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Pyramidal Business Groups and Asymmetric Financial Frictions†

By DUKSANG CHO*

Given capital market imperfections, an entrepreneur can alleviate financial frictions by creating a pyramidal business group in which a parent firm offers its subsidiary firm internal finance. This endogenous creation of pyramidal business groups can beget asymmetric financial frictions between business-group firms and stand-alone firms. I build a model to show that these asymmetric financial frictions can have sizable effects on resource allocation. On one hand, the financial advantage of pyramidal business groups can foster productive firms by incorporating them as subsidiaries. On the other hand, the asymmetrically large amount of external capital controlled by pyramidal business groups can be expended by unproductive business-group firms and push up the equilibrium price of capital. The model suggests that with fine investor protection or low financial frictions, the benefits of pyramidal business groups can be dominated by their costs because the probability of fostering productive subsidiaries diminishes as the efficiency of external capital markets improves, while the prevalence of pyramidal business groups is not attenuated due to their continuing asymmetric financial advantage.

Key Word: Business Group, Capital Market, Financial friction, Pyramidal Ownership Structure, Resource Allocation
JEL Code: E23, E44, G32, O16

I. Introduction

A pyramidal business group is a collection of legally independent corporations controlled by a coterie of shareholders. It is a common ownership structure for

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a country's largest firms, with exceptions of some countries such as the United States or the United Kingdom.[1] The economy-wide repercussions of pyramidal business groups, however, have been unclear despite the fact that they are salient economic institutions too sizable to be ignored. For instance, pyramidal business groups in South Korea not only have been acclaimed as engines of growth for the country's rapid development but also have been the subjects of controversy for their economic concentration.[2]

In this paper, I build a model of pyramidal business groups in a general equilibrium framework and aim to answer the following question: Can pyramidal business groups affect the efficiency of an economy? I focus on a pyramidal ownership structure, which arises due to capital market imperfections and gives rise to asymmetric financial frictions between business-group firms and stand-alone firms.[3]

Built on the 'span of control' model developed by Lucas (1978), two assumptions are made here. First, I assume that capital markets are imperfect, constraining a firm's ability to raise external capital. A limited commitment problem is introduced such that an entrepreneur controlling his or her firms can divert τ fraction of the firms' cash flow before outside investors are reimbursed. In the model, this realized diversion keeps the expected rate of return on external equity finance identical to the risk-free interest rate. An entrepreneur, thus, can earn positive profits as the private benefits of control and has an incentive to create firms to control with flotation costs.[4]

Second, I allow for a business group as a private means that can alleviate financial frictions. In the model, a business group is constructed as a collection of two firms connected through a pyramidal ownership structure such that a business-group entrepreneur controls a parent firm that controls a subsidiary firm. There is no limited commitment problem between the parent and the subsidiary because both firms are controlled by the common entrepreneur. Thus, the parent can offer as much internal finance as possible to the subsidiary without financial frictions. Specifically, the financial advantage of a pyramidal business group in the model is twofold. Not only does the subsidiary use its internal equity finance offered by the parent as leverage to raise external capital, but also the parent uses its equity shares of the subsidiary as leverage to raise external capital. Thus, it is the financial advantage of a business group that makes it possible for an entrepreneur to build up a business group as a competitive ownership structure in equilibrium.

An occupational choice model is used to examine the impacts of business groups

[1]La Porta, Lopez-de Silanes, and Shleifer (1999) examine 27 wealthy countries and show that most of the largest corporations in a country are business groups controlled by families or the state through pyramidal ownership schemes. La Porta, Lopez-de Silanes, Shleifer, and Vishny (2000) argue that the degree of investor protection is closely related to the corporate governance structure and that business groups are common in countries with poor investor protection. Masulis, Pham, and Zein (2011) examine 28,635 listed firms in 45 countries, including developing economies, and reaffirm that pyramidal business groups are a common ownership structure around the world. They show that the prevalence of business groups is negatively associated with the capital availability of an economy, but insignificantly associated with the degree of investor protection. They argue that business groups emerge in order to alleviate financial frictions.

[2]As of 2004 in South Korea, business groups controlled by a few families hold 56% of the market capitalization in the country according to Masulis, Pham, and Zein (2011).

[3]Given that a business group is a dominant ownership structure of the largest corporations in a country, this study revisits a question raised by many others: does the size distribution of firms in a country affect its economic efficiency?

[4]Note that a common implementation of financial frictions in the literature hinges on an out-of-equilibrium path and that such a diversion does not occur in equilibrium (e.g. Buera, Kaboski, and Shin, 2011).

in a general equilibrium. I introduce an individual's problem of occupational choices given heterogeneity in managerial talent and wealth throughout the population. Every period, each individual chooses his or her occupation from a worker, a stand-alone entrepreneur, a business-group entrepreneur, or a manager who can be hired by a business-group entrepreneur. Given the degree of financial frictions capturing capital market imperfections, three types of capital markets are specified: external debt, external equity, and internal equity markets. These three types of capital markets are used to build up three types of firms: a private company, a publicly held corporation, and a pyramidal business group. This variety of firms' ownership structures captures private institutions stemming from agents' endogenous reactions against capital market imperfections, which generates asymmetric financial frictions among the firms in the model.

The model shows that business groups can have a non-monotonic impact on resource allocation given the degree of financial frictions. In an economy with poor investor protection, the internal capital markets of business groups substitute for underdeveloped external capital markets and foster financially constrained but productive firms. A numerical example of the model shows that the rich become business-group entrepreneurs by hiring the poor but talented as business-group managers. It also shows that an economy with business groups accumulates a larger amount of capital stock than an economy without business groups because the rich save more in order to create business groups featuring internal capital markets. This implies that business groups can be efficient private institutions at the early stages of economic development, during which financial frictions are rampant.

In an economy with fine investor protection, however, the asymmetric financial frictions between business group firms and stand-alone firms become a source of resource misallocation. The rich but unproductive choose to create business groups despite flotation costs because they can earn ex-ante positive profits by incorporating productive subsidiaries, while their ex-post profits can be negative because the probability of launching productive subsidiaries declines with the rising managerial compensation as investor protection improves. Moreover, business-group entrepreneurs use their financial advantage to consume more and save less by raising a larger amount of external capital without increasing net capital in production. Thus, the larger demand and the lower supply of capital push up the equilibrium price of capital and force stand-alone entrepreneurs, most of whom are financially constrained, to raise less external capital, produce less, and consume less. This numerical example shows that stand-alone entrepreneurs' wealth drops significantly and that an economy dominated by business groups features decreasing levels of capital stock and stagnating aggregate consumption as the fraction of diversion τ goes to zero.

An interesting lesson we can learn from the model is that the relative number of business-group firms in the numerical example does not decrease endogenously with the improvement of investor protection. This occurs because the incentive for an entrepreneur to build a business group in the model is not attenuated unless the asymmetric financial frictions between the business group and the stand-alone firms shrink. This result is consistent with Masulis, Pham, and Zein (2011), who report an insignificant association between the prevalence of family business groups and the degree of investor protection. Given that the direction of effects business groups have

on an economy in the model is reversed as investor protection improves, the unvarying number of business-group firms implies that mitigating capital market imperfections will scarcely reduce factor misallocation or even worsen it without due consideration of pyramidal business groups, which could generate asymmetric financial frictions in equilibrium.

Although I simplify the problem of business groups by focusing on the financial advantage of their internal capital markets, there is a larger pool of questions about business groups that should be examined, such as questions pertaining to monopolies, political economies, risk sharing, or the intangible assets of business groups. For example, Khanna and Yafeh (2007) review several issues of business groups and conclude that their origins and effects are largely unknown. Note that the objective of this paper is to narrow down the problem and understand a certain trait of business groups, their internal capital markets, in a general equilibrium framework.

In the literature, the pyramidal ownership structure of a business group has been examined from two different viewpoints. First, a traditional view is that it is an expropriation device. The main argument of this view is that the pyramidal ownership structure creates a discrepancy between ownership and control. Although the controlling shareholder of a business group, typically a family, owns a small portion of the shares of business-group affiliates, its pyramidal scheme allows the family to take control over the business group and to earn the private benefits of control at the expense of other shareholders. This separation of ownership from control can generate agency problems, resource misallocation, and economic entrenchment. See Morck, Wolfenzon, and Yeung (2005) for a review of this perspective.

Second, more recent studies examine pyramidal business groups as start-up breeders. They focus on the role of business groups that offer internal finance to start-up firms and help them grow larger by supplementing the inefficiency of external capital markets. Almeida and Wolfenzon (2006b) offer a theory of business groups based on the financial advantage of pyramidal business groups. In their model, the controlling shareholder of a parent firm uses the firm's retained earnings to launch a subsidiary firm that provides cash flow to the controlling shareholder. Despite the discrepancy between ownership and control, business groups can be economically beneficial because subsidiary firms would be dismissed without the help of internal capital markets due to setup costs that cannot be raised from external capital markets given financial frictions. Bena and Ortiz-Molina (2013) use data from 38 European countries and show that business groups do play a significant role in creating new firms.

These two perspectives on pyramidal business groups are not mutually exclusive. They are rather opposite sides of the same coin in that the first can cause the second. The opportunity to earn additional cash flow from a subsidiary firm is an incentive for the controlling shareholder of a parent firm, which offers internal finance and helps to launch its subsidiary firm.

A natural question arises. Between these two viewpoints, which aspect of business groups is dominant? Simply put, are business groups good or bad for an economy? In spite of its relevance, the answer to this question has remained unclear, as most researchers have focused on the internal efficiency of an individual business group. Few researchers have developed models of business groups in a general equilibrium framework.

