Corporate Governance in State-Owned and Privately-Owned Enterprises

Despoina Chouliara

Professor Pietro Peretto, Faculty Advisor
Professor Michelle Connolly, Faculty Advisor

Duke University
Durham, North Carolina
2022

Acknowledgements

I would like to foremost thank my thesis advisor Professor Pietro Peretto. The completion of this thesis would not have been possible without his expertise and guidance. I would also like to thank my honors seminar adivsor, Professor Michelle Connolly, who throughout the academic year provided valuable support and insight into this paper.

Abstract

In this paper I examine the principal/agency relationship in corporate governance and introduce it in a steady state growth model. More specifically, I will model a profit-maximizing privately-owned enterprise and a series of state-owned enterprises with varying economic goals. I will use the insights of agency theory to revisit the debate about public versus private ownership with the objective of exploring how ownership affects a firm's performance and whether the sole objective of profit-maximization is optimal for the firm and the aggregate economy. Hence, the scope of this paper is to enhance our understanding of the channels through which corporate governance influences the aggregate economy.

1 Introduction

State-owned enterprises (SOEs) are firms fully or partially owned by the government. With assets worth over $45 trillion – equivalent to half of global GDP – SOEs have a firm presence in the world economy, especially in sectors such as transportation, energy, finance and telecommunications (IMF, 2020). The purpose, mission and objectives of SOEs are varied and ever-evolving, relating mostly to some aspect of public service and/or social outcome. Typically, SOEs are used to support infant industries, address market failures, such as natural monopolies, or to promote certain policy goals (Gaspar et al., 2020). SOEs were particularly popular in the early- to mid- 20th century, with many industrialized countries viewing state ownership as an answer to market failures (Shirley & Walsh, 2000). Since the 1980s, most countries have gone down the privatization path, but with the recent rise of Chinese SOEs, state ownership is still prominent to this day. This reality, however, is not entirely reflected in economic theory, where the archetypical firm is a profit-maximizing privately-owned firm.

Privately-owned and state-owned companies constitute two fundamentally different types of firm due to their different ownership structures and objectives. Being privately owned, this category of firms prioritize profit-maximization and are thought to be "more successful in addressing problems of corporate governance".[1] On the other hand, SOEs prioritize noncommercial goals to benefit the public but often suffer from cases of poor governance, corruption, abuse of public power and lack of transparency. Considering corporate governance impacts the behavior and performance of firms, innovative activity and entrepreneurship, understanding the differing corporate governance in state-owned and privately-owned enterprises can shed light into the overall effect of corporate governance on the economy.

A key difference between state-owned and privately-owned firms is the incentive and ability of owners to monitor managers (Alchian, 1965). According to the principles of agency theory, state and private firms face a similar problem; owners agree on a contract with the manager they hire to run the day-to-day operations of the firm and as a result, they face a principal/agent problem with those whom they hire to do the managing. Resolving this principal/agent dilemma is crucial to efficient firm operation. Although both state and private firms face this problem, their responses differ. Their performance can differ significantly due to the different contractual agreements motivated by the distinct types of ownership and firm objectives.

In this theoretical paper, I will model a profit-maximizing privately-owned firm and four state-owned enterprises with other financial objectives. I will use the insights of agency theory and revisit the debate about public versus private ownership with the objective of exploring how managers respond to incentives, how different economic goals affect a firm's performance and the aggregate economy, and how ownership affect a firm's performance. Hence, the scope of this paper is to enhance our understanding of the channels through which corporate governance influences the aggregate economy.

[1] Shirley and Walsh (2000), p. 4.

2 Literature Review

2.1 Corporate Governance and the Principal-Agent Problem

Economists have developed several theories of the firm, including (i) the property-rights or incomplete contract approach,[2] (ii) the transaction-cost approach,[3] (iii) the team production approach[4] and (iv) the principal/agent approach.[5] In this paper, I will use the principal/agent view of the firm, according to which the firm is viewed as a collection of contracts among factors of production. More specifically, Jensen and Meckling (1976) define the firm as "a legal fiction which serves as a focus for a complex process in which the conflicting objectives of individuals are brought into equilibrium process".[6]

The separation of control and ownership in the modern corporation, first documented by Berle and Means (1932), is the major conflict in corporate governance and fundamental in principal/agent theory. The key agency relationship in the firm is the contract under which the shareholders (the principal) hire a manager (the agent) to be in charge of the firm's operations. Since both parties aim to maximize their respective utilities, the agent will not always act in the best interest of the principal, and the firm faces a principal/agent problem (Jensen & Meckling, 1976).

The shareholders and manager face significant areas of divergence; the manager might not exert full effort, might appropriate a larger amount of the corporations' resources in the form of perquisites and aim to increase the number of resources under their control, commonly referred to as empire-building (Farinha, 2003; Hope & Thomas, 2008; Jensen & Meckling 1976). The main agency conflict that our model will explore concerns the payment of dividends. Managers have incentives to gain excess cash flow to increase the resources under their control, while principals prefer to receive this excess flow in the form of dividend payments. Principals want to increase their own income, prevent the manager's empire-building behavior and ensure that no other projects will be funded other than the ones with positive net present value (Farinha, 2003; Frankfurter and Wood Jr., 2002; Jensen & Meckling, 1976).

The principal tries to resolve this principal/agent problem by establishing the most appropriate incentive contract for the agent which will allocate risks and reward productive work as well as by monitoring the manager. The shareholders want to avoid incomplete contracts and instead choose long-term incentive contracts that align the managers' interests with those of the firm and the shareholders (Holmstrom & Milgrom, 1991; Shleifer & Vishny, 1997). Therefore, shareholders typically choose incentive contracts that are performance based in order to attract skilled managers and incentivize them to exert effort (Beyer et al., 2014).

[2] See Grossman and Hart (1986); Hart and Holmstrom (2010).
[3] See Williamson (1987).
[4] See Alchian and Demsetz (1972).
[5] See Jensen and Meckling (1976).
[6] Jensen and Meckling (1976), p. 311.

2.2 State-Owned Enterprise

2.2.1 Objectives and Organizational Structure

Unlike privately-owned enterprises, state-owned enterprises are expected to achieve a combination of economic, political and social goals that often conflict with profit-maximization. As Shleifer and Vishny (1994) explain, the rationale behind state ownership includes correcting market failures, maximizing social welfare and improving private firm decisions when their actions diverge from social goals. Through the establishment of SOEs the state could aim for the support of infant industries, the provision of public goods, the public control of natural resources or the promotion of regional policies (Goldeng et. al, 2008; Tonurist & Karo, 2016).

Aside from having various goals, SOEs are also characterized by the presence of multiple principals and varying organizational structures (Vagliasindi, 2008). The principals of SOEs could include different public sector organizations, including ministries and the Parliament/Congress. The ownership function of SOEs usually falls under three categories. Under the centralized model the SOE has a single owner, either a ministry, agency or holding company; under the decentralized model the SOE is supervised by many ministries, including a relevant sector ministry, and sometimes even the general government; under the dual model the SOE is usually supervised by one line-ministry and the finance ministry (Moreno de Acevedo Sanchez, 2016; OECD, 2005). The ownership structure of SOEs is in fact ever-evolving, as many SOEs today are only partially owned by the government (IMF, 2020).

The role of managers is another key characteristic of SOEs. Due to internal and external governance factors, management is usually expected to operate inefficiently. Unlike private firms, the manager faces weaker incentives, since there are high barriers of exit and there is no threat of takeover and bankruptcy (Shirley & Xu, 1998; Vagliasindi, 2008).

