divorce law*, which switches the property rights to divorce from the spouse who wants to keep to

the one who wants to dissolve the marriage, and a *no-fault divorce law*, which lays out the ground for divorce that directly affects the cost of getting a divorce. The laws in most states also make clear whether both or only one is allowed. Consider for example from the state of Nevada, where both an III ground and a unilateral divorce are allowed:

§125:010 Divorce from the bonds of matrimony may be obtained for any of the following causes: No Fault: 1. When the husband and wife have lived separate and apart for 1 year without cohabitation the court may, in its discretion, grant an absolute decree of divorce at the suit of either party. 2. Incompatibility. Fault: 1. Insanity existing for 2 years prior to the commencement of the action. Upon this cause of action the court, before granting a divorce, shall require corroborative evidence of the insanity of the defendant at that time.

§125:120 In any action when it appears to the court that grounds for divorce exist, the court in its discretion may grand a divorce to either party.

This is in contrast with the state of South Dakota, where a mutual consent is required:

§25-4-17.2 The court may not render a judgment decreeing the legal separation or divorce of the parties on the grounds of irreconcilable differences without the consent of both parties unless one party has not made a general appearance.

These laws not only differ in their legal definitions, but also in the economic implication of their effects. No-fault divorce laws tend to decrease the cost of filing for a divorce since ones no longer need to prove faults and hence are likely to increase the divorce rates. The effect of unilateral divorce law is however more controversial. [7],

in his explanation based on the Coase theorem, argues that the law merely changed the property rights and the law should not affect the divorce outcome absent the transaction cost of resource allocations between the spouses. The Becker conjecture is further elaborated by [33] who develops a compensation scheme to show how the divorce outcome is the same under the mutual consent and the unilateral divorce law. In another important theoretical contribution, [12], using a Scitovsky compensation criterion, shows that a unilateral divorce law may increase, decrease, or have no effect on the divorce rates even when the transaction cost of reallocating the resources between the spouses is minimal.

The effect of unilateral divorce law therefore remains an empirical question and tends to be inconclusive. Some studies such as [33] find that the law has no effect on the divorce rates while others such as [16] and [45] find that the law significantly increases the divorce rates. In this paper, we identify three methodological issues that contribute to the possibly erroneous findings in these studies: the omitted bias in studies that treat the unilateral and no-fault divorce laws as synonymous, the measurement error in the law from different interpretation of the law, and failure to take into account the autocorrelated structure of the error terms in the estimation. The challenge is whether or when living separate and apart ground becomes a no-fault ground because even though this ground is widely regarded as a no-fault law *de jure* since couples are allowed to divorce without having to establish fault grounds, one may cast doubt on whether such law is a no-fault law *de facto* since those who are eager to get a divorce may choose to prove or fabricate evidence to prove faults rather than wait especially when the required waiting period is too long.

1.2 Literature Review

To our knowledge, most empirical studies on the effect of divorce laws, with the exception of [18] and [21], treat unilateral divorce law and no-fault divorce law as

synonymous. The effects of these laws can be very different from the theoretical perspective since the former law defines the *rights to get a divorce* while the latter law lays out the *ground for divorce*.

The effect of unilateral divorce law from a theoretical perspective was first discussed by [7] in his *Treatise on the Family*. The argument, based on a version of Coase theorem of property rights, follows that the change from a mutual consent divorce to a unilateral divorce is merely a change of the rights to divorce from the spouse who wants to stay in the marriage to the one who wants to divorce. Absent the transaction cost in the bargaining process between spouses, this should not affect the efficiency of the marriage and hence the divorce outcome. Whether a couple decides to get a divorce will depend on the *total* gain from divorce rather than the gain of each spouse before the bargaining takes place since the gainer can always compensate the loser to agree to the outcome. A more elaborate transfer scheme is shown in [33] based on this argument.

Another significant theoretical contribution to the subject is in [12]. Using Sci-tovsky compensation criterion, he shows that the effect of unilateral divorce law may be uncertain even when the cost in the bargaining process is minimal. In essence, the effect of these laws depend on the shape of the utility possibility frontiers of the spouses before and after the divorce and the allocation of the resources in each scenario. In the case when the two frontiers never cross, the implication is similar to Becker's since the divorce outcome is determined by the total gain alone. However, a comparison of the effects of mutual consent and unilateral divorce law becomes uncertain when the frontiers cross. In this situation, both the initial and the post divorce allocations are important. If the allocations are on the outer frontier of the union of the utility possibility sets from marriage and divorce, then it is possible that a change from a mutual consent divorce to a unilateral divorce will increase the divorce rates. Conversely, if the initial allocations are inside the union of the utility

possibility sets, then divorce rates in a mutual consent regime may be *higher* than those in a unilateral regime.

The Coase-Becker argument is further elaborated in [33], who develops a compensation scheme for husband and wife and shows that the divorce outcome only depends on the combined resources of the spouses. Using cross-sectional data on women from the Current Population Survey in 1979, she found no difference in divorce rates between women living in unilateral versus mutual consent states. [4] reexamined Peters' results by controlling for geographical heterogeneity in divorce propensities and found a significant impact of the law. Using an ordinary least squares method, [16] proposed to resolve this dispute by regressing state panel data of divorce rates during 1970-1985 on a dummy variable of unilateral divorce law that is one if the state adopts this law at that time and zero otherwise. State and time fixed effects are included in the regression to control for differences across states over the national level and differences over time. Moreover, a state-specific linear and quadratic time trends were included to control for other unobserved heterogeneity at the state level. The results, which are robust to different legal classifications, show that unilateral divorce significantly increases divorce rates and that this change is permanent. [45] replicated Friedberg's results, expanded the range of the analyzed data to 1956-1988, and modified Friedberg's model to capture the dynamic effect of the law by including a set of dummy variables that indicate how long the law has been in effect. He finds that unilateral divorce law significantly increases the divorce rates, but in contrast to Friedberg, finds that the effect of the law lasts for less than ten years.

The model used by [16] and [45] is a differences-in-differences model in spirit and the estimation technique is an ordinary least squares. However, if the error terms are autocorrelated over time, and this problem is ignored in the estimation process, and as [8] showed, the standard errors are likely to be underestimated. Moreover,

these studies do not specifically address the difference between the effect of a no-fault divorce law (whether mutual consent or unilateral) versus a fault divorce law and the difference between the effect of a unilateral no-fault law versus a mutual consent divorce law. As most states tend to make a regime switch from a fault divorce regime to a unilateral no-fault divorce regime, any significant impact of these laws on an increase in the divorce rates in studies that make no distinction between these laws may be attributed to either a decrease in the cost of divorce via the no-fault law or a significant bargaining cost between spouses that increases the divorce rates via the unilateral law. [21], using an ordinary least squares method, replicated the results in [45] and included another set of dummy variables for no-fault divorce laws à la Wolfers using data from [20] and found that the increase in the divorce rates is explained by the inclusion of some types of no-fault divorce laws such as incompatibility or living separate and apart as permissible grounds for divorce rather than unilateral divorce law. The problem that may arise in this study is due to the fact that all states that allow for a living separate and apart ground, regardless of the length of the required time, belong to the definition of a no-fault state in [20]. For example, Rhodes Island, a state that as early as 1893 allowed for a divorce when couples can prove that they have been living apart for 10 years, is classified as a no-fault state as of that period. In a more recent study, [18] reviewed the historical data of divorce law reforms in all states, expanded the range of the data in the analysis to 1940-2005, and used the year in which the law was in effect rather than the year in which the law was passed to construct divorce law variables. Effects of separation ground and III ground on the divorce rates are studied separately and the estimation technique allows for a first order autocorrelated structure of the error term. In contrast to the previous findings, none of the laws appear to have a significant impact on the change in the divorce rates. The results in [18] may however be subject to the same definition problem of the living separate and apart ground as we previously argue. A reduction

in the separation time to a new level that is still high, e.g. from 10 to 8 years, may have no impact on the divorce rates since couples may find a cheaper alternative to divorce by fabricating evidence of faults and filing for a divorce on these grounds. A model that analyzes the effect of a reduction in the waiting period using a binary variable that merely indicates whether living separate and apart is permissible as a ground for divorce can therefore be faulty.

1.3 Data

One of the most common sources in the difference in the findings of the effect of divorce laws on divorce rates is the data. While the data on the divorce rates used in most studies is often reliable and consistent across studies, such is not the case for historical data on divorce laws. In our study, we consider that a state s has a unilateral divorce law at time t if one of the spouses is allowed to file a divorce based on an III ground during January and June of year t or during July and December of year $t - 1$. Note that we consider the year that the law is in effect rather than the year that the law is passed since any change in the divorce rates that is due to the law is likely to be observed only after the law has been in effect for some periods. In fact, in states where there exists a considerable gap between the time that the law is passed and the time that the law is in effect, the divorce rates are most likely declining during that period since most couples will want to take advantage of the law that provides divorce at a lower cost. Note also that we consider an III ground a necessary condition for a unilateral divorce.

This is due to the fact that many states define living separate and apart as living apart in two different addresses as well as the absence of any sexual intercourse during that period. We therefore regard living separate and apart as a ground that requires a mutual consent in our study since the disagreed party can always petition to the court that they engage in sexual intercourse during the separation period, a

State	Separation		No-fault ground		Wolfers	Friedberg
	Length	Year	III	+ Unilateral	Unilateral	Unilateral
Alabama	5	1915	1972	1972	1971	1971
	2	1947				
Alaska			1935	1935	1935	pre-1968
Arizona	5	1931	1974	1974	1973	1973
Arkansas	3	1937				
	1.5	1991				
California			1970	1970	1970	1970
Colorado			1972	1972	1971	1971
Connecticut	1.5	1973	1973	1973	1973	1973
Delaware	3	1957	1975			
	1.5	1968				
DC	5	1935				
	1	1966				
Florida			1972	1972	1971	1971
Georgia			1973	1973	1973	1973
Hawaii	3	1967	1974	1974	1973	1973
	2	1970				
Idaho	5	1945	1971	1971	1971	1971
Illinois	2	1984				1984
Indiana			1974	1974	1973	1973
Iowa			1971	1971	1970	1970
Kansas			1970	1970	1969	1969
Kentucky	5	1850	1972	1972	1972	1972
Louisiana	7	1916				pre-1968
	4	1932				
	2	1938				
	1	1979				
	0.5	1991				
Maine			1974	1974	1973	1973
Maryland	5	1937				pre-1968
	3	1947				
	1.5	1961				
	1	1983				
Massachusetts			1976	1976	1975	1975
Michigan			1972	1972	1972	1972
Minnesota	5	1935	1974	1974	1974	1974
	1	1974				
Mississippi			1977			
Missouri			1974	1974		
Montana	0.5	1976	1976	1976	1975	1975
Nebraska			1972	1972	1972	1972
Nevada	5	1931	1967	1967	1973	1973
	3	1939				
	1	1967				
New Hampshire	3	1938	1972	1972	1971	1971
	2	1957				
New Jersey	1.5	1972	2007			1971

State	Separation		No-fault ground		Wolfers	Friedberg
	Length	Year	III	+ Unilateral	Unilateral	Unilateral
New Mexico			1933	1933	1973	1973
New York	1	1968				
North Carolina	10	1907				
	5	1921				
	2	1933				
	1	1965				
North Dakota			1971	1971	1971	1971
Ohio	2	1975	1990			1974
	1	1982				
Oklahoma			1953	1953	1953	pre-1968
Oregon			1972	1972	1973	1973
Pennsylvania	2	1988	1981			1980
Rhode Island	10	1893	1975	1975	1976	1976
	3	1975				
South Carolina	3	1969				1969
	1	1979				
South Dakota			1985		1985	1985
Tennessee	2	1977	1977			
Texas	10	1925	1970		1974	1974
	7	1953				
	3	1967				
Utah	3	1965	1987	1987		pre-1968
Vermont	3	1941				pre-1968
	2	1971				
	0.5	1972				
Virginia	3	1960				pre-1968
	2	1964				
	1	1975				
Washington	8	1917	1973	1973	1973	1973
	5	1921				
	2	1965				
West Virginia	2	1969	1978	1978		pre-1968
Wisconsin	5	1866	1978			1977
	1	1978				
Wyoming	2	1939	1977	1977	1977	1977

Table 1.1: Divorce laws in the United States, 1850-1995. The length of the separation requirement is in years. Sources of separation requirement are [13] and [44]. The III ground refers to divorce ground that includes such terms as incompatibility, irreconcilable difference, and irretrievable breakdown where a mutual consent is required. The column with + Unilateral refers to the year in which no mutual consent is required to file a divorce based on the ground in the preceding column. The year used in our analysis is rounded up to the next year if the divorce law is effective after June of that year. The year used in Wolfers and Friedberg is based on the calendar year.

claim that is very hard to disprove.

The main sources of the required separation period that is sufficient for a couple to file for a divorce on living separate and apart ground are [44] and [13]. In states that do not explicitly allow living separate and apart as a ground for divorce, we adopt a common law rule that a very long separation period (e.g. eight or more years) is a sufficient ground for a divorce. In fact, there exists a very fine distinction between *desertion*, when one party wilfully leaves the other, and *separation*, when the decision to live apart is often consensual. For example, in *Cagle v. Cagle* 193 Ga. 34 (17 S.E. 2d 75), the Supreme Court of Georgia defined desertion as ‘the voluntary separation of one of the married parties from the other, or the voluntary refusal to renew a suspended cohabitation, without justification either in the consent or the wrongful conduct of the other’ while ‘a separation by mutual consent of the parties does not constitute desertion’. Spouses who both want a divorce may therefore live apart for a long enough period and file for a divorce on desertion ground even when the state does not explicitly allow living apart as a ground for divorce.

1.4 A Least Cost Model of Choosing Grounds for Divorce

In this section, we develop a model that allows us to estimate the effect of various divorce laws on the divorce rate. While some grounds such as incompatibility and irreconcilable differences in the marriage are clearly no-fault grounds, it is difficult to decide if living separate and apart for a specified length of time should be included as a no-fault ground. Although a waiting period is widely regarded as a no-fault law *de jure* since couples are allowed to divorce without having to establish fault grounds such as adultery or cruelty, one may cast doubt on whether such law is a no-fault law *de facto* since those who are eager to get a divorce may choose to prove or fabricate evidence to prove faults rather than wait especially when the required waiting period is too long. It is therefore often difficult to decide if or when waiting period is truly a

no-fault ground. The model developed in this section aims to overcome this difficulty by estimating the *de facto* no-fault waiting time such that couples no longer choose to prove fault grounds if the required waiting period is less than or equal to this threshold.

Let a couple i differ from others in their (total) benefit (B_i) and cost (C_i) of the divorce. Both the benefit and the cost can be expressed as a sum of the deterministic part that is similar for all marriages, and a stochastic part that is couple-specific, i.e.

$$\begin{aligned} B_i &= B + \eta_i \\ C_i &= C + \nu_i, \end{aligned}$$

where B and C are the deterministic part and η_i and ν_i are the stochastic parts of the benefit and cost, respectively. Cost is comprehensive including financial costs, time costs, and psychic costs. Couples residing in a state that adopts regime r can choose to divorce either by filing for a divorce and paying c_r , or choosing to wait for a state mandated waiting period (w) before getting divorced. If they wait by living separate and apart, their cost equals $c(w)$, where $c(\cdot)$ is a continuous function that is increasing in w . The cost associated with any state divorce law can be fully specified by indicating the grounds for divorce, the property rights to divorce, and the waiting period sufficient for divorce. Let state s at time t be classified into one of the three mutual exclusive and exhaustive regimes as shown in Figure 1.2. The columns indicate whether fault grounds are required or whether no-fault grounds, which include grounds such as incompatibility in the marriage, irretrievable breakdown, and irreconcilable differences, are permitted. Some states allow both no-fault as well as fault grounds. In these states, no-fault grounds are almost always used (reference). Hence, we classify such states as no-fault. The rows indicate whether a unilateral divorce is permitted. Note that we define a unilateral divorce law such that

		No-fault grounds	
		No	Yes
Unilateral	No	Regime 1 (1,162)	Regime 2 (159)
	Yes	–	Regime 3 (872)

Table 1.2: Regime of divorce laws. The number in the parenthesis denotes the number of observations in our data during 1956-1988.

all unilateral divorces must be filed on an no-fault ground for the reason explained earlier. Regime 1 is the fault regime in which couples filing for divorce must prove faults and pay the cost equal to c_1 . Regime 2 is the III mutual consent regime in which couples are required to file for a divorce based on any of the III ground and both spouses must agree to the divorce. We conjecture that $c_2 \leq c_1$, that is, the cost of filing for a divorce in this regime is lower than that in the state where a fault ground must be established since, say, adultery and cruelty are harder to prove in practice than incompatibility and that adultery and cruelty can always be cited in the court as an evidence of incompatibility in the marriage. The last regime is the no-fault unilateral regime in which either party can file for a divorce based on any of the no-fault ground and pays the cost equal to c_3 . In general, it follows from the Coase theorem that $c_3 \leq c_2$, with strict inequality when a significant transaction cost is incurred during the rebargaining process between the spouses.

