2023, Volume 46, Issue 91, 39-52 / ISSN 2304-4306

E C O N O M Í A

revistas.pucp.edu.pe/economia

FONDO EDITORIAL

www.fondoeditorial.pucp.edu.pe

Industrial Policies vs Public Goods under Asymmetric Information

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Abstract

This paper presents an analytical framework that captures the informational problems and trade-offs that policy makers face when choosing between public goods (e.g., infrastructure) and industrial policies (e.g., firm or sector-specific subsidies). The paper first provides a discussion of the literature on industrial policies. It then presents an illustrative model, where the economy consists of a set of firms that vary by productivity and a government that can support firms through general or targeted expenditures. The paper examines the cases of full and asymmetric information on firm productivity. Working under full information, it describes the first-best allocation of government resources among firms according to their productivity. It then introduces uncertainty by restricting information regarding firm productivity to be private to the firm. The paper develops an optimal contract (which replicates the first-best) consisting of a tax-based mechanism that induces firms to reveal their true productivity. As this requires high government capacity, the paper considers other simpler policies, one of which is the provision of public goods to all firms. The paper concludes that providing public goods is likely to dominate industrial policies under most scenarios, especially when government capacity is low.

Article History: Received: 31 May 2022 / Revised: 11 January 2023 / Accepted: 20 February 2023

Keywords: Industrial Policy; Public Goods; Uncertainty; Private Information; Firm Subsidies; Taxes

JEL Classification: H2, H4, O1, O2

https://doi.org/10.18800/economia.202301.003

1. Introduction

In the last decade there has been a revival of interest in industrial policies among policy makers around the world (Warwick and Nolan, 2014; Stiglitz et al., 2013; Pellegrin et al., 2015). This resurgence of interest strengthened particularly in the aftermath of the economic crisis of 2008–2009, as governments looked for ways to increase their economies' productivity in the context of severely constrained finance (Warwick, 2013). However, since their heydays from the 1940s to 1960s, industrial policies have been the subject of heated discussion and debate.

The main theoretical justification for the use of industrial policy is the need to address market imperfections. In an environment with full information and strong governance, optimal design of industrial policy is in principle a simple matter. Policy makers should eliminate relative distortions across sectors and resolve or take advantage of the externalities and spillovers that some sectors could have relative to others. An optimal policy would then equalize the social marginal value of allocating resources across sectors. In practice, however, the public sector faces two key issues that hinder the implementation of industrial policy (Rodrik, 2004): its imperfect knowledge of existing constraints, incentives, and opportunities across the economy; and its vulnerability to corruption, manipulation, and rent seeking.

Government capacity is a key factor in the effectiveness of complex industrial policies (Maloney and Nayyar, 2018; Crespi et al., 2014). State capacity refers to the ability of governments to design and implement policies effectively, including the availability of skilled personnel, the effectiveness and technical competency of institutions, and the ability to implement policies consistently (Andrews et al., 2017). Limited government capacity can lead to policy failures, inefficiencies, and corruption, and can also reduce the credibility of policies and discourage private sector participation. As such, the design of industrial policy has to reflect capacities and capabilities of governments, and, in some cases, strengthening government capacity may be an important precondition for the successful implementation of complex policies (Andrews et al., 2017; Stiglitz, 2017). Developing countries, which tend to have weaker institutions and lower government capacity are thus likely to face greater challenges when pursuing industrial policies (Gisselquist, 2017).

The aim of this paper is to present an analytical framework that captures the informational problems and trade-offs that policy makers face when choosing either public goods (e.g., public information, infrastructure, and law and order) or industrial policies (e.g., firm or sector-specific subsidies, grants, and tax breaks). The model attempts to capture the possibility that private entrepreneurs may have incentives to misrepresent information about the social value of their firms or industry in order to obtain special treatment from the government. We explore an optimal industrial and tax policy that is robust to uncertainty about firm-specific productivity. It requires, however, substantial government capacity, as the planner must be able to set firm-specific taxes that are a function of firms' claimed productivity. Through this tax system, the government induces firms to reveal their true productivity, thus being able to implement the first-best allocation despite asymmetric information. Finally, the model explores less optimal but simpler policies, more appropriate when the planner does not have the ability to set up an elaborate tax and compliance system. In this, possibly more realistic context, the model finds that providing public goods tends to be preferable to industry or firm-specific industrial policies.