2.2.2 State versus Private Ownership

Proponents of state ownership explain that in the presence of market failures it is the public sector that can achieve social and developmental objectives, in terms of productive, allocative, and distributional efficiency. As Shleifer and Vishny (1997) explain, "where monopoly power, externalities, or distributional issues raise concerns, private profit-maximizing firms may fail to address these concerns".[7] Critics of state ownership, however, emphasize that since the goals of SOEs deviate significantly from profit-maximization, their economic performance is likely to be inferior leading to slower economic growth (Goldeng et al., 2008).

What is at the core of the state versus private ownership debate is the scholars' pursuit of understanding whether the type of ownership has an effect on the performance of companies. Alchian (1965) was one of the first economists to emphasize the importance of ownership, claiming that state and private ownership produce different economic performances due to the different "rewards-costs structure impinging on the employees and the 'owners' of the organization".[8] Shleifer and Vishny (1997) propose that corporate governance suggests that ownership issues, such as the concentration and identity of owners, do affect

[7] Shleifer and Vishny (1997), p. 767.
[8] Alchian (1965), p. 821.

the performance of companies. This viewpoint is part of the agency theory perspective on state versus private ownership that suggests that "economic performance levels by and large are the result of the incentives, costs, and exposure to disciplinary (market) forces implied by the different ownership structures".[9] Contrary to this view, the prominent perspective among free-market economists is that a firm's economic performance is primarily determined by the market structure, emphasizing the importance of market competition in encouraging greater efficiency, innovation and productivity. Applying these perspectives into the discussion of state ownership, the former view would explain the underperformance of a SOE on its ownership structure, while the latter would emphasize the non-competitive market structures in which SOEs typically operate.

Looking at the relevant literature more closely, scholars such as Kay and Thompson (1986) claim that in competitive markets the difference between public and private firms would be negligible. Incentives of managers are determined by the competitive and regulatory environment, hence in a competitive market structure SOEs could attain production efficiency and efficient monitoring of management (Kay & Thompson, 1986). Shirley and Walsh (2000) on the other hand discuss the importance of ownership claiming that "political interference in SOEs overwhelms competition effects."[10] Furthermore, Shleifer and Vishny (1994) argue that SOEs are bound to be inefficient regardless of the market structure due to the pursuit of political goals such as over-employment, political corruption and subsidies. Such inefficient and distortionary behaviors are more unlikely in private firms, due to the shareholders' pursuit of wealth maximization. The nature of their ownership allows SOEs to be subject to soft budget constraints; losses are met with credit injections from the state, so SOEs don't face a threat of bankruptcy creating distorted incentives (Lin & Li, 2008).

3 The Model

We will use a growth model, where time is infinite and continuous. All variables are functions of time. We assume that the economy is closed and there is no physical capital. In the production side of the economy, the final sector produces a homogeneous good using the differentiated non-durable goods produced by the intermediate sector. In this model, all corporate governance action takes place in the intermediate sector.

3.1 Preferences and Technology

Households

The economy is populated by a representative household with $L(t) = L_0 e^{\varphi t}$, $L_0 \equiv 1$, members, each endowed with one unit of labour. The household has preferences

$$U(t) = \int_t^\infty e^{-(\rho-\varphi)(\tau-t)} log\left(\frac{C(\tau)}{L(\tau)}\right) d\tau, \quad \rho > \varphi \geq 0, \tag{1}$$

[9] Goldeng, Grunfeld and Benito (2008), p. 1245.

[10] Shirley and Walsh (2000), p. 6.

where t is the point in time when the household makes decisions, ρ is the discount rate, φ is the population growth rate that grows at a constant and exogenous rate, and C is consumption. The household supplies labour inelastically. It thus faces the flow budget constraint

$$\dot{A} = rA + wL \ - C, \tag{2}$$

where A is households' wealth, r is the rate of return on wealth and w is the wage. The intertemporal consumption plan that maximizes (1) subject to (2) consists of the Euler equation

$$r = \rho \ - \varphi \ + \frac{\dot{C}}{C}. \tag{3}$$

Final Producers

The final sector good Y is consumed, used to produce intermediate goods and invested in the creation of new intermediate goods. The final good is our numeraire, $P_Y \equiv 1$. Labor market clearing yields that employment in the final sector equals population size L thus the production technology function follows as,

$$Y = \int_0^N X_i^\theta \left[Z_i^a Z^{1-a} \frac{L}{N^{1-\sigma}} \right]^{1-\theta} di, \tag{4}$$

where Y is the output and N is the mass of intermediate goods, Z_i is the quality of the intermediate good i, and $Z = \int_0^N (Z_j/N) \, dj$ is the average quality of intermediate goods. We interpret N as the mass rather than the number of intermediate goods, because we view intermediate goods as continuous; this is also mathematically accurate since the function of final output is an integral. The variables a and σ regulate the private returns to quality and the social returns to variety respectively. Solving the final producers' problem of profit-maximization, we find the demand curve of each intermediate firm i,

$$X_i = \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} Z_i^a Z^{1-a} \frac{L}{N^{1-\sigma}}, \tag{5}$$

where P_i is the price of intermediate good i. As derived from first order conditions, total compensation to intermediate goods' suppliers is given by $\int_0^N P_i X_i \, di = \theta Y$, while to labor suppliers $wL = (1 - \theta) Y$.

Intermediate Producers

Each intermediate firm's technology requires 1 unit of final good per unit of intermediate good produced and has a fixed operating cost $\phi {Z_i}^a Z^{1-a}$ in units of final good. The technology component $Z_i^a Z^{1-a}$ reveals the contribution of good i to factor productivity in final production. Each firm i accumulates knowledge according to

$$\dot{Z}_i = I_i, \tag{6}$$

where I_i is the level of in-house investment in units of final output. Now, we introduce corporate governance in our model and express the profit of each intermediate good producer as

$$\Pi_i = \left((P_i - 1) \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} - \phi \right) \cdot Z_i^a Z^{1-a} \cdot M(e_i) - I_i, \tag{7}$$

where $M(e_i)$ is a variable describing the firm's manager contribution to production. It is a function of the effort level e_i exerted by the manager of firm i. To simplify notation for future calculations, we will define a new variable $B_i = \left((P_i - 1) \left(\frac{\theta}{P_i} \right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} - \phi \right) \cdot Z_i^a Z^{1-a}$, which expresses the gross operating profit of firm i without incorporating managerial input. Thus, we can rewrite the profit function as

$$\Pi_i = B_i \cdot M(e_i) - I_i. \tag{8}$$

Taking the sector's average quality as given, the firm chooses the time paths of $P_i(t)$ and $I_i(t)$ to maximize the value of the firm:

$$V_i(0) = \int_0^\infty e^{-\int_0^t r(s)ds} \, \Pi_i(t) \, dt. \tag{9}$$

3.2 Corporate Governance

Let us now explore how corporate governance affects intermediate-good production. We will model two types of firms in the intermediate-good production sector; a privately-owned and a state-owned enterprise. Inspired by the insights of agency theory, we will explore how a firm's objective function motivates different types of incentive contracts as a solution to the principal-agent problem and leads to different firm performances. In each case, the shareholder of the firm – the principal – hires a a manager – the agent – in charge of the firm's operations.

3.2.1 Privately-Owned Enterprise

Economic theory suggests that the objective function of privately-owned firms is profit-maximization so as to achieve shareholder value maximization (Lankoski & Smith, 2017). Privately-owned enterprises face a principal/agent problem, due to the separation of ownership and control; the shareholders, or else owners of a company, hire managers to run their company and they sign an incentive contractual agreement. As discussed previously, the areas of potential conflict in this principal/agent problem are multiple, however, this model will specifically look into the conflict surrounding cash dividends. We assume the private firm's objective function is profit maximization. We assume that the manager decides on the price level, P_i, and the shareholder decides on the investment level, I_i.