Among them, Almeida and Wolfenzon (2006a) show that the financial advantage of business groups can cause asymmetric financial frictions between business-group firms and stand-alone firms, which result in factor misallocation in equilibrium. Despite its novel insight, their model is stylized, making it difficult when using it to capture the dynamic aspects of an economy allowing for forward-looking behaviors of individuals, such as savings or self-financing. This can be a problem if we want to examine the economic impact of asymmetric financial frictions because the wealth distribution of an economy is endogenously determined by the agents' dynamic optimization, which may undo factor misallocation stemming from financial frictions (e.g., Moll, 2014).

Ševčík (2015) examines the economic impact of business groups using a heterogeneous agent model with financial frictions in which the wealth distribution of an economy is endogenously determined. He studies the extent to which the internal capital markets of business groups can alleviate financial frictions and concludes that aggregate output in Canada would be reduced by 3% if its business groups were shut down. The business groups in his model, however, are partnerships rather than pyramids. This can be a problem if we want to examine the economic repercussions of pyramidal business groups that feature the separation of ownership from control. Specifically, in his model the degree of financial frictions captured by the ratio of capital to wealth is a given constant identical for all firms, while in the present model the ratio is endogenously determined and business-group entrepreneurs leverage their wealth into control over capital worth vastly more through a pyramidal ownership structure.

In order to deal with these limitations, I introduce the following feature in my model. First, each individual chooses his or her consumption, savings, and occupation every period. Thus, the joint distribution of individuals' wealth and occupations is endogenously determined. Second, an individual who chooses to be an entrepreneur also chooses his or her firms' ownership structure. I connect corporate capital structures with corporate ownership structures given capital market imperfections. A pyramidal business group is introduced as a private means by which an entrepreneur alleviates financial frictions. Thus, asymmetric financial frictions among firms arise from the endogenous choice of the firms' ownership structures.

The rest of this paper proceeds as follows. In Section 2, I introduce an individual's problem of occupational choice. In Section 3, given financial frictions, three types of capital markets and three types of firms are specified. In Section 4, a stationary equilibrium is defined by introducing a matching rule between a business-group entrepreneur and a manager. In Section 5, I remark on the model. The costs and benefits of pyramidal business groups are discussed. In Section 6, a numerical example of the model is constructed and the results of the model are presented. Lastly in Section 7, I discuss the limitations of the model and propose future research directions.

II. A Heterogeneous Agent Model with Occupational Choices

A. *Economic Environment*

An economy consists of infinitely lived individuals. Every period, each individual

is endowed with an indivisible labor force and characterized by his or her own managerial talent z that changes over periods following a Markov chain.[5] Here, we assume that an individual consumes c out of his or her own wealth a such that $c \in [0, a]$ and that a utility function $u(c)$ satisfies standard conditions such that $u'(c) > 0, u''(c) < 0,$ and $\lim_{c \to 0} u'(c) = \infty.$

Given (z, a), an individual chooses his or her next period occupation $o(z, a)$ from a worker (W), a stand-alone entrepreneur (SA), or a business-group entrepreneur (BG). At the beginning of the next period, a worker sells his or her indivisible labor force and earns wage w, and an entrepreneur runs a firm and earns from the firm's stochastic cash flow π.

An entrepreneur raises her firm's capital k given (z, a). At the beginning of the next period, the entrepreneur observes a shock to the managerial talent z' and hires labor ℓ given k.[6] The firm then produces cash flow π, defined as the optimized gross output net of labor costs $w\ell$ and capital depreciation $\delta' k$, such that

$$(1) \qquad \pi(z', \delta' \mid z, k) = \max_{\ell} z' k^{\alpha} \ell^{\theta} - w\ell + (1 - \delta')k, \quad a, \theta > 0, \quad a + \theta < 1,$$

where $a + \theta < 1$ is a span of control shaping the production function into decreasing returns to scale. We assume that the capital depreciation rate $\delta' \in (0, 1)$ is a random variable independent of z'.

A stand-alone entrepreneur can run either a private company or a publicly held corporation. A private company is a firm fully owned by its stand-alone entrepreneur, and it raises capital from external debt markets. A publicly held corporation can be incorporated by its stand-alone entrepreneur who pays flotation costs k^F. It can raise capital from external equity markets as well as external debt markets.

A business group is defined as a collection of two corporations: a parent that offers internal equity finance and a subsidiary that receives internal equity finance. An individual of (z_1, a_1),[7] who chooses to be a business-group entrepreneur $o(z_1, a_1) = BG,$ runs the parents with z_1 and hires a manager of (z_2, a_2) who runs the subsidiary with z_2. The business-group entrepreneur can choose z_2, while a_2 is randomly drawn with a probability of $P^{BG}(z_2, a_2)$. The business-group entrepreneur earns from the cash flow of both firms at the beginning of the next period.

An individual of (z, a), who chooses to be a worker or a stand-alone entrepreneur

[5] An exogenous process of managerial talent can be understood as a parsimonious means of capturing the impact of financial frictions on factor allocation by abstracting away from the endogenous nature of managerial talent. In Section 6, I will specify a state space and a transition probability of managerial talent z.

[6] We can think of this timing structure, raising k given z and then producing cash flow π after observing z', as the risk an entrepreneur takes when making investment decisions.

[7] I use (z_1, a_1) instead of (z, a) because (z_1, a_1) is convenient for comparing a parent's managerial talent z_1 indexed by 1 to a subsidiary's managerial talent z_2 indexed by 2.

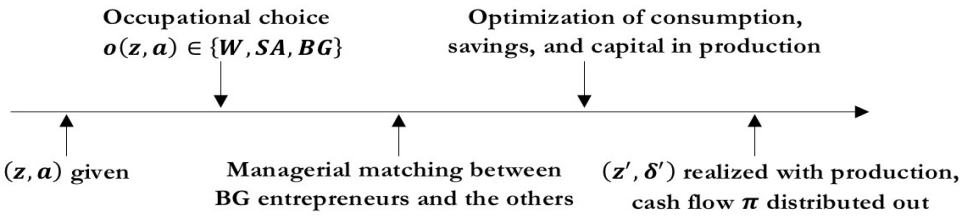

FIGURE 1. TIME-LINE OF AN INDIVIDUAL'S PROBLEM WITHIN A PERIOD

$o(z, a) \in \{W, SA\}$, can be matched to a business-group entrepreneur with a probability of $P^M(z, a)$. If the matching is realized, the individual becomes a manager and earns managerial compensation $w^M(z,a)$ at the beginning of the next period. Note that the managerial compensation w^M is a function of (z,a), which is pinned down when the matching is realized despite the fact that the subsidiary firm's production will be realized with z' in the next period.

Figure 1 summarizes the timing of an individual's problem within a period. Given (z,a), an individual initially chooses his or her occupation, after which the matching between business-group entrepreneurs and the others are realized. Finally, the output is produced with realized shocks to managerial talent z' at the beginning of the next period.

B. *An Individual's Problem*

Every period, each individual solves the following problem given his or her managerial talent z and wealth a such that

$$V(z,a) = \max_{o \in \{W, SA, BG\}} \{V^W(z,a), V^{SA}(z,a), V^{BG}(z,a)\} \tag{2}$$

given $\{r, w, w^M(z,a), P^M(z,a), P^{BG}(z_2, a_2)\}$, which respectively stand for the rate of return on capital, the wage for a worker, managerial compensation, the probability of being matched with a business-group entrepreneur, and the probability of being matched with a manager featuring (z_2, a_2).

$V^W(z,a)$ is the value if an individual chooses to be a worker such that

$$\begin{aligned} V^W(z,a) &= (1 - P^M(z,a)) \cdot V_0^W(z,a) + P^M(z,a) \cdot \max\{V_0^W(z,a), V^M(z,a)\}, \\ V_0^W(z,a) &= \max_{s \in [0,a]} u(a-s) + \beta E_{z'}[V(z', w + (1+r)s) \mid z], \end{aligned} \tag{3}$$

where s is the risk-free asset matured in the next period with interest rate r.

$V^M(z,a)$ is the value if an individual becomes a manager given $w^M(z,a)$ such that

$$V^M(z,a)=\max_{s\in[0,a]} u(a-s)+\beta E_{z'}[V(z',w^M(z,a)+(1+r)s)\,|\,z]. \tag{4}$$

Note that both the next-period wealth for a worker, $w+(1+r)s$, and that for a manager, $w^M(z,a)+(1+r)s$, are realized without uncertainty.

$V^{SA}(z,a)$ is the value if an individual chooses to be a stand-alone entrepreneur who runs a private company or a publicly held corporation such that

$$\begin{aligned} V^{SA}(z,a)&=(1-P^M(z,a))\cdot V_0^{SA}(z,a)+P^M(z,a)\cdot\max\{V_0^{SA}(z,a),V^M(z,a)\},\\ V_0^{SA}(z,a)&=\max_{k^C,k^D,k^E} u(a-k^C)+\beta E_{z',\delta'}[V(z',a')\,|\,z,k(k^C,k^D,k^E)], \end{aligned} \tag{5}$$

where the firms' capital in production k is a function of private finance k^C, external debt finance k^D, and external equity finance k^E. The entrepreneur's next-period wealth a' is a function of shocks to managerial talent z' and the capital depreciation rate δ' given $\{k^C,k^D,k^E\}$.

