Competing Politically Connectible Firms: A Quantitative Analysis of Endogenous Innovation and Corruption

Ozgur Seker

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Abstract

In this paper, I propose a model of endogenous innovation and political connection of competing firms trying to get monopoly rents in an environment of exogenous political competition. The model endogenizes the TFP growth, corruption through political connections, R&D intensity, and steady-state probabilities of firms' relative positions dependent on exogenous political parameters. The model results match the documented facts in the politically connected firms literature and give insights into the dynamics of corruption and innovation between competing politically connectable firms.

1 Introduction

There are two primary approaches to corruption, understood as "the abuse of public office for private gain" in the literature. The greasing the wheel approach argues that corruption increases business efficiencies by removing cumbersome obstacles with political power. On the other hand, the opposing view claims it could be only a second-best option under deficient institutions. Although there is no conclusive evidence for both sides in the literature (Campos, Dimova, & Saleh, 2016), it is mostly suggested that the real effect is dependent on the type of corruption and the institutions.

On the other hand, there are many empirical evidence showing the effects of the political connections on firms which could be seen as the main source of corruption. However there are little theoretical work focusing on its dynamics and relation with the political environment.

In this paper, I develop a model endogenizing corruption and innovation as a result of competition between firms that could connect to political parties and invest in R&D activities. Not only do I focus on co-movement of corruption and TFP growth depending on political institutions/parameters, but I

also try to answer how elections and election results could affect the R&D activities in a sector where firms could connect to the political parties.

In my model, the election process among two parties, red and blue, is given exogenously. The probability of an election and the probability of the incumbent party winning are exogenous political institution parameters related to political stability. Meanwhile, two firms in a sector, red and blue, have a la Bertrand competition in which they can only make a profit through their technological and bureaucratic advantage, if any. After learning about election status, firms choose R&D intensity to get technological advantage and decide to connect or not to their same color party to get bureaucratic cost advantage in the future periods if their party is in power.

Since the political connection is costly, firms choose to connect to the government party in their color when they are the technological leader or equal competitors. The technological laggard firms try to catch the technological leader by increasing R&D intensity when their party is in power due to higher potential profits with political connections. However, they don't want to connect before catching the incumbent. This mechanism incentivizes the incumbent to increase R&D intensity and keep the market leadership as long as possible. In this setup, political events, elections, and their outcomes affect innovation and TFP growth in the economy by distorting the future payoffs for the firms. This mechanism leads to higher innovation after political turnovers since the market leaders are more likely to be connected to the leading government. Moreover, political institutions are affecting the steady-state probabilities of the technological gap. TFP growth probability is higher when two firms are equal in terms of technology, and the likelihood of that case depends on the exogenous political parameters.

First implications of the model are consistent with documented facts in the literature about relation between political connectedness and innovation (Akcigit, Baslandze, & Lotti, 2020), election and innovation (Atanassov, Julio, & Leng, 2019), effect of political persistence (Bellettini, Berti Ceroni, & Prarolo, 2013) and sudden deaths (BELLETTINI, BERTI CERONI, & PRAROLO, 2013) on growth, and effect of political turnover on R&D (Chen, 2021).

In my model, corruption is defined as the total steady-state probabilities of the states in which a firm is connected to the government party to get a bureaucratic advantage. The main result of the relationship between corruption and TFP growth is that although they are mostly negatively correlated, their relationship is ambiguous. Institutional factors affect corruption monotonously. Connection benefits and government persistence increase corruption while the election frequency decreases. However, their effects on TFP growth are not monotonous except for election frequency. TFP growth is increasing during election periods. TFP growth and government persistence have an inverted U-shaped relation. An increase in the connection benefits increases the TFP growth for some specific intervals,

although it has a negative effect overall. Although it looks like the sand the wheel argument is more common in the results, it is possible to find relevant institutional setups for both ideas, greasing the wheel and sand the wheel, in the model.

This paper is a similar work to (Akcigit & Ates, 2021), (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005), (Aghion, Harris, & Vickers, 1997) with generating growth through competition, it adds exogenous political factors instead of focusing on balanced growth path. It employs benefits of political connections similar to (Akcigit et al., 2020); differently, it includes elections and competing parties in a polarized environment. A paper focusing on the effects of political polarization is (Azzimonti, 2011). It has polarization in the households' preferences while endogenizing the government expenditures and election results. Another theoretical model focusing on politically connected firms is (Bellettini, Berti Ceroni, & Prarolo, 2014). It endogenizes the election results without political polarization and political competition. There are also empirical works motivating my model. The empirical works (Claessens, Feijen, & Laeven, 2006), (Özcan & Gündüz, 2015), (Lu, Pan, & Zhang, 2015) show how politically connected firms generate asymmetric benefits against their competitors. Moreover, the work of (Campos et al., 2016), (Nur-tegin & Jakee, 2020), (Mallik & Saha, 2016), (Aidt, 2009) show no conclusive result is generated on the relation between corruption and growth.