Manager

The shareholder of the firm, or else the principal, hires a manager, the agent, to run the firm's everyday operations. The principal and agent agree on a contractual agreement, and based on the terms of the agreement the manager exerts effort e_i. Hence, the managers take the compensation parameter as it is given by the shareholder. We assume the manager consumes their income, which is a constant fraction s_i of the level of profit Π_i; the manager has a linear utility function in consumption and they face the same discount rate ρ as the households:

$$U_i^{priv-manager} = s_i \Pi_i - ZK(e_i) \tag{10}$$

where $K(e_i)$ is an increasing convex function that describes the cost of effort e_i : $K(0) = 0$, $\lim_{e_i \to 1} K(e_i) = +\infty$ and $\lim_{e_i \to 1^-} K'(e_i) = +\infty$. We have scaled the cost of effort by the level of technology due to mathematical reasons as well as due to the added cost of effort involved when managers have to master new technologies. The manager's compensation incentivizes them to aim for profit-maximization, thus aligning the manager's interests with those of the firm.

In our model we assume that fraction, s_i, of the firm's profits Π_i are spent on the manager's compensation and $(1 - s_i)$ are devoted to dividends D_i – a payment to the shareholders. Thus,

$$D_i = (1 - s_i)\,\Pi_i. \tag{11}$$

At time t, the manager takes as given by the shareholder the path of investment, $I_i(\tau)$, and chooses the path of price, $P_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{priv-manager} = \int_0^\infty e^{-\rho\tau} U_i^{priv-manager}(\tau)\; d\tau = \int_0^\infty e^{-\rho\tau}(s_i\Pi_i - ZK(e_i))d\tau. \tag{12}$$

The private manager is chosen from one of the households, thus we use the households' discount rate ρ. The manager exerts effort to increase the profitability of the firm; the generation of profits, compensation paid to the managers and the level of dividend pay all depend on the action of the manager. However, there is a disutility of exerting effort, so managers now face a sequence of intra-temporal problems. The manager's optimal decision is for their marginal benefit to equal its marginal cost. Our first-order conditions are as follows:

$$\frac{\partial U_i^{priv-manager}}{\partial P_i} = 0 \Rightarrow\; s_i \cdot \frac{\partial B_i}{\partial P_i} \cdot\; M(e_i) = 0 \Rightarrow\; P_i = \frac{1}{\theta}, \tag{13}$$

$$\frac{\partial U_i^{priv-manager}}{\partial e_i} = 0 \Rightarrow\; s_i \cdot B_i \cdot \frac{\partial M(e_i)}{\partial e_i} - Z \cdot \frac{\partial K(e_i)}{\partial e_i} = 0. \tag{14}$$

Equation (13) gives us the price level that maximizes the manager's utility. Price $P_i = \frac{1}{\theta}$ is also the gross profit maximizing price ($\frac{\partial B_i}{\partial P_i} = 0$) and the value-maximizing price conditional on technology; the incentive contract incentivizes the manager to choose the price that maximizes profit, which then maximizes the shareholder's value. Looking at the last first-order condition, (14), the left-hand side variable signifies the manager's marginal cost and the right-hand side the manager's marginal cost. This brings us to our solution:

$$\frac{K'(e_i)}{M'(e_i)} = \frac{s_i \cdot B_i}{Z} \Rightarrow\; e = \widetilde{e}\left(\frac{s_i B_i}{Z}\right). \tag{15}$$

Therefore, the level of effort the manager exerts is an implicit function of the variable $\frac{s_i B_i}{Z}$; $\frac{B_i}{Z}$ is the profitability scaled by the level of technology, while the variable s_i incorporates incentives into the function.

Shareholder

The principal's objective is to hire an agent that will increase the firm's profitability so that their own compensation – the dividend flow D_i – increases. To provide incentives to the manager, the shareholder compensates the manager for their effort, by giving them the portion of profits not paid directly to the shareholder. At time t, the shareholder takes as given by the manager the path of price, $P_i(\tau)$, and chooses the path of investment, $I_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{shareholder} = \int_0^{\infty} e^{-r\tau} D_i(\tau)\, d\tau = \int_0^{\infty} e^{-r\tau}(1 - s_i)\Pi_i\, d\tau. \tag{16}$$

The principal's goal is to set equal the marginal benefit and the marginal cost from offering a certain level of compensation to the agent. The principal takes the effort decisions as a constraint so when the principal makes the compensation decision, they observe the agent's effort level. Constrained by the level of effort the manager chooses according to the level of compensation agreed, the shareholder wants to use the current value Hamiltonian H_i to solve the following dynamic optimization problem:

$$H_i = D_i + q_i \cdot I_i =$$

$$(1 - s_i)\left[\left((P_i - 1)\left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} - \phi\right) \cdot Z_i^a Z^{1-a} \cdot M(e_i) - I_i\right] + q_i \cdot I_i \Rightarrow$$

$$H_i = (1 - s_i)\left[B_i \cdot M(e_i) - I_i\right] + q_i \cdot I_i \tag{17}$$

where q_i is the shadow value of the marginal increase in product quality. We will use the first-order conditions to describe the shareholder's compensation and investment decisions:

$$s_i : \quad \frac{\partial H_i}{\partial s_i} = 0 \Rightarrow -\left(B_i \cdot M(e_i) - I_i\right) + (1 - s_i)\left(B_i \frac{\partial M(e_i)}{\partial e_i}\frac{\partial e_i}{\partial s_i}\right) = 0 \Rightarrow$$

$$1 - s_i = \frac{\Pi_i}{B_i \frac{\partial M(e_i)}{\partial e_i}\frac{\partial e_i}{\partial s_i}} \tag{18}$$

$$I_i : \frac{\partial H_i}{\partial I_i} = 0 \Rightarrow s_i - 1 + q_i = 0 \Rightarrow q_i = 1 - s_i \tag{19}$$

$$Z_i : \frac{\partial H_i}{\partial Z_i} = rq_i - \dot{q}_i \Rightarrow M(e_i)B_i \frac{\alpha}{Z_i}(1 - s_i) = rq_i - \dot{q}_i \tag{20}$$

The compensation decision (18) shows that the contract's incentives depend on the profit scaled by the gross operating profit and the marginal change in managerial input as a response to the contract's compensation level s_i. Let us now discuss the shareholder's investment decisions. Increasing the quality of an intermediate good by one unit requires one unit of final output which costs $P_Y = 1$. In this privately-owned firm, however, the cost of investment to the shareholder is $1 - s_i < 1$. This lower cost of investment to the shareholder can be explained from the incentive contract. Investment costs are part of the manager's compensation, but the manager is not in control of the investment level, since this is decided by the shareholder. Through this incentive contract, the shareholders don't incur all of the investment costs, since the manager "subsidizes" part it. We find the rate of return to in-house investment by substituting for $q_i = 1 - s_i$ in (20):

$$r = \frac{\alpha}{Z_i} M\left(e_i\right) B_i + \frac{\dot{q}_i}{q_i}. \tag{21}$$

The firm's rate of return to in-house investment measures the return shareholders receive from investing in the company.

3.2.2 State-Owned Enterprise

State-owned enterprises are generally more difficult to model than private firms, for they pursue multiple, non-commercial objectives, answer to several different ministries, and operate under peculiar constraints (Lawson, 1994). We will explore four scenarios for the SOE, which will vary in terms of the firm's objective function and the type of incentive contract. In all scenarios, the principal/agent relationship is parallel to that of the private firm: the principal - the state - hires an agent - the state manager - to run operations. In our model, we refer to the principal of the SOE as the "government" and label each scenario according to the incentive contract the government has established for the state manager. In all the scenarios, we assume that the manager decides on price level P_i and the government decides on investment level I_i.