Lastly, $V^{BG}(z_1,a_1)$ is the value if an individual of (z_1,a_1) chooses to be a business-group entrepreneur who controls a business group consisting of two corporations, a parent with (z_1,k_1) and a subsidiary with (z_2,k_2). The business-group entrepreneur determines both firms' capital amounts k_1 and k_2 by choosing $\{k_i^C,k_i^D,k_i^E\}_{i\in\{1,2\}}$ given $\{z_2,w^M(z_2,a_2)\}$. k_1^c is the private finance that the business-group entrepreneur offers to the parent, and k_2^c is the internal equity finance that the parent offers to the subsidiary. I will specify how the business-group entrepreneur optimizes k_1 and k_2 in the following section. For now, the focus is on how the business-group entrepreneur chooses z_2, the optimal managerial talent for the subsidiary, given $w^M(z_2,a_2)$ and $P^{BG}(z_2,a_2)$ such that

$$\begin{aligned} V^{BG}(z_1,a_1)&=\max_{z_2}\left[\begin{array}{l}(1-\sum_{a_2}P^{BG}(z_2,a_2))\cdot V_0^{SA}(z_1,a_1)\\ +\sum_{a_2}P^{BG}(z_2,a_2)\cdot\max\{V_0^{SA}(z_1,a_1),V_0^{BG}(z_1,a_1\,|\,z_2,a_2)\}\end{array}\right],\\ V_0^{BG}(z_1,a_1\,|\,z_2,a_2)&=\max_{\{k_i^C,k_i^D,k_i^E\}_{i\in\{1,2\}}} u(a_1-k_1^C)+\beta E_{z_1',z_2',\delta_1',\delta_2'}[V(z_1',a_1')\,|\,z_1,z_2,k_1,k_2]. \end{aligned} \tag{6}$$

The business-group entrepreneur's next-period wealth a_1' is a function of $(z_1',\delta_1',z_2',\delta_2')$ given the firms' capital structure $\{k_i^C,k_i^D,k_i^E\}_{i\in\{1,2\}}$. Note that the probability of matching with a manager $P^{BG}(z_2,a_2)$ is endogenously determined in a stationary equilibrium and that its sum can be less than one such that $\sum_{a_2}P^{BG}(z_2,a_2)\le 1$. If the demand of z_2 is higher than the supply of z_2, some

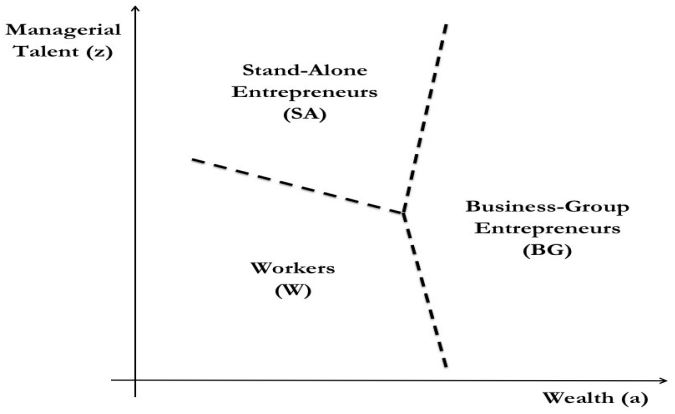

FIGURE 2. OCCUPATIONAL CHOICE GIVEN MANAGERIAL TALENT z AND WEALTH a

business-group entrepreneurs would fail to be matched with their targeted managers featuring z_2.

Figure 2 is an expository diagram of an individual's occupational choice given his or her managerial talent z and wealth a.[8] First, it shows that the poor and untalented are likely to become workers because they are not productive enough to run firms and because they do not have enough wealth to hire managers. Secondly, it shows that the more talented one is, the more likely they are to become entrepreneurs. A declining line separating SA from W captures financial frictions with which would-be entrepreneurs could become workers if they do not have enough wealth. Lastly, it shows that the rich tend to become business-group entrepreneurs because they can pay managerial compensation and hire talented individuals as business-group managers running subsidiary firms.

III. Financial Frictions and Three Types of Firms

Suppose that an entrepreneur who controls her firm can divert τ fraction of the firm's cash flow. The tunneling ratio τ captures the degree of financial frictions in an economy. Accordingly, $(1-\tau)$ captures the degree of investor protection in an economy because $(1-\tau)$ is the residual cash flow investors can enforce on a firm if the firm does not undertake reimbursements.[9]

Given financial frictions, an entrepreneur can choose her firms' ownership

[8]Figure 2 is not the equilibrium output of the model. It is an example constructed to clarify the idea of an individual's occupational choice problem.

[9]The fraction of diversion, τ, is a parsimonious modeling device capturing the economy-wide degree of financial frictions in order to focus on macroeconomic implications. Detailed practices from which financial frictions arise are abstracted in the model. Due to this lack of a microeconomic structure, the model is silent with regard to how an entrepreneur can divert her firm's cash flow. Diversion in the model can therefore be interpreted as a wide variety of microeconomic limited commitment problems in the real world, such as agency costs during the managerial pursuit of private benefits (Jensen and Meckling, 1976) or tunneling practices of transferring resources (Johnson *et al*., 2000). Thus, τ or (1-τ) is interchangeably labeled throughout this study, i.e., the degree of financial frictions, tunneling, investor protection, or the rule of law.

structure: a private company, a publicly held corporation, or a pyramidal business group. Specifically, an entrepreneur can run her private company, which is only allowed to access external debt markets with the help of the entrepreneur's wealth as collateral. I assume that the external debt finance is bounded above by the firm's lowest cash flow in order to guarantee its repayment.

To raise more external finance, an entrepreneur can pay flotation costs and incorporate a publicly held corporation that can tap into external equity markets. I assume that an entrepreneur owns all shares of her firm at the onset of its incorporation, which can be sold to outside shareholders to raise external equity finance. The extent of external equity finance her firm can raise is assumed to be proportional to the firm's expected cash flow and the fraction of shares sold to outside shareholders.

Lastly, an entrepreneur can hire a manager with managerial compensation and build up a business group that consists of two corporations, a parent run by the entrepreneur and a subsidiary run by the manager. The business-group entrepreneur uses a pyramidal ownership structure to control both firms and makes the parent offer internal equity finance to the subsidiary without financial frictions. Similar to stand-alone corporations, both the parent and the subsidiary can sell their shares to outside shareholders and raise external equity finance.

A. *A Private Company*

Given her managerial talent and wealth, (z,a), an entrepreneur can run a private company that is a firm fully owned by her. Due to the lack of external equity finance, a private company relies on external debt finance. The firm's capital in production k is determined as follows. First, the entrepreneur of a private company is obliged for the company's liability so that her wealth net of consumption $a-c$ becomes the firm's collateral k^C such that

$$k^C = a - c \geq 0. \tag{7}$$

Second, given the collateral k^C and the opportunity of diversion $\tau\pi$, the firm's capital in production k is bounded above as follows.

$$\underbrace{(1+r)k}_{\text{Debt Repayment}} \leq \underbrace{(1+r)k^C}_{\text{Collateral}} + \underbrace{(1-\tau)\inf_{z',\delta'} \pi(z',\delta' \mid z,k)}_{\text{Secured Cash Flow to Debtholders}} \tag{8}$$

Lastly, the entrepreneur of a private company can choose k and decide how much external debt finance will be raised. I assume that the firm, or the entrepreneur, can invest in a risk-free asset by taking $k < k^C$. Thus, the entrepreneur can earn a risk-free residual cash flow from the firm such that

$$(1+r)(k^C - k) + \inf_{z',\delta'}[\pi(z',\delta' \mid z,k)]. \tag{9}$$

To summarize, a stand-alone entrepreneur running a private company solves

$$V_0^{SA}(z,a) = \max_{k^C \in [0,a], k} u(a-k^C) + \beta E_{z',\delta'}[V(z',a')|z] \tag{10}$$

subject to

$$\begin{aligned} a' &= \pi(z',\delta' \mid z,k) + (1+r)(k^C - k), \\ k &\le k^C + \frac{1-\tau}{1+r} \inf_{z',\delta'}[\pi(z',\delta' \mid z,k)]. \end{aligned} \tag{11}$$

The entrepreneur of a private company can divert her firm's cash flow. The total cash flow she earns, however, is the sum of the diverted cash flow and the residual cash flow after debt repayment, which is identical to the non-diverted cash flow after debt repayment. Unlike the publicly held corporations or business groups introduced in the following sections, we can therefore interpret that in equilibrium, diversion does not occur in a private company that is fully owned by its entrepreneur.

B. *A Publicly Held Corporation*

An entrepreneur of (z,a) can choose to incorporate her firm into a publicly held corporation with flotation costs $k^F > 0$. After its incorporation, a publicly held corporation can tap into external equity markets. The corporation's capital in production k is determined by the sum of private finance k^C, external debt finance k^D, and external equity finance k^E, net of flotation costs k^F such that

$$k = k^C + k^D + k^E - k^F. \tag{12}$$

Each type of capital is determined as follows. First, the entrepreneur can transfer a fraction of her wealth k^C to her corporation. k^C is determined by the entrepreneur's wealth a net of her consumption c and private risk-free asset s. I assume that the flotation costs k^F should be paid by the entrepreneur with k^C before the firm's incorporation such that[10]

$$k^C = a - c - s \ge k^F. \tag{13}$$

In contrast to a private company, the entrepreneur's wealth cannot be used as collateral for her corporation because a publicly held corporation is a legal entity that

[10] k^F captures expenses such as underwriting fees, legal fees, or registration fees of issuing shares. Although in the real world flotation costs consist of fixed costs as well as costs proportional to the extent of shares issued, only the fixed costs are employed in the model with k^F. I exclude the proportional costs that can be paid with external financing after issuing shares because the efficiency of these back-loaded costs is scarcely distinguishable from the degree of financial frictions τ. Moreover, in the model, k^F is paid every period if an entrepreneur runs a publicly held corporation successively.

is separate from its entrepreneur. According to this construction, however, the wealth transfers from its entrepreneur to the publicly held corporation work as collateral; this is why I abuse the notation of k^C.