The structure of the remaining paper will be as follows: In section II, the model is explained in detail. Then, the results from the quantitative analysis are elaborated in section III. Finally, section IV is allocated to the further research ideas on top of this paper, and section V concludes.

2 Model

This section presents a theoretical model of endogenous innovation and political connection. Competition in one sector is similar to the one studied in (Akcigit & Ates, 2021) without knowledge diffusion, but discrete-time with key ingredients exogenous elections and connection decisions. In my quantitative analysis, I focus on the Markovian perfect equilibrium of the game between competing firms and steady-state probabilities in this equilibrium.

In my model, red and blue parties are in an exogenous political competition. In each period, an election happens with some exogenous probability, which stands for election frequency. The government party wins the election with some exogenous probability, which stands for government persistence. Meanwhile, two firms in a sector are in a Bertrand competition with a linear production function. Their markups are determined by their relative marginal cost, and the one with lower marginal cost gets all the market share with monopoly rents. Their relative marginal costs are determined by their technology gap and bureaucratic costs. To reduce their marginal cost, they choose the continuous

variable their R&D intensity (to increase productivity) and binary variable whether to connect to the same color party[1] (to reduce bureaucratic costs).

2.1 Timeline and Political Environment

Timeline is as follows:

- Two competing firms start the period with the information on the productivity gap, the current government party, and their connection status.
- At the beginning of the period, firms learn whether there will be an election or not.
- Static competition happens, and static profits are distributed. Connection costs are paid.
- Each firm chooses R&D intensity and pays the R&D costs.
- Each firm decides to connect or not for the next term if it is not connected.
- If it is an election period, the election result reveals at the end of the period. Connections to the losing party disappear.
- Their R&D results, hence the new technology gap, reveal at the end of the period.
- The new period starts with knowing the productivity gap, the government party, and their connection status.

Elections are held in each period with probability π_e, which denotes election intensity. Election results are exogenous. The party in power wins the election with probability p_0.

Competing Red and Blue firms could connect to only the same color party among Red and Blue parties. Having a connection to the party in power reduces the bureaucratic costs of the firm by the rate of τ. Denote that, since the connection decisions will be active in the next term, it is sometimes beneficial to connect to the opposition party too.

Firms cannot choose to cut their political connections, and they have to pay exogenous connection costs w_c while they are connected. Connections disappear once their party loses an election. This assumption could be rationalized as politicians retire after losing the election and new politicians emerge in the same political position.

π_e, p_0, τ are exogenous institutional parameters of election frequency, government persistence, and connection benefits, respectively.

[1] See Appendix for justification

2.2 Static Competition

In the same sector, two firms, red and blue, produce the same good—no entry and exit to simplify. The demand for this good has constant elasticity and

$$Q_D = \frac{Y}{p}$$

where p stands for the price of the good.

Firm $i \in \{red, blue\}$ has the production function

$$y_i = q_i l_i$$

and the cost function

$$(1 + \tau_i) w l_i$$

where q_i, w, τ_i, l_i denote technology, wage, bureaucratic cost, and labor respectively. Bureaucratic cost $\tau_i \in \{\tau, 0\}$ is either 0 or τ dependent on firm's connection and government status. τ is one of the key exogenous variables in the analysis.

Denote that $\bar{p}_i = \frac{(1+\tau_i)w}{q_i}$ is the marginal cost of firm i and also the minimum price that firm i will start to produce. Firm i will lead the market when $\bar{p}_i < \bar{p}_{-i}$ and will set the price $\bar{p}_{-i}$. The static profit will be

$$\Pi_i = Y[1 - \frac{\bar{p}_i}{\bar{p}_{-i}}]$$

State variables for the firm i will be m_i, c_i, c_{-i}, g: Respectively relative productivity step size[2], firm i's connection, firm $-i$'s connection, governing political party. To simplify the analysis, productivity gap between two firms is assumed to be 1 step at most. $m_i \in \{-1, 0, 1\}$. Firm i will be called tech leader if $m_i = 1$ and tech laggard if $m_i = -1$