Scenario 1: Input-Output Target Model
Under planned economies all production decisions are made by the government; this was the case in USSR where state enterprises had to meet specific output targets. In this scenario, we will consider a model where the principal of the SOE has a specific input/output target for the firm. Since each unit of intermediate good requires one unit for final output and the price of a final good is $P_Y \equiv 1$, then in the intermediate sector the quantity of outputs is equal to the quantity of inputs.

Manager
We assume that the government has set a target output/input level for the SOE. Hence, the government compensates the manager according to

$$\Psi_{\mathrm{i}} = c_i - b_i \left(kZ - X_i M(e_i)\right)^2, \tag{22}$$

where c_i is a constant, kZ is the government's target output/input scaled by technology, $X_i M(e_i)$ is the firm's actual output/input and b_i is a constant that determines the amount by which actual output's deviation from target output harms the manager's compensation. Thus, we have assumed that the government is equally unsatisfied with all types of deviations from target output, whether that is a surplus or a shortage.

Similar to the private firm, we assume the manager has a linear utility function in consumption expressed as:

$$U_i^{state-manager} = c_i - b_i \left(Zk - X_i M(e_i)\right)^2 - ZK(e_i), \tag{23}$$

where $K(e_i)$ is an increasing convex function that describes the cost of effort $e_i:\ K(0) = 0$, $\lim_{e_i \to 1} K(e_i) = +\infty$ and $\lim_{e_i \to 1^-} K'(e_i) = +\infty$. Therefore, the state manager wants to maximize their utility discounted by the households' discount rate ρ:

$$V\left(t\right)_i^{state-manager} = \int_0^\infty e^{-\rho\tau} U_i^{state-manager}(\tau)\, d\tau \Rightarrow$$

$$V\left(t\right)_i^{state-manager} = \int_0^\infty e^{-\rho\tau} [c_i - b_i \left(Zk - X_i M(e_i)\right)^2 - ZK(e_i)]\, d\tau\ . \tag{24}$$

The manager exerts effort to reach the target output set by the government. However, there is a disutility of exerting effort, so managers now face a sequence of intra-temporal problems.

The manager's optimal decision is for their marginal benefit to equal its marginal cost. Our first-order condition is as follows:

$$\frac{\partial U_i^{state-manager}}{\partial P_i} = 0 \Rightarrow Zk - X_i M(e_i) = 0. \tag{25}$$

We can express the effort function of the manager as:

$$e = \widetilde{e}\left(\frac{Zk}{X_i}\right). \tag{26}$$

The effort function of the manager is a function of the target output/input Zk and actual output X_i without the managerial input. Since the manager decides both on the price and the level of effort, the first-order condition gives us the manager's corner solution. Unlike the privately-owned firm, the state manager's effort decision does not depend on the compensation parameters c_i and b_i. The manager decides on a combination of price p_k and effort e_k so that $X_i(p_k)M(e_k) = k$.

<u>Government</u>

On the other side of this principal/agent relationship, we will assume that the government wants to maximize the present value of the firm's profits after paying the manager:

$$V(t)_i^{government} = \int_0^\infty e^{-r\tau} \left[\Pi_i - \left(c_i - b_i(Zk - X_i M(e_i))^2\right)\right] d\tau. \tag{27}$$

The principal's goal is to set equal the marginal benefit and the marginal cost from offering a certain level of compensation to the agent. However, from (26) we understand that in this contractual agreement the manager's effort does not depend on the compensation level, but rather on the target output/input set by the government and the price level chosen by the manager. The shareholder wants to use the current value Hamiltonian H_i to solve the following dynamic optimization problem:

$$H_i = D_i + q_i \cdot I_i = \Pi_i - \left(c_i - b_i(Zk - X_i M(e_i))^2\right) + q_i \cdot I_i \tag{28}$$

The government's compensation and investment decisions are as follows:

$$b_i : \frac{\partial H_i}{\partial bi} = 0 \Rightarrow$$

$$B_i \frac{\partial M(e_i)}{\partial e_i}\frac{\partial e_i}{\partial b_i} + (Zk - X_i M(e_i))^2 + 2b_i(Zk - X_i M(e_i))\left(-X_i \frac{\partial M(e_i)}{\partial e_i}\frac{\partial e_i}{\partial b_i}\right) = 0 \tag{29}$$

$$I_i : \frac{\partial H_i}{\partial I_i} = 0 \Rightarrow q_i = 1 \tag{30}$$

$$Z_i : \frac{\partial H_i}{\partial Z_i} = rq_i - \dot{q}_i = \frac{\alpha}{Z_i} M(e_i) B_i \tag{31}$$

Managerial input is independent of the compensation, so we can substitute for $\frac{\partial M(e_i)}{\partial e_i}\frac{\partial e_i}{\partial b_i} = 0$ in (29). We are left with $2b_i(Zk - X_i M(e_i)) = 0$, so using the manager's decision in (26) we conclude that in this principal/agent relationship there is no need to include incentives. The government's investment decisions show that the government's cost per unit of investment volume is $q_i = 1$. This is in accordance with the contractual agreement, since the manager is not involved in the investment decision. Substituting for $q_i = 1$, $P_i = p_k$ and $k = X_i(p_k)M(e_k)$ we find the firm's rate of return to in-house investment:

$$r = \frac{\alpha}{Z_i}[(p_k - 1)k - \phi M(e_k) Z_i^a Z^{1-a}] \tag{32}$$

Comparing the return rate of this SOE and the private firm, we observe that the two return functions have the same structure and variables. The two firms will eventually produce different returns based on the target output/input set by the government, the managerial input, the fixed operating costs and on the market structure. The SOE manager's compensation does not depend on the firm's fixed operating costs, thus we could expect increased inefficiency in this firm. Moreover, the SOE manager decides on a combination of price p_k and effort e_k so as to achieve $k = X_i(p_k)M(e_k)$, thus if this firm operates in a non-competitive market we could expect price distortions. The contractual agreement allows the manager to distort the price and exert less effort, while still achieving the target level of output/input.

Scenario 2: Compensation scaled by gross profit
In this scenario we will consider a SOE whose objective is to maximize gross profit, the value of revenue minus input expenditures.

Manager
Similar to the private firm, the principal and agent agree on a contractual agreement, and based on the terms of the agreement the manager exerts effort e_i. Hence, the manager takes the compensation parameter as it is given by the principal. The manager's consumption is their income level, which is a constant fraction c_i of the level of gross profit Ω_i, which we express as

$$\Omega_i = (P_i - 1)\left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} Z_i^a Z^{1-a} M(e_i) \Rightarrow \Omega_i = (P_i - 1)\, X_i M(e_i). \tag{33}$$

To simplify future calculations, let us define the new variable

$$F_i = (P_i - 1)\left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} Z_i^a Z^{1-a} \Rightarrow \Omega_i = F_i M(e_i) \tag{34}$$

which describes the gross profit level Ω_i without the managerial input variable $M(e_i)$. We assume the manager has a linear utility function in consumption and they face the same discount rate ρ as the households. At time t, the manager takes as given by the government the path of investment, $I_i(\tau)$, and chooses the path of price, $P_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{state-manager} = \int_0^\infty e^{-\rho\tau} U_i^{state-manager}(\tau)\, d\tau = \int_0^\infty e^{-\rho\tau}(c_i\Omega_i - ZK(e_i))\, d\tau \tag{35}$$

The state manager is chosen from one of the households, thus we use the households' discount rate ρ. The manager exerts effort to increase the gross profit of the firm, thus the manager's action affects their own compensation, the level of gross profit and the available cash flow to the government. Managers now face a sequence of intra-temporal problems. The manager's optimal decision is for their marginal benefit to equal its marginal cost. Our first-order conditions are as follows:

$$\frac{\partial U_i^{state-manager}}{\partial P_i} = 0 \Rightarrow \; c_i \cdot \frac{\partial \Omega_i}{\partial P_i} = 0 \Rightarrow \; P_i = \frac{1}{\theta} \tag{36}$$

$$\frac{\partial U_i^{state-manager}}{\partial e_i} = 0 \Rightarrow \; c_i \cdot \; F_i \cdot \frac{\partial M\left(e_i\right)}{\partial e_i} - Z \cdot \frac{\partial K(e_i)}{\partial e_i} = 0 \tag{37}$$

The state manager selects the same value-maximizing price $P_i = \frac{1}{\theta}$ as the manager of the private firm. The first-order condition on effort (37) brings us to our solution:

$$\frac{K'(e_i)}{M'(e_i)} = \frac{c_i \cdot F_i}{Z} \Rightarrow \; e = \widetilde{e}\left(\frac{c_i F_i}{Z}\right). \tag{38}$$

Therefore, the level of effort the manager exerts is an implicit function of the variable $\frac{c_i F_i}{Z}$; $\frac{F_i}{Z}$ is the level of output scaled by technology, while the variable c_i incorporates incentives into the function.