To motivate the model, the next section presents a brief overview of experiences and issues in the implementation of industrial policies. We then present and solve the model. We do it under full information to serve as a benchmark. We then solve it under private information, where we examine optimal policies.

2. A Brief Overview of Selected Industrial Policy Experiences

Industrial policies consist of selective government interventions to promote certain economic sectors with the aim of increasing their productivity and spread positive externalities throughout the economy (Pack, 2000; Aiginger and Sieber, 2006; Weiss, 2013). Industrial policies can vary in a range that goes from "vertical" policies that favor specific firms or narrow sectors to "horizontal" policies that target broad sectors by improving their business environment (Rodrik, 2008; Warwick, 2013). The more horizontal these policies are, the more they approach public goods. Countries around the world have implemented industrial policies with varying degrees of success. An analysis of Chilean industrial policy, for instance, describes the use of several horizontal and vertical policy instruments, though with a growing emphasis on the latter in recent years (Crespi et al., 2014). Horizontal industrial policies used in Chile include guarantees for loans to small enterprises, subsidies to new exports, and a program to foster innovation; while vertical industrial policies feature the creation of a semi-public entrepreneurial institution (*Fundación Chile*) and a program to attract FDI in technology. As is often the case with vertical industrial policies, *Fundación Chile* has had many failed projects, for instance the cultivation of the southern hake, but also a few huge successes, including the development of the salmon and blueberry industries (Crespi et al., 2014).

Choosing between industrial policy instruments is often complicated due to uncertainty and the existence of information asymmetries between the public and private sectors. In order to manage these challenges, Rodrik (2004) proposes that industrial policy be viewed as a discovery process, whereby public and private sector collaborate to identify underlying costs and opportunities. In this vein, Fernández-Arias et al. (2016) describe several instances of successful collaborations across Latin America, including in the sugarcane industry in Argentina, the tourism industry in Costa Rica, and shipbuilding programs in Uruguay. This type of public-private collaborative approach, however, is hampered by the risk that the private sector might exploit its informational advantage to derive unproductive rents from industrial policies through capture. Crespi et al. (2014) illustrates this risk using the case of the rice industry in Costa Rica. It describes how private involvement in the institution in charge of managing policies for the rice sector have resulted in excessive support to rice producers and a decrease in agricultural productivity. An analysis of industrial policies in the Middle East and North Africa region also highlights the risk of state capture in the use of both vertical and horizontal instruments (Jaud and Freund, 2015). The report notes that, in Tunisia, for example, firms highly connected to former president Ben Ali were found to be most present in protected sectors including telecoms, automobiles, and tourism.

Given the risks and costs associated with the implementation of industrial policies, policymakers, particularly in developing countries, should consider the best match between their capacity and the type of policy to be implemented (Chang, 2011; Crespi et al., 2014). Vertical policies require a greater capability to control capture by the private sector, and thus higher administrative costs, than do horizontal policies. For example, while tax incentives have been widely used to attract new investment and spur economic growth, including in Singapore and Korea, the cost of implementing and enforcing these policies can be particularly high (Tanzi and Shome, 1992). These implementation costs generally increase with the complexity of subsidies and taxes involved in industrial policies, especially under low government capacity (Chang, 2011). A committee reviewing the use of tax incentive policies in Papua New Guinea, for instance, highlighted concern about the challenges of implementing or effectively monitoring R&D and infrastructure incentives in the face of scarce administrative or technical capacity (PNG Tax Committee, 2014; Chang, 2011). Likewise, Yülek et al. (2020) point to higher state capacity as the main reason for different outcomes of industrial policies in the automobile sectors of South Korea and Turkey. Finally, Page and Tarp (2017) highlight the key role of the high capacity of bureaucracies charged with managing and implementing industrial policies in East Asian countries.