Second, a publicly held corporation can use external debt finance k^D. Given the assumption that an entrepreneur controlling her firm can divert τ fraction of the firm's cash flow π, the external debt finance k^D is constrained in order to guarantee its repayment, as follows. Note that a publicly held corporation can invest in a risk-free asset by taking $k^D < 0$.

$$(14) \qquad (1+r)k^D \le (1-\tau)\inf_{z',\delta'}[\pi(z',\delta' \mid z,k)]$$

Third, a publicly held corporation can tap into external equity markets. The corporation can raise external equity $k^E = k^E(\sigma)$ by selling its $\sigma \in [0, \bar{\sigma}_{SA}]$ fraction of shares. Suppose that $(1-\bar{\sigma}_{SA}) > 0$ fraction of the firm's shares is required for an entrepreneur to take control of his or her stand-alone corporation. I assume that external capital markets are competitive and well diversified so that the publicly held corporation can raise external equity with the risk-free interest rate r.

$$(15) \qquad \underbrace{(1+r)k^E}_{\substack{\text{Expected Payoff to}\\ \text{Outside Shareholders}}} = \sigma \cdot \underset{z',\delta'}{E}\left[\underbrace{(1-\tau)\pi(z',\delta' \mid z,k)}_{\text{Cash Flow after Tunneling}} - \underbrace{(1+r)k^D}_{\text{Debt Reimbursement}}\right],$$
$$\sigma \in [0, \bar{\sigma}_{SA}], \ \bar{\sigma}_{SA} < 1$$

As can be observed in the above equation, the firm's cash flow π is sequentially distributed to the entrepreneur with tunneling $\tau\pi$, to creditors with debt reimbursement $(1+r)k^D$, and to shareholders with residual claims.

To summarize, a stand-alone entrepreneur running a publicly held corporation solves

$$(16) \qquad V_0^{SA}(z,a) = \max_{s \ge 0, k^C, k^D, \sigma \in [0,\bar{\sigma}_{SA}]} u(a-s-k^C) + \beta E_{z',\delta'}[V(z',a') \mid z]$$

subject to

$$(17) \qquad \begin{aligned} a' &= (1+r)s + \tau\pi(z',\delta' \mid z,k) + (1-\sigma)\{(1-\tau)\pi(z',\delta' \mid z,k) - (1+r)k^D\} \\ k &= k^C + k^D + k^E - k^F \\ k^C &\in [k^F, a-s] \\ k^D &\le \frac{1-\tau}{1+r}\inf_{z',\delta'}[\pi(z',\delta' \mid z,k)] \\ k^E &= \frac{\sigma}{1+r}\underset{z',\delta'}{E}[(1-\tau)\pi(z',\delta' \mid z,k) - (1+r)k^D]. \end{aligned}$$

Condition 1. The Value function $V(z,a)$ satisfies the following condition:

$$E_{z',\delta'}[V_a(z',a')\cdot\{E_{z',\delta'}\pi(z',\delta'\,|\,z,k)-\pi(z',\delta'\,|\,z,k)\}\,|\,z,k]>0 \tag{18}$$

Condition 1 describes an entrepreneur running a firm who is averse to risk. Note that if the marginal value of wealth V_a monotonically decreases in wealth a, Condition 1 holds. V_a, however, is not in general a monotonically decreasing function of a. The individual's value function $V(z,a)$ may be locally convex even when its underlying utility function is concave because the individual's choice set is non-convex. We need an additional structure to hold Condition 1. Henceforth, we assume that for all (z,k), a minimum cash flow $\inf_{z',\delta'}\pi(z',\delta'\,|\,z,k)$ is low enough to satisfy Condition 1. Given that the marginal utility of consumption goes to infinity as consumption goes to zero, the marginal value of wealth $V_a(z',a')$ with the sufficiently low minimum cash flow can be large enough to make the left-hand side of equation (18) positive.

Proposition 1. Given the risk-free investment opportunity for a corporation, $k^D<0$, a standalone entrepreneur weakly prefers not to hold private assets such that

$$s=0\,.$$

Given Condition 1 and the risk-free investment opportunity, a stand-alone entrepreneur of a publicly held corporation strictly prefers fully external equity finance such that

$$\sigma=\bar{\sigma}_{SA}.$$

Proof. See Online Appendix B.[11]

Corollary 1. From Proposition 1, the stand-alone entrepreneur's choice variables degenerate into $\{k^C,k^D,\sigma\}$. Thus, we can simplify the problem of a private company and that of a publicly held corporation into the common problem of a stand-alone entrepreneur such that

$$V_0^{SA}(z,a)=\max_{k^C,k^D,\sigma\in\{0,\bar{\sigma}_{SA}\}} u(a-k^C)+\beta E_{z',\delta'}[V(z',a')|z] \tag{19}$$

subject to

[11]For Online Appendix, refer to the KDI Journal of Economic Policy's website (kdijep.org).

$$
\begin{aligned}
a' &= \tau\pi(z',\delta' \mid z,k) + (1-\sigma)\{(1-\tau)\pi(z',\delta' \mid z,k) - (1+r)k^D\} \\
k &= k^C + k^D + k^E - k^F \cdot 1_{\sigma=\bar{\sigma}_{SA}} \\
k^C &\in [k^F \cdot 1_{\sigma=\bar{\sigma}_{SA}}, a] \\
k^D &\leq \frac{1-\tau}{1+r} \inf_{z',\delta'} [\pi(z',\delta' \mid z,k)] \\
k^E &= \frac{\bar{\sigma}_{SA} \cdot 1_{\sigma=\bar{\sigma}_{SA}}}{1+r} E_{z',\delta'} [(1-\tau)\pi(z',\delta' \mid z,k) - (1+r)k^D].
\end{aligned} \tag{20}
$$

C. *A Business Group*

A business group is defined as a collection of two publicly held corporations, Firm 1 and Firm 2, which are controlled by a business-group entrepreneur. Let z_1 denote the productivity of Firm 1 that inherits from the business-group entrepreneur and let z_2 be the productivity of Firm 2 that inherits from the manager.

We assume that a business group is connected through a pyramidal ownership structure such that Firm 2 is owned and controlled by Firm 1 that is owned and controlled by a business-group entrepreneur. More specifically, the business-group entrepreneur incorporates Firm 1 with private finance k_2^C, keeps at least $(1-\bar{\sigma}_{BG})$ shares of Firm 2, and controls Firm 2. I assume that the manager of Firm 2 takes managerial compensation $w^M(z_2,a_2)$ relinquishes her control rights and cash flow rights over Firm 2, and hands them over to Firm 1. As a result, the entrepreneur of a business group can control both firms and divert cash flow from both firms.

Two items here are important to note. First, the pair of managerial talent z_2 and its corresponding managerial compensation $w^M(z_2,a_2)$ can be understood as a contract between an entrepreneur buying z_2 and a manager selling z_2 with the price of $w^M(z_2,a_2)$. Thus, the manner in which $w^M(z_2,a_2)$ is pinned down can be critical in the model. Given the lack of managerial talent markets, I assume that $w^M(z_2,a_2)$ is a certainty equivalent for an individual, who can run a stand-alone firm or become a worker as outside options. This will be formally specified in the following section.

Second, I assume that $(1-\bar{\sigma}_{BG})$ fraction of shares is required to acquire control rights over a business group. $\bar{\sigma}_{BG}$ can differ from that of a stand-alone firm, $\bar{\sigma}_{SA}$, because $(1-\bar{\sigma}_{BG})$ needs to capture large enough block shares in order to ensure exclusive control rights over business-group firms, while $(1-\bar{\sigma}_{SA})$ only captures the stand-alone entrepreneur's payoff structure proportional to the firm's cash flow. Thus, I assume that $\bar{\sigma}_{BG} \leq \bar{\sigma}_{SA}$, although the model lacks a micro-foundation with regard to pinning down $\bar{\sigma}_{SA}$ and $\bar{\sigma}_{BG}$.

1. Capital Structure of Firm 2

For now, suppose that Firm 2 is run by a manager who has z_2 and a_2. I assume that the flotation costs k^F and the managerial compensation $w^M = w^M(z_2, a_2)$ should be paid by Firm 1 through internal equity finance k_2^C such that

$$k_2^C \geq k^F + w^M. \tag{21}$$

This implies that Firm 2 should be incorporated before tapping into external capital markets. Firm 2 raises external debt finance k_2^D under the following constraint given the assumption that the business-group entrepreneur, who controls Firm 1 that controls Firm 2, can expropriate cash flow from Firm 2.

$$k_2^D \leq \frac{1-\tau}{1+r} \inf_{z_2', \delta_2'} \pi(z_2', \delta_2' \mid z_2, k_2) \tag{22}$$

Firm 2 raises external equity finance k_2^E by selling its σ_2 fraction of shares.

$$\underbrace{(1+r)k_2^E}_{\substack{\text{Expected Payoff to} \\ \text{Outside Shareholders}}} = \sigma_2 \cdot \underset{z_2', \delta_2'}{E} \left[\underbrace{(1-\tau)\pi(z_2', \delta_2' \mid z_2, k_2)}_{\text{Cash Flow after Tunneling}} - \underbrace{(1+r)k_2^D}_{\text{Debt Reimbursement}} \right], \tag{23}$$

$$\sigma_2 \leq \bar{\sigma}_{BG}$$

From the equations above, the capital in production of Firm 2, k_2, is determined by the sum of internal equity finance k_2^C, external debt finance k_2^D, and external equity finance k_2^E net of flotation costs k^F and managerial compensation w^M such that

$$k_2 = k_2^C + k_2^D + k_2^E - k^F - w^M. \tag{24}$$

2. Capital Structure of Firm 1

A business-group entrepreneur of (z_1, a_1) can transfer her wealth k_1^C to Firm 1. I assume that both firms' flotation costs and Firm 2's managerial compensation should be paid by the entrepreneur with k_1^C such that

$$k_1^C = a_1 - c - s \geq \underbrace{k^F}_{\substack{\text{Flotation Costs} \\ \text{of Firm 1}}} + \underbrace{k^F + w^M}_{\substack{\text{Gross Flotation Costs} \\ \text{of Firm 2}}}. \tag{25}$$

This arises not only because the timing of incorporating both Firm 1 and Firm 2 is simultaneous in the model but also because the contract between the entrepreneur and the manager should be established before Firm 2 is incorporated.