<u>Government</u>

The government's objective is to hire a manager that will increase the firm's gross profit level, since the maximization of gross profit is the main objective of the SOE and constitutes part of the government's agenda. In this model, we assume that the principal receives the flow of profits remaining after compensating the manager D_i and thus it is in their interest to ensure a reasonable level of profits. At time t, the principal takes as given by the manager the path of price, $P_i\left(\tau\right)$, and chooses the path of investment, $I_i\left(\tau\right)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{government} = \int_0^\infty e^{-r\tau} D_i(\tau) d\tau \Rightarrow$$

$$V(t)_i^{government} = \int_0^\infty e^{-r\tau} \left[\left(1 - c_i\right) F_i M\left(e_i\right) - \phi Z_i^a Z^{1-a} M\left(e_i\right) - I_i\right] \; d\tau. \tag{39}$$

Constrained by the level of effort the manager chooses as a result of the compensation agreed, the principal wants to solve the following dynamic optimization problem, using the current value Hamiltonian:

$$H_i = D_i \; + q_i \cdot \; I_i =$$

$$\left(1 - c_i\right)\left[\left(P_i - 1\right)\left(\frac{\theta}{P_i}\right)^{\frac{1}{1-\theta}} \frac{L}{N^{1-\sigma}} Z_i^a Z^{1-a} M(e_i)\right] - \phi Z_i^a Z^{1-a} M(e_i) - I_i + q_i \cdot I_i \Rightarrow$$

$$H_i = \left(1 - c_i\right) F_i M(e_i) - \phi Z_i^a Z^{1-a} M(e_i) - I_i + q_i \cdot \; I_i, \tag{40}$$

where q_i is the shadow value of the marginal increase in product quality. The following first-order conditions describe the government's compensation and investment decisions:

$$c_i: \quad \frac{\partial H_i}{\partial c_i} = 0 \Rightarrow \; 1 - c_i = \frac{\phi Z_i^a Z^{1-a}}{F_i} + \frac{M(e_i)}{\frac{\partial M(e_i)}{\partial e_i}\frac{\partial e_i}{\partial c_i}} \tag{41}$$

$$I_i: \; \frac{\partial H_i}{\partial I_i} = 0 \Rightarrow -1 + q_i = 0 \Rightarrow \; q_i = 1 \tag{42}$$

$$Z_i: \; \frac{\partial H_i}{\partial Z_i} = rq_i - \dot{q}_i \; \Rightarrow \frac{\alpha}{Z_i} M(e_i) \left[F_i(1 - c_i) - \phi Z_i^a Z^{1-a}\right] = rq_i - \dot{q}_i \tag{43}$$

The government decides on the level of compensation (41) based on the level of fixed operating costs scaled by gross profit and the level of managerial input scaled by the managerial input's response to changes in the compensation. In other words, the government decides on the compensation factor based on the operating efficiency of the firm and how the manager's performance responds to incentives. In fact, equation (41) provides important insight into the firm's performance. The contract in place does not directly incentivize the manager to improve operating efficiency. However, the government considers the level of fixed operating costs when deciding on the compensation parameter, which could indirectly encourage the state manager to not overlook operating efficiency. The first-order conditions with respect to investment (42) results in $q_i = 1$. Since the manager does not partake in the firm's investment decisions, the government incurs all of the investment costs and each unit of investment volume costs them the price of final output $P_Y = 1$. Substituting for $q_i = 1$ we find the firm's rate of return to in-house investment:

$$r = \frac{\alpha}{Z_i} M(e_i) \left[F_i(1 - c_i) - \phi Z_i^a Z^{1-a}\right] \tag{44}$$

Unlike the private firm, the return to innovation of this SOE scales the output with the compensation factor $1 - c_i$. The return function highlights the importance of how managerial input responds to incentives. Analyzing the return rate's response to a change in the compensation factor, we find that the values of $F_i(1 - c_i))$ and $M(e_i)$ have an inverse relationship, thus giving an ambiguous result.

Scenario 3: Compensation as a linear combination of profit and output

Having explored SOEs with profit-maximizing, output-maximizing and gross-profit maximizing objectives, in this scenario I will build a model where the manager's compensation is a linear combination of profit and input/output. An output-maximizing or gross-profit maximizing firm could approach $\Pi_i = 0$ since the manager overlooks efficiency and investment costs, thus this scenario explores an incentive contract that puts weight on both the quantity of production and profitability.

Manager

Similar to the other scenarios discussed, the government and state manager reach a contractual agreement and based on the terms of the agreement the manager exerts effort e_i. The state manager's utility is linear in consumption and can be expressed as

$$U_i^{state-manager} = c_i \Pi_i + (1 - c_i) X_i M(e_i) - ZK(e_i), \tag{45}$$

where $K(e_i)$ is an increasing convex function that describes the cost of effort e_i : $K(0) = 0$, $\lim_{e_i \to 1} K(e_i) = +\infty$ and $\lim_{e_i \to 1^-} K'(e_i) = +\infty$. The manager receives as compensation the constant amount c_i of profit level Π_i and $(1 - c_i)$ of input/output level Ω_i. For $c_i = 1$ the SOE behaves like the profit-maximizing private firm, while for $c_i = 0$ the SOE aims for output maximization.

At time t, the manager takes as given by the shareholder the path of investment, $I_i(\tau)$, and chooses the path of price, $P_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{state-manager} = \int_0^\infty e^{-\rho\tau} \left[c_i\Pi_i + (1 - c_i)X_i M(e_i) - ZK(e_i)\right] d\tau \tag{46}$$

Solving for the first-order conditions, we get:

$$\frac{\partial U_i^{state-manager}}{\partial P_i} = 0 \Rightarrow P_i = \frac{1}{\theta} \tag{47}$$

$$\frac{\partial U_i^{state-manager}}{\partial e_i} = 0 \Rightarrow (c_i B_i + (1 - c_i)X_i)M'(e_i) = ZK'(e_i) \tag{48}$$

Similar to the private firm and the gross profit maximizing SOE, the manager selects the value-maximizing price $P_i = \frac{1}{\theta}$. Looking at our last first-order condition, the left-hand side signifies the manager's marginal benefit and the right-hand side the manager's marginal cost. This brings us to our solution:

$$e = \widetilde{e}\left(\frac{c_i B_i + (1 - c_i)X_i}{Z}\right). \tag{49}$$

The effort function of the state manager is an implicit function that incorporates the gross operating profit, level of input/output, technology and incentives. Similar to the other effort functions found for the other firms studied, effort is a function of the firm's cash flow paid to the manager $c_i B_i + (1 - c_i)X_i$ scaled by the level of the sector's level of technology Z.