Before starting to the transition dynamics, static profit as a function of the state

$$\Pi(m_i, c_i, c_{-i}, g) = \begin{cases} Y[1 - \lambda^{-m} \frac{1+\tau_i}{1+\tau_{-i}}], & \text{if } \lambda^{-m} \frac{1+\tau_i}{1+\tau_{-i}} < 1 \\ 0, & \text{otherwise} \end{cases}$$

where

$$\tau_i = \begin{cases} 0, & \text{if } g = i \text{ and } c_i = 1 \\ \tau, & \text{otherwise} \end{cases}$$

[2]Basically $\log_{1+\lambda}(q_i/q_{-i})$ where λ is the innovation step size

2.3 R&D and Connection - Dynamic Competition

Each firm chooses R&D intensity, defined as the arrival probability of innovation with exogenous step size λ. The cost of R&D intensity x, $R(x) : [0,1] \to \mathbf{R}$, satisfies the following properties:[3]

- $R(x)$ is a monotonic increasing, differentiable, and convex function.
- $R(0) = 0$ and $R'(0) = 0$
- $\lim_{x\to 1} R(x) = \infty$ and $\lim_{x\to 1} R'(x) = \infty$

Suppose R&D intensities of firm i and its competitor are x_i and x_{-i} respectively. Then the transition probabilities of technology gap m_i will look like below.

		m_i': -1	0	1
m_i	-1	$1 - x_i(1 - x_{-i})$	$x_i(1 - x_{-i})$	0
	0	$x_{-i}(1 - x_i)$	$1 + 2x_i x_{-i} - (x_i + x_{-i})$	$x_i(1 - x_{-i})$
	1	0	$x_{-i}(1 - x_i)$	$1 - x_{-i}(1 - x_i)$

Firms will also choose to connect or not if they are not connected. Connection status today of firm i will be denoted by $c_i = \{0, 1\}$ and it is 0 if firm i is not connected. $c_i^* \geq c_i$ will be connection decision of firm i and tomorrow's connection status c_i' will be

$$c_i' = \begin{cases} 0, & \text{if Party } i \text{ loses an election} \\ c_i^*, & \text{otherwise} \end{cases}$$

In each period, there will be two different cases, election period or not. Let value functions V_e, V_n and policy functions x_e, x_n, c_e^*, c_n^* be separated for these two cases.

Given the competitors' policy decisions x_{-i}, c_{-i}^*, the firm i's dynamic problems when there is no election will be

$$V_n(m_i, c_i, c_{-i}, g) = \max_{x_n, c_n^*} \Pi(.) - w_c c_i - R(x_n) + \beta \sum_{m_i'} P(m_i'|m_i, x_{-i}, x_n) V(m_i', c_i^*, c_{-i}^*, g)$$

$$s.t. \quad x_n \in [0,1]$$

$$c_n^* \geq c_i, \quad c_n^* \in \{0,1\}$$

[3] $R(x) = \frac{\alpha x^2}{1-x}$ is used for R&D costs

when there is an election, the firm i's dynamic problem will be

$$V_e(m_i, c_i, c_{-i}, g) = \max_{x_e, c_e^*} \Pi(.) - w_c c_i - R(x_e) + \beta \sum_{m_i'} \sum_{g'} P(m_i'|m_i, x_{-i}, x_n) P(g'|g) V(m_i', c_i', c_{-i}', g')$$

$$s.t. \quad x_e \in [0,1]$$

$$c_e^* \geq c_i, \quad c_e^* \in \{0,1\}$$

$$c_j' = \begin{cases} c_j^*, & \text{if } g' = j \\ 0, & \text{otherwise} \end{cases}, \quad \forall j \in \{i, -i\}$$

$$P(g'|g) = \begin{cases} p_0, & \text{if } g' = g \\ 1 - p_0, & \text{otherwise} \end{cases}$$

where

$$V(m_i, c_i, c_{-i}, g) = \pi_e V_e(m_i, c_i, c_{-i}, g) + (1 - \pi_e) V_n(m_i, c_i, c_{-i}, g)$$

The Nash equilibrium of the dynamic game above is not analytically tractable. Still, it is easy to compute due to discrete states.[4] After computing Nash equilibrium, we could find transition probabilities among states, so the steady-state probability of each state. It could lead us to how likely a productivity growth overall under different conditions and how likely a state with corruption exists.

3 Mechanisms and Results

My quantitative analysis of this model doesn't cover all the possible parameters. Instead, it focuses on a default parameter selection and changes in different dimensions based on this default parameter set. Although it is not conclusive, it could give enough insight and intuition about different dynamics.

The first observation is that tech leaders are more likely to be connected to the government party. One of the reasons for that is tech leaders have a higher willingness to connect to the government. The other one is that the one with government party color has higher R&D intensity among equal competitors.