Given the capital structure of Firm 2, $\{k_2^C, k_2^D, k_2^E\}$, and its cash flow, $\pi(z_2', \delta_2' \mid z_2, k_2)$, Firm 1 raises external debt finance k_1^D under the following constraint,

$$(1+r)k_1^D \leq (1-\tau)\pi_1 \quad \forall(z_1', z_2', \delta_1', \delta_2'),$$

where π_1 is the gross cash flow from Firm 1, defined as

$$\pi_1 = \underbrace{\pi(z_1', \delta_1' \mid z_1, k_1^* = k_1 - k_2^C)}_{\substack{\text{Gross Output Net of Labor Costs and} \\ \text{Capital Depreciation from Firm 1}}} + \underbrace{(1-\sigma_2)\{(1-\tau)\pi_2 - (1+r)k_2^D\}}_{\text{Residual Claims of Firm 1 from Firm 2}},$$

$$\pi_2 = \underbrace{\pi(z_2', \delta_2' \mid z_2, k_2)}_{\substack{\text{Gross Output Net of Labor Costs and} \\ \text{Capital Depreciation from Firm 2}}}$$

We can rewrite the above inequality such that

$$k_1^D \leq \frac{1-\tau}{1+r}\left[\begin{array}{l} \inf_{z_1', \delta_1'}[\pi(z_1', \delta_1' \mid z_1, k_1^*)] \\ +(1-\sigma_2)\left\{(1-\tau)\inf_{z_2', \delta_2'}[\pi(z_2', \delta_2' \mid z_2, k_2)] - (1+r)k_2^D\right\} \end{array}\right]. \tag{26}$$

Conceptually, the internal equity finance k_2^C used by Firm 2 should be raised from Firm 1's retained earnings (e.g., Almeida and Wolfenzon, 2006b). Given the limitation that firms are created and liquidated every period, however, I use Firm 1's capital k_1 as a proxy for Firm 1's retained earnings. Thus, the internal equity finance k_2^C is raised out of k_1, and Firm 1's capital in production becomes $k_1^* = k_1 - k_2^C > 0$.

Lastly, Firm 1 raises external equity finance k_1^E by selling its σ_1 fraction of shares to outside shareholders such that

$$\underbrace{(1+r)k_1^E}_{\substack{\text{Expected Payoff to} \\ \text{Outside Shareholders}}} = \sigma_1 \cdot \underset{z_1', z_2', \delta_1', \delta_2'}{E}[(1-\tau)\pi_1 - (1+r)k_1^D], \quad \sigma_1 \leq \bar{\sigma}_{BG}.$$

This equation can be rewritten as follows.

$$(27)\quad k_1^E = \frac{\sigma_1}{1+r}\left[\begin{array}{l}(1-\tau)\underset{z_1',\delta_1'}{E}[\pi(z_1',\delta_1' \mid z_1,k_1^*)] \\ +(1-\tau)(1-\sigma_2)\left\{(1-\tau)\underset{z_2',\delta_2'}{E}[\pi(z_2',\delta_2' \mid z_2,k_2)]-(1+r)k_2^D\right\} \\ -(1+r)k_1^D\end{array}\right].$$

From the equations above, the capital in production of Firm 1, k_1^*, is determined by the sum of private finance k_1^C, external debt finance k_1^D, and external equity finance k_1^E, net of flotation costs k^F and internal equity finance k_2^C such that

$$(28)\quad \begin{aligned} k_1^* &= k_1 - k_2^C \\ &= k_1^C + k_1^D + k_1^E - k^F - k_2^C. \end{aligned}$$

3. A Business-Group Entrepreneur's Problem

Given (z_2,a_2) and $w^M = w^M(z_2,a_2)$, a business-group entrepreneur of (z_1,a_1) solves the following problem,

$$(29)\quad \begin{aligned} V_0^{BG}(z_1,a_1 \mid z_2,w^M) = &\max_{\substack{s\geq 0 \\ \{k_i^C,k_i^D,k_i^E\}_{i\in\{1,2\}}}} u(a_1-s-k_1^C) \\ &+\beta E_{z_1',z_2',\delta_1',\delta_2'}[V(z_1',a_1') \mid z_1,z_2], \end{aligned}$$

subject to

$$(30)\quad \begin{aligned} a_1' = &(1+r)s+\tau\pi(z_1',\delta_1' \mid z_1,k_1^*)+\tau\pi(z_2',\delta_2' \mid z_2,k_2) \\ &+(1-\sigma_1)\{(1-\tau)\pi(z_1',\delta_1' \mid z_1,k_1^*)-(1+r)k_1^D\} \\ &+(1-\sigma_1+\sigma_1\tau)(1-\sigma_2)\{(1-\tau)\pi(z_2',\delta_2' \mid z_2,k_2)-(1+r)k_2^D\}, \end{aligned}$$

Equation (21) - (28).

Condition 2. The value function $V(z_1,a_1)$ satisfies the following conditions:

$$(31)\quad \begin{aligned} &E_{(z_i',\delta_i')_{i\in\{1,2\}}}\left[V_a(z_1',\delta_1')\cdot\left\{\begin{array}{c}E_{z_1'.\delta_1'}\pi(z_1',\delta_1' \mid z_1,k_1^*) \\ -\pi(z_1',\delta_1' \mid z_1,k_1^*)\end{array}\right\} \mid z_1,z_2,k_1^*,k_2\right]>0, \\ &E_{(z_i',\delta_i')_{i\in\{1,2\}}}\left[V_a(z_1',\delta_1')\cdot\left\{\begin{array}{c}E_{z_2'.\delta_2'}\pi(z_2',\delta_2' \mid z_2,k_2^*) \\ -\pi(z_2',\delta_2' \mid z_2,k_2^*)\end{array}\right\} \mid z_1,z_2,k_1^*,k_2\right]>0. \end{aligned}$$

Proposition 2. Given non-negative financial frictions $\tau > 0$ and the risk-free investment opportunity of Firm 2 such that $k_2^D < 0,$ a business-group entrepreneur weakly prefers no private risk-free asset and a full external debt finance of Firm 1 such that

$$s = 0,$$
$$k_1^D = \frac{1-\tau}{1+r}\left[\begin{array}{l}\inf\limits_{z_1',\delta_1'}[\pi(z_1',\delta_1' \mid z_1, k_1^*)] \\ +(1-\sigma_2)\left\{(1-\tau)\inf\limits_{z_2',\delta_2'}[\pi(z_2',\delta_2' \mid z_2, k_2)] - (1+r)k_2^D\right\}\end{array}\right].$$

Given Condition 2 and the risk-free investment opportunity of Firm 2, a business-group entrepreneur strictly prefers full external equity finance of both firms such that

$$\sigma_1 = \sigma_2 = \bar{\sigma}_{BG}.$$

Proof. See Online Appendix C.

Corollary 2. From Proposition 2, the business-group entrepreneur's choice variables degenerate into $\{k_1^C, k_2^C, k_2^D\}$. Thus, we can rewrite the business-group entrepreneur's problem as follows.

$$\begin{aligned} V_0^{BG}(z_1, a_1 \mid z_2, w^M) = &\max_{k_1^C, k_2^C, k_2^D} u(a_1 - k_1^C) \\ &+ \beta E_{z_1',z_2',\delta_1',\delta_2'}[V(z_1', a_1') \mid z_1, z_2] \end{aligned} \tag{32}$$

subject to

$$k_1^C \in [2k_F + w^M, a],$$
$$k_2^C \in [k^F + w^M, k_1],$$
$$k_2^D \le \frac{1-\tau}{1+r}\inf_{z_2',\delta_2'}[\pi_2(z_2',\delta_2' \mid z_2, k_2)],$$
$$k_1^* = k_1^C - k^F - k_2^C + \frac{1-\tau}{1+r}\left\{\begin{array}{l}\bar{\sigma}_{BG}E_{z_1',\delta_1'}[\pi(z_1',\delta_1' \mid z_1, k_1^*)] \\ +(1-\bar{\sigma}_{BG})\inf\limits_{z_1',\delta_1'}[\pi(z_1',\delta_1' \mid z_1, k_1^*)] \\ -(1-\bar{\sigma}_{BG})(1+r)k_2^D\end{array}\right\}$$
$$+\frac{(1-\tau)^2(1-\bar{\sigma}_{BG})}{1+r}\left[\begin{array}{l}\bar{\sigma}_{BG}E_{z_2',\delta_2'}[\pi(z_2',\delta_2' \mid z_2, k_2)] \\ +(1-\bar{\sigma}_{BG})\inf\limits_{z_2',\delta_2'}[\pi(z_2',\delta_2' \mid z_2, k_2)]\end{array}\right],$$

$$
\begin{aligned}
&k_2 = k_2^C - k^F - w^M + (1-\bar{\sigma}_{BG})k_2^D + \frac{1-\tau}{1+r}\bar{\sigma}_{BG}E_{z_2',\delta_2'}[\pi(z_2',\delta_2' \mid z_2,k_2)],\\
&a_1' = \tau\pi(z_1',\delta_1' \mid z_1,k_1^*) + \tau\pi(z_2',\delta_2' \mid z_2,k_2)\\
&\quad + (1-\bar{\sigma}_{BG})(1-\tau)\left[\begin{array}{l}\pi(z_1',\delta_1' \mid z_1,k_1^*) - \inf\limits_{z_1',\delta_1'}[\pi(z_1',\delta_1' \mid z_1,k_1^*)]\\ -(1-\bar{\sigma}_{BG})\left\{\begin{array}{l}(1-\tau)\inf\limits_{z_2',\delta_2'}[\pi(z_2',\delta_2' \mid z_2,k_2)]\\ -(1+r)k_2^D\end{array}\right.\end{array}\right] \qquad (33)\\
&\quad + (1-\bar{\sigma}_{BG}+\bar{\sigma}_{BG}\tau)(1-\bar{\sigma}_{BG})\left\{\begin{array}{l}(1-\tau)\pi(z_2',\delta_2' \mid z_2,k_2)\\ -(1+r)k_2^D\end{array}\right..
\end{aligned}
$$

Note that in Corollary 2, Firm 1's capital in production k_1^* decreases with k_2^C but increases with the cash flow of Firm 2, $\pi(z_2',\delta_2' \mid z_2,k_2)$ on the right-hand side of k_1^*. Given that $\pi(z_2',\delta_2' \mid z_2,k_2)$ increases with k_2 and that k_2 increases with k_2^C, we find that the financial advantage of a business group derives not only from no limited commitment problems such that $k_2^C < k_1$ but also from an increase in the cash flow from Firm 2 to Firm 1.