Government

We assume the government receives the flow of profits D_i remaining after compensating the manager. At time t, the government takes as given by the manager the path of price, $P_i(\tau)$, and chooses the path of investment, $I_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{government} = \int_0^\infty e^{-r\tau} D_i \, d\tau = \int_0^\infty e^{-r\tau} \left[\Pi_i - (c_i\Pi_i + (1 - c_i) X_i M(e_i))\right] d\tau =$$

$$\int_0^\infty e^{-r\tau} \left[(1 - c_i)\Pi_i - (1 - c_i)X_i M(e_i)\right] \, d\tau. \tag{50}$$

The principal's goal is to set the marginal benefit from offering a certain level of compensation to the manager to equal the marginal cost. Constrained by the level of effort the manager chooses as a result of the compensation agreed, the government solves the following dynamic optimization problem, using the current value Hamiltonian:

$$H_i = D_i + q_i \cdot \ I_i = (1 - c_i)\Pi_i - (1 - c_i)X_i M(e_i) + q_i \cdot I_i, \tag{51}$$

where q_i is the shadow value of the marginal increase in product quality. The following first-order conditions describe the government's compensation and investment decisions:

$$c_i : \quad \frac{\partial H_i}{\partial c_i} = 0 \Rightarrow 1 - c_i = \frac{(\Pi_{\mathrm{i}} + \phi Z_i^a Z^{1-a} M\left(e_i\right)) - X_i M\left(e_i\right)}{((P_i - 1)X_i - \phi Z_i^a Z^{1-a} - X_i) \frac{\partial M(e_i)}{\partial e_i} \frac{\partial e_i}{\partial c_i}} \Rightarrow$$

$$1 - c_i = \frac{((P_i - 1)X_i M(e_i) - X_i M\left(e_i\right) - I_i}{(B_i - X_i) \frac{\partial M(e_i)}{\partial e_i} \frac{\partial e_i}{\partial c_i}} \tag{52}$$

$$I_i : \frac{\partial H_i}{\partial I_i} = 0 \Rightarrow \; q_i = 1 - c_i \tag{53}$$

$$Z_i : \frac{\partial H_i}{\partial Z_i} = r q_i - \dot{q}_i \Rightarrow \frac{\alpha}{Z_i} \left(1 - c_i\right) M(e_i) \left[B_i - X_i\right] = r q_i - \dot{q}_i \tag{54}$$

Equation (52) provides insight into how the government takes into account the managerial input, managerial input's response to incentives, gross profit and investment level when deciding on the level of compensation to the manager. Since part of the manager's compensation depends on the investment level, equation (53) gives the same value for q_i as for the private firm. The government enjoys the lower cost of investment $1 - c_i$ which could encourage the government to increase its level of investment. Substituting for $q_i = 1 - c_1$, we get the rate of return to in-house investment:

$$r = \frac{\alpha}{Z_i} M(e_i) \left[B_i - X_i\right] + \frac{\dot{q}_i}{q_i} \tag{55}$$

Unlike the profit-maximizing private firm, the rate of return of this SOE is a function of the difference between gross profit and output, rather than only gross profit. The SOE charges the gross profit maximizing and value-maximizing price $\frac{1}{\theta}$, thus we conclude that the rate of return of the SOE is lower than the rate of the private firm conditional on the level of managerial input and technology. This conclusion is reflective of the firm's objective function and contractual agreement. Based on the contract's incentives, this firm will achieve an output level higher than the profit-maximizing level, while maintaining a positive level of profit. However, since the contract's weight on profits is less than that of the private firm, the manager might not achieve the same efficiency of operating costs as the private firm.

Scenario 4: Compensation as a linear combination of profit and price
In this scenario, I will explore a SOE with price distortions. Therefore, we build an incentive contract which is a linear combination of profit and price.

Manager

Similar to the other scenarios discussed, the government and state manager reach a contractual agreement. The state manager's utility is linear in consumption and can be expressed as

$$U_i^{state-manager} = c_i \Pi_i + (1 - c_i) P_i - Z K(e_i), \tag{56}$$

The manager receives as compensation the constant amount c_i of profit level Π_i and $(1 - c_i)$ of price level P_i. For $c_i = 1$ the SOE behaves like the profit-maximizing private firm, while for $c_i = 0$ the problem is ill-defined. Thus, we assume $0 < c_i \leq 1$.

At time t, the manager takes as given by the shareholder the path of investment, $I_i(\tau)$, and chooses the path of price, $P_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{state-manager} = \int_0^{\infty} e^{-\rho\tau} \left[c_i \Pi_i + (1 - c_i) P_i - ZK(e_i)\right] d\tau \tag{57}$$

The first-order conditions give us:

$$\frac{\partial U_i^{state-manager}}{\partial P_i} = 0 \Rightarrow \; c_i = \frac{1}{1 - X_i M(e_i)\left(1 + \frac{P_i - 1}{(\theta-1)P_i}\right)} \tag{58}$$

$$\frac{\partial U_i^{state-manager}}{\partial e_i} = 0 \Rightarrow \frac{K'(e_i)}{M'(e_i)} = \frac{B_i c_i}{Z} = \frac{B_i}{Z\left[1 - X_i M(e_i)\left(1 + \frac{P_i - 1}{(\theta-1)P_i}\right)\right]} \tag{59}$$

The first order conditions show that the price decided by the state manager is an implicit function of output, effort and compensation. Thus, the manager might not select the value-maximizing price level.

Government

We assume the government receives the flow of profits D_i remaining after compensating the manager. At time t, the shareholder takes as given by the manager the path of price, $P_i(\tau)$, and chooses the path of investment, $I_i(\tau)$, for $\tau \in [t, \infty)$ and tries to maximize

$$V(t)_i^{government} = \int_0^{\infty} e^{-r\tau} ((1 - c_i)\Pi_i + (c_i - 1)P_i) \; d\tau \tag{60}$$

The principal's goal is to set the marginal benefit from offering a certain level of compensation to the manager to equal the marginal cost. Constrained by the level of effort the manager chooses as a result of the compensation agreed, the government wants to solve the following dynamic optimization problem, using the current value Hamiltonian:

$$H_i = \; D_i + q_i \cdot I_i = (1 - c_i)\Pi_i + (c_i - 1)P_i + q_i \cdot I_i \tag{61}$$

where q_i is the shadow value of the marginal increase in product quality. The following first-order conditions describe the shareholder's compensation and investment decisions:

$$c_i : \quad \frac{\partial H_i}{\partial c_i} = 0 \Rightarrow 1 - c_i = \frac{\Pi_i - P_i}{B_i \frac{\partial M(e_i)}{\partial e_i} \frac{\partial e_i}{\partial c_i}} \tag{62}$$

$$I_i : \; \frac{\partial H_i}{\partial I_i} = 0 \Rightarrow q_i = 1 - c_i \tag{63}$$

$$Z_i : \frac{\partial H_i}{\partial Z_i} = rq_i - \dot{q}_i \Rightarrow r = \frac{\alpha}{Z_i}\left[B_i M(e_i)\right] + \frac{\dot{q}_i}{q_i} \tag{64}$$

The first-order condition on incentives (62) finds that the compensation parameter is determined by the difference between profit and price scaled by gross profit and the marginal increase in managerial input in response to changes in compensation. Since the state manager's compensation depends on the level of investment $q_i \neq 1$, the government enjoys the lower cost of investment $1 - c_i$; the manager absorbs parts of the cost of investment. The rate of return to innovation has a similar structure to that of all other firms where the manager's compensation is a function of profit; it depends on the gross operating profit and managerial input scaled by $\frac{\alpha}{Z_i}$.

Due to the complex relationship between effort, price and compensation we cannot provide an interpretation of the price and output level. Moreover, the parameters of this incentive contract raise a scaling issue. The price and profit level are variables of different magnitudes that are not comparable. We attempted to solve this scenario scaling P_i by X_i, however this alteration yielded negative cash flow to the government.