Couples optimize by getting a divorce if and only if the benefit exceeds the cost of divorce, and choosing the cheapest cost of divorce available. For simplicity, we assume that there is no migratory divorce. Hence, couple i divorces if and only if

$$\nu_i - \eta_i < B - \min \{c_r, c(w)\}, r \in \{1, 2, 3\}.$$

Note from previously that we make use of the Coase theorem so that the divorce outcome depends on the total resources left after the divorce rather than the resource allocated to each individual. Let the difference in the stochastic parts $\nu_i - \eta_i$ follow

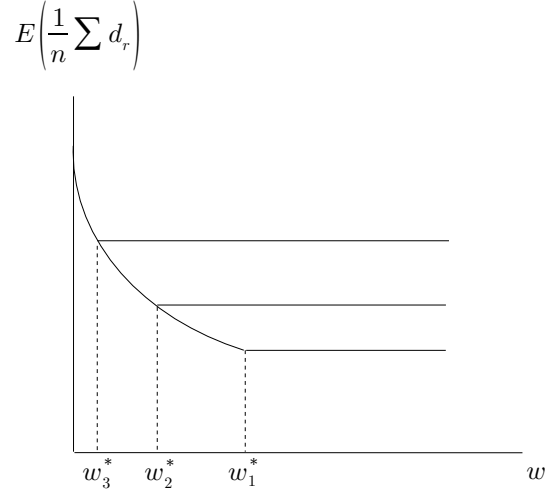


FIGURE 1.1: The effect of waiting time on the expected divorce rates in different regimes.

a well defined probability distribution function \mathcal{F} , and d_i be a binary variable that is equal to one if couple i divorces and zero otherwise, the (expected) average divorces in an economy with n marriages in state that is in regime r is given by

$$\mathbb{E} \left(\frac{1}{n} \sum_{i=1}^n d_{ir} \right) = \mathcal{F} (B - \min \{c_r, c(w)\}) . \quad (1.1)$$

Let w_r^* be the fault equivalent waiting period such that $c_r = c(w_r^*)$, then for $w > w_r^*$, the divorce rate is equal to $\mathcal{F}(B - c_r)$, which is independent of the waiting time. For $w < w_r^*$, the divorce rate is equal to $\mathcal{F}(B - c(w))$, which is decreasing in w since $\mathcal{F}(\cdot)$ and $c(\cdot)$ are increasing functions. From the previous conjecture that $c_3 \leq c_2 \leq c_1$, the divorce rate as a function of the waiting time w can therefore be illustrated as in Figure 1.1.

1.5 Estimating the Divorce Spline

Recall from previously that state s at time t belong to one of the three divorce regimes. To get a divorce in regime 1, ones must either prove faults or live separate

and apart for a specified period. In regime 2, one may claim an III ground if the divorce is uncontested. Finally, in regime 3, one party alone can file a divorce on an III ground. While the effect of an III ground or a unilateral divorce law on the divorce rates can be captured by a simple dummy variable in an econometric model, it is difficult to determine when a living separate and apart ground becomes a no-fault law in the sense that it sufficiently lowers the cost to divorce so that the couples choose to file for divorce on this ground rather than the fault ground. To capture the change in the divorce cost that results from a reduction in the required time a couple must live separate and apart, we propose a spline estimation that estimates the critical waiting time in the first divorce regime denoted by w^* such that for any required period a couple residing in state s at time t must live separate and apart $w_{st} < w^*$, the spouse choose to wait and file for divorce and for $w_{st} \geq w^*$, it is cheaper to fabricate some evidence to file for a divorce based on one of the fault grounds. Our econometric specification makes extensive use of the spline function defined by

$$d_{st} = [\beta_0 + \beta_1 w_{st} + \beta_2 (w_{st} - w^*) \mathcal{I}(w_{st} > w^*)] R_{st}^1 + \alpha R_{st}^2 + \gamma R_{st}^3 + \Delta_{st} + \epsilon_{st},$$

where d_{st} is the divorce per 1,000 population in state s at time t , w_{st} is the required time a couple must live separate and apart to file for divorce, Δ_{st} is the state and time fixed effect, and state specific linear and quadratic time trend, and ϵ_{st} is the error term assumed to be first order autocorrelated between t and $t - 1$ but independent across s . R_{st}^1 , R_{st}^2 and R_{st}^3 are dummy variables equal to one if state s at time t belongs to the divorce regime 1, 2, and 3, respectively. The term in the bracket $[\cdot]$ produces a spline linear function such that the effect of $w_{st} < w^*$ on d_{st} is equal to β_1 and the effect of $w_{st} \geq w^*$ on d_{st} is equal to $\beta_1 + \beta_2$. Note that we choose to capture the effect of regime 2 and 3 on the divorce rates by using dummy variables for these regimes. This is because almost all states that belong to these regimes, i.e. states

that introduce an III ground, do not lower its required waiting period. As a result, we do not have enough variation in the waiting time to identify the effective waiting time in these regimes. Nevertheless, it is straightforward to algebraically solve for the effective waiting time in these regimes using the parameters from the estimation. More specifically, since β_0 is the expected divorce rate when the required waiting time to get a divorce is zero, it follows that for $\beta_0 > \alpha$ and $\beta_0 > \gamma$, the effective waiting time for divorce regime 2 and 3 is $\beta_1(\alpha - \beta_0)$ and $\beta_1(\gamma - \beta_0)$, respectively. These terms can be interpreted as the required waiting time for divorce based living separate and apart ground that has an effect on the divorce rates equal to a mutual consent III ground and a unilateral III ground, respectively.

Note also that the effective waiting time w^* is a parameter in the model and is nonlinear in the specification. The estimation of the above specification is therefore complicated by the fact the function is non differentiable at w^* so that gradient based optimization techniques do not apply. To estimate this equation, we follow [31] by linearizing the nonlinear term in the bracket $[\cdot]$ using a first-order Taylor expansion. First, define

$$g(w_{st}; \beta, w^*) = \beta_0 + \beta_1 w_{st} + \beta_2 (w_{st} - w^*) \mathcal{I}(w_{st} > w^*).$$

Note that

$$(w_{st} - w^*) \mathcal{I}(w_{st} > w^*) = (w_{st} - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)}) - (w^* - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)}). \quad (1.2)$$

where $(-1) \mathcal{I}(w_{st} > w^{*(0)})$ is the first order derivative of $(w_{st} - w^*) \mathcal{I}(w_{st} > w^*)$ evaluated at a fixed candidate value of the effective waiting time $w^{*(0)}$. Substitute (1.2) into $g(w_{st}; \beta, w^*)$ to get

$$g(w_{st}; \beta, w^*) = \beta_0 + \beta_1 w_{st} + \beta_2 (w_{st} - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)}) - \beta_2 (w^* - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)}). \quad (1.3)$$

The function in (1.3) can be reparameterized by

$$g(w_{st}; \beta, \delta, w^*) = \beta_0 + \beta_1 w_{st} + \beta_2 (w_{st} - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)}) - \delta \mathcal{I}(w_{st} > w^{*(0)}), \quad (1.4)$$

where w_{st} , $(w_{st} - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)})$, and $\mathcal{I}(w_{st} > w^{*(0)})$ are the variables observed in the data given $w^{*(0)}$, and β_1 , β_2 , and δ are the corresponding coefficients to be estimated respectively. Note from (1.3) and (1.4) that $\delta = \beta_2(w^* - w^{*(0)})$ and hence for $\beta_2 \neq 0$, the necessary condition for the convergence of $w^{*(0)}$ such that $w^{*(0)}$ is close to the true value w^* requires that δ is close to zero. In particular, it follows that

$$\hat{w}^* = \frac{\hat{\delta}}{\hat{\beta}_1} + w^{*(0)}$$

is the updated estimate for the effective waiting time w^* . The process can be iterated until convergence. The above expression also gives a standard error for \hat{w}^* by the delta method, i.e.

$$\text{s.d.}(\hat{w}^*) = \left(\frac{\text{var}(\hat{\delta}) + \text{var}(\hat{\beta}_2) \left(\frac{\hat{\delta}}{\hat{\beta}_2} \right)^2 + 2 \left(\frac{\hat{\delta}}{\hat{\beta}_2} \right) \text{cov}(\hat{\delta}, \hat{\beta}_2)}{\hat{\beta}_2^2} \right)^{\frac{1}{2}}.$$

Substitute (1.4) into the original specification gives

$$d_{st} = [\beta_0 + \beta_1 w_{st} + \beta_2 (w_{st} - w^{*(0)}) \mathcal{I}(w_{st} > w^{*(0)}) - \delta \mathcal{I}(w_{st} > w^{*(0)})] R_{st}^1 + \alpha R_{st}^2 + \gamma R_{st}^3 + \Delta_{st} + \epsilon_{st}. \quad (1.5)$$

The estimation results of the above specification are given in Table 1.3. In specification 1, we assume that the cost to divorce in states where there appear no explicit waiting time is equal to eight years. We then examine the robustness of the results to this assumption in specification 2 by assuming a five year instead of an eight year waiting requirement. Specification 3 uses only observations with known waiting time.

Parameter	(1)	(2)	(3)	(4)
β_0	3.5771*** (0.1235)	3.5351*** (0.1203)	6.7167*** (0.5865)	3.5315*** (0.1163)
β_1	-0.2062*** (0.0582)	-0.1997*** (0.0582)	-0.3215*** (0.0620)	-0.1982*** (0.0575)
β_2	0.1900*** (0.0573)	0.1960*** (0.0586)	0.3271*** (0.0628)	
δ	-0.0279 (0.0640)	0.0290 (0.0661)	-0.1023 (0.0743)	0.0392 (0.0458)
α	3.3150*** (0.0820)	3.2911*** (0.0803)	6.3640*** (0.5831)	3.2899*** (0.0800)
γ	3.2410*** (0.0635)	3.2313*** (0.0627)	6.1893*** (0.5769)	3.2317*** (0.0626)
N	1631	1631	809	1631

Table 1.3: Estimation results of the spline linear function using a generalized least squares method with first autocorrelated errors between time. Standard errors are in parenthesis. *, **, *** denote estimates that are statistically significant at 0.1, 0.05, and 0.01, respectively. All specifications include the state and year fixed effect, and state specific linear and quadratic time trend. Specification 1 and 2 assume that the unknown waiting time is equal to 8 and 5 years, respectively. Specification 3 uses only observations with known waiting time. Specification 4 imposes the restriction that $\beta_1 + \beta_2 = 0$. The estimated w^* is equal to $[1.5, 2)$ in all specifications.

Specification 4 imposes the restriction that $\beta_1 + \beta_2 = 0$. The estimated effective waiting time is equal to $[1.5, 2)$ in all specifications. Note that since there are only eight distinct values of waiting time w_{st} , we are only to identify w^* in an interval range. Although the value of the estimates vary across different specifications, the sign and significance of the estimates produced are strikingly similar. A waiting time shorter than two years significantly increases the divorce rates, while the waiting time longer than two years has no significant effect on the divorce rates. Based on this finding, we conclude that by 1988, which is the end of our sample period, there is only one state, Illinois, that does not have a no-fault law, i.e. there exist no III ground for divorce and the waiting time required to divorce on living separate and apart ground is equal to or longer than two years.

1.6 Dynamic Divorce à la [45]

Using the findings in the previous section, we define a no-fault law as a divorce law that allows for grounds such as an III ground or living separate and apart ground less than 2 year. We then define a set of dummy variables à la [45], i.e. let τ_s^{NF} be the time that state s introduces a no-fault law, then

$$NF_{st}^k \equiv I(t - \tau_s^{NF} = k),$$

where $I(\cdot)$ is an indicator function, and k is an arbitrary number defined in two-year increments, e.g. 1-2 years, 3-4 years, etc. In the terminology given by [45], NF_{st}^k indicates that the no-fault law in state s at time t has been in effect for *exactly* k years.

Similarly, we define

$$U_{st}^k \equiv I(t - \tau_s^U = k),$$

where τ_s^U be the time that state s introduces a unilateral law. The first set of dummy variables captures the change in the cost to divorce, while the second set of dummy variables captures the effect of the unilateral divorce law. More specifically, the full econometric specification for the effect of the divorce laws à la [45] is given by

$$d_{st} = \sum_{k=1}^K \beta^k NF_{st}^k + \sum_{k=1}^K \gamma^k U_{st}^k + \Delta_{st} + \epsilon_{st},$$

where the change in k is defined in a two-year increment, e.g. 1-2, 3-4, etc., K is an arbitrary number such that NF_{st}^K is interpreted as the no-fault law has been in effect in state s at time t for K years or more, β^k and γ^k are corresponding parameters to be estimated, and d_{st} , Δ_{st} , and ϵ_{st} are as previously defined.

The estimation results are shown in Table 1.4. Specification 1 is a short specification for the effect of the laws where K is set at 15 years. Specification 2 is a

short specification but the set of dummy variables for no-fault laws is dropped. We present the findings from this specification to show how an omitted variable problem, which seems dominant in previous studies that do not control for the effect of the change in the cost of divorce on the divorce outcome such as [33], [16], and [45] can bias the result. Specification 3 is a long specification where K is chosen at 25 years. Similarly, specification 4 drops the set of dummy variables for the no-fault laws in the longer specification.

We find that the increase in the divorce rates in the early years after the law was passed is mainly due to the change in the cost to divorce. Specification 1 shows that the no-fault laws can have a significant impact on the increase in the divorce rates up until 15 years after the passage of the laws. The finding is strongly consistent with dynamic model proposed by [35], that is, the immediate effect of the law can be explained by the pipeline effect increases the divorce rates among couples married before the law change, while the long run effect can be explained by the selection effect where the higher gain from marriage from the reduction in the cost to divorce lowers that matching quality of couples married after the law. After we control for the change in the cost to divorce, we find that the unilateral law has no pipeline effect. The finding tends to confirm the Coase theorem that a switch in the property rights to divorce from the person who wants to remain in the marriage to the other person who wants to divorce does not increase the divorce rates. Interestingly, we find that the unilateral law has a strongly negative effect on the divorce rates seven years after the passage of the law. This result is coherent with the prediction by [35] that a unilateral divorce law can have a selection effect that lowers the divorce rates in the long run since couples married after the law change are of better matching quality as compared to the mutual consent divorce regime.

The results shown in specification 2 and 4 reveal that an omitted variable problem can produce strongly biased estimates for the effect of unilateral divorce law.

The estimated effect of the unilateral divorce law is positive and highly significant immediately after the passage of the law, a result that rejects the Coase theorem found in previous studies such as [16] and [45]. As we have previously discussed, this effect is no longer significant after the cost to get a divorce is controlled for.

1.7 Concluding Remarks

In this paper, we study the effect of no-fault divorce law, unilateral divorce law, and waiting time to get a divorce on the divorce rates in 51 states in the United States during 1956-1989. The Coase theorem states that absent the transaction cost of reallocating resources between the spouses, the change from a mutual consent law to a unilateral law should not affect the divorce rates since it merely switches the rights to divorce from the spouse who wants to keep the marriage to the one who wants to dissolve it. The actual effect however has remained an empirical question and studies that find that the law has no effect support the theorem while those that find a positive significant effect argue otherwise that the transaction cost is not negligible. We identify three methodological issues that contribute to the possibly erroneous findings in these studies: the omitted bias in studies that treat the unilateral and no-fault divorce laws as synonymous, the measurement error in the law from different interpretation of the law, and failure to take into account the autocorrelated structure of the error terms in the estimation. In our model, we propose a spline linear model with the unknown threshold that captures the effect of the waiting time on the divorce rates in three regimes: the fault regime where no fault ground such as irreconcilable differences between the spouses is allowed, the no-fault mutual consent regime where a type of no-fault ground exists but requires the consents of both spouses to file for a divorce, and the no-fault unilateral regime where one spouse is allowed to file for divorce based on a no-fault ground.