3. A Model of Industrial Policy under Private Information

The objective of our model is to capture, in a simple way, the trade-offs that a benevolent planner faces when deciding whether to provide industry- or firm-specific subsidies or a public good (i.e. infrastructure) to maximize total income in a context of private information. The main assumptions are that the government does not observe the productivity of the firms and that there are financial constraints that prevent firms from increasing their sizes by borrowing or issuing equity in financial markets.

To simplify the exposition, we consider a static model with two firms—we can think of two industries or two firms within the same industry—whose productivities are private information and that are constrained in their initial capital k_0. Productivity can take on two values, high or low, represented by $z_H > z_L > 1$, respectively. Let $\pi_H = \Pr(z_j = z_H)$ and $\pi_L = 1 - \pi_H$ denote the probabilities that firm $j = 1, 2$ draws a high and a low productivity type, respectively. The assumption $z_L > 1$ ensures that, when there is perfect information, the planner prefers subsidies or investing in the public good to running a fiscal surplus.

We normalize the marginal cost of production to zero and the goods prices to one. Importantly, firms choose their size, and are constrained in their initial capital k_0, which we assume, without loss of generality, to be the same for both firms.[1] That is, if k_j is the size of firm j, the firm can produce $z_j k_j$ goods at a marginal and total cost of zero. Crucially, we assume that firms cannot use financial markets to increase their sizes, either because they are underdeveloped, or due to some other financial frictions like complete lack of commitment to repay their debts.

Yet, the government can provide a subsidy so that firms can increase their sizes (vertical

[1] The assumption is without loss of generality because the technology is linear in the stock of capital.

industrial policy) or a public good that increases simultaneously the productivity of all firms (horizontal industrial policy). In particular, the government has a budget of T which can be allocated to provide a public good, denoted by g, or to provide a subsidy to firm $j = 1, 2$, denoted by s_j. The government budget constraint is thus,

$$g + s_1 + s_2 \leq T,$$

and we denote the government surplus by,

$$d = T - g - s_1 - s_2 \geq 0.$$

The value of output of firm $j = 1, 2$ that receives a subsidy s_j and has a productivity draw of z_j is given by,

$$v_j = z_j \left(k_0 + s_j + \alpha g \right).$$

We assume that $\alpha < 1$, which means that the public good could increase the productivity of each firm, but by less than a direct subsidy. Otherwise, providing the public good always dominates the firm's specific subsidy and there is no relevant economic trade-off to consider.

While we consider a static model, a single period is composed of different sub-periods. The timing of events within the period is as follows:

1. Nature draws the firms' productivities. Firms observe their productivities but the government does not.

2. Firms report their productivities to the government (as argued below, by the Revelation Principle this assumption is without loss of generality).

3. Contingent on the firms' reports, the government provides the public good and subsidies to the firms.

4. Firms produce.

3.1 First-Best Allocation

We begin by considering the first-best allocation assuming that the government is able to observe the productivities of both firms. The objective of the government is to maximize the total value of output plus the government surplus,

$$W^{FB} = \max_{s_1, s_2, g, d} z_1 \left(k_0 + s_1 + \alpha g \right) + z_2 \left(k_0 + s_2 + \alpha g \right) + d$$

subject to,

$$\begin{aligned} d &= T - (g + s_1 + s_2) \\ d &\geq 0, \ g \geq 0, \ s_j \geq 0 \ \text{ for } j = 1, 2. \end{aligned}$$

To solve this problem we first note that, in the first-best solution, the government surplus d is zero. Since $z_L > 1$, the marginal benefit of allocating a dollar to a subsidy is always greater than the marginal benefit of keeping that dollar to increase the government surplus $\left(\frac{\partial W^{FB}}{\partial s_j} = z_j > 1 = \frac{\partial W^{FB}}{\partial d} \text{ for } j = 1, 2\right)$. Thus, $d > 0$ cannot be optimal.