IV. A Matching Rule and a Stationary Equilibrium

A. *A Matching Rule between Business-Group Entrepreneurs and Others*

To complete the model, we consider an ad-hoc matching rule. It is designed to mitigate the gap between the model and the real world. Although the model assumes one-period matching between a business-group entrepreneur and a manager by construction, in the real world the matching between a business-group entrepreneur of (z,a) and a subsidiary Firm 2 of z_2 is stable over time.

First, we assume that managerial compensation $w^M(z_2,a_2)$ is equal to the certainty equivalent for a manager who has outside options such that

$$V^M(z_2,a_2 \mid w^M(z_2,a_2)) = \max\{V_0^W(z_2,a_2), V_0^{SA}(z_2,a_2)\}. \qquad (34)$$

This assumption implies that a business-group entrepreneur acquires all of the gains from building a business group and that the manager of Firm 2 will have less wealth in the next period than the expected wealth a stand-alone entrepreneur would have due to the risk-averse preference.

Second, we assume that the business-group entrepreneur can choose z_2 but cannot choose a_2. A business-group entrepreneur and its manager of Firm 2 who

has a_2 are randomly matched given z_2. As a result, while an individual always accepts the offer of being a manger given the managerial compensation as a certainty equivalent, a business-group entrepreneur of (z,a) can turn down the opportunity of launching a subsidiary Firm 2 if the matched manager has too high a_2 that induces $w_M(z_2,a_2) > \overline{w}^M(z,a \mid z_2)$, where $\overline{w}^M(z,a \mid z_2)$ is the largest managerial compensation a business-group entrepreneur of (z,a) can be better off such that

$$(35) \quad \overline{w}^M(z,a \mid z_2) = \sup\{w^M > 0 : V_0^{BG}(z,a \mid z_2, w^M) \geq V_0^{SA}(z,a \mid \sigma \leq \overline{\sigma}_{BG})\}.$$

Lastly, assume that a business-group entrepreneur, who screens out $w^M(z_2,a_2) > \overline{w}^M(z,a \mid z_2)$ and gives up the opportunity of launching a subsidiary Firm 2, should keep at least $(1-\overline{\sigma}_{BG})$ shares of Firm 1. This assumption begets a business group without Firm 2, which sells only $\overline{\sigma}_{BG}$ fraction of shares, not $\overline{\sigma}_{SA}$. Although the capital structures of a business group without Firm 2 is ex-post suboptimal, it is ex-ante optimal for a business-group entrepreneur who wants to launch Firm 2 with the possibility of being matched with $w^M(z_2,a_2) \leq \overline{w}^M(z,a \mid z_2)$. The possibility of no subsidiary Firm 2 can be understood as an opportunity cost for a business-group entrepreneur. Given the limitation of the model defining a business group as a collection of two corporations, a business group without Firm 2 can be understood as a business group with fewer pyramidal layers.

B. *A Stationary Equilibrium*

Given the matching rule, a stationary equilibrium consists of a stationary joint distribution of managerial talent and wealth $F(z,a)$; the probability of being hired as a manager $P^M(z,a)$ and the probability of being matched with a manager $P^{BG}(z_2,a_2)$; prices $\{r,w,w^M(z_2,a_2)\}$; and individual policy functions such as (i) occupation $o(z,a)$ for an individual, (ii) the private risk-free asset $s(z,a)$ for a worker or a manager, (iii) private finance $k^C(z,a)$, external debt finance $k^D(z,a)$, and external equity finance $k^E(z,a)$ for a stand-alone entrepreneur, (iv) the optimal managerial talent for a subsidiary firm $z_2(z,a)$, private finance $k_1^C(z,a \mid z_2,a_2)$, internal equity finance $k_2^C(z,a \mid z_2,a_2)$, and external debt finance $k_2^D(z,a \mid z_2,a_2)$ for a business-group entrepreneur matched with $w^M(z_2,a_2) \leq \overline{w}^M(z,a \mid z_2)$, and (v) private finance $k^C(z,a)$ and external finance $k^D(z,a)$ for a business-group entrepreneur matched with $w^M(z_2,a_2) > \overline{w}^M(z,a \mid z_2)$ such that

1. Given the stationary joint distribution of managerial talent and wealth $F(z,a)$, the probability of being hired as a manager $P^M(z,a)$, the probability of being matched with a manager $P^{BG}(z_2,a_2)$, and prices $\{r,w,w^M(z_2,a_2)\}$, the individual policy functions solve the individual's problem in Section 2.2;

2. The joint distribution of managerial talent and wealth $F(z,a)$ is stationary such that

$$F(z,a)=\int_{\{(\tilde{z},\tilde{a})|z'(\tilde{z})\le z,a'(z',\delta'|\tilde{z},\tilde{a})\le a\}} dF(\tilde{z},\tilde{a}); \tag{36}$$

3. The probability of a worker or a stand-alone entrepreneur being hired as a manager, $P^M(z_2,a_2)$, and the probability of a business-group entrepreneur being matched with a manager, $P^{BG}(z_2,a_2)$, satisfy the following condition:

$$\begin{aligned}&\int_{o(z_2,a_2)\in\{W,SA\}} P^M(z_2,a_2)F(z_2,da_2)\\&=\int_{o(z,a)=BG}\int_{\substack{o(z_2,a_2)\in\{W,SA\}\\ w^M(z_2,a_2)\le\bar{w}^M(z,a|z_2)}} P^{BG}(z_2,a_2)da_2dF(z,a)\quad\forall z_2;\end{aligned} \tag{37}$$

4. Capital market and labor market clear. See Online Appendix A for a full description.

V. Remarks on the Model

A. *Financial Advantage of Business Groups*

In order to gauge how well internal capital markets can alleviate exogenous financial frictions in the model, we consider how much private wealth of an entrepreneur is required to raise a fixed amount of capital in production given the ownership structure of firms.

Suppose that a business group consists of two firms that replicate a stand-alone firm's capital structure with identical managerial talent such that

$$k=k_1^*=k_2,\quad z=z_1=z_2,\quad \sigma=\bar{\sigma}_{SA}=\bar{\sigma}_{BG}.$$

We now compare the required level of private finance for a stand-alone firm k^C to that for a business group k_1^C in order to raise $k=k_1^*=k_2$. For a stand-alone firm, the feasible capital in production k is determined by the following equation.

$$k=k^C-k^F+\frac{1-\tau}{1+r}\{\bar{\sigma}E\pi(z',\delta'\mid z,k)+(1-\bar{\sigma})\inf\pi(z',\delta'\mid z,k)\} \tag{38}$$

Similarly, the set of feasible capital in production for a business group, i.e., k_1^* for Firm 1 and k_2 or Firm 2, is determined by the following equations.

$$
\begin{aligned}
k_1^* &= k_1^C - k^F - k_2^C + \frac{1-\tau}{1+r}\{\bar{\sigma}E\pi(z_1', \delta_1' \mid z, k_1^*) + (1-\bar{\sigma})\inf \pi(z_1', \delta_1' \mid z, k_1^*)\} \\
&\quad + \frac{(1-\tau)^2(1-\bar{\sigma})\bar{\sigma}}{1+r}\{E\pi(z_2', \delta_2' \mid z, k_2) - \inf \pi(z_2', \delta_2' \mid z, k_2)\}, \\
k_2 &= k_2^C - k^F - w^M + \frac{1-\tau}{1+r}\{\bar{\sigma}E\pi(z_2', \delta_2' \mid z, k_2) + (1-\bar{\sigma})\inf \pi(z_2', \delta_2' \mid z, k_2)\}.
\end{aligned} \tag{39}
$$

By solving for the equations above with $k_1^* = k_2 = k$,

$$
\begin{aligned}
k_1^C &= 2k^C + w^M - \frac{(1-\tau)^2(1-\bar{\sigma})\bar{\sigma}}{1+r}\{E\pi(z_2', \delta_2' \mid z, k) - \inf \pi(z_2', \delta_2' \mid z, k)\} \\
&= 2k^C + w^M - (1-\tau)(1-\bar{\sigma})k^E,
\end{aligned} \tag{40}
$$

where k^E is the feasible external equity finance that a stand-alone firm with managerial talent z can raise given k^C.