We estimate that the fault equivalent waiting period, i.e. the waiting time that

the couple is indifferent between waiting before filing for a divorce based on living separate and apart ground and immediately filing for a divorce based on a fault ground to be between 1.5 and 2 years. Based on this finding, we conclude that by 1988, Illinois and Vermont are the only states that do not have a no-fault ground for divorce.

We also study the dynamic effect of the divorce laws using the specification similar to [45]. The results show that the increase in the divorce rates immediately after the passage of the no-fault divorce laws is due to the reduction in the cost to divorce, rather than the change in the property rights to divorce from one spouse to another. This result is in contrast with that found in previous studies in the literature such as [16] and [45], which are biased from omitted variable problem.

We however find that a unilateral divorce law does have a negative impact on the divorce rates in the long run. This result is in coherent with the theoretical prediction by [35], who argues that couples married under the unilateral divorce law regime will be of better matching quality and hence less likely to divorce.

Specification	(1)	(2)	(3)	(4)
U^1	-0.0163 (0.0571)	0.1215*** (0.0383)	0.0055 (0.0576)	0.1269*** (0.0387)
U^3	-0.0059 (0.0756)	0.1189** (0.0514)	0.0287 (0.0775)	0.1312** (0.0523)
U^5	-0.0629 (0.0919)	0.0978 (0.0631)	-0.0013 (0.0963)	0.1191* (0.0651)
U^7	-0.2611** (0.1087)	-0.0038 (0.0759)	-0.1727 (0.1161)	0.0285 (0.0795)
U^9	-0.4744*** (0.1284)	-0.1421 (0.0903)	-0.3562** (0.1397)	-0.0964 (0.0960)
U^{11}	-0.5129*** (0.1509)	-0.2292** (0.1068)	-0.3460** (0.1663)	-0.1643 (0.1147)
U^{13}	-0.5585*** (0.1775)	-0.1937 (0.1256)	-0.3415* (0.1982)	-0.1092 (0.1356)
U^{15}	-0.3330 (0.2091)	-0.0536 (0.1471)	-0.0423 (0.2325)	0.0509 (0.1580)
U^{17}			0.0043 (0.2693)	0.1314 (0.1826)
U^{19}			0.0767 (0.3229)	0.1912 (0.2284)
U^{21}			0.8461** (0.4091)	0.8152*** (0.3026)
U^{23}			0.3644 (0.4443)	0.1138 (0.3163)
U^{25}			0.3353 (0.3397)	0.0359 (0.0316)
NF^1	0.1504*** (0.0430)		0.1369*** (0.0428)	
NF^3	0.1446** (0.0569)		0.1286** (0.0573)	
NF^5	0.1846*** (0.0696)		0.1534** (0.0712)	
NF^7	0.2807*** (0.0818)		0.2351*** (0.0852)	
NF^9	0.3475*** (0.0958)		0.2846*** (0.1022)	
NF^{11}	0.2897*** (0.1107)		0.1946 (0.1212)	
NF^{13}	0.3624*** (0.1296)		0.2314 (0.1458)	
NF^{15}	0.2693* (0.1522)		0.0767 (0.1725)	
NF^{17}			0.0907 (0.2004)	
NF^{19}			0.0568 (0.2312)	
NF^{21}			-0.0518 (0.2678)	
NF^{23}			-0.2589 (0.3030)	
NF^{25}			-0.2941 (0.3750)	
N	1631	1631	1631	1631

Table 1.4: The effect of divorce laws using a dynamic specification à la [45]. All specifications include state and year fixed effect, and state specific linear and quadratic time trend. The method of estimation is a generalized least squares with first-order autocorrelated error terms.

A Generalized Nash Bargaining Model of Bribery

2.1 Background

After the pioneering work by [36], the literature on the economics of corruption has considerably expanded (see, for example, [1], [5], [41], and [2], for some comprehensive surveys). Even though corruption is a risky activity, since the gain from undetected corruption is high and the penalty on the corruptible agents is also very severe, the role of risk aversion of agents on the outcome of corruption has been left relatively unexplored. In this chapter where the focus is on the type of corruption that involves bribery, I will discuss how the degree of risk aversion of related agents, i.e. the official who takes bribe and the firm who gives bribe, affect the prevalence of bribery and the equilibrium level of bribe in a cooperative game theoretic context.

For the type of bribery between large firms and high ranking officials or the society where bribery has become a norm in business, a cooperative game theoretic framework of bribery can more realistically capture the practice of bribery that does its non-cooperative counterpart. This is because bribes are normally negotiated several times before the level is agreed upon. The equilibrium bribe is therefore

more likely an outcome of a relative bargaining power between the agents rather than the opportunity to act as the first mover in the bribery game. A cooperative game theoretic model of bribery also yields a number of testable implications in light of the limitation of data of most corruption surveys. In particular, the determinants of the level of bribe in noncooperative models are contingent upon who the first-stage mover in the bribery game is. To the best of my knowledge, there is no corruption-related survey, so scarce that it is, that provides information as to whether it is the official or the firm who initiates the bribe. Empirical studies of this issue thus remain relatively unexplored in the absence of this information.

The role of risk aversion in the bribery game also implies a few insights that may shed light on the optimal anti-corruption policies. For example, will an increase in the salary of high ranking public officials in Singapore in 2007 induce a ‘trade-off’ between a lower probability of accepting bribe and higher bribe demanded by officials who continue to be corrupt as predicted by [9] and [30]? While the answer from these risk neutral models is a definite ‘yes’, the model based on risk-averse agents that will be developed in the next section will show how the degree of risk aversion may affect the presence of this trade-off.

2.2 The Model

Consider a cooperative game between two players, a government official (player 1) and a firm (player 2), who contemplate whether to engage in a corruption as well as determine the amount of the bribe. Both players have a complete information regarding the characteristics of the other. The utility of player i when there is no bribery is denoted by V_i . If the official does not take bribe, his utility is a function of his income Y and some psychological gain such as the moral value from being honest m . For simplicity, I will consider the utility function of the official of the following

form

$$V_1 = u_1(Y + m),$$

where $u_1(\cdot)$ is a continuously differentiable increasing function in its argument whose inverse exists¹. For algebraic convenience, $u_1(\cdot)$ is also assumed to be a homogenous function of degree k_1 , i.e. $u_1(aX) = a^{k_1}u_1(X)$, for $a, k_1 \geq 0$.

When the firm pays no bribe, the utility of the firm is

$$V_2 = u_2(\pi),$$

where π denotes the status quo profit the firm gains without paying bribe to the official. Without loss of generality, we only consider the pecuniary gain of the firm although the moral value of the firm can also be incorporated into its utility function in an analogous manner. Likewise, u_2 is assumed to be a twice differentiable continuous homogenous function of degree k_2 whose inverse exists.

If the firm and the official decide to engage in corruption, the firm will gain an increase in profit such that the new level of profit becomes Π , where $\Pi > \pi$. Under corruption, the firm agrees to pay the bribe to the official denoted by τ . Let d denote an indicator function that is equal to 1 if the corruption is detected and 0 otherwise and let $p = \Pr(d = 1)$ denote the probability that the corruption is detected. The expected utility of both players from the corruption if the activity is not detected becomes

$$U_1(d = 0) = u_1(Y + \tau),$$

$$U_2(d = 0) = u_2(\Pi - \tau).$$

If the corruption is detected, each is subject to pay a penalty $(1 - \lambda_i)$ that is multiplicative in the argument of their utility functions, i.e. the expected utility of the

¹ The comparative results that follow also hold for a class of utility function that are additively separable, i.e. $U_1(Y, m) = u_1(Y) + v_1(m)$, where $u_1(\cdot)$ is a continuously differentiable, increasing, and homogenous function and $v_1(\cdot)$ is an increasing function whose inverse exists.

remaining assets after the fines are paid becomes

$$U_1(d = 1) = u_1(\lambda_1(Y + \tau)),$$

$$U_2(d = 1) = u_2(\lambda_2(\Pi - \tau)),$$

where $0 \leq \lambda_1, \lambda_2 < 1$. Note that the closer λ_i is to zero, the heavier the penalty imposed. For example, $\lambda_1 = 0$ denotes the legal environment in which a government official found guilty of corruption is expelled and forced to surrender the bribe to the government. In reality, a much severe penalty is normally levied e.g. some monetary fines may be levied and other assets of the condemned may be confiscated. This can be incorporated into the model by including their assets into the utility function in addition to salary and profit. The multiplicative form of this penalty scheme also captures some aspects of penalty that involves imprisonment. For example, a person found guilty of corruption may be imprisoned for a certain period, thus losing parts of his lifetime income while being incarcerated. Note that under the multiplicative penalty scheme, higher ranking officials and bigger firms are penalized more for a certain λ_1 and λ_2 imposed.

The probability that the bribery is detected p is greatly simplified in this model. In essence, p captures the overall quality of the legal process from the stage that the crime is detected, the criminals are prosecuted, found guilty, sentenced, and penalized. Factors that increase the level of p include the transparency in the public sector, the enforceability of laws, as well as the effectiveness of all agents involved in the legal process such as the police, the prosecutor, the jury, the judge.

Finally, it should be emphasized that whether the corruption is detected or not, the moral value of the official is lost and cannot be regained once he decides to be corrupt. Using the property that $u_i(\cdot)$ is a homogeneous function of degree k_i , the

expected utility of the official who accepts the bribe thus becomes

$$\begin{aligned} E(U_1) &= (1 - p)u_1(Y + \tau) + pu_1(\lambda_1(Y + \tau)) \\ &= (1 - p + p\lambda_1^{k_1})u_1(Y + \tau). \end{aligned} \tag{2.1}$$

Similarly, the expected utility of the firm who offers the bribe is

$$\begin{aligned} E(U_2) &= (1 - p)u_2(\Pi - \tau) + pu_2(\lambda_2(\Pi - \tau)) \\ &= (1 - p + p\lambda_2^{k_2})u_2(\Pi - \tau). \end{aligned} \tag{2.2}$$

The greater k_1 and k_2 are, the higher the reduction in the utility level of the official and the firm when they are penalized. These parameters are closely related to degree of risk aversion of each player and reflect how willing the players are to engage in a risky activity. In essence, they reflect the reduction of the *utility* (rather than *income*) of the player as a result of the punishment. Note also that since $0 \leq (1 - p + p\lambda_i^{k_i}) \leq 1$, for $i \in \{1, 2\}$, uncertainty scales down the level of utility vis-à-vis the situation in which there is no uncertainty involved. The expected utility possibility set of the players can then be defined as

$$\mathcal{U} = \{(E(U_1(x_1)), E(U_2(x_2))) | x_1 + x_2 \leq Y + \Pi\}. \tag{2.3}$$

The frontier of \mathcal{U} can be traced out by keeping the total resources fixed and varying the level of τ . Since the allocation to the official and the firm always exhausts the total resources, and the utility of each player is strictly increasing in its argument, it follows that the locus $(E(U_1), E(U_2))$, as defined by (2.1) and (2.2), must always be on the frontier of \mathcal{U} . The following proposition characterizes the convexity property of \mathcal{U} .

Proposition 1 (Convexity). *If u_i is strictly concave and λ_i is positive, then \mathcal{U} is a strictly convex set.*

Thus, the extension of the deterministic utility model to incorporate uncertainty in the outcome will not change the convexity property of the utility possibility set. In order to induce both players to cooperate to corrupt, the level of bribe that both parties agree upon must satisfy the individual rationality condition, i.e. their expected utility from corruption must be as least as high as their status quo utility. The following proposition gives the property of τ such that this condition holds.

Proposition 2 (Individual Rationality Condition). *The outcome $(E(U_1), E(U_2))$ satisfies the individual rationality condition if and only if $\underline{\tau} \leq \tau \leq \bar{\tau}$ such that*

$$\begin{aligned}\underline{\tau} &= \frac{m + (1 - (1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}})Y}{(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}} \\ \bar{\tau} &= \Pi - \frac{\pi}{(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}}.\end{aligned}$$

It is easy to verify that $\underline{\tau} \geq m$. Intuitively, the minimum amount of bribe that the official is willing to accept must be greater than or equal to his forgone moral value in order to induce him to engage in a risky activity. $\bar{\tau} - \underline{\tau}$ can also be viewed as a probability adjusted rent from corruption such that there are some room for corruption if and only if $\bar{\tau} > \underline{\tau}$.

2.2.1 The Prevalence of Corruption

Consider an economy that is populated with a continuum of government officials who differ by their moral values m , a latent trait that is generally unobserved by the outsider, but assumed to follow a well defined probability distribution function on a positive support denoted by \mathcal{F}_m . It follows from individual rationality condition that the proportion of the corrupt officials is $\mathcal{F}_m(m^*)$, where

$$m^* = \frac{(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}}{(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}} [(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}} \Pi - \pi] - [1 - (1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}] Y. \quad (2.4)$$

Equation (2.4) defines a threshold of the moral standard that distinguishes corrupt from honest officials. It should be emphasized that m^* may well be negative, in which case no official is corrupt. For example, a government whose interest is to completely eradicate corruption may choose to pay the minimum salary such that $m^* \leq 0$, i.e.

$$\bar{Y} = \frac{(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}} [(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}} \Pi - \pi]}{(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}} [1 - (1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}]}. \quad (2.5)$$

\bar{Y} is closely related to the concept of efficiency wage. Note that the policy can be implemented without having the knowledge of m . As is well known, this policy can be very costly since \bar{Y} is increasing in Π and π for any $\bar{Y} \geq 0$. This may be very hard to implement especially for high ranking public officials who often deal with very large business enterprises.

The effect of $\lambda_1, \lambda_2, \theta, \Pi, p$, and Y on m^* can be verified using a simple comparative static analysis of $\mathcal{F}_m(m^*)$. Since $\mathcal{F}_m(m^*)$ is nondecreasing in m^* , we only need to verify the sign of the derivative of m^* in (2.4) with respect to its arguments. The results are summarized in the following proposition.

Proposition 3 (Prevalence of Corruption). *For $m^* \geq 0$, $\mathcal{F}_m(m^*)$ is nondecreasing in $\lambda_1, \lambda_2, \Pi$ and nonincreasing in p, π, Y .*

The above proposition provides a list of anticorruption policies i.e. an increase in the salary of the public officials, an increase in the penalty of those involved in corruption, and an increase in transparency which allows for a higher probability of detection of corrupt activities. It also characterizes that bribe payers are likely smaller firms and firms that gain relatively more from paying bribe. In addition, in an economy where public officials are rather homogenous in their moral values m , a sufficiently large change in any of these policies is required in order for them to be effective in reducing the prevalence of corruption since \mathcal{F}_m may be a step function.

This helps explain and support previous studies a reduction in the level of corruption in most countries tends to be detectable only after a major reform.

2.2.2 *The Level of Bribe*

In general, there is a range of bribe that satisfies the individual rationality condition and it remains to be decided how τ is chosen. In this paper, I propose a generalized Nash bargaining solution to cooperative game such that τ solves the following constrained optimization problem:

$$\max_{\tau \in [\underline{\tau}, \bar{\tau}]} \mathcal{N} \equiv (E(U_1) - V_1)^\alpha (E(U_2) - V_2)^{1-\alpha} \text{ s.t. } (E(U_1), E(U_2)) \in \mathcal{U}, \quad (2.6)$$

where \mathcal{N} is the objective function and $E(U_1), E(U_2), V_1, V_2$, and \mathcal{U} are defined as the above and $\alpha \in [0, 1]$ are the bargaining power of the official relative to that of the firm. The level of bribe that maximizes (2.6) can be shown to coincide with the equilibrium bribe in the situation where the official and the firm with respective discount rates equal to $1 - \alpha$ and α infinitely take turn to propose the amount of bribe in a noncooperative manner. The assumption that the players choose a generalized Nash bargaining solution to determine the level of bribe is appropriate especially for large firms that are known to go through several negotiation processes with the public official before both parties agree on the amount of bribe. The assumption is also attractive from the empirical perspective since we know from few, if any, surveys who initiates the bribe, which makes it difficult to analyze this problem using noncooperative models whose outcomes often depend on who the first mover of the game is. Another attractive feature of the generalized version of the Nash bargaining solution is that the parameter α is able to absorb other determinants of bribe, which are not explicitly modeled, although it should be emphasized that these are factors that affect the amount of bribe only and not the decision whether or not to pay bribe, e.g. the negotiation skill of the firm. In addition, one can

vary the level of α to trace out all outcomes on the frontier of \mathcal{U} that satisfy the individual rationality condition. The model is thus as general as the collective model à la Chiappori (1992) in the sense that all individually rational and Pareto efficient outcomes along the frontier are possible equilibrium outcome.