Therefore, the first-best problem is reduced to,

$$W^{FB} = \max_{s_1, s_2, g} z_1 (k_0 + s_1 + \alpha g) + z_2 (k_0 + s_1 + \alpha g)$$

subject to,

$$T = g + s_1 + s_2, \ s_1 \geq 0, \ s_2 \geq 0, \text{ and } g \geq 0.$$

Let the government policy be a vector $G = (s_1, s_2, g) \in \mathbb{R}^3_+$, which includes the (non-negative) subsidies and the (non-negative) provision of the public good.[2] Since the social planner faces a linear programming problem, the solution is at a vertex of the feasible set. Therefore, the only three policies to consider are the following:

$$G = (s_1, s_2, g) = (T, 0, 0),$$
$$G = (s_1, s_2, g) = (0, T, 0),$$
$$G = (s_1, s_2, g) = (0, 0, T).$$

Let $\mathbf{z} = (z_1, z_2)$ denote the vector of realized productivities of firm 1 and 2, respectively. We have the following cases to consider:

- **Case 1:** suppose that $\mathbf{z} = (z_H, z_L)$:

  1. If $G = (T, 0, 0) \Rightarrow W = z_H (k_0 + T) + z_L k_0 = (z_H + z_L) k_0 + z_H T$.
  2. If $G = (0, T, 0) \Rightarrow W = z_H k_0 + z_L (k_0 + T) = (z_H + z_L) k_0 + z_L T$.
  3. If $G = (0, 0, T) \Rightarrow W = z_H (k_0 + \alpha T) + z_L (k_0 + \alpha T) = (z_H + z_L) k_0 + (z_H + z_L) \alpha T$.

First, note that since $z_L < z_H$, policy $G = (T, 0, 0)$ always dominates policy $G = (0, T, 0)$. Therefore, we are left to consider the policy that assigns all the budget to subsidize firm 1, $G = (T, 0, 0)$, versus the policy that assigns all the budget to the public good, $G = (0, 0, T)$. Note that the subsidy policy dominates the public good policy if and only if,

$$(z_H + z_L)k_0 + z_H T > (z_H + z_L)k_0 + (z_H + z_L)\alpha T.$$

Canceling common terms, the previous inequality holds if and only if

$$\alpha < \frac{z_H}{z_H + z_L}. \tag{1}$$

If condition (1) is satisfied, it is optimal to spend the entire budget to subsidize the high productivity firm. In contrast, if condition (1) is not satisfied, the planner spends the entire budget on the public good. Intuitively, in this case the productivity associated with the public good is so high that the planner simply ignores any difference in productivity across firms.

[2]We assume that the planner cannot transfer capital from one firm to the other. If such a policy were feasible, the planner would expropriate all capital from a low productivity firm (either directly or through taxes) and give it to a high productivity firm. We do not allow for such expropriation policies. The government may tax firms, but those taxes cannot be used to transfer resources across firms. In this case, taxes are a transfer from the firms to the government and do not affect aggregate welfare. Therefore, we set those taxes to zero.

- **Case 2:** Suppose that $\mathbf{z} = (z_L, z_H)$:

This case is symmetric to the previous one: if condition (1) is satisfied, the government only subsidizes firm 2 and allocates 0 to the public good and to subsidize firm 1.

- **Case 3:** Suppose that $\mathbf{z} = (z_j, z_j)$ for $j = H, L$:

1. If $G = (T,0,0) \Rightarrow W = z_j(k_0 + T) + z_j k_0 = 2z_j k_0 + z_j T$.
2. If $G = (0,T,0) \Rightarrow W = z_j k_0 + z_j(k_0 + T) = 2z_j k_0 + z_j T$.
3. If $G = (0,0,T) \Rightarrow W = z_j(k_0 + \alpha T) + z_j(k_0 + \alpha T) = 2z_j k_0 + 2z_j \alpha T$.