At this point, we can compare the effective degree of financial frictions between business-group firms and stand-alone firms. By fixing capital in production as $k = k_1^* = k_2$, we observe the ratio of capital in production to private finance for a stand-alone entrepreneur (SA) and for a business-group entrepreneur (BG) such that

$$
\lambda_{SA} = \frac{k}{k^C}, \quad \lambda_{BG} = \frac{k_1^* + k_2}{k_1^C}. \tag{41}
$$

The financial advantage of a business group can then be measured by the following ratio.

$$
\frac{\lambda_{BG}}{\lambda_{SA}}\Big|_{k=k_1^*=k_2} = \frac{1}{1 + \frac{1}{2}\left\{\frac{w^M}{k^C} - (1-\tau)(1-\bar{\sigma})\frac{k^E}{k^C}\right\}} \tag{42}
$$

This ratio depends both on the cost of building up a subsidiary firm, w^M, and the efficiency of external capital markets, $(1-\tau)(1-\bar{\sigma})k^E$. If the latter outweighs the former, the ratio becomes greater than 1. This implies that a business group raises more external finance than a stand-alone firm does given the same amount of private finance. For instance, suppose that $\frac{w^M}{k^C} = 0.4$ and $\frac{k^E}{k^C} = 20$ given $\tau = 0.3$ and $\bar{\sigma} = 0.9$. Then, the ratio becomes 2, meaning that a business group k raises twice

as much capital than a stand-alone firm does given the same amount of private finance.

The asymmetric financial advantage of business groups can be lessened if business groups are subject to a lower fraction of equity shares sold to outside shareholders such that $\bar{\sigma}_{BG} < \bar{\sigma}_{SA}$. With this condition, the above ratio can be rewritten as follows.

$$(43) \qquad \frac{1}{1+\frac{1}{2}\left[\frac{w^M}{k^C}+\left\{2\left(1-\frac{\bar{\sigma}_{BG}}{\bar{\sigma}_{SA}}\right)-(1-\tau)(1-\bar{\sigma}_{BG})\frac{\bar{\sigma}_{BG}}{\bar{\sigma}_{SA}}\right\}\frac{k^E}{k^C}\right]}$$

Given the same specification as above but with $\bar{\sigma}_{BG} = 0.87$ and $\bar{\sigma}_{SA} = 0.9$, we can observe that the ratio becomes 1.01 and the asymmetric financial advantage of business groups is almost nullified. This teaches us that the minimum equity shares $(1-\bar{\sigma}_{BG})$ which the controlling shareholder of a business group should keep to control over the business group can have sizable effects on mitigating the asymmetric financial advantage of business groups. However, note that this example is devised for a stark comparison and that business-group entrepreneurs can choose z_2 and optimize their external financing. Thus, we can guess that $\bar{\sigma}_{BG}$ should be much lower in order to lessen the asymmetric financial advantage of business groups in equilibrium.

B. *Asymmetric Financial Frictions*

Given the finite amount of capital stock in an economy, the asymmetric financial advantage of business groups is in other words the asymmetric financial frictions between business-group firms and stand-alone firms, which can result in factor misallocation in a general equilibrium. Note that managerial compensation w^M is a certainty equivalent proportional to the firm's expected cash flow net of risk premium while external equity finance k^E can grow more rapidly than w^M and that $(1-\tau)(1-\bar{\sigma})k^E$ can grow much more rapidly than w^M. Thus, the improvement of investor protection captured by a declining τ can increase the gap of external finance raised by business-group firms and stand-alone firms.

The asymmetric financial frictions are of concern because it can be another source of factor misallocation. In equilibrium, alleviated financial frictions for business groups can increase the demand for external capital and push up the price of capital. For stand-alone firms, however, the higher price of capital r acts as a higher degree of financial frictions τ in that the financial constraints of external finance always come with $1/(1+r)$ as well as $(1-\tau)$. Thus, given the lack of internal capital markets with the higher price of capital, stand-alone firms cannot raise as much capital as they could in an economy without business groups. As a result, an economy with business groups can give rise to a higher price of capital and lower aggregate output due to factor misallocation. Moreover, given that the asymmetric financial

frictions between business-group firms and stand-alone firms are intensified as the degree of financial frictions are mitigated, we can guess that the costs of business groups are more likely to dominate their benefits in equilibrium as financial frictions decrease. Last but not the least, the financial advantage of business groups increasing with investor protection $(1-\tau)$ implies that the prevalence of business groups needs not attenuate as investor protection improves.

C. *External Finance Substituting for Private Finance*

As the degree of financial frictions τ decreases, the model shows that both the volume of external equity finance k^E and corporate savings, or corporate lending $-k^D$, can expand without increasing capital in production k. Suppose that firms are financially unconstrained and that the degree of financial frictions is lessened such that

$$d\tau < 0, \quad dk = dk_1^* = dk_2 = 0. \tag{44}$$

From Corollary 2, we find that a business-group entrepreneur can be better off by increasing consumption $dc > 0$ and decreasing both private finance $dk_1^C < 0$ and external debt finance $dk_2^D < 0$ without altering the next-period wealth $da' = 0$ such that

$$\begin{aligned} dc &= -dk_1^C, \\ da'|_{dk_1^*=dk_2=0} &= d\tau - \tau(1-\bar{\sigma}_{BG})(1+r)dk_2^D = 0, \\ dk_1^* + dk_2 &= -d\tau + dk_1^C + \tau(1-\bar{\sigma}_{BG})dk_2^D = 0. \end{aligned} \tag{45}$$

Note that a decrease in private finance $dk_1^C < 0$ without a change in capital in production $dk_1^* = dk_2 = 0$ means a larger amount of net external finance such that

$$d(k_1^D + k_1^E) > 0, \quad d(k_2^D + k_2^E) > 0. \tag{46}$$

Moreover, from Corollary 2 with $dk_2 = 0,$ we can observe that internal equity finance k_2^C increases with corporate savings $-k_2^D$ such that

$$dk_2^C = -(1-\bar{\sigma}_{BG})dk_2^D > 0. \tag{47}$$

Similarly, from Corollary 1, a stand-alone entrepreneur can be better off by increasing consumption $dc > 0$ and decreasing both private finance $dk^C < 0$ and external debt finance $dk^D < 0$ without altering the next-period wealth $da' = 0$ such that

$$
\begin{aligned}
& dc = -dk^C, \\
(48) \qquad & da'|_{dk=0} = d\tau - (1-\sigma)(1+r)dk^D = 0, \\
& dk = -d\tau + dk^C + (1-\bar{\sigma}_{SA})dk^D = 0.
\end{aligned}
$$

A decrease in private finance $dk^C < 0$ without a change in capital in production $dk = 0$ means a larger level of net external finance such that

$$
(49) \qquad d(k^D + k^E) > 0.
$$

These results show that an excessive amount of external equity finance can be reinvested through corporate savings for risk sharing. In the case of business groups, a parent firm's excessive external finance flows into its internal equity finance that is used by the subsidiary firms when they invest for risk sharing. Moreover, by raising more external finance, an entrepreneur can reduce wealth transferred to her firm, consume more, and save less. The declining savings ratio of the rich, most of whom are financially unconstrained business-group entrepreneurs, can result in a decline in the capital stock of an economy. Thus, in the model, the strictly positive correlation between the price of capital and aggregate capital in production of an economy can be broken as financial frictions decrease.

VI. A Numerical Example of the Model

A. *Setup*

I construct a numerical example of the model and use it to compare two economies: an economy with business groups in which an entrepreneur can choose to create a business group and an economy without business groups in which building a business group is not an option for an entrepreneur.

Table 1 summarizes the parameters used in the numerical example. A CRRA utility

TABLE 1—PARAMETERS

Description	Parameter
Time discounting factor	$\beta = 0.85$
Relative risk aversion	$\gamma = 1.2$
Span of control	$\alpha + \theta = 0.8$
Capital share	$\alpha = 0.8/3$
Labor share	$\theta = 0.8 * 2/3$
Average capital depreciation rate	$E\delta' = 0.059$
Flotation costs	$k^F = 20$
Stand-alone firm's equity share sold out	$\bar{\sigma}_{SA} = 0.9$
Business-group firm's equity share sold out	$\bar{\sigma}_{BG} = 0.7$

TABLE 2—THE TRANSITION PROBABILITY OF MANAGERIAL TALENT

p_{-9}	p_{-8}	p_{-7}	p_{-6}	p_{-5}	p_{-4}	p_{-3}	p_{-2}	p_{-1}	p_0
0.005	0.005	0.01	0.01	0.01	0.01	0.1	0.2	0.3	0.2
p_{+1}	p_{+2}	p_{+3}	p_{+4}	p_{+5}	p_{+6}	p_{+7}	p_{+8}	p_{+9}	
0.1	0.01	0.01	0.01	0.01	0.0025	0.0025	0.0025	0.0025	

function is employed such that $u(c)=\frac{c^{1-\gamma}-1}{1-\gamma}$. I choose parameters that are conventional in the literature with one exception, a time-discounting factor β, which is intentionally set to a very low value for rapid convergence of the numerical calculation. Model-specific parameters such as flotation costs and maximum equity shares sold to outside shareholders are based on the rule of thumb.[12]

The wealth space is discretized into twenty exponentially increasing grids from $a(1)=1.0\times10^{-4}$ to $a(20)=1.0\times10^{6}$. The managerial talent space is discretized into twenty exponentially increasing grids from $z(1)=1$ to $z(20)=4$. The transition probability of the managerial talent from $z=z(i)$ to $z'=z(j)$ is defined as follows: $\forall i\in\{1, 2, \cdots, 19, 20\}$, $j=\max\{1, \min\{20, i+k\}\}$ *with probability* p_k, $k\in\{-9, -8, \cdots, 8, 9\}$, in Table 2.[13]

Lastly, I assume that the capital depreciation rate δ' is a simple random variable, which is independent of shocks to managerial talent such that

$$\delta'=\begin{cases}\overline{\delta}=0.8 & \textit{with probability } 0.05\\ \underline{\delta}=0.02 & \textit{with probability } 0.95\end{cases}. \tag{50}$$

B. *Observations*

Observation 1 (Occupational Choice). *The rich choose to become business-group entrepreneurs. The poor but talented are hired as business-group managers with positive probabilities. The northwest region of* (z,a), *where individuals with positive probabilities of being hired as managers reside, becomes smaller as investor protection improves. The poor, untalented become workers.*

Figure 3 shows the occupational choices of individuals given a moderate degree of financial frictions, $\tau=0.5$. We find that the east, where the rich reside, is filled with business-group entrepreneurs and that the northwest, where the poor but talented reside, is filled with stand-alone entrepreneurs who can be hired as business-

[12]For example, I choose $\overline{\sigma}_{BG}=0.7$ because it is one of the criteria the Fair Trade Commission in South Korea uses to identify if a corporation is a business-group subsidiary.