It is straightforward to verify that in this setting, the incorporation of uncertainty of the outcome into the model does not change the usual properties of the generalized Nash bargaining solution, i.e. τ^* that solves (2.6) satisfies the following axioms: Pareto optimality, invariance to the positive affine transformation, and independence of irrelevant alternatives (See, for example, Mas-Colell et al. (1995) for more discussion).

Let us define the following notations for conciseness. For a univariate function $y = f(x)$, $f'(x) = \frac{df(x)}{dx}$. For a multivariate function $y = f(x_1, \dots, x_n)$ and $i, j \in \{1, \dots, n\}$,

$$y_{x_i x_j} \equiv \frac{\partial^2}{\partial x_i \partial x_j} f(x_1, \dots, x_n).$$

The first order necessary conditions yields the tangency condition given by

$$\mathcal{N}_\tau = \left(\frac{\alpha}{1 - \alpha} \right) \left(\frac{E(U_2) - V_2}{E(U_1) - V_1} \right) + \frac{E(U_2)_\tau}{E(U_1)_\tau} = 0. \quad (2.7)$$

The feasibility condition is automatically satisfied for $\tau^* \in [\underline{\tau}, \bar{\tau}]$. Since $E(U_1)_\tau > 0$, while $E(U_2)_\tau, E(U_1)_{\tau^2}, E(U_2)_{\tau^2} < 0$, it is straightforward to verify that the second order sufficient condition $\mathcal{N}_{\tau\tau} < 0$ holds, which ensures the maximization of (2.6).

A comparative static analysis of the effect of other variables on τ^* is straightforward from the implicit function theorem. The results are summarized below with all proofs provided in the appendix.

Proposition 4 (Comparative Static Analysis of Bribe). *Let τ^* be the local solution for the maximization problem in (2.6), then*

While it has been previously shown that the penalty on both players can be used to reduce the prevalence of corruption, the impact of each type of penalty on the level of bribe of those who continue to corrupt is different. In Proposition 4.1, the equilibrium bribe is decreasing in λ_1 and increasing in λ_2 . Note again that λ_i measures the degree of *leniency* of the corruption law on player i once indicted for corruption. Hence, an increase in the penalty on the official who takes bribe may lead to an increase in the level of bribe if he continues to corrupt. On the contrary, an increase in the penalty on the firm who gives bribe will lead to a decrease in the amount of bribe. These results are in accord with those implied by models with risk neutral agents such as [9] and [30].

The effect of change in salary on the amount of bribe has an unclear direction. In Proposition 4.2, the first term on the right hand side $\frac{u''(\cdot)}{u'(\cdot)}$ is minus the Arrow-Pratt degree of absolute risk aversion, which is negative for all concave utility functions. The second term is the marginal gain from corruption with respect to change in income of the official over his absolute gain. As we have seen previously, $\tau > m$ since the level of bribe that induces the official to corrupt must be higher than the moral value forgone. Also, monotonicity and concavity property of the utility function implies that $0 < u'_1(Y + \tau) < u'_1(Y + m)$. Hence $(1 - p + p\lambda_1^{k_1})u'_1(Y + \tau) - u'_1(Y + m) < 0$ and the last term on the right hand side is negative. The sum of the two terms therefore has an unclear sign. Although it is in general difficult to verify the sign of τ_Y^* at different ranges of Y , if the utility function of the official $u_1(x)$ satisfies the Inada condition, i.e. $\lim_{x \rightarrow 0} u'_1(x) = \infty$ and $\lim_{x \rightarrow \infty} u'_1(x) = 0$, then the bribe is likely to be increasing in income for a very low level of income and vice versa. This warns against the use of public wage reform as an anticorruption tool in the developing countries whose public salary is initially low, which may cause a trade-off between a reduction in the prevalence of corruption and an increase in bribe. Such a trade-off may however not be present in the developed countries whose public salary

is sufficiently high. Note that for models with risk neutral agents, $u''(\cdot) = 0$ and the bribe is always increasing in the salary of the official, a result consistent with those in Nash bargaining model with risk neutral agents in [9] and [30].

The change in the opportunity for corruption also has an unclear effect on the amount of bribe. In Proposition 4.3, the first term on the right hand side is minus the Arrow-Pratt degree of risk aversion of the firm, which is negative for all concave utility functions. The second term is the marginal increase in the expected utility of the firm with respect to a reduction in the bribe paid, scaled by its bargaining power, which is positive. The sum of the two terms therefore have an ambiguous sign. Likewise, if the utility function of the firm $u_2(x)$ satisfies the Inada condition, i.e. $\lim_{x \rightarrow 0} u_2'(x) = \infty$ and $\lim_{x \rightarrow \infty} u_2'(x) = 0$, then the bribe is likely to be increase in θ for small firms with low profit and vice versa. This suggests that emerging firms tend to bear a greater burden from corruption than do larger firms. Similarly, models with risk neutral agents imply that greater opportunity for corruption always lead to more bribe regardless of the firm size. Similarly, for a special case with risk neutral firms, $k_2 = 0$ implies that the first term is zero and hence the level of bribe is always increasing in the size of rent from corruption. This result is coherent with the conjecture discussed in [40].

The last result in Proposition 4.4 suggests many interesting policy implications. Note that it is straightforward to show that $\zeta > 0$, $\zeta_{\lambda_1} > 0$, and $\zeta_{\lambda_2} < 0$. Since it is possible to trace the frontier of \mathcal{W} by varying the relatively bargaining power α , we may find a critical value of the bargaining power, denoted by $\bar{\alpha}$, such that $\tau_p^* = 0$ at $\bar{\alpha}$. As shown in Figure 2.2, the geometric interpretation of Proposition 4.4 implies that at $\bar{\alpha}$, the slope of the ratio of the gain of the firm to that of the official $\left(\frac{E(U_2) - V_2}{E(U_1) - V_1} \right)$ is equal to the slope of their scaled relative utility outside the cooperation $\zeta \frac{V_2}{V_1}$. For any $\alpha \in [0, \bar{\alpha})$, we have that the slope of the ratio of the gain from bribery

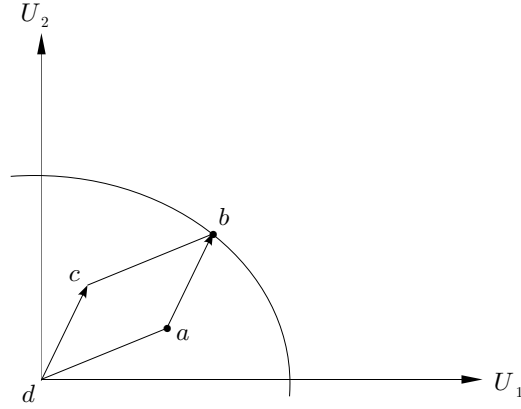


FIGURE 2.2: The geometric interpretation of the effect of a change in probability of detection on bribe. The bargaining power of the official such that $\tau_p^* = 0$, denoted by $\bar{\alpha}$, forms a parallelogram $abcd$ such that $ab \parallel cd$, where a is the threat point, b is the expected utility from corruption and the slope of cd is equal to the slope of ad scaled by ζ . $\forall \alpha \in [0, \bar{\alpha})$, $\tau_p^* < 0$ and $\forall \alpha \in (\bar{\alpha}, 1]$, $\tau_p^* > 0$.

exceeds that of the scaled ratio of the outside utility so that $\tau_p^* < 0$. Similarly, for $\alpha \in (\bar{\alpha}, 1]$, $\tau_p^* > 0$. Intuitively, an increase in the probability of detection tend to increase the bribe demanded by officials whose bargaining power is relatively high, and vice versa.

The scale factor ζ depends on the (relative) penalty of the official and the firm. In the first case shown in Figure 2.2, the official is penalized less relative to the firm, i.e. $\lambda_1 > \lambda_2$ so that $\zeta^0 > 1$. The corresponding $\bar{\alpha}(\zeta^0)$ is relatively low so that an increase in the probability of detection is likely to increase the bribe. In the second case, the official is penalized more relative to the firm. The corresponding $\bar{\alpha}(\zeta^1)$ is relatively high and an increase in the probability of detection will tend to reduce the bribe. This result strongly supports the promotion of transparency as an anti-corruption policy in many developing countries whose penalty for the corrupt officials is usually high.

2.3 Policy Recommendations

The analysis thus far makes no representation regarding the social impact of bribery. The act of bribery is almost always frowned upon, regardless of whether the bribe is paid to induce officials to do things that they are not supposed to, or paid to induce them to expedite the process that is within their duty. One must, however, acknowledge the fact that the absence of bribe in the second case may result in a threat point equilibrium where lukewarm public officials lack incentives to deliver services that they are bound to do, and thus creates another type of corruption that does not involve bribe. The question of whether the act of bribery is appropriate is therefore a complex question. In a society that adopts a deontological approach to the role of the government, the prevalence of bribery should always be minimized, even if the resulting equilibrium absent the bribe is less efficient. This is in contrast to a teleological society where bribery is perceived as a mean rather than an end in itself. We explore this question in two subsequent sections by first analyzing the response of the firm to bribery and then examining the optimal anti-corruption policies set by the government to maximize certain objectives.

2.3.1 Response of the Firm

In this section, we will first look at the profit maximizing behavior of the firm in response to the presence of bribery. Without loss of generality, it is assumed throughout the section that the firm is risk neutral, i.e. the objective of the firm is to maximize the (expected) profit less the amount of bribe if any. Also, m is assumed to be zero for simplicity. Let us now consider a firm that needs to bribe an official to operate a business. If it decides not to pay the bribe, it can earn a net profit of π from another career, where π is normalized to zero. The business with the license has a total cost equal to $C(q)$, where q is the quantity of commodities produced, with the

usual properties that $C'(q), C''(q) > 0$. The revenue is determined by the demand function $R(q)$ such that $R'(q) > 0$ and $R''(q) < 0$. The profit function is given by the identity $\Pi(q) = R(q) - C(q)$.

If the firm can operate the business without having to pay bribe to get the license, the firm's objective function is

$$\max_q \Pi(q), \quad (2.8)$$

with the corresponding first order condition

$$\Pi'(q) = 0,$$

where $R''(q) < 0$ and $C''(q) > 0$ ensure that the second order condition holds.

How can the presence of bribery change the equilibrium quantity? When bribe must be paid, the firm's objective is to maximize its expected profit less the amount of bribe paid to obtain the license. For the moment, suppose that the penalty scheme for paying bribe is dependent of the quantity produced, that is, $\lambda_2 = \lambda_2(q)$, which is especially true for illegal business. The firm's objective function in the presence of bribery is

$$\max_q [1 - p + p\lambda_2(q)][\Pi(q) - \tau(q)], \quad (2.9)$$

with the corresponding first order condition after a simple rearrangement given by

$$\left(\frac{p\lambda_2'(q)}{1 - p + p\lambda_2(q)} \right) [\Pi(q) - \tau(q)] + [\Pi'(q) - \tau_q(q)] = 0.$$

How is the new equilibrium quantity compared with that without the bribe? Notice from the comparative static analysis of τ that $\tau_{\Pi} > 0$. Hence, $\text{sgn } \tau_q = \text{sgn } \tau_{\Pi} \Pi'(q)$. In words, the equilibrium bribe is increasing in the range when the total profit (before the bribe) is increasing in quantity and vice versa. This result yields the following proposition.

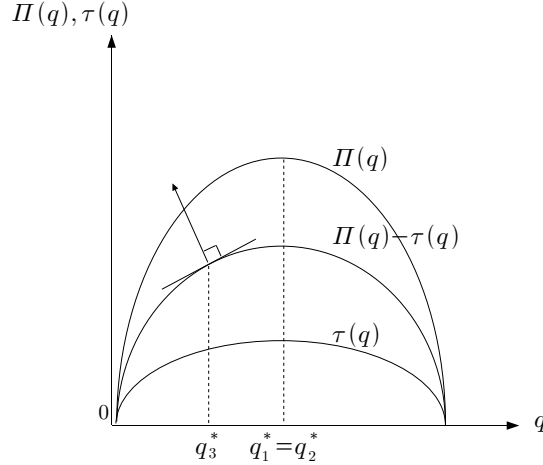


FIGURE 2.3: The effect of bribe on the equilibrium quantity of goods. q_1^* is the equilibrium quantity when no bribe is required. q_2^* is the equilibrium quantity when bribe is paid under the fixed penalty scheme λ . And q_3^* is the equilibrium quantity under the penalty scheme $\lambda = \lambda(q)$, where $\lambda'(q) < 0$. A tangency line with slope $-\frac{p\lambda_2'(q)}{1-p+p\lambda_2(q)}[\Pi(q) - \tau(q)]$ determines the profit maximizing quantity q_3^* on $\Pi(q) - \tau(q)$.

Proposition 5. *If $\lambda_2'(q) = 0$, then q^* that maximizes (2.8) also maximizes (2.9). If $\lambda_2'(q) < 0$, then q^* that maximizes (2.8) is more than q^* that maximizes (2.9).*

It is therefore possible to design an appropriate penalty scheme such that the presence of bribery does not necessarily deter the quantity produced. This is particularly appropriate for commodities that are viewed as socially desirable, such as infrastructure and medical supplies.

Bribery is also not uncommon in underground economy. Often, bribe is paid to the law enforcement officer to ‘look away’ by business owners of socially undesirable commodities such as drug and prostitution. In this case, it is also possible to have bribe that functions as a Pigovian tax that lowers the equilibrium amount of unwanted goods. From the first order condition of (2.9), the tangency condition requires that the slope at the optimal quantity on the $\Pi(q) - \tau(q)$ line is equal to $-\left(\frac{p\lambda_2'(q)}{1-p+p\lambda_2(q)}\right)[\Pi(q) - \tau(q)]$. A penalty scheme $\lambda_2'(q) < 0$ where the leniency is decreasing in the quantity produced requires that the equilibrium quantity in the

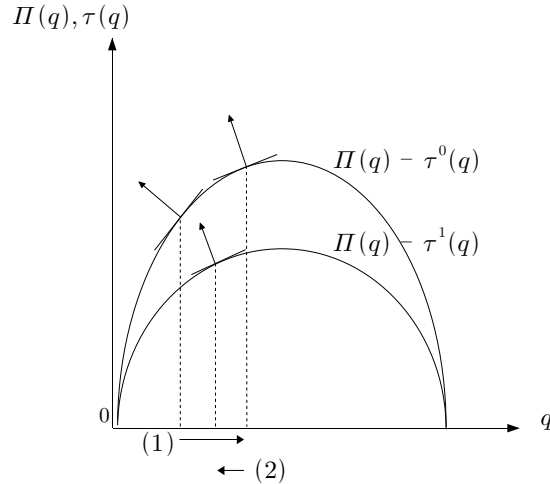


FIGURE 2.4: The change in bribe and equilibrium quantity under the penalty scheme $\lambda_2(q)$. (1) An increase in bribe from $\tau^0(q)$ to $\tau^1(q)$ reduces the penalty in terms of fine, which results in an increase in q from the new tangency condition. (2) A decrease in the profit after the bribe is paid results in a decrease in q . The total effect is uncertain.

presence of bribery occurs in the range where the marginal gross profit is increasing. This result is graphically illustrated in Figure.

It is unfortunately difficult to control the equilibrium quantity of this unwanted goods via the manipulation of the level of bribe. This is because the change in the amount of bribe alters both the tangency condition and the resource constraint in the manner analogous to the substitution and income effect. As shown in Figure, an increase in bribe, say, due to factors that affect τ besides p and λ_2 , decreases the slope of the tangency condition and thus the quantity of goods. An intuition behind this is because the actual penalty paid is a multiplicative factor of the profit after bribe so that an increase in bribe will lower the penalty paid if caught and therefore induce the firm to produce more. However, an increase in bribe also lowers the net profit to the firm after the bribe is paid and thus the quantity of the goods produced. These effects work in an opposite direction and the resulting new equilibrium is unclear.