Since in this case the two firms are identical, the first and second policies give identical outcomes. Therefore, if $2z_j\alpha T > z_j T$ or, equivalently,

$$\alpha > 1/2, \tag{2}$$

it is optimal to spend all the budget in public infrastructure. In contrast, if $\alpha < 1/2$, providing individual subsidies always dominates any public investment.[3]

To have a meaningful economic trade-off between vertical and horizontal industrial policy we assume that the value of α is not so high so that public investment always dominates the individual subsidies and α is not so low so that public investment is never optimal. For that reason, throughout the rest of the paper we impose the following assumption:

Assumption 1: *the productivity of public investment, represented by the parameter α, satisfies the bounds given by inequalities (1) and (2).*

Assumption 1 imposes upper and lower bounds on the productivity of public infrastructure in order for this problem to have a non-trivial solution. If any of the bounds is violated, the optimal solution will be to provide only public infrastructure or to provide only subsidies. Summarizing, under Assumption 1, the first-best solution when productivity is observable is characterized by the policy,

$$G^{FB}(z_1, z_2) = \begin{cases} (T,0,0) & \text{if} \quad (z_1,z_2) = (z_H, z_L), \\ (0,T,0) & \text{if} \quad (z_1,z_2) = (z_L, z_H), \\ (0,0,T) & \text{if} \quad (z_1,z_2) = (z_L, z_L) \text{ or } (z_1,z_2) = (z_H, z_H). \end{cases}$$

The associated first-best welfare is,

$$W^{FB}(z_1, z_2) = \begin{cases} (z_H + z_L) k_0 + z_H T & \text{if} \quad (z_1,z_2) = (z_H, z_L) \text{ or } (z_1,z_2) = (z_L, z_H), \\ 2z_H(k_0 + \alpha T) & \text{if} \quad (z_1,z_2) = (z_H, z_H), \\ 2z_L(k_0 + \alpha T) & \text{if} \quad (z_1,z_2) = (z_L, z_L). \end{cases} \tag{3}$$

The ex-ante expected first-best welfare is, thus,

$$\begin{aligned} E\left[W^{FB}\right] = {} & \Pr(z_1 = z_H, z_2 = z_H) 2z_H(k_0 + \alpha T) + \Pr(z_1 = z_H, z_2 = z_L)\left[(z_H + z_L)k_0 + z_H T\right] \\ & + \Pr(z_1 = z_L, z_2 = z_H)\left[(z_H + z_L)k_0 + z_H T\right] + \Pr(z_1 = z_L, z_2 = z_L) 2z_L(k_0 + \alpha T) \end{aligned}$$

or,

$$E\left[W^{FB}\right] = 2\pi_H^2 z_H(k_0 + \alpha T) + 2\pi_H\pi_L\left[(z_H + z_L)k_0 + z_H T\right] + 2\pi_L^2 z_L(k_0 + \alpha T). \tag{4}$$

[3] Of course, if providing subsidies dominates investing in the public good, the distribution of subsidies between the two equally productive firms is irrelevant.

3.2 Optimal contract with private information

In this section we develop a simple direct mechanism that is able to implement the first-best allocation when the government does not observe the firms' productivities. By the Revelation Principle (Myerson, 1982), without loss of generality, we can focus on direct mechanisms where firms report their productivities to the planner. If convenient, firms will have an incentive to misrepresent their types to receive the subsidy. For example, suppose that the government policy is such that everyone who claims to be high productivity receives a subsidy and whatever remains in the budget is allocated to the public good. In such a case, a low productivity firm will report high productivity because the marginal profit of a subsidy is always greater than the marginal profit of the public good, since $\alpha < 1$.

Without additional instruments, if the government provides the subsidy to firms depending on their reported productivities, some or all firms will lie about their type. Therefore, we assume that the government is able to impose a firm-specific tax f_j to firm $j = 1, 2$ that will be a function of the firm's reported productivity type. Those taxes will help provide the right incentives for the firms to reveal their true (unobserved) productivity, and the proposed mechanism will be able to implement the first-best allocation. Therefore, the profits of firm j are given by,