4 General Equilibrium

We will now discuss the general equilibrium of the model, concentrating on the steady state. The equilibrium is symmetric, therefore we can omit the subscript i, since all variables refer to both average and firm-level quantities. In equilibrium, all intermediate firms charge the same price and have the same quality at all times. Solving for the households' saving behavior we find,

$$r = \rho + z \Rightarrow z = r - \rho, \tag{65}$$

where ρ is the households' discount rate and z is the economy's rate of growth. We will use each firm's rate of return to in-house investment to calculate and compare the steady state level of growth in the economy z.

4.1 Privately-Owned Firm

We consider an intermediate sector where all firms behave like the privately-owned firm modeled earlier. All firms charge the same price $P_i = \frac{1}{\theta}$ and they collect $N \cdot PX = \theta Y \Rightarrow X = \theta^2 Y/N$ from the final producer. We impose symmetry in the production function and thus obtain the total output as

$$Y = \theta^{\frac{2\theta}{1-\theta}} \ N^{\sigma} Z L. \tag{66}$$

In symmetric equilibrium, the firms' profit function can be expressed as:

$$\Pi = \left[\left(\frac{1}{\theta} - 1 \right) \theta^{\frac{2}{1-\theta}} \frac{L}{N^{\sigma}} - \phi \right] ZM - I. \tag{67}$$

Using the aggregate demand function for intermediate goods, X, we will define the new variable $x = X/Z$, the quality-adjusted demand for intermediate goods:

$$x = \frac{X}{Z} = \theta^{\frac{2}{1-\theta}} \frac{L}{N^{\sigma}}. \tag{68}$$

The private firm's rate of return to in-house investment was found in (21). In aggregate terms, we can express it as:

$$r_p = \alpha M \frac{B}{Z} \Rightarrow \ r_p = \alpha M \left[\left(\frac{1}{\theta} - 1 \right) x - \phi \right] \tag{69}$$

Thus, the growth rate is as follows:

$$z_p = \alpha M \left[\left(\frac{1}{\theta} - 1 \right) x - \phi \right] - \rho. \tag{70}$$

4.2 State-Owned Enterprise

Now, we will consider the five different types of SOEs and how their steady state compares to that of the private firm.

4.2.1 Scenario 1: Input/Output Target

In this scenario, we consider an intermediate sector where all firms are state-owned and have an input/output target as explored in Scenario 1. At the firm-level, the government sets an output/input target equal to Zk and the compensation agreement between the government and state manager incentivizes the manager to choose a combination of price p_k and effort e_k so that $X_i(p_k)M(e_k) = k$. In symmetric equilibrium, all firms charge price p_k and each firm produces the level of output Zk. The firm's profit function can be expressed as:

$$\Pi = (p_k - 1)Zk - \phi Z M - I \tag{71}$$

The rate of return to in-house investment and rate of growth are as follows:

$$r_{s1} = \alpha M \frac{B}{Z} \Rightarrow r_{s_1} = \alpha \left[(p_k - 1) k - \phi M \right] \tag{72}$$

$$z_1 = \alpha \left[(p_k - 1) k - \phi M \right] - \rho \tag{73}$$

The comparative performance of this SOE and the privately-owned firm depends on the level of the target output/input.

4.2.2 Scenario 2: Compensation scaled by gross profit

In this scenario, we consider an intermediate sector consists of SOEs whose objective function is gross profit maximization. The government compensates the manager with c of the firm's gross profit. In this scenario, firms charge $P = \frac{1}{\theta}$, thus the firms' profit and output function are the same as those of the private firms. The firms' rate of return to in-house investment and rate of growth can be expressed as:

$$r_{s2} = \frac{\alpha}{Z} M \left[F(1-c) - \phi Z \right] \Rightarrow r_{s_2} = \ \alpha M \left[\left(\frac{1}{\theta} - 1 \right) x (1-c) - \phi \right] \tag{74}$$

$$z_2 = \alpha \left[\left(\frac{1}{\theta} - 1 \right) x (1-c) - \phi \right] - \rho \tag{75}$$

4.2.3 Scenario 3: Compensation as a linear combination of profit and input expenditure

In this scenario, we consider an intermediate sector where firms are state-owned and compensate the state manager with a linear combination of profit and input expenditure. The firm selects price, $P = \frac{1}{\theta}$, thus its profit and output can be expressed in the same way as for the profit-maximizing private firm. The firm's rate of return to in-house investment and the growth rate can be expressed as:

$$r_{s3} = \frac{\alpha}{Z} M(B - X) \Rightarrow \; r_{s3} = \alpha M \left[\left(\frac{1}{\theta} - 1 \right) x - \phi \right] \tag{76}$$

$$z_3 = \alpha M \left[\left(\frac{1}{\theta} - 1 \right) x - \phi \right] - \rho \tag{77}$$

4.2.4 Scenario 4: Compensation as a linear combination of profit and price

In this scenario, the incentive contract compensates the state manager based on both the level of profit and price. As found in (58), the price selected by such a firm depends on the compensation parameter, output and the managerial input. Let us call the level of price selected as p_c and express output as

$$X_c = \left(\frac{\theta}{p_c} \right)^{\frac{1}{1-\theta}} \frac{L}{N^{\sigma}} ZM \tag{78}$$

We now have to emphasize that equation (78) is an implicit function since the price selected p_c depends on output X_c. We express the quality-adjusted output as $x_c = \frac{X_c}{Z}$ and substitute it to find the rate of return to in-house investment and the rate of economic growth:

$$r_{s4} = \frac{\alpha}{Z} B_c M \Rightarrow \; r_{s4} = \alpha M \left[(p_c - 1) \, x_c - \phi \right] \tag{79}$$

$$z_4 = \alpha M \left[(p_c - 1) \, x_c - \phi \right] + \rho \tag{80}$$

The return and growth rates both include the implicit functions of price and output.

5 Discussion

In this paper, we modeled a collection of privately-owned and state-owned enterprises with varying economic objectives. Each firm attempted to solve its principal/agent problem through a different contractual agreement reflecting the firm's objective function and ownership. Our model was inspired by the work of Iacopetta, Minetti and Peretto (2019) in "Financial Markets, Industry Dynamics and Growth", where they used a growth model with endogenous market structure and provided its dynamic solution. Due to time constraints and the technical complexities of solving for dynamic equilibrium, this paper used a growth model that assumed a market structure with a set number of firms and only solved for the steady state.

Our firm-level model sheds light on how incentives affect a firm's performance. The incentive contract established between the agent and the principal determines the manager's effort function as well as the compensation and investment decisions of the shareholder. In the private firm, the manager is compensated based on profit, thus he/she is incentivized to improve the efficiency of operating costs. On the other hand, the SOEs in the first and second scenario have set up a compensation scheme that is a function of output and provides weaker incentives to the manager to improve firm efficiency. Moreover, in Scenario 1, the existence of a target level of output allows for even greater managerial slack, as the manager's aim for utility maximization will encourage him/her to distort prices in order to attain the target level of output with less effort. Scenario 3 and 4 explore compensation schemes that are more constraining for the manager. By rewarding the manager with a combination of different performance metrics, including profit, these SOEs solve the managerial slack problem of Scenario 1 and 2, while pursuing their goal of achieving production at a level other than the profit-maximizing one. The scope of state ownership implies that SOEs often want to achieve economic goals other than profit-maximization, while avoiding negative profits. Therefore, Scenario 3 and 4 highlight the ability of an incentive contract to limit managerial slack and promote the firm's and shareholders' objectives.