2.3.2 Optimal Anti-corruption Penalty Schemes

As we have briefly discussed, the role of the government in setting the anti-corruption policies is less clear. Policy recommendations to a deontological government whose main objective to minimize the incidence of bribery typically include a penalty scheme for both the bribe giver and bribe taker to the full extent of law, a generous salary and benefit package to the officials, and a close monitoring system that maximizes transparency of the government contracts and transactions. Theoretical considerations and empirical evidence of the success of these policies can be found in previous literatures such as [41].

In this section, I propose a teleological approach to the optimal anti-corruption penalty schemes that minimizes the level of bribe in the presence of bribery. This is appropriate when the presence of bribery *per se* does not enter into the judge's utility function and when the bribe is given to secure government contracts for socially desirable commodities. Notice that this objective function closely resembles a lexicographic utility function of a judge whose primary objective is to ensure a socially optimal equilibrium quantity (efficiency) and whose secondary objective is to minimize the equilibrium bribe (equity). A decrease in bribe tends to yield a more equitable outcome since the bribe can be perceived as a transfer of profit from the entitled agent (the entrepreneur) to the undeserved agent (the official).

Formally, the judge's objective function can be written as

$$\min_{\lambda_1, \lambda_2} \tau(\lambda_1, \lambda_2, Y, p, \Pi)$$

subject to the following constraints

$$\begin{aligned} \underline{\lambda}_1 &\leq \lambda_1 \leq \overline{\lambda}_1, \\ \underline{\lambda}_2 &\leq \lambda_2 \leq \overline{\lambda}_2, \\ \overline{\tau} - \underline{\tau} &> 0, \end{aligned}$$

where $\overline{\lambda}_i$ and $\underline{\lambda}_i$ are the maximum and minimum leniency for Player i from the retribution perspective respectively that is exogenous in the model, and the expressions for $\overline{\tau}$ and $\underline{\tau}$ are given in Proposition 2.

The first constraint is the possible level of leniency for the retribution purpose of law as permissible by the penal code. The second constraint can be interpreted as an efficiency condition in which a judge perceives bribery as grease in the wheel that facilitates the function of the economy. His objective is thus to minimize the bribe amount and not to eliminate the incidence of bribery. It can also be interpreted as the circumstances where the harshest possible penalty scheme that is sufficient to deter bribery is beyond the maximum level set by the law, that is, $\underline{\lambda}_1$ and $\underline{\lambda}_2$. Note that I assume that the probability of detection is outside the instrument set of the judge. This is not uncommon since it normally requires a lengthy legal process to arrest, convict, and finally sentence a corruptible agent.

An analytic solution to the above problem can be found by the usual method of optimization with constraints, even though complications may arise due to the nonlinearity of the efficiency constraint. Nevertheless, we may still characterize these solutions (hereafter referred to as λ_1^*, λ_2^*) as well as some interesting comparative statics without solving the program as follows. Consider first the penalty scheme λ_1 and λ_2 depicted by a unit space as shown in Figure 2.5. For an appropriate level of Y , p , and Π , there exists a point (λ_1, λ_2) such that $\overline{\tau} = \underline{\tau}$. This point can be traced to form a continuous line with a negative slope such as the line ab as shown in Figure 2.5, which determines the combination of λ_1 and λ_2 such that both players are indifferent between the situation with or without bribery. The negativity in the slope is due to the usual ‘trade-off’ property as both penalties have the deterrent effect on the incidence of bribery; a lower level of penalty of one player requires that the other player is punished more severely in order to maintain the condition that $\overline{\tau} = \underline{\tau}$. All points outside this line denote the penalty scheme such that bribery

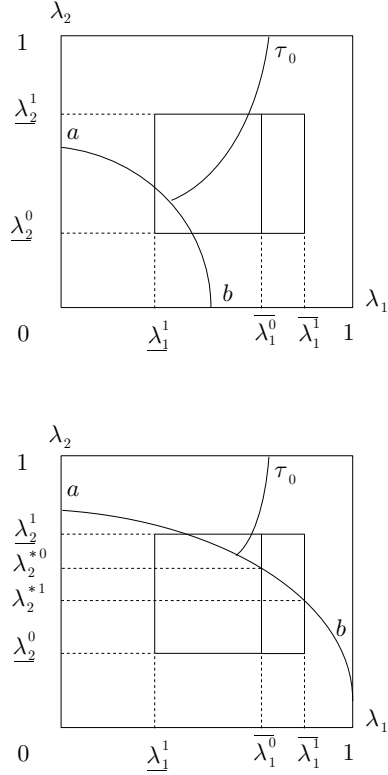


FIGURE 2.5: The optimal penalty level for the bribe giver and bribe taker when the efficiency is binding (Case 1) and not binding (Case 2). In the first case, the bribe taker receives the most lenient penalty level while the bribe giver is punished at the maximum extent of law. A change in $\bar{\lambda}_1$ from $\bar{\lambda}_1^0$ to $\bar{\lambda}_1^1$ only affects the optimal penalty of the bribe taker. In the second case, the bribe taker receives the most lenient penalty level while the bribe giver is punished at λ_2^* , the level less than the maximum extent of law. A change in the upper bound of punishment of the bribe taker can affect the optimal penalty of both players.

occurs ($\bar{\tau} > \underline{\tau}$), while all points within this line denote the penalty scheme that is too harsh so that there is no bribery ($\bar{\tau} < \underline{\tau}$).

To determine the optimal penalty scheme, let us first denote an isobribe curve, i.e. the combination of penalty of both players such that the level of bribe is held constant. Totally differentiate τ with respect to λ_1 and λ_2 , it follows that

$$\tau_{\lambda_1} d\lambda_1 + \tau_{\lambda_2} d\lambda_2 = d\tau.$$

By the comparative static analysis of bribe, it has been shown that $\tau_{\lambda_1} > 0$ and

$\tau_{\lambda_2} < 0$. Hence, the isobribe curve is positively slope. An example of the isobribe is depicted by the line τ_0 in Figure 2.5. Similarly, all points to the right of τ_0 denote a penalty scheme that yields a lower level of bribe in equilibrium. A bribe minimizing penalty scheme would required that the official is always punished as leniently as possible, i.e. $\lambda_1^* = \bar{\lambda}_1$ while the firm is punished as severely as possible if the efficiency constraint is not binding. Notice that this holds true at any level of Y that satisfy the constraints. These results are summarized in the following proposition (without proof).

Proposition 6. *If $\bar{\tau}(\lambda_1^*, \lambda_2^*, Y^*) = \underline{\tau}(\lambda_1^*, \lambda_2^*, Y^*)$, then $\lambda_1^* = \bar{\lambda}_1$ and $\underline{\lambda}_2 < \lambda_2^* < \bar{\lambda}_2$. If $\bar{\tau}(\lambda_1^*, \lambda_2^*, Y^*) < \underline{\tau}(\lambda_1^*, \lambda_2^*, Y^*)$, then $\lambda_1^* = \bar{\lambda}_1$ and $\lambda_2^* = \underline{\lambda}_2$.*

The above proposition yields some interesting comparative static results. Consider the first case in Figure 2.5 where the efficiency constraint is not binding. An increase in the upper bound for the penalty of the official from $\bar{\lambda}_1^0$ to $\bar{\lambda}_1^1$ only affects the optimal penalty level of the official. In the second case where the efficiency constraint is binding, an increase in the upper bound for the penalty of the official from $\bar{\lambda}_1^0$ to $\bar{\lambda}_1^1$ affects the optimal penalty level of both the official and the firm. While the official is received a more lenient penalty at $\lambda_1^* = \bar{\lambda}_1^1$ for the retribution purpose, the firm is punished more at $\lambda_1^{*1} < \lambda_1^{*0}$.

2.4 Conclusion

This chapter proposes a generalized Nash bargaining model of bribery between an official and a firm. While the game theoretic model of corruption and bribery has received attention from economists and political scientists for many decades (see, for example, [36], for her pioneering work in the economics of corruption), the role of risk aversion of agents on the prevalence of bribery and the equilibrium level of bribe has been left relatively unexplored. In my model, as opposed to previous models by

[9] and [30] with risk neutral agents, the degree of risk aversion of related agents in the bribery game is shown to play a crucial role in determining the effectiveness of some anti-corruption policies such as the public compensation reform.

The model yields a generalized result of the the well known proposition in [9] and [30] that a public wage reform will induces a trade-off between a reduction in the prevalence of bribery and an increase in the equilibrium bribe among officials who continue to take bribe. In particular, I argue that such trade-off may not exist when the initial wage of the official is relatively high. This justifies, for example, a relatively large wage gap between high and low ranking officials in one of the most corruption-free countries such as Singapore. In addition, I also show how an effective judicial system may be an effective anti-corruption measure that is able to reduce the incidence of bribery as well as lower the equilibrium bribe. Other main predictions of the model are that the prevalence of bribery is decreasing in the severity of the penalty imposed on either player, the gain from bribery, the initial status quo profit of the firm, an increase in the degree of risk aversion of the player, the probability that bribery is detected, and the morality of the official. The equilibrium bribe is decreasing in the penalty imposed on the firm and the degree of risk aversion of the official, but increasing in the penalty imposed on the official and the degree of risk aversion of the firm. The effect of the probability of detection, the gain from profit, and the salary of the official must however be empirically determined.

The last part of the chapter discusses the role of the state in coping with corruption. I analyze the response of the firm toward the bribe, i.e. how the quantity of goods produced is altered by the bribe payment to the official and show that, depending on the penalty scheme imposed on the agents involved in bribery, the presence of bribery does not necessarily reduce the level of goods produced compared to that in the absence of bribery. In a world where the state adopts a teleological perception towards bribery, i.e. when the economic outcome resulting from bribery rather than

the act of bribery *per se* is a matter of concern, I also discuss the tax-like effect of bribery and show how bribery, with an appropriately designed penalty scheme, can be used to deter unwanted commodities, such as illegal drugs, prostitution, and gambling. The chapter concludes with an optimal penalty scheme that minimizes the level of bribe in the presence of bribery.

Evidence from BEEPs

3.1 Background

Unfortunately, the empirical study of corruption lacks behind its theoretical counterpart due to the scarcity of corruption-related data. Since the nature of bribery normally precludes ones from truthfully answering the questions, reliable surveys concerning the incidence of corruption are rare. Most empirical research of the determinant of the incidence of corruption, as [40] pointed out, are often based on cross-country analysis where the dependent variable is the indices of the severity of corruption constructed from expert opinions. The conclusions based on these studies are therefore often ambiguous for a number of reasons. First, the indices are constructed from perceptions of a selected group of experts, who are not representative of the whole population. Second, it is based on perception rather than actual value, which renders a severe problem of measurement error in the dependent variable. Moreover, cross country indices are generally not comparable, a problem analogous to the interpersonal comparison of utility.

A notable exception is [40], who acquires a private firm-level data of the incidence

and amount of graft paid by firms in Ugandan. In his findings, the incidence of bribery and the level of bribe are shown to be increasing in the profit per employee of the firm, which supports his conjecture that more profitable firms are extracted more rent by the officials as the size of the rent increases. The results are tested and shown to be robust to a number of specifications and robustness analysis.

In this chapter, I use a publicly available corruption data from the Business Environment and Enterprise Performance Surveys 1999-2005 (BEEPS) to test a number of some testable implications derived in the previous chapter. As the survey contains only information of the bribe giver, the focus of the empirical analysis in this chapter is on the characteristics of the bribe-paying firms. The estimation results are in coherent with the theoretical predictions and are shown to be robust to the endogeneity and the sample response bias correction. In particular, there is a strong evidence suggesting that bribery is more rampant among emerging business entrepreneurs and that an effective judiciary tends to provide a good check and balance that deters the corruption within the executive branch in the country.

3.2 Evidence from BEEPS

With the effort of the World Bank and other international organizations, more publicly available firm-level data has recently become available. A few surveys, among notably the World Business Environment Survey 2000 (WBES) and the Business Environment and Enterprise Performance Surveys 1999-2005 (BEEPS), include in the questionnaires a number of corruption-related questions. While WBES is a one year cross sectional survey that covers respondents from almost all countries around the world, BEEPS is a repeated bi-annual cross sectional survey of firms in the Central Eastern Europe and Central Asia, many of which were formerly in the Soviet Union. In 2005, a number of firms in BEEPS is sampled from the 2004 group and resurveyed, thus allowing for a possibility to study the dynamic nature of corrup-

tion. Both surveys contain detailed information of the firms, including the level of unofficial payment that firms of similar characteristics to the respondent normally pay to the officials. Questions that are corruption-related are tacitly stated, e.g.

When firms in your industry do business with the government, how much of the contract value must they offer in additional or unofficial payments to secure the contract?

To further reassure the respondents to truthfully reveal their experience, the questionnaire also makes some explicit statements at the beginning of this type of questions, e.g. that it does not imply that the firm makes an actual unofficial payment or condone bribery. Despite the comprehensive information from the firm's side, both surveys have no information pertaining to the official who receives or asks for bribe. BEEPS therefore tends to be the better choice between the two available surveys as countries covered in the survey are likely to share fairly similar institutional and geographical characteristics. In the empirical analysis, I use data from BEEPS 2005 based on the reason that the survey covers the largest number of respondents among BEEPS in other years and that it is the most recent so that any evidence found should imply a more immediate policy recommendation.

I start by selecting a number of variables from the survey that are candidates for the firm's characteristics in the model, i.e. τ , π , Π , and $1 - \alpha$. The amount of bribe paid by the firm τ is approximated by the variable *bribe*, which is the amount of unofficial payment 'firms like the respondent' tend to pay to the official in percentage of total sales. Naturally, the term 'firms like yours' is used to minimize the survey response bias, especially in countries where bribery is a punishable crime. It may however cause a measurement error when the response of firms is based on their perceptions rather than their actual experiences. This type of error is perhaps intrinsic in the survey and the results should therefore be interpreted with caution.

It is also difficult to differentiate between the profit before (π) and after the bribery (Π). In general, the bribe is paid either to increase revenue, such as to secure contracts of public projects, or decrease cost, such as to avoid tax payment. Under a reasonable assumption that firms truthfully report their sales, we may approximate Π by *sale*, which is the total annual sales of the firm that should be increasing or at least nondecreasing after the bribery. The level of profit absence the bribery π is approximated by two variables: *size*, which is the number of full-time employees in the firm, classified into small (2-49), medium (50-249), and large (250-999) in the survey, and *labor cost*, which is the total wage payment of the firm. In our static setting, these two variables are not affected by bribery and are good proxies for the level of profit the firm would receive without having to recourse to any unofficial payments.¹

Another good proxy variable that determines the threat point position of the firm is *alternative*, which reflects the degree the firm agrees to the following question:

How often is the following statement true? ‘If a government agent acts against the rules I can usually go to another official or to his superior and get the correct treatment without recourse to unofficial payments/gifts.’

A number of other firm’s characteristics are chosen candidates for the bargaining power of the firm $1 - \alpha$, which include the number of years the firm has been established (*age*), the percentage of college educated workers (*college*), the gender of the principal owner of the firm (*sex*), the type of the firm (*type*) e.g. individual, family, foreign, government, and the legal status of the firm (*legal*) e.g. single proprietorship, partnership, cooperative. Note that these variables may very well affect the profitability of the firm π and whether one is a threat point or a bargaining power must be empirically determined.

¹ In a dynamic setting, however, a firm may grow by an increase in the firm’s profit from bribery.