$$v_j = z_j \left(k_0 + s_j + \alpha g\right) - f_j. \tag{5}$$

Let $z_i \in \{z_H, z_L\}$ denote firm i's type and $m_i \in \{z_H, z_H\}$ denote the message space of firm i.[4] That is, firm i can report that it is a high productivity or a low productivity firm. Let $\mathbf{m} = (m_1, m_2) \in Z = \{z_H, z_L\}^2$ be the vector of reports of firm 1 and 2, respectively. A government policy rule is a mapping from the reported types to a vector of policies $A : Z \Rightarrow (s_1, s_2, g, f_1, f_2) \in \mathbb{R}^5_+$ which specifies the subsidies, taxes, and the provision of the public good as a function of the reports. We represent a generic policy rule by $a \in A$ and each of its components by $a(\mathbf{m}) = (s_1^a(\mathbf{m}), s_2^a(\mathbf{m}), g^a(\mathbf{m}), f_1^a(\mathbf{m}), f_2^a(\mathbf{m}))$. For example, $s_1^a(\mathbf{m})$ represents the subsidy received by firm 1 under the policy rule a if firms 1 and 2 report the types $\mathbf{m} \in Z$, and so on for the other terms. A mechanism is a message space Z and decision rule $a \in A$ that induces a strategic game given preferences represented by equation (5) for $j = 1, 2$. The solution concept that we consider is that of a Nash Equilibrium.

Given a policy rule $a(m_1, m_2) \in A$, firm 1 will report the type $\widehat{z}_1 \in \{z_H, z_L\}$ that maximizes its value independently of its true type. Namely, suppose that true productivity of firm 1 is $z_1 \in \{z_H, z_L\}$ and that firm 2 reports the type $m_2 \in \{z_H, z_L\}$. Then the problem of the firm is to report the productivity type that maximizes its value given the report of firm 2 under the policy rule a:

$$\max_{\widehat{z}_1 \in \{z_H, z_L\}} z_1 \left(k_0 + s_1^a(\widehat{z}_1, m_2) + \alpha g^a(\widehat{z}_1, m_2)\right) - f_1^a(\widehat{z}_1, m_2).$$

Firm 2 faces an identical problem given the report of firm 1.

We now consider a mechanism in which truth-telling is a dominant strategy independently of the other player's report and that implements the first-best allocation. The decision rule $\tilde{a} \in A$ that we consider is as follows. Consider an arbitrary firm $i = 1, 2$:

[4] By the Revelation Principle, we are using a direct mechanism in which firms report productivity types.

- If firm i reports low productivity, $m_i = z_L$, then firm i does not receive a subsidy and does not pay any tax independently of the report of the other firm. If both firms report low productivity, the government provides the public good, $g = T$.
- If firm i reports high productivity, $m_i = z_H$, and firm $j \neq i$ reports low productivity, $m_j = z_L$, firm i pays a tax f and receives a subsidy $s_i = T$.
- If both firms report high productivity, $m_1 = m_2 = z_H$, then both firms pay a tax $\tilde{f}$, the subsidies are zero, $s_i = 0$ for $i = 1, 2$, and the government provides the public good, $g = T$.

In other words, the mechanism is represented by the policy rule,

$$a(\mathbf{m}) = \begin{cases} (s_1, s_2, g, f_1, f_2) = (T, 0, 0, f, 0) & \text{if} \quad \mathbf{m} = (z_H, z_L) \\ (s_1, s_2, g, f_1, f_2) = (0, T, 0, 0, f) & \text{if} \quad \mathbf{m} = (z_L, z_H) \\ (s_1, s_2, g, f_1, f_2) = \left(0, 0, T, \tilde{f}, \tilde{f}\right) & \text{if} \quad \mathbf{m} = (z_H, z_H) \\ (s_1, s_2, g, f_1, f_2) = (0, 0, T, 0, 0) & \text{if} \quad \mathbf{m} = (z_L, z_L) \end{cases}.$$

We next show that by appropriately choosing the taxes f and $\tilde{f}$, the government can induce truth-telling and achieve the first-best level of utility. The difference with the first-best problem, however, is that part of the overall welfare will take the form of government surplus, $d > 0$, rather than just the firms' profits. Since the model is symmetric, we focus on the decision problem of firm 1.