The case in which tech leader is connected to the government party has the lowest level of R&D intensity for each firm, and the tech leaders have the lowest level of R&D intensity whenever they are connected to the government party despite higher firm value. These results are consistent with the documented facts in the literature, which shows that politically connected firms are less likely to

[4] See appendix for computation procedure

innovate and more likely to have higher market value (Akcigit et al., 2020).

Since there is a cap on the productivity gap as in (Aghion et al., 2005), the main motivation source for the tech leader firm is to keep this productivity gap open against the laggard firm. If the government is in the color of the tech leader, then the laggard is less motivated to innovate, and so does the tech leader. However, if the government is in the color of the laggard, then the laggard innovates more, and so does the tech leader. Moreover, the tech leader knows that the laggard will not connect until she catches up with the tech leader; the tech leader tries to keep the productivity gap harder to enjoy her monopoly markups. This mechanism leads to higher TFP growth during election periods and after political turnovers since these cases are increasing the R&D motivation of the laggard firm. These results are consistent with (Atanassov et al., 2019), (BELLETTINI et al., 2013), (Chen, 2021). These effects are increasing with the government persistence and decreasing with election frequency consistent with (BELLETTINI et al., 2013).

There are three key institutional parameters –election frequency, government persistence, and connection benefits– that I will focus on their effects on overall TFP growth and corruption. The summarizing figures are given below. In the figures, corruption and TFP growth are drawn in their own scales against the exogenous variables around default configuration.[5] In figure 1, we see that corruption is increasing with the government's persistence which is intuitive. On the other hand, a little government persistence is good for TFP growth, but it starts to decrease TFP growth sharply after some point. So, we could say that we can observe a positive correlation between corruption and TFP growth for the countries with low government persistence while observing the opposite in general.

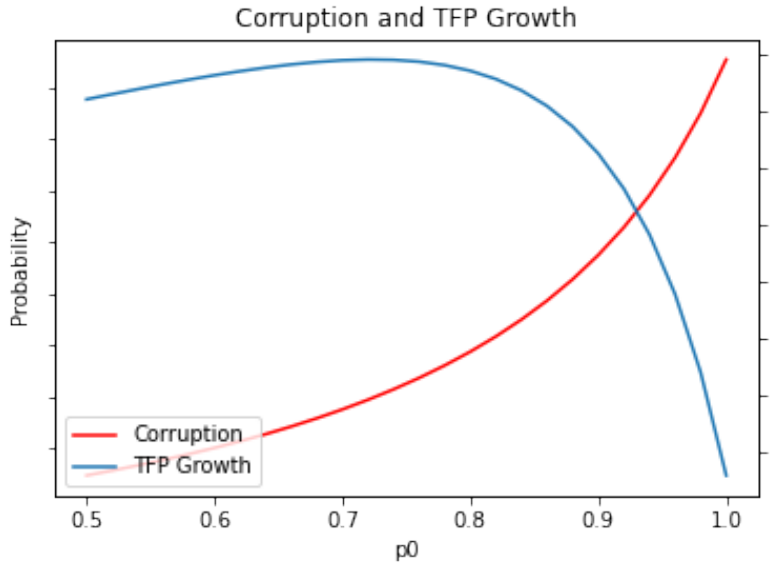

Figure 1: Corruption and TFP Growth vs Government Persistence

[5]See appendix for configuration.

In figure 2, we can see the monotonous effect of election frequency on both corruption and TFP growth. Since the elections in the models have a constant probability of turnover, and it is around 0.6, we can also interpret it as the frequency of the contested elections. Therefore, if the driving factor is the frequency of the contested elections, then we can expect corruption and TFP growth to be negatively correlated.