The relative economic performance of the privately-owned and state-owned enterprises modeled depends on incentives and the managers' effort response to incentives. The steady state growth rates reveal the important role a firm's incentive contracts have on an economy's level of growth. Assuming the same level of managerial input across the different firms, the general equilibrium of the privately-owned firm and the SOE in Scenario 3 yield the highest level of growth, since they choose the profit-maximizing price $P_i = \frac{1}{\theta}$. However, once we consider the market structure and the impact of the manager in production we cannot make definite comparisons of growth levels. The market structure of this model assumes that new firms cannot enter the market and all firms charge the price level. Drawing upon our analysis of the corporate governance dynamics of each firm, we can expect that an economy of privately-owned firms will have the higher growth rate. Although SOEs don't produce at the profit-maximizing level, their growth rates show that they can attain the private firm's growth level if they strengthen the incentives to the managers, especially regarding operating efficiency, in order to increase the value of managerial input M.

In a competitive market structure with free entry, the performance of the privately-owned enterprise would be superior to the SOEs of our model. Based on the incentive contract, the private manager wants to maintain the firm's market share, but the free entry condition implies that the firm might lose market share to new firms. Thus, the manager is incentivized to maintain positive expected profits and ensure that the firm's level of investment is optimal, leading to increased economic growth. On the other hand, since none of the SOEs of the model achieve profit-maximization their investment level would not be optimal. If they operate in a market with other firms, their inefficiency and lower investment level, would encourage the owners, the government, to impose regulations in the market. This paper could have provided more insight into the interaction of SOEs and market structure, if we used a growth model with endogenous market structure. However, considering SOEs usually operate in markets with barriers to entry, this paper's analysis is significant in understanding SOEs.

Our model leaves several ideas to be explored in future research. The incentive contract of the government to the manager should be reflective of the social and economic objectives of the SOE. In this model we have only explored compensation incentives based on metrics of production, but it would be insightful to understand how social goals could be communicated in an incentive contract. Another area of improvement for the paper concerns our treatment of the SOE principal, the government. We have assumed that similar to the shareholders of the private firm, the government wants to maximize the residual profits. The principals of the SOE, however, are usually bureaucrats and politicians whose utility does not depend on the SOEs' residual claims. Compared to the shareholders of a private firm, we expect the principals of the SOE to be less incentivized to monitor the manager. Overall, incentives in a SOE are more distorted since SOEs are subject to soft budget constraints and any underperformance is met with credit injections. Therefore, applying these complexities of the principal/agent relationship in SOEs could provide key insight into their economic performance.

Works Cited

Alchian, A. A. (1965). Some economics of property rights. *Il Politico, 30*(4), 816–829. http://www.jstor.org/stable/43206327

Alchian, A. A., & Demsetz, H. (1972). Production, information costs, and economic organization. *The American Economic Review, 62*(5), 777-795. https://www.jstor.org/stable/1815199

Berle, A. A., & Means, G. C. (with Weidenbaum, M. L.,& Jensen, M.). (1991). *The modern corporation and private property.* Transactions Publishers. (Original work published 1932)

Beyer, A., Guttman, I., & Marinovic, I. (2014). Optimal contracts with performance manipulation. *Journal of Accounting Research, 52*(4), 817-847. https://doi.org/10.1111/1475-679X.12058

Farinha, J. (2003). Dividend policy, corporate governance and the managerial entrenchment hypothesis: an empirical analysis. *Journal of Business Finance & Accounting, 30*(9-10), 1173-1209. https://doi.org/10.1111/j.0306-686X.2003.05624.x

Frankfurter, G. M., & Wood Jr, B. G. (2002). Dividend policy theories and their empirical tests. *International Review of Financial Analysis, 11*(2), 111-138. https://doi.org/10.1016/S1057-5219(02)00071-6

Gaspar, V., Medas, P., Ralyea, J., & Ture, E. (2020, October 14). Fiscal policy for an unprecedented crisis. *IMFBlog.* https://blogs.imf.org/2020/10/14/fiscal-policy-for-an-unprecedented-crisis/

Goldeng, E., Grünfeld, L. A., & Benito, G. R. (2008). The performance differential between private and state owned enterprises: The roles of ownership, management and market structure. *Journal of Management Studies, 45*(7), 1244-1273. https://doi.org/10.1111/j.1467-6486.2008.00790.x

Grossman, S. J., & Hart, O. D. (1986). The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy, 94*(4), 691-719. https://doi.org/10.1086/261404

Hart, O., & Holmstrom, B. (2010). A theory of firm scope. *The Quarterly Journal of Economics, 125*(2), 483-513. https://doi.org/10.3386/w14613

Holmstrom, B., & Milgrom, P. (1991). Multitask principal-agent analyses: incentive contracts, asset ownership, and job design. *Journal of Law, Economics & Organization, 7*(Special Issue), 24-52. https://doi.org/10.1093/jleo/7.special_issue.24

Hope, O. K., & Thomas, W. B. (2008). Managerial empire building and firm disclosure. *Journal of Accounting Research, 46*(3), 591-626. https://doi.org/10.1111/j.1475-679X.2008.00289.x

Iacopetta, M., Minetti, R., & Peretto. P. F. (2019). Financial markets, industry dynamics and growth. *The Economic Journal*, 129(621), 2192–2215. https://doi.org/10.1111/ecoj.12635

IMF. (Eds.) (2020). *Fiscal monitor: Policies to support people during the COVID-19 pandemic.* International Monetary Fund.

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305-360. https://doi.org/10.1016/0304-405X(76)90026-X

Kay, J. A., & Thompson, D. J. (1986). Privatisation: a policy in search of a rationale. *The Economic Journal, 96*(381), 18-32. https://doi.org/10.2307/2233423

Lankoski, L., & Smith, C. N. (2018). Alternative objective functions for firms. *Organization & Environment. 31*(3), 242-262. https://doi.org/10.1177/1086026617722883

Lawson, C. (1994). The theory of state-owned enterprises in market economies. *Journal of Economic Surveys, 8*(3), 283-309. https://doi.org/10.1111/j.1467-6419.1994.tb00104.x

Lin, J. Y., & Li, Z. (2008). Policy burden, privatization and soft budget constraint. *Journal of Comparative Economics, 36*(1), 90-102. https://doi.org/10.1016/j.jce.2007.11.001

Moreno de Acevedo Sánchez, E. (2016). *State-owned enterprise management: advantages of centralized models* (Institutions for Development Sector, Institutional Capacity of the State Division, Discussion Paper, IDB-DP-454). Inter-American Development Bank.

OECD (2005). *Corporate Governance of State-Owned Enterprises: A Survey of OECD Countries*. OECD Publications.

Shirley, M. M., & Walsh, P. P. (2000). *Public versus private ownership (Vol. 2420)*. World Bank Publications.

Shirley, M. M., & Xu, L. C. (1998). Information, Incentives, and Commitment: An Empirical Anaysis of Contracts between Government and State Enterprises. *Journal of Law, Economics, and Organization, 14*(2), 358-378. https://doi.org/10.1093/jleo/14.2.358

Shleifer, A., & Vishny, R. W. (1994). Politicians and firms. *The Quarterly Journal of Economics, 109*(4), 995-1025. https://doi.org/10.2307/2118354

Shleifer, A., & Vishny, R. W. (1997). A survey of corporate governance. *The Journal of Finance, 52*(2), 737-783. https://doi.org/10.1111/j.1540-6261.1997.tb04820.x

Tonurist, P., & Karo, E. (2016). State owned enterprises as instruments of innovation policy. *Annals of Public and Cooperative Economics, 87*(4), 623-648. https://doi.org/10.1111/apce.12126

Vagliasindi, Maria. (2008). *Governance arrangements for state owned enterprises* (Policy Research Working Paper No. 4542). The World Bank. https://doi.org/10.1596/1813-9450-4542

Williamson, O. E. (1987). Transaction cost economics: The comparative contracting perspective. *Journal of Economic Behavior & Organization, 8*(4), 617-625. https://doi.org/10.1016/0167-2681(87)90038-2