Suppose that $z_1 = z_H$. The profit of firm 1 as a function of all possible messages is,

$$z_1 = z_H \Rightarrow \text{if} \begin{cases} (m_1, m_2) = (z_H, z_L) & \text{then} \quad v_1 = z_H (k_0 + T) - f \\ (m_1, m_2) = (z_H, z_H) & \text{then} \quad v_1 = z_H (k_0 + \alpha T) - \tilde{f} \\ (m_1, m_2) = (z_L, z_L) & \text{then} \quad v_1 = z_H (k_0 + \alpha T) \\ (m_1, m_2) = (z_L, z_H) & \text{then} \quad v_1 = z_H k_0 \end{cases}.$$

We now construct taxes f and $\tilde{f}$ that make truth-telling optimal for firm 1. If firm 2 reports high productivity, $m_2 = z_H$, truth telling is optimal if,

$$z_H (k_0 + \alpha T) - \tilde{f} \geq z_H k_0$$

or,

$$\tilde{f} \leq \alpha z_H T. \tag{6}$$

If firm 2 reports low productivity, $m_2 = z_L$, truth telling is optimal if,

$$z_H (k_0 + T) - f \geq z_H (k_0 + \alpha T)$$

or,

$$f \leq (1 - \alpha) z_H T. \tag{7}$$

Conditions (6) and (7) are upper bounds on the taxes f and $\tilde{f}$ such that a high productivity firm does not want to misrepresent its type. For example, setting $f = \tilde{f} = 0$ works. The problem remains, however, that a low productivity firm will always claim to be high productivity to receive the subsidy. We now turn to this case.

Suppose now that $z_1 = z_L$. Then,

$$z_1 = z_L \Rightarrow \text{if} \begin{cases} (m_1, m_2) = (z_H, z_L) & \text{then} \quad v_1 = z_L (k_0 + T) - f \\ (m_1, m_2) = (z_H, z_H) & \text{then} \quad v_1 = z_L (k_0 + \alpha T) - \tilde{f} \\ (m_1, m_2) = (z_L, z_L) & \text{then} \quad v_1 = z_L (k_0 + \alpha T) \\ (m_1, m_2) = (z_L, z_H) & \text{then} \quad v_1 = z_L k_0 \end{cases}.$$

We now look for conditions such that truth-telling is optimal for a low productivity firm. If firm 2 reports high productivity, $m_2 = z_H$, truth-telling is optimal for firm 1 if,

$$z_L k_0 \geq z_L (k_0 + \alpha T) - \tilde{f}$$

or,

$$\tilde{f} \geq \alpha z_L T. \tag{8}$$

If firm 2 reports low productivity, $m_2 = z_L$, truth-telling is optimal if,

$$z_L (k_0 + \alpha T) \geq z_L (k_0 + T) - f$$

or,

$$f \geq (1 - \alpha) z_L T. \tag{9}$$

Conditions (8) and (9) are lower bounds on the taxes so that a low productivity firm will not claim that it is a high productivity firm.

Summarizing, we have found that it is optimal for all firms to report their true productivities as long as the taxes f and $\tilde{f}$ satisfy,

$$(1 - \alpha) z_L T \leq f \leq (1 - \alpha) z_H T, \tag{10}$$

$$\alpha z_L T \leq \tilde{f} \leq \alpha z_H T. \tag{11}$$

The mechanism always taxes firms that report high productivity. The taxes are such that low productivity firms do not find it optimal to claim to be of high productivity. But the taxes cannot be so high that a high productivity firm would want to claim to be of low productivity. This mechanism implements the first-best allocation since the subsidy is only given whenever it is productive to do so. The level of welfare is the same as that in the first-best solution, the difference being that part of that welfare is derived from government surplus $d = f_1 + f_2$ rather than just by the firms' profits. The only case in which the government does not raise any surplus is when both firms claim to be low productivity and the government provides the public good.

3.3 Simple Policies

Even though the mechanism that we described above is straightforward, it may be argued that it still requires some degree of sophistication that may not be available or feasible in less developed countries. For that reason here we compare two simple (but sub-optimal) policies that do not involve taxes at all and that set the government surplus to zero.

- Simple policy 1: provide only the public good.