The proxy variable used to determine the probability that bribery is detected and players are penalized p is *court*, which is the degree the firm believes the court system in the country in which it operates is fair and impartial. While ones might suspect this variable to be highly endogenous in the model in the sense that executive corruption is often highly correlated with judicial corruption, there is no obvious instrument for *court*. As such, we resort to the assumption of *trias politica* that the judiciary is independent of the executive.²

In the remaining part of this section, I estimate the determinants of the incidence of bribery and the level of bribe. Recall that the incidence of bribery is determined by

$$\Pr(\tau > 0) = \mathcal{F}(m^*),$$

where

$$m^* = \frac{(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}}{(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}} [(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}} \Pi - \pi] - [1 - (1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}] Y.$$

Assume that the moral standard of the official is normally distributed and define a binary variable *bribery* which equals one if *bribe* > 0 and zero otherwise. A simple first order Taylor approximation of m^* yields an estimable probit regression equation given by

$$\Pr(\text{bribery}_i = 1) = \Phi(x'_i \beta),$$

where $\Phi(\cdot)$ is the standard normal probability distribution function, x_i is a vector of explanatory variables of the characteristics of firm i , and β is a vector of corresponding coefficients. The level of bribe can be estimated by a regression equation

$$\text{bribe} = z'_i \gamma + \epsilon_i,$$

² Following the judicial reform in several post Soviet Union countries, the *de jure* judicial independence has at least been established by the constitution. Judges in most courts in the post Soviet Russia are appointed for an unlimited term and could be removed by a committee of their peers (Solomon, 2002).

	Variable		Expected sign	
	Empirical	Theoretical	Corruption	Bribe
<i>sale</i>		Π	(+)	(?)
<i>size</i>		π	(-)	(-)
<i>labor cost</i>		π	(-)	(-)
<i>alternative</i>		π	(-)	(-)
<i>court</i>		p	(-)	(?)
<i>age</i>		π, α	(-, 0)	(-, +)
<i>college</i>		π, α	(-, 0)	(-, +)

Table 3.1: The expected signs of corruption and bribe equations.

where *bribe* is the reported amount of bribe that is strictly greater than zero, z_i is a vector of explanatory variables of the characteristics of firm i , γ is a vector of corresponding coefficients, and ϵ is the error term. By construction, it follows that x_i be contained in z_i since all variables that affect the incidence of bribery also affect the level of bribe but not vice versa since α has no impact on the incidence of bribery.

The expected sign of the estimated coefficients of the key variables is summarized in Table 3.1. These signs are derived from the comparative static analysis of the incidenc of bribery and the level of bribe discussed in the previous chapter. The expected sign of *sale* is positive for the bribery equation but uncertain for the bribe equation, depending on the degree of risk aversion of the firm. The expected sign of *labor cost* and *alternative* which serve as proxy variables for the threat point is negative for both the bribery and bribe equation. The expected sign of *court* is negative for the corruption equation, but is uncertain for the bribe equation, depending on the relative bargaining power of the firm and the official. The expected sign of *age* and *college* is undetermined. Should these variables affect the threat point of the firm, they are likely to affect both the bribery and the bribe equation in the same direction. Should they affect only the bargaining position of the firm in negotiating bribe, they are likely to be insignificant in the bribery equation but be negative in the bribe equation.

Variable	bribe reported	bribe = 0	bribe > 0	bribe missing
Quantitative (\bar{x})				
<i>bribe</i>	1.034	0	2.928	NA
<i>sale</i>	6.247	6.308	6.239	6.523
<i>alternative</i>	2.998	3.097	2.993	3.441
<i>court</i>	2.909	3.025	2.855	3.245
<i>age</i>	14.502	15.525	13.310	15.015
<i>skilled</i>	49.741	51.315	47.156	47.847
<i>college</i>	27.776	26.505	29.457	27.889
<i>share</i>	77.165	78.338	74.774	74.119
Qualitative (n)				
<i>size</i>				
2-49	5,960	3,810	3,008	848
50-249	1,676	1,075	832	231
250-999	826	588	342	104
<i>sex</i>				
male	4,483	2,723	2,441	681
female	1,685	1,116	792	223
<i>Largest shareholder</i>				
individual	5,356	3,336	2,766	746
family	731	457	420	146
general public	81	55	31	5
domestic company	451	319	173	41
foreign company	460	309	222	71
bank	6	6	1	1
investment fund	38	26	14	2
government	747	577	87	105
<i>N</i>	8,462	5,473	2,989	1,193

Table 3.2: Descriptive statistics, classified by the reported value of bribe. The means are reported for quantitative variables and the numbers of observations are reported for qualitative variables.

I first examine the pattern of missing data as firms that fail to answer corruption-related questions may raise concern about the selection bias. As shown in Table ??, of the total number of firms in the survey; 5,473 firms report no incidence of bribery; 2,989 firms report paying bribe; 1,193 firms refuse to answer the question, which amounts to merely 12 percent of the firms in the survey. A glance at Table 3.2 reveals that firms that refuse to answer the bribe-related question tend to be similar in characteristics to other firms, except that the average amount of sale among these

Specification	Probit		
	(1)	(2)	(3)
<i>constant</i>	-2.0170*** (0.2752)	-2.0015*** (0.2774)	-1.9400*** (0.2931)
<i>sale</i>	0.0325 (0.0257)	0.0265 (0.0261)	0.0235 (0.0263)
<i>college</i>	0.0004 (0.0009)	0.0002 (0.0009)	0.0001 (0.0009)
<i>age</i>	0.0027* (0.0015)	0.0027* (0.0015)	0.0031* (0.0016)
<i>court</i>	0.0280 (0.0183)	0.0315* (0.0185)	0.0315 (0.0186)
<i>labor cost</i>	-0.0492 (0.0318)	-0.0458 (0.0323)	-0.0526 (0.0327)
<i>size</i>			
<i>medium</i>	-0.0113 (0.0928)	-0.0026 (0.0937)	0.0069 (0.0940)
<i>large</i>	-0.0256 (0.1487)	-0.0157 (0.1508)	0.0045 (0.1523)
Interviewee FE			Yes
Firm type FE		Yes	Yes
Country FE	Yes***	Yes***	Yes***
LR	746.23	750.54	757.47
<i>N</i>	5093	5042	5042

Table 3.3: The probit regression of incidence of missing reported bribe. Standard errors are in parenthesis. Coefficients with *, **, *** are statistically significant at 0.1, 0.05, and 0.01 level of confidence respectively.

firms is higher.

The missing pattern is analyzed using a probit regression as follows. Define a binary variable *missing* as the dependent variable in the regression where *missing* = 1 if the firm fails to answer the bribe question and regress it on the explanatory variables of interest using a probit regression model. All specifications include x_i , the explanatory variables in the corruption equation. The first specification includes the country fixed effect. The second specification adds in the firm type fixed effect, as interviewees in bigger cooperates may truly have no knowledge whether bribery actually takes place, while smaller business enterprise may be reluctant to report

the incidence for fear of being disclosed. The third specification also controls for the position of the interviewee in the firm, e.g. owner, manager, financial officer. At a lower level of confidence, older firms tend to be more reluctant to answer the corruption-related question. All specifications yield a similar estimation result that other main variables of interest do not significantly explain the missing pattern and hence the selection bias tends to be minimal.

We now proceed to estimate the bribery equation using a probit regression. Common explanatory variables in specification (1) and (2) are *sale*, *court*, *alternative*, *government*, *age*, *college*, and *family*. The first specification uses *size*, the size of the firm in terms of number of employees (classified in small, medium, and large), as a proxy variable for the status quo profit that the firm would receive without having to pay bribe. The second specification uses *labor cost* instead. The estimates from both specifications are strikingly similar and are in accord with the theoretical prediction. Firms with higher sales are more likely to pay bribe while those with higher labor cost are in better position to refuse to pay grafts. Firms that can resort to other officials to receive the same services without having to pay bribe are less likely to pay bribe. An increase in the judicial quality significantly decreases the incidence of bribery. Family owned enterprises as opposed to large corporations are also more likely to pay bribe. A somewhat surprisingly result, even though only significant at a lesser degree, is that a higher percentage of college educated workforce tends to increase the likelihood of paying bribe.

As the variable *sale*, a proxy variable for Π , is correlated to the incidence of bribery by construction, that is, $\Pi > \pi$ if *bribery* = 1 and $\Pi = \pi$ otherwise, I reestimate the *bribery* equation using an instrumental variable probit estimation. In specification 3, I assume that the only explanatory variable endogenous in the model is *sale* and use *share* and *skilled* as the instruments. In specification 4, both *sale* and *labor cost* are assumed endogenous and the instrument sets are expanded to include

Specification	Probit		IV Probit		SRB
	(1)	(2)	(3)	(4)	(5)
<i>constant</i>	-0.6703*** (0.1656)	-0.5477*** (0.1617)	-2.5184*** (0.7816)	-1.7926*** (0.3904)	7.4473 (108.6252)
<i>sale</i>	0.0651*** (0.0122)	0.0690*** (0.0182)	0.9052*** (0.3234)	0.6482*** (0.1645)	0.3935*** (0.1042)
<i>size</i>					
<i>medium</i>	-0.1720*** (0.0596)				
<i>large</i>	-0.3722*** (0.0902)				
<i>labor cost</i>		-0.0508*** (0.0208)	-0.8885*** (0.3245)	-0.6576** (0.1860)	-0.2455** (0.1061)
<i>court</i>	-0.0512*** (0.0135)	-0.0451*** (0.0139)	-0.0353** (0.0169)	-0.0349** (0.0162)	-0.2869*** (0.0748)
<i>alternative</i>	-0.0312** (0.0123)	-0.0315** (0.0127)	-0.0251 (0.0154)	-0.0271* (0.0141)	-0.2921*** (0.0619)
<i>government</i>	0.0012 (0.0013)	0.0009 (0.0013)	0.0005 (0.0016)	0.0009 (0.0015)	-0.0069 (0.0044)
<i>age</i>	-0.0016 (0.0011)	-0.0020* (0.0012)	-0.0005 (0.0015)	0.0001 (0.0020)	-0.0101** (0.0042)
<i>college</i>	0.0012* (0.0007)	0.0014** (0.0007)	0.0004 (0.0009)	0.0005 (0.0008)	0.0055* (0.0029)
<i>family</i>	0.2391*** (0.0445)	0.2453*** (0.0461)	0.2825*** (0.0571)	0.2348*** (0.0747)	0.6059*** (0.1663)
1st stage equation					
<i>sale (F)</i>			785.06*** [0.0000]	88.11*** [0.0000]	
<i>labor cost (F)</i>				104.75*** [0.0000]	
Overidentification					
χ^2			0.41060 [0.5242]	4.3080 [0.1160]	
Exogeneity					
χ^2			9.4700*** [0.0021]	16.2100*** [0.0003]	
Response equation					
<i>interviewee (χ^2)</i>					14.2600** [0.0268]
χ^2	745.88 [0.0000]	694.85 [0.0000]	453.68 [0.0000]	528.65 [0.0000]	77.84 [0.0000]
<i>N</i>	5550	5260	5172	5172	5260

Table 3.4: Results from *bribery* equation. All specifications include country fixed effect. Standard errors are in parenthesis and p -values are in bracket. ***, **, * denote estimates that are significant at 0.1, 0.05, and 0.01 level of confidence respectively. The overidentification test reports the Amemiya-Lee-Newey minimum χ^2 statistic. The exogeneity test reports the Wald χ^2 statistic. Excluded instruments are *share* and *skilled* in (3) and *share*, *skilled*, *private*, and *foreign* in (4).

private and *foreign*. The selection of these instruments combines follow from an initial conjecture, combined with that fact that they should be highly correlated to the instrumented variable but uncorrelated with the error term. Most estimates, i.e. *sale*, *labor cost*, *court*, and *family*, from both specifications remain highly significant and are robust to the endogeneity correction. We strongly reject the null hypothesis that the model is underidentified, which suggests that the instruments are highly correlated with the suspect endogenous variables. Also, the null hypothesis that the model is just identified cannot be rejected, which implies that the instruments are reasonably uncorrelated with the error terms. An interesting result from specification 3 is that there is a strong evidence that *sale* is endogenous in the model. This supports our previous conjecture and justifies the use of *sale* as a proxy variable for Π .

The sample response bias might also raise another concern since respondents who pay bribe may have an incentive to lie. In our data, Table 3.2 shows that the percentage of firms who report paying no bribe is 65 percent, a noticeably high figure that possibly warrants our suspicion of the sample response bias in the data. To correct this problem, I follow Leung and Yu (2002), who investigate the impact of survey response bias on the analysis of the determinants of substance use by assuming that those who report a positive amount of bribe e.g. $bribery_i = 1$ are truthful while those who report paying no bribe e.g. $bribery_i = 0$ may lie. Define two latent binary variables $y_i = 1$ if firm i actually pays the bribe and $w_i = 1$ if firm i lies. Hence,

$$\begin{aligned}\Pr(bribery_i = 1) &= \Pr(w_i = 0, y_i = 1) \\ \Pr(bribery_i = 0) &= \Pr(w_i = 0, y_i = 0) + \Pr(w_i = 1, y_i = 1).\end{aligned}$$

The log-likelihood function becomes

$$\begin{aligned}\ln \mathcal{L} &= \sum_{i=1}^N \{bribery_i \ln \Pr(w_i = 0, y_i = 1) \\ &\quad + (1 - bribery_i) [\Pr(w_i = 0, y_i = 0) + \Pr(w_i = 1, y_i = 1)]\}.\end{aligned}$$

It remains to determine the joint probability distribution. Following our assumption that firms do not lie if they do not pay bribe, $\Pr(w_i = 0|y = 0) = 1$. Assume that the conditional distribution of $w_i|y_i = 1$ is determined by the relation $w_i = \mathcal{I}(w_i^* > 0)$, where $\mathcal{I}(\cdot)$ is an indicator function and

$$w_i^* = h_i'\delta - \eta_i,$$

where w^* is the unobserved threshold that determines the decision to lie, h_i is the firm characteristics, δ is the corresponding coefficient, and $\eta_i \sim \mathcal{G}(\eta)$ is the error term with a well defined probability distribution function. For simplicity, assume that $\mathcal{G}(\cdot) = \Phi(\cdot)$ and recall from previously that the probability of bribery is determined by $\Pr(y_i = 1) = \Phi(x_i'\beta)$, the log-likelihood function can then be rewritten as

$$\ln \mathcal{L} = \sum_{i=1}^N \{ bribery_i \ln [(1 - \Phi(x_i'\beta)) \Phi(h_i'\delta)] + (1 - bribery_i) \ln [\Phi(x_i'\beta) + (1 - \Phi(x_i'\beta)) (1 - \Phi(h_i'\delta))] \},$$

which is estimable by the method of maximum likelihood.

Results from the response bias correction is shown in specification 5 and 6. In specification 5, I use *interviewee*, the person who is interviewed by the survey conductor, as the excluded variable, i.e. this variable should not affect the bribe giving decision of the firm but can affect the probability of truthfully report the corruption-related information in the survey. In specification 6, another variable, *establishment*, is added in the excluded variables set. Estimates from the maximum likelihood are strongly consistent with those obtained from the ordinary probit and instrumental probit estimations, that is, firms with higher sales and lower labor cost, a lower judicial quality, and firms with less alternatives are more likely to pay bribe. The interviewee fixed effect is highly significant, which suggests that an incentive to lie tends to vary across different types of interviewees.