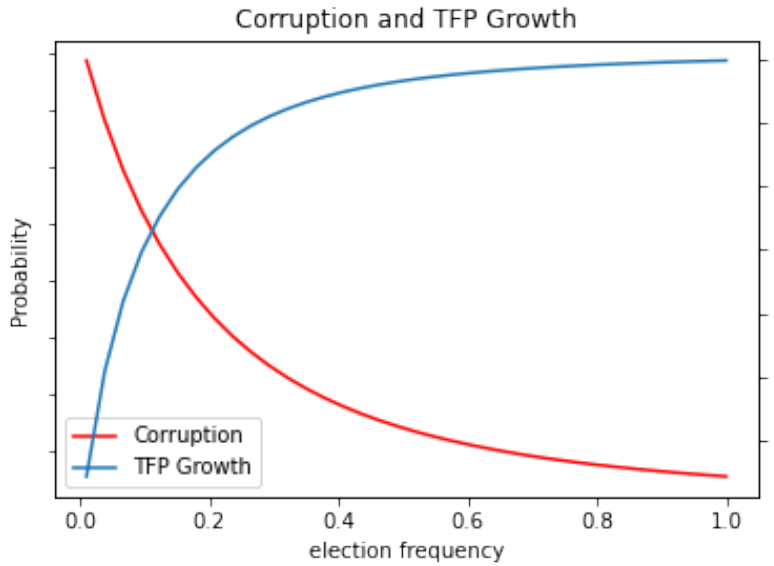

Figure 2: Corruption and TFP Growth vs (Contested) Election Frequency

In figure 3, the corruption is increasing with the connection benefits monotonously. However, TFP growth's relation with connection benefits is more complicated. Although it looks like decreasing overall, it is increasing with the connection benefits for a specific interval due to two conflicting forces. The first force is that when connection benefits are higher, the firm in the government party color is more motivated to innovate due to higher monopoly markups when she captures the market. On the other side, higher connection benefits lead to a higher probability of tech leaders being connected to the government party, which leads to lower innovation motivation for all. Moreover, when the connection benefits are higher than the technology gap benefit, even tech leader cannot enjoy the monopoly as much as she should when the government color is different. This factor leads to lower motivation for innovation.

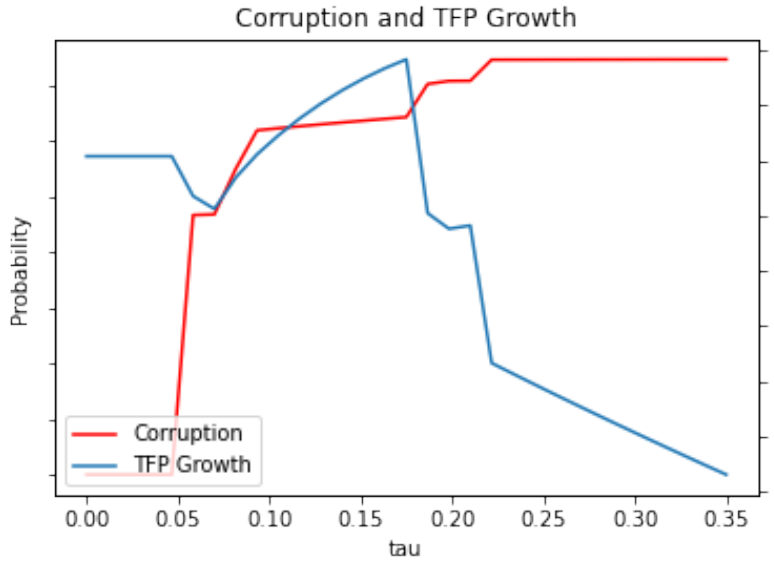

Figure 3: Corruption and TFP Growth vs Connection Benefits

4 Further Research Agenda

This paper focuses on a specific relationship structure, which we could call marriage type, between firms and political parties. However, different types are also possible in which a firm could connect to multiple parties, or a party could connect to multiple firms. A complementary theoretical work could be modeling these structures and investigating how these insights change.

On the other hand, the more appealing area is to focus on the relationship dynamics between firms and parties. This relationship contains two main problems: time inconsistency and unobservable effort. The political party needs help during election campaigns but could give back the reward if she wins the election. This leads to time inconsistency. Moreover, after contributing, the firm would like the party to show more effort in the election campaign since she will get connection benefits only if the party wins the election. However, the firm might not be able to see the election effort. Similarly, the party would like the firm to have higher monopoly power to be able to charge more for political connection, but the party might be unable to observe the R&D intensity of the firm. These dynamics in the party-firm relationship will differentiate the pareto optimal contract and the best sustainable one. The outcomes of these dynamics and matching them with the documented facts will be one of my further research projects on top of this paper. This project will also endogenize the election results, government persistence, and firm-party relation structure (marriage, serial monogamy, or polygamy).

5 Conclusion

There is relatively little theoretical work in the literature on politically connected firms and corruption. This paper tries to contribute to that area. It endogenizes the political connection decision and corruption with a simple approach that only elaborates the firms' side of the problem. However, it matches the documented facts in the politically connected firms literature. Also, it gives us intuition about how conflicting empirical evidence on the relationship between corruption and growth could emerge. It could be enriched with different firm-party structures and a deeper investigation of the dynamics of the firm-party relation. Moreover, complementary empirical work would help a lot in understanding the effects of the political environment on productivity growth and corruption.

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Appendix

Color Restriction Assumption - Write Later

Why no entry exit, in Turkey, the main source of TFP growth is existing firms not the new entrants. The existing firms are more efficient and more likely to be affiliated to a political camp.

Computation Procedure - Write Later