- Simple policy 2: provide a subsidy to whomever claims to be of high productivity. If both firms report high productivity, set the subsidy to $s_1 = s_2 = T/2$.[5]

Simple Policy 1

If the government provides the public good and sets subsidies to zero, the welfare conditional on productivities z_1 and z_2 is,

$$z_1 (k_0 + \alpha T) + z_2 (k_0 + \alpha T) = (z_1 + z_2)(k_0 + \alpha T).$$

It then follows that the expected welfare under Simple Policy 1 is,

$$\begin{aligned} E\left[W^{SP1}\right] &= \Pr(z_1 = z_H, z_2 = z_H)(z_H + z_H)(k_0 + \alpha T) + \Pr(z_1 = z_H, z_2 = z_L)(z_H + z_L)(k_0 + \alpha T) \\ &\quad + \Pr(z_1 = z_L, z_2 = z_H)(z_L + z_H)(k_0 + \alpha T) + \Pr(z_1 = z_L, z_2 = z_L)(z_L + z_L)(k_0 + \alpha T) \end{aligned}$$

or,

$$E\left[W^{SP1}\right] = \left[\pi_H^2 z_H + \pi_H \pi_L (z_H + z_L) + \pi_L^2 z_L\right] 2 (k_0 + \alpha T). \tag{12}$$

It is simple to show that the expected first-best welfare can be written as,

$$E\left[W^{FB}\right] = E\left[W^{SP1}\right] + 2\pi_H \pi_L T \left[z_H - (z_H + z_L)\alpha\right].$$

Then, by condition (1), $E\left[W^{FB}\right] > E\left[W^{SP1}\right]$, so that the optimal policy strictly dominates Simple Policy 1. Indeed, condition (1) guarantees that there are cases in which it is optimal to provide the subsidy and hence the suboptimality of the proposed simple policy.

Simple Policy 2

The second simple policy consists of subsidizing any firm that claims to be high productivity. Since $\alpha < 1$, all firms will report high productivity and receive a subsidy $s_i = T/2$. The expected welfare under Simple Policy 2 is thus,

$$\begin{aligned} E\left[W^{SP2}\right] &= \Pr(z_1 = z_H, z_2 = z_H)(z_H + z_H)(k_0 + T/2) + \Pr(z_1 = z_H, z_2 = z_L)(z_H + z_L)(k_0 + T/2) \\ &\quad + \Pr(z_1 = z_L, z_2 = z_H)(z_L + z_H)(k_0 + T/2) + \Pr(z_1 = z_L, z_2 = z_L)(z_L + z_L)(k_0 + T/2) \end{aligned}$$

or,

$$E\left[W^{SP2}\right] = \left[\pi_H^2 z_H + \pi_H \pi_L (z_H + z_L) + \pi_L^2 z_L\right] 2 (k_0 + T/2). \tag{13}$$

Note that condition (2) ($\alpha > 1/2$) implies that Simple Policy 1 dominates Simple Policy 2. In contrast, whenever $\alpha < 1/2$, the subsidy dominates public investment when we restrict the analysis to simple policies.

[5] A third Simple policy that randomizes between the two firms and gives the subsidy accordingly gives the same ex-ante welfare as Simple Policy 2.

4. Discussion and Conclusion

The paper derives two main results. The first is that industrial policies in the form of firm subsidies can attain the first-best allocation of government resources if accompanied by an appropriate mix of taxes, even in the context of private information. Implementing this tax-and-subsidy mechanism, however, requires a significant level of government capability for precise and targeted policy design and implementation. The second result is that when this capability is lacking and productivity information is not publicly observed, the provision of public goods dominates granting firm subsidies (evenly, randomly, or to those claiming to have high productivity).

The second result relies on the condition that public goods be sufficiently productive, complementing or supporting private investment and economic activity more broadly. Only when public goods are thus productive, can there be a meaningful trade-off between public goods and firm subsidies under both perfect and private information.

The first result depends on the linearity of the production function. Linearity is used here not only for the sake of simplicity but also to emphasize the case for industrial policy (by making firm's capital and public goods perfect substitutes). In a neoclassical production function, where, say, public infrastructure and private capital are complementary factors of production, the optimal policy is likely to involve providing a mixture of public goods and firm subsidies, instead of firm subsidies alone. This would reinforce the case for public goods when governments have difficulties conducting precise tax-and-subsidy policies.

Considering more general production functions and allowing for costly state verification or imperfect monitoring are possible extensions to the model and analysis. We leave them for future research.

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