The bribe equation is first estimated by an ordinary least squares method. To make the two equations of interest comparable, the set of explanatory variables

Specification	OLS		GMM	
	(1)	(2)	(3)	(4)
<i>constant</i>	0.0883** (0.0404)	0.1055*** (0.0386)	0.1134*** (0.0311)	0.1246*** (0.0302)
<i>sale</i>	0.0179*** (0.0029)	0.0218*** (0.0041)	0.0189*** (0.0052)	0.0209*** (0.0052)
<i>size</i>				
<i>small</i>	-0.0075 (0.0137)			
<i>medium</i>	-0.0611*** (0.0217)			
<i>labor cost</i>		-0.0117** (0.0047)	-0.0092* (0.0055)	-0.0130** (0.0055)
<i>court</i>	-0.0097*** (0.0033)	-0.0091*** (0.0034)	-0.0095*** (0.0034)	-0.0096*** (0.0034)
<i>alternative</i>	-0.0077** (0.0031)	-0.0072** (0.0032)	-0.0076** (0.0031)	-0.0074** (0.0031)
<i>government</i>	0.0010*** (0.0003)	0.0012*** (0.0003)	0.0011*** (0.0004)	0.0009** (0.0004)
<i>age</i>	-0.0001 (0.0003)	-0.0001 (0.0003)		
<i>college</i>	-0.0001 (0.0002)	-0.0001 (0.0002)	-0.0001 (0.0001)	0.0000 (0.0002)
<i>family</i>	0.0208* (0.0107)	0.0211* (0.0109)	0.0225** (0.0106)	0.0197* (0.0106)
<i>construction</i>				0.0004*** (0.0002)
<i>transportation</i>				-0.0004** (0.0002)
<i>wholesale</i>				-0.0004*** (0.0001)
<i>real estate</i>				-0.0002 (0.0002)
Kleibergen-Paap χ^2			502.945 [0.0000]	495.037*** [0.0000]
Hansen <i>J</i> -statistic			2.569 [0.4629]	2.096 [0.5527]
Sargan <i>C</i> -statistic				
<i>labor cost</i>			0.391 [0.5318]	0.613 [0.4338]
<i>court</i>			0.050 [0.8233]	0.158 [0.6906]
<i>F</i>	5.32 [0.0000]	4.91 [0.0000]	3.92 [0.0000]	4.74 [0.0000]
<i>N</i>	1971	1869	1829	1829

Table 3.5: Results from *bribe* equation. All specifications include country fixed effect. Standard errors are in parenthesis and the *p*-values are in bracket. *, **, *** denote estimates that are significant at 0.1, 0.05, 0.01 respectively. Instruments for *sale* in specification (3) and (4) are *share*, *skilled*, *age*, and *material cost*. The Kleibergen-Paap test is for underidentification, the Hansen J-test is for overidentification, and the Sargan test is the exogeneity test of a specific explanatory variable.

is same as the one in the previous equation. Similarly, specification 1 uses *size* as a proxy variable for the status quo profit while specification 2 uses *labor cost* instead. Both specifications produce estimates whose signs are consistent with the theory. The incidence of bribery as well as the level of bribe is increasing in *sale* and decreasing in *size* and *labor cost*, the proxy measures of the status quo profit, as well as *alternative*, a variable that is closely related with the threat point of the firm. The variable *government* does not show up significant in the bribery equation, but is highly significant in the bribe equation, which suggests that although firms with high percentage of sale to the government is not more likely to pay bribe than other types of firms, they tend to have less bargaining power in negotiating bribe with the officials.

I explore the robustness of this findings using a general method of moments, which is a general case of the instrumental variable estimation when the error terms are heteroskedastic. In specification, I use the same explanatory variables except for *age*, which is highly insignificant when estimated by the least squares, and combine it with *share*, *skilled*, and *material cost* as instruments for *sale*. The sign, magnitude, and the significance of the GMM estimates are strikingly similar to the previous results found by the OLS. The instruments appear to be reasonable as they are highly correlated with *sale*, but not correlated with the error terms. Two possibly endogenous explanatory variables, *labor cost* and *court*, are tested using Sargan *C*-test. We fail to reject the null hypothesis that each of these variables is exogenous in the model. The evidence that *labor cost* is exogenous justifies the use of this variable as a proxy variable for the status quo profit of the firm since it does not tend to be affected by *bribe*. The exogeneity of *court* supports our previous assumption of *trias politica* that the judiciary and the executive are fairly independent. In the last GMM specification, I include the percentage of products in various industry types, i.e. *construction*, *transportation*, *wholesale*, and *real estate*, as more controlled

variables. Previous estimates are robust to this specification. In addition, evidence suggests that firms operating in construction business significantly give more bribe while those in the transportation and wholesale business significantly give less.

An interesting result that is robust across all specifications is that *court* significantly reduces both incidence of bribery and the level of bribe. As we have previously discussed, even though the first result is expected from the theory, the effect of the judicial quality on the level of bribe of the executive must be empirically verified. The strong evidence that *court* significantly reduces the level of bribe suggests, for example, that an effective check and balance of powers can be an effective anti-corruption device that does not tend to induce any trade-off between a reduction in the prevalence of bribery and an increase in bribe.

3.3 Conclusion

The chapter aims to test some of the testable implications of the model developed in chapter two. As is well known, the lack of reliable corruption related surveys is not uncommon due to the nature of corruption that normally precludes the respondents from truthfully the information. Most empirical studies of corruption must therefore rely on surveys of expert's opinions. Conclusions drawn from these studies are as a result subject to a number of measurement errors.

A notable exception to the aforementioned practice is [40] who conducts a private survey of the bribe experience of Ugandan firms in 2003. He finds that firms with higher profit per employee significantly pay more bribe, a result consistent with his conjecture that officials are able to extract larger rent in terms of bribe payment from larger firms. In this chapter, I acquire firm-level data from BEEPs 2005, a publicly available data conducted by the World Bank that covers a number of Eastern European countries including former Soviet Union states, and test a number of conjectures derived from the model of bribery developed in chapter two. The

survey contains a detailed information of the characteristics of the firm such as type of ownership of the firm, the number of years the firm has operated, financial characteristics including profit, and various types of cost, as well as some corruption-related information such as whether and how much firms pay in unofficial payment.

As opposed to the previous specification a la [40] , I attempt to differentiate between two types of profit: the profit that the firm gains *after* the bribe and the profit that the firm gains *before* the bribe. Although the survey contains no explicit information that would allow ones to distinguish between the two, I conjecture that firms normally pay bribe to increase their sale revenues through secured government contract or to lower tax payment. The sale reported by the firm in the survey is then used as a proxy variable for the profit after the bribe and other firm's characteristics such as firm size and the labor cost is used as proxy variables for the *status quo* profit of the firm. The survey also contains the information related to the perception of the firm towards the judicial quality of the country in which the firm operates, a variable used as a proxy variable for the probability that the agents involved in bribery is found guilty and subsequently punished.

The model is initially estimated using two separate equations: a probit equation for the incidence of bribery and an ordinary least squares for the level of bribe, with profit, firm size, the perception of the firm towards the judicial quality, and other controlled variables. The estimated coefficients are highly significant, and the signs are all in accord with the theory, i.e. the prevalence of corruption is decreasing in the level of profit, the size of the firm, and the effectiveness of the judiciary as perceived by the firms. The level of bribe is increasing in the profit but decreasing in the firm size, a result coherent with the gain from cooperation and the threat point conjecture. An increase in the judicial quality also significantly decreases the amount of bribe, which confirms that a strong check and balance system between the judiciary and the executive is an effective anti-corruption policy.

I perform two robustness analyses: the endogeneity correction and the survey response bias correction. Some explanatory variables such as profit are endogenous by construction, that is, firms gain higher profit after they pay bribe. Indeed, the profit is found to be endogenous while the size of the firm and the labor cost are not. This supports the previous conjecture that the former is a suitable proxy for the profit after the bribe while the latter is an appropriate proxy for the status quo profit. The endogeneity problem is corrected using standard procedures of instrumental variable regression, which yields estimation results similar to the previous findings.

As the nature of bribery may induce some bribe-giving respondents to lie, I correct for the survey response bias using the method of maximum likelihood under the assumption that some respondents who report no bribe experience may lie while those who report incidence of bribery truthfully report the amount of bribe paid. The results found after this correction are consistent with the previous ones. The findings suggest that bribery is more rampant among emerging business entrepreneurs and that an effective judiciary tends to provide a good check and balance that deters the corruption within the executive branch in the country.

Appendix A

Proof

Proposition (Convexity). *If u_i is strictly concave and λ_i is positive, then \mathcal{U} is a strictly convex set.*

Proof. Let $U, U' \in \mathcal{U}$, we need to show that there exists a feasible $U'' \in \mathcal{U}$ and $0 \leq \rho \leq 1$ such that $U'' \geq \rho U + (1 - \rho)U'$. Let (x_1, x_2) and (x'_1, x'_2) be the resources allocated to player 1 and 2 in U and U' respectively. Feasibility condition requires that $x_1 + x_2 \leq Y + \Pi$ and $x'_1 + x'_2 \leq Y + \Pi$. Let the resources allocated in U'' be

$$(x''_1, x''_2) = (\rho x_1 + (1 - \rho)x'_1, \rho x_2 + (1 - \rho)x'_2).$$

It is straightforward to verify that $x''_1 + x''_2 \leq Y + \theta\Pi$. It follows from concavity property of u_1 and u_2 that

$$\begin{aligned} u_1(\rho x_1 + (1 - \rho)x'_1) &\geq \rho u_1(x_1) + (1 - \rho)u_1(x'_1) \\ u_2(\rho x_2 + (1 - \rho)x'_2) &\geq \rho u_2(x_2) + (1 - \rho)u_2(x'_2). \end{aligned}$$

If $0 \leq \lambda_1, \lambda_2 \leq 1$, then $1 - p + p\lambda_1^{k_1}$ and $1 - p + p\lambda_2^{k_2} \geq 0$. Multiplying the corresponding terms through the above inequalities will not change the sign. This establishes the property that $U'' \geq \rho U + (1 - \rho)U'$. \square

Proposition (Individual Rationality Condition). *The outcome $(E(U_1), E(U_2))$ satisfies the individual rationality condition if and only if $\underline{\tau} \leq \tau \leq \bar{\tau}$ such that*

$$\begin{aligned}\underline{\tau} &= \frac{m + (1 - (1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}})Y}{(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}} \\ \bar{\tau} &= \Pi - \frac{\pi}{(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}}.\end{aligned}$$

Proof. The individual rationality requires that $E(U_1) \geq V_1$ and $E(U_2) \geq V_2$. Substitute the expressions in the first condition gives

$$\begin{aligned}(1 - p + p\lambda_1^{k_1})u_1(Y + \tau) &\geq u_1(Y + m) \\ u_1((1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}(Y + \tau)) &\geq u_1(Y + m).\end{aligned}$$

Since u_1 and u_2 are strictly increasing in their arguments, it follows that

$$\begin{aligned}(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}(Y + \tau) &\geq Y + m \\ \frac{m + [1 - (1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}]Y}{(1 - p + p\lambda_1^{k_1})^{\frac{1}{k_1}}} &\leq \tau.\end{aligned}$$

Similarly,

$$\begin{aligned}(1 - p + p\lambda_2^{k_2})u_2(\Pi - \tau) &\geq u_2(\pi) \\ u_2((1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}(\Pi - \tau)) &\geq u_2(\pi) \\ (1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}(\Pi - \tau) &\geq \pi \\ \Pi - \frac{\pi}{(1 - p + p\lambda_2^{k_2})^{\frac{1}{k_2}}} &\geq \tau.\end{aligned}$$

Combining the two restrictions gives the minimum and maximum acceptable level of bribe. □

Proposition (Prevalence of Corruption). *For $m^* \geq 0$, $\mathcal{F}_m(m^*)$ is nondecreasing in $\lambda_1, \lambda_2, \Pi$ and nonincreasing in p, π, Y .*

Proof. The signs of m_Y^* , m_π^* , and m_Π^* are trivial. For the effect of λ_1, λ_2 , and p , it is convenient to define $r_1 = 1 - p + p\lambda_1^{k_1}$ and $r_2 = 1 - p + p\lambda_2^{k_2}$. Note that $r_{1\lambda_1} = pk_1\lambda_1^{k_1-1} \geq 0$, $r_{2\lambda_2} = pk_2\lambda_2^{k_2-1} \geq 0$, $r_{1p} = -1 + \lambda_1^{k_1} \leq 0$, and $r_{2p} = -1 + \lambda_2^{k_2} \leq 0$. Hence,

$$m_{\lambda_1}^* = \frac{1}{k_1} r_1^{\frac{1}{k_1}-1} r_{1\lambda_1} \left(\Pi + Y - \frac{\pi}{r_2^{\frac{1}{k_2}}} \right)$$

$$m_{\lambda_2}^* = \frac{1}{k_2} r_1^{\frac{1}{k_1}} \frac{\pi}{r_2^{1+\frac{1}{k_2}}} r_{2\lambda_2}.$$

The second equation is positive. For the first equation, $m^* \geq 0$ is sufficient to guarantee that the term in the bracket is positive. Hence, $m_{\lambda_1}^*$ and $m_{\lambda_2}^* \geq 0$. For the effect of p , we have

$$m_p^* = \frac{1}{k_1} r_1^{\frac{1}{k_1}-1} r_{1p} \left(\Pi + Y - \frac{\pi}{r_2^{\frac{1}{k_2}}} \right) + \frac{1}{k_2} r_2^{\frac{1}{k_2}-1} r_{2p} \pi.$$

The last term on the right hand side is negative. $m^* \geq 0$ is sufficient to guarantee that the term in the bracket is positive so that the first term on the right hand side is negative. Hence $m_p^* \leq 0$. \square

Proposition. $\tau_\alpha^* \geq 0$, $\tau_m^* \geq 0$, $\tau_{\lambda_2}^* \geq 0$, $\tau_{\lambda_1}^* \leq 0$, and $\tau_\pi^* \leq 0$.

Proof. For all proofs for the comparative statics, it is convenient to define the following term

$$\Phi = \frac{\mathbf{E}(U_2) - V_2}{\mathbf{E}(U_1) - V_1}.$$

The derivative of the Nash product with respect to τ can then be rewritten as

$$\mathcal{N}_\tau = \alpha \Phi^{1-\alpha} \mathbf{E}(U_1)_\tau + (1-\alpha) \Phi^{-\alpha} \mathbf{E}(U_2)_\tau,$$

which gives the first order condition

$$-\frac{\alpha}{1-\alpha}\Phi = \frac{\mathbf{E}(U_2)_\tau}{\mathbf{E}(U_1)_\tau}.$$

Note that

$$\begin{aligned} \mathbf{E}(U_1)_\tau &= (1-p+p\lambda_1^{k_1})u'_1(Y+\tau) &> 0 \\ \mathbf{E}(U_2)_\tau &= -(1-p+p\lambda_2^{k_2})u'_2(\Pi-\tau) &< 0 \\ \mathbf{E}(U_1)_{\tau\tau} &= (1-p+p\lambda_1^{k_1})u''_1(Y+\tau) &< 0 \\ \mathbf{E}(U_2)_{\tau\tau} &= (1-p+p\lambda_2^{k_2})u''_2(\Pi-\tau) &< 0. \end{aligned}$$

Hence, the derivative of Φ with respect to τ is

$$\Phi_\tau = \frac{\mathbf{E}(U_2)_\tau (\mathbf{E}(U_1) - V_1) - \mathbf{E}(U_1)_\tau (\mathbf{E}(U_2) - V_2)}{(\mathbf{E}(U_1) - V_1)^2} < 0.$$

The second order derivative of the Nash product is

$$\begin{aligned} \mathcal{N}_{\tau\tau} &= \alpha [(1-\alpha)\Phi^{-\alpha}\Phi_\tau\mathbf{E}(U_1)_\tau + \Phi^{1-\alpha}\mathbf{E}(U_1)_{\tau\tau}] \\ &\quad + (1-\alpha) [(1-\alpha)\Phi^{-\alpha-1}\Phi_\tau\mathbf{E}(U_2)_\tau + \Phi^{-\alpha}\mathbf{E}(U_2)_{\tau\tau}] < 0. \end{aligned}$$

Note that the negativity of $\mathcal{N}_{\tau\tau}$ ensures that τ^* is the local solution that maximizes rather than minimizes the Nash product.

For convenience, I use τ but it should be understood throughout the proof that the analysis is done at τ^* . The remaining of the proof follows by totally differentiating the first order condition and applying the implicit function theorem. Hence, for any variable $x \in \{m, \alpha, k_i, \pi, \Pi, Y, \lambda_i, p\}$

$$\tau_x^* = -\frac{\mathcal{N}_{\tau x}}{\mathcal{N}_{\tau\tau}}.$$

The negativity of $\mathcal{N}_{\tau\tau}$ implies that the sign of τ_x^* is determined by the sign of $\mathcal{N}_{\tau x}$.

For the effect of the moral standard of the official, note that

$$\begin{aligned} \Phi_m &= \Phi \frac{u'_1(Y+m)}{\mathbf{E}(U_1)-V_1} \\ &> 0. \end{aligned}$$

Hence

$$\begin{aligned}\mathcal{N}_{\tau m} &= \alpha \mathbf{E}(U_1)_\tau (1 - \alpha) \Phi^{-\alpha} \Phi_m \\ &\quad + (1 - \alpha) \mathbf{E}(U_2)_\tau (-\alpha) \Phi^{-\alpha-1} \Phi_m > 0.\end{aligned}$$

We also conclude from the symmetry of m and π that $\mathcal{N}_{\tau\pi} < 0$ without going through a formal proof. For the effect of the bargaining power of the official,

$$\begin{aligned}\mathcal{N}_{\tau\alpha} &= \mathbf{E}(U_1)_\tau [\Phi^{1-\alpha} - \alpha \Phi^{1-\alpha} \log \Phi] \\ &\quad + \mathbf{E}(U_2)_\tau [-\Phi^{-\alpha} - (1 - \alpha) \Phi^{-\alpha} \log \Phi].\end{aligned}$$

Divide through by $\mathbf{E}(U_1)_\tau > 0$ and apply the first order condition to get (note that this does not change the sign of the expression)

$$\begin{aligned}\frac{\mathcal{N}_{\tau\alpha}}{\mathbf{E}(U_1)_\tau} &= [\Phi^{1-\alpha} - \alpha \Phi^{1-\alpha} \log(\Phi)] + \frac{\alpha}{1-\alpha} [\Phi^{1-\alpha} + (1 - \alpha) \Phi^{1-\alpha} \log(\Phi)] \\ \mathcal{N}_{\tau\alpha} &= \mathbf{E}(U_1)_\tau \frac{\Phi^{1-\alpha}}{1-\alpha} > 0.\end{aligned}$$

For the effect of the leniency of the official λ_1 , note that

$$\mathbf{E}(U_1)_{\tau\lambda_1} = pk_1 \lambda_1^{k_1-1} u'_1(Y + \tau) > 0.$$

Also

$$\Phi_{\lambda_1} = -\Phi \frac{pk_1 \lambda_1^{k_1-1} u_1(Y + \tau)}{\mathbf{E}(U_1) - V_1} < 0.$$

Take the first order derivative of the first order condition with respect to λ_1 to get

$$\begin{aligned}\mathcal{N}_{\tau\lambda_1} &= \alpha [(1 - \alpha) \Phi^{-\alpha} \Phi_{\lambda_1} \mathbf{E}(U_1)_\tau + \Phi^{1-\alpha} \mathbf{E}(U_1)_{\tau\lambda_1}] \\ &\quad - (1 - \alpha) \mathbf{E}(U_2)_\tau \alpha \Phi^{-\alpha-1} \Phi_{\lambda_1}.\end{aligned}$$

Divide through by $\mathbf{E}(U_1)_\tau > 0$ and apply the first order condition to get

$$\begin{aligned}\frac{\mathcal{N}_{\tau\lambda_1}}{\mathbf{E}(U_1)_\tau} &= \alpha(1 - \alpha) \Phi^{-\alpha} \Phi_{\lambda_1} + \alpha \Phi^{1-\alpha} \frac{\mathbf{E}(U_1)_{\tau\lambda_1}}{\mathbf{E}(U_1)_\tau} + \alpha^2 \Phi^{-\alpha} \Phi_{\lambda_1} \\ &= \alpha \Phi^{1-\alpha} \left[\frac{pk_1 \lambda_1^{k_1-1}}{1-p+pk_1} - \frac{pk_1 \lambda_1^{k_1-1} u_1(Y+\tau)}{\mathbf{E}(U_1) - V_1} \right] \\ \mathcal{N}_{\tau\lambda_1} &= \mathbf{E}(U_1)_\tau \Phi^{1-\alpha} pk_1 \lambda_1^{k_1-1} \left[\frac{-V_1}{(1-p+pk_1)(\mathbf{E}(U_1) - V_1)} \right] < 0.\end{aligned}$$

We also conclude from the symmetry of λ_1 and λ_2 that $\mathcal{N}_{\tau\lambda_2} > 0$ without a formal proof. For the effect of the risk aversion of the official k_1

$$\Phi_{k_1} = -\Phi \frac{p\lambda_1^{k_1} u_1(Y + \tau) \log(\lambda)}{\mathbf{E}(U_1) - V_1} > 0.$$

$$\begin{aligned} \mathcal{N}_{\tau k_1} &= \alpha(1 - \alpha)\Phi^{-\alpha}\Phi_{k_1}\mathbf{E}(U_1)_\tau + \alpha u_1'(Y + \tau)\Phi^{1-\alpha}p\lambda_1^{k_1} \log(\lambda_1) \\ &\quad - \alpha(1 - \alpha)\Phi^{-\alpha-1}\Phi_{k_1}\mathbf{E}(U_2)_\tau. \end{aligned}$$

Divide through by $\mathbf{E}(U_1)_\tau > 0$ and apply the first order condition to get

$$\begin{aligned} \frac{\mathcal{N}_{\tau k_1}}{\mathbf{E}(U_1)_\tau} &= \alpha\Phi^{-\alpha}\Phi_{k_1} + \frac{\alpha\Phi^{1-\alpha}p\lambda_1^{k_1} \log(\lambda_1)}{1-p+p\lambda_1^{k_1}} \\ &= \alpha\Phi^{1-\alpha}p\lambda_1 \log(\lambda_1) \left(\frac{1}{1-p+p\lambda_1^{k_1}} - \frac{u_1(Y+\tau)}{\mathbf{E}(U_1)-V_1} \right) \\ \mathcal{N}_{\tau k_1} &= \mathbf{E}(U_1)_\tau \alpha\Phi^{1-\alpha}p\lambda_1^{k_1} \log(\lambda_1) \left(\frac{-V_1}{(1-p+p\lambda_1^{k_1})(\mathbf{E}(U_1)-V_1)} \right) > 0. \end{aligned}$$

□

Proposition. $\text{sgn } \tau_Y^* = \text{sgn } \frac{u_1''(Y+\tau)}{u_1'(Y+\tau)} - \frac{(1-p+p\lambda_1^{k_1})u_1'(Y+\tau) - u_1'(Y+m)}{(1-p+p\lambda_1^{k_1})u_1(Y+\tau) - u_1(Y+m)}.$

Proof. The proof follows that of the previous proof. First, note that

$$\Phi_Y = -\Phi \left(\frac{(1-p+p\lambda_1^{k_1})u_1'(Y+\tau) - u_1'(Y+m)}{\mathbf{E}(U_1) - V_1} \right).$$

Since $\tau \geq \underline{\tau} > m$ and $u_1'(\cdot)$ is strictly concave, $\Phi_Y > 0$. Note also that $\mathbf{E}(U_1)_{\tau Y} = (1-p+p\lambda_1^{k_1})u_1''(Y+\tau)$. Take the derivative of \mathcal{N}_τ with respect to Y to get

$$\begin{aligned} \mathcal{N}_{\tau Y} &= \alpha[(1-\alpha)\Phi^{-\alpha}\Phi_Y\mathbf{E}(U_1)_\tau + \Phi^{1-\alpha}\mathbf{E}(U_1)_{\tau Y}] \\ &\quad - \alpha(1-\alpha)\mathbf{E}(U_2)_\tau\Phi^{-\alpha-1}\Phi_Y. \end{aligned}$$

Divide through by $\mathbf{E}(U_1)_\tau > 0$ and apply the first order condition to get

$$\begin{aligned} \frac{\mathcal{N}_{\tau Y}}{\mathbf{E}(U_1)_\tau} &= \alpha(1-\alpha)\Phi^{-\alpha}\Phi_Y + \alpha^2\Phi^{-\alpha}\Phi_Y + \alpha\Phi^{1-\alpha}\frac{\mathbf{E}(U_1)_{\tau Y}}{\mathbf{E}(U_1)_\tau} \\ \mathcal{N}_{\tau Y} &= \mathbf{E}(U_1)_\tau \alpha\Phi^{1-\alpha} \left(\frac{u_1''(Y+\tau)}{u_1'(Y+\tau)} - \frac{(1-p+p\lambda_1^{k_1})u_1'(Y+\tau) - u_1'(Y+m)}{(1-p+p\lambda_1^{k_1})u_1(Y+\tau) - u_1(Y+m)} \right). \end{aligned}$$

Since $\mathbf{E}(U_1)_\tau \alpha \Phi^{1-\alpha} > 0$, it follows that

$$\operatorname{sgn} \tau_Y^* = \operatorname{sgn} \frac{u_1''(Y + \tau)}{u_1'(Y + \tau)} - \frac{(1 - p + p\lambda_1^{k_1})u_1'(Y + \tau) - u_1'(Y + m)}{(1 - p + p\lambda_1^{k_1})u_1(Y + \tau) - u_1(Y + m)}.$$

□

Proposition. $\operatorname{sgn} \tau_\Pi^* = \operatorname{sgn} \frac{u_2''(\Pi - \tau)}{u_2'(\Pi - \tau)} + \frac{(1 - p + p\lambda_2^{k_2})u_2'(\Pi - \tau)}{(1 - p + p\lambda_2^{k_2})u_2(\Pi - \tau) - u_2(\pi)}.$

Proof. Note that

$$\Phi_\Pi = \frac{(1 - p + p\lambda_2^{k_2})u_2'(\Pi - \tau)}{\mathbf{E}(U_1) - V_1} > 0.$$

Also $\mathbf{E}(U_2)_{\tau\Pi} = -(1 - p + p\lambda_2^{k_2})u_2''(\Pi - \tau) > 0$. Take the derivative of \mathcal{N}_τ with respect to Y to get

$$\begin{aligned} \mathcal{N}_{\tau\Pi} &= \alpha(1 - \alpha)\mathbf{E}(U_1)_\tau \Phi^{-\alpha} \Phi_\Pi \\ &\quad + (1 - \alpha)(-\alpha \Phi^{-\alpha-1} \Phi_\Pi \mathbf{E}(U_2)_\tau + \Phi^{-\alpha} \mathbf{E}(U_2)_{\tau\Pi}). \end{aligned}$$

Divide through by $\mathbf{E}(U_2)_\tau < 0$ and apply the first order condition to get

$$\begin{aligned} \frac{\mathcal{N}_{\tau\Pi}}{\mathbf{E}(U_2)_\tau} &= -(1 - \alpha)(1 - \alpha)\Phi^{-\alpha-1}\Phi_\Pi - \alpha(1 - \alpha)\Phi^{-\alpha-1}\Phi_\Pi - (1 - \alpha)\Phi^{-\alpha} \frac{u_2''(\Pi - \tau)}{u_2'(\Pi - \tau)} \\ &= -(1 - \alpha)\Phi^{-\alpha-1}\Phi_\Pi - (1 - \alpha)\Phi^{-\alpha} \frac{u_2''(\Pi - \tau)}{u_2'(\Pi - \tau)} \\ \mathcal{N}_{\tau\Pi} &= (1 - \alpha)\Phi^{-\alpha}(1 - p + p\lambda_2^{k_2})u_2'(\Pi - \tau) \left(\frac{u_2''(\Pi - \tau)}{u_2'(\Pi - \tau)} + \frac{(1 - p + p\lambda_2^{k_2})u_2'(\Pi - \tau)}{(1 - p + p\lambda_2^{k_2})u_2(\Pi - \tau) - u_2(\pi)} \right). \end{aligned}$$

Since $(1 - \alpha)\Phi^{-\alpha}(1 - p + p\lambda_2^{k_2})u_2'(\Pi - \tau) > 0$, it follows that

$$\operatorname{sgn} \tau_\Pi^* = \operatorname{sgn} \frac{u_2''(\Pi - \tau)}{u_2'(\Pi - \tau)} + \frac{(1 - p + p\lambda_2^{k_2})u_2'(\Pi - \tau)}{(1 - p + p\lambda_2^{k_2})u_2(\Pi - \tau) - u_2(\pi)}.$$

□

Proposition. $\operatorname{sgn} \tau_p^* = \operatorname{sgn} \zeta \frac{V_2}{V_1} - \frac{\mathbf{E}(U_2) - V_2}{\mathbf{E}(U_2) - V_1}.$

Proof. Note that

$$\Phi_p = \frac{(-1 + \lambda_2^{k_2})u_2(\Pi - \tau) - (-1 + \lambda_1^{k_1})u_1(Y + \tau)\Phi}{\mathbf{E}(U_1) - V_1}.$$

Also $\mathbf{E}(U_1)_{\tau p} = (-1 + \lambda_1^{k_1})u_1'(Y + \tau) < 0$ and $\mathbf{E}(U_2)_{\tau p} = -(-1 + \lambda_1^{k_1})u_2'(\Pi - \tau) > 0$.

Take the derivative of \mathcal{N}_τ with respect to p to get

$$\begin{aligned} \mathcal{N}_{\tau p} &= \alpha [(1 - \alpha)\Phi^{-\alpha}\Phi_p\mathbf{E}(U_1)_\tau + \Phi^{1-\alpha}\mathbf{E}(U_1)_{\tau p}] \\ &\quad + (1 - \alpha) [-\alpha\Phi^{-\alpha-1}\Phi_p\mathbf{E}(U_2)_\tau + \Phi^{1-\alpha}\mathbf{E}(U_2)_{\tau p}]. \end{aligned}$$

Divide through by $\mathbf{E}(U_1)_\tau > 0$ and apply the first order condition to get

$$\begin{aligned} \frac{\mathcal{N}_{\tau p}}{\mathbf{E}(U_1)_\tau} &= \alpha(1 - \alpha)\Phi^{-\alpha}\Phi_p + \alpha^2\Phi^{-\alpha}\Phi_p \\ &\quad + \alpha\Phi^{1-\alpha} \left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right) + (1 - \alpha)\Phi^{-\alpha} \frac{\mathbf{E}(U_2)_{\tau p}}{\mathbf{E}(U_1)_\tau}. \end{aligned}$$

After a simple manipulation, we have

$$\begin{aligned} \frac{\mathbf{E}(U_2)_{\tau p}}{\mathbf{E}(U_1)_\tau} &= - \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_1^{k_1}} \right) \frac{u_2'(\Pi - \tau)}{u_1'(Y + \tau)} \\ &= - \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \left(\frac{1 - p + p\lambda_2^{k_2}}{1 - p + p\lambda_1^{k_1}} \right) \frac{u_2'(\Pi - \tau)}{u_1'(Y + \tau)} \\ &= - \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_1^{k_1}} \right) \frac{\alpha}{1 - \alpha} \Phi. \end{aligned}$$

And

$$\begin{aligned} \Phi_p &= \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \frac{(1 - p + p\lambda_2^{k_2})u_2(\Pi - \tau)}{\mathbf{E}(U_1) - V_1} \\ &\quad - \left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right) \frac{(1 - p + p\lambda_1^{k_1})u_1(Y + \tau)}{\mathbf{E}(U_1) - V_1} \Phi. \end{aligned}$$

Substitute these expressions to get

$$\begin{aligned} \frac{\mathcal{N}_{\tau p}}{\mathbf{E}(U_1)_\tau} &= \alpha\Phi^{1-\alpha} \frac{\Phi_p}{\Phi} + \alpha\Phi^{1-\alpha} \left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right) - \alpha\Phi^{1-\alpha} \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \\ &= \alpha\Phi^{1-\alpha} \left[\frac{\Phi_p}{\Phi} + \left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right) - \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \right] \\ &= \alpha\Phi^{1-\alpha} \left[\left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \frac{\mathbf{E}(U_2)}{\mathbf{E}(U_2) - V_2} - \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \right] \\ &\quad - \alpha\Phi^{1-\alpha} \left[\left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right) \frac{\mathbf{E}(U_1)}{\mathbf{E}(U_1) - V_1} - \left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right) \right]. \end{aligned}$$

Rearrange the term in the bracket and denote

$$\zeta = \left(\frac{-1 + \lambda_2^{k_2}}{1 - p + p\lambda_2^{k_2}} \right) \left(\frac{-1 + \lambda_1^{k_1}}{1 - p + p\lambda_1^{k_1}} \right)^{-1},$$

where $\zeta > 0$, it follows that

$$\text{sgn } \tau_p^* = \text{sgn } \zeta \frac{V_2}{V_1} - \frac{\text{E}(U_2) - V_2}{\text{E}(U_2) - V_1}.$$

For the derivative of ζ , it is straightforward to show that $\zeta_{\lambda_1} > 0$ and $\zeta_{\lambda_2} < 0$. \square

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Biography

Tongyai Iyavarakul was born on October 19, 1977 in Bangkok, Thailand. He attended Chitralada School and earned a Bachelor of Arts in Economics degree from Thammasat University, Thailand in 1999. He earned a masters degree in economics from the London School of Economics in the U.K. in 2000, a masters degree in statistics from the University of Chicago in 2004, and a doctoral degree in economics from Duke University in 2009. After the completion of his doctoral degree, he returned to work in Thailand as an economic analyst at the Office of the Prime Minister.