[13]Note that given the exponentially increasing managerial talent space, the transition probability defined in Table 2 mimics a scale-free growth process bounded below $z'=z(1)$ with negative drift, which can approximate a stationary Pareto distribution (e.g., Gabaix, 1999).

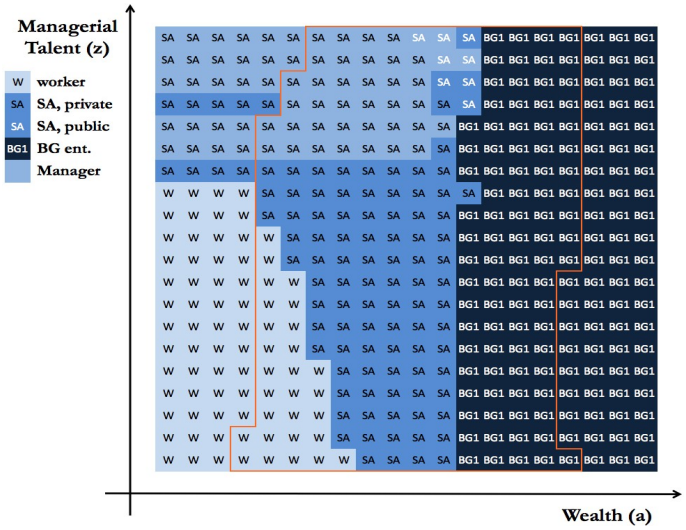

FIGURE 3. OCCUPATIONAL MAP IN AN ECONOMY WITH BUSINESS GROUPS GIVEN $\tau = 0.5$

Note: No population exists outside the border of the orange line.

group managers. This occupational policy function shows that pyramidal business groups work as start-up breeders that can foster productive firms given capital market imperfections. In the southwest, a declining line separating a SA region from a W region indicates that wealth is required for an individual to become a stand-alone entrepreneur given financial frictions.

As the fraction of diversion decreases to $\tau = 0.1,$ two changes are observed in Figure 4 below, which depicts the occupational choices of individuals in an economy with business groups given $\tau = 0.1.$ First, the rich but untalented still become business-group entrepreneurs because they expect to earn ex-ante positive profits by hiring the talented as managers. We will see that these unproductive business-group entrepreneurs can be a source of resource misallocation. If we shut down the possibility of creating pyramidal business groups, the southeast region in Figure 6 shows that the rich but untalented business-group entrepreneurs would become workers in an economy without business groups given $\tau = 0.1.$

Second, Figure 4 shows that fewer individuals are hired as business-group managers. Note that the managerial compensation $w^M(z_2, a_2)$ is likely to increase as financial frictions decrease because an outside option of running a stand-alone firm should be a better option with lower financial frictions. Thus, business-group entrepreneurs must hire the more talented but still financially constrained in order to earn positive profits. The contracted upper northwest region in Figure 4 captures this rising cut-off value of managerial talent, which can give business-group entrepreneurs positive profits with high enough managerial talent but low enough managerial compensation.

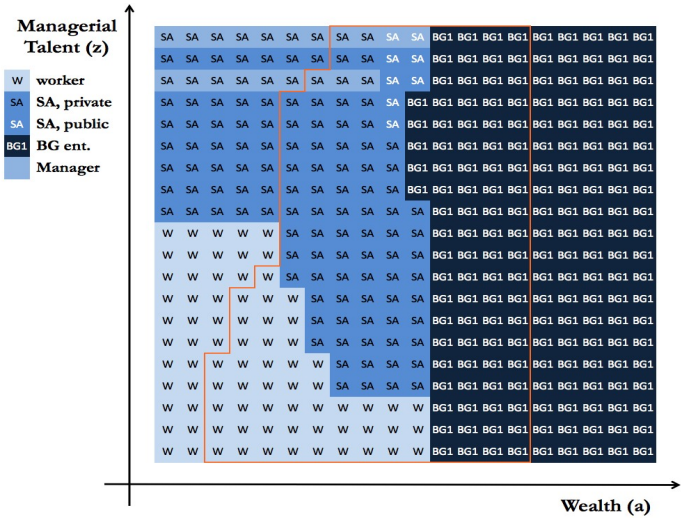

FIGURE 4. OCCUPATIONAL MAP IN AN ECONOMY WITH BUSINESS GROUPS GIVEN $\tau = 0.1$

Note: No population exists outside the border of the orange line.

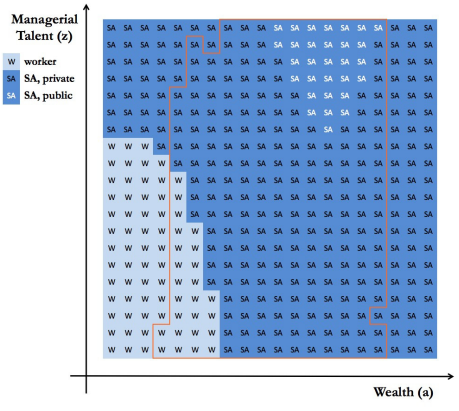

FIGURE 5. OCCUPATIONAL MAP IN AN ECONOMY WITHOUT BUSINESS GROUPS GIVEN $\tau = 0.5$

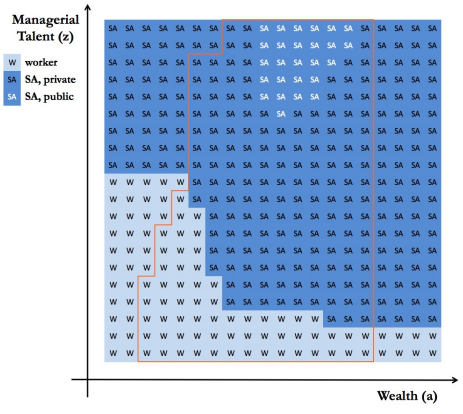

FIGURE 6. OCCUPATIONAL MAP IN AN ECONOMY WITHOUT BUSINESS GROUPS GIVEN $\tau = 0.1$

Note: No population exists outside the border of the orange line.

Observation 2 (The Relative Number of Business-Group Firms). *The prevalence of business groups shows an insignificant correlation with the strength of investor protection as measured by* $(1-\tau)$. *Specifically, the relative number of business-group firms out of all corporations does not decrease with* $(1-\tau)$.

Observation 2 can be understood as a corollary of Observation 1, which states that the rich become business-group entrepreneurs regardless of the degree of financial frictions. Figure 7 below presents two interesting features about the prevalence of business groups. First, business-group firms cannot thrive under overly severe financial frictions, such as $\tau \geq 0.7$, because overly severe financial frictions

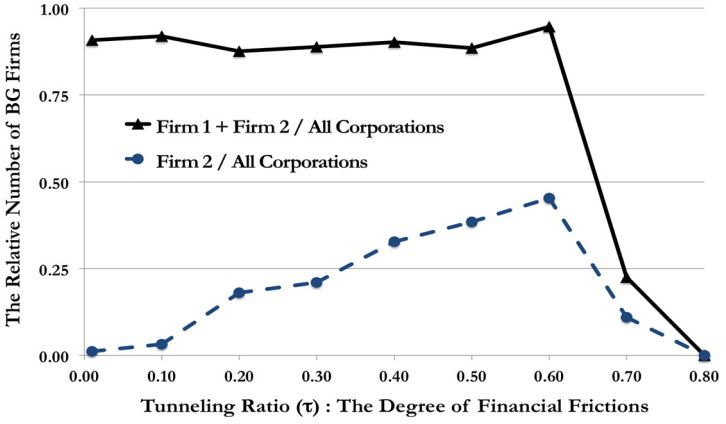

FIGURE 7. THE PREVALENCE OF BUSINESS GROUPS MEASURED BY THE RELATIVE NUMBER OF FIRMS

undermine the financial advantage of a pyramidal ownership structure that leverages external capital markets.

Second, although the total number of business-group firms is unvarying, the number of subsidiary firms decreases as financial frictions decrease. Observation 1 already shows that the number of individuals who have a positive probability of being hired as managers decreases as financial frictions decrease. We will observe in the following observations that subsidiaries are more productive than parents and that this decreasing ratio of subsidiary firms can weaken the benefits of pyramidal business groups as start-up breeders.

Observation 3 (Asymmetric Financial Frictions between Business-Group Firms and Stand-Alone Firms). *Business-group firms have a larger ratio of capital to labor than stand-alone firms. The variance of the capital-to-labor ratios is smaller within business-group firms than within stand-alone firms.*

Given the Cobb-Douglas production function, the ratio of capital to labor would be identical for all types of firms if an economy had no financial frictions and no shocks to managerial talent. Thus, business-group firms' higher mean and smaller variance of the capital-to-labor ratios suggest that business-group firms have better financial conditions than stand-alone firms. Figure 8 shows that these instances of asymmetric financial frictions persist and hardly vary even when investor protection improves.

Figure 8 also shows that public corporations achieve capital-to-labor ratios nearly identical to those of business groups as τ goes to zero. This implies that firms would be financially unconstrained if they could use external equity finance with fine investor protection. However, the asymmetric financial frictions between the business-group and the stand-alone firms do not wane because most standalone entrepreneur do not pay flotation costs k^F and turn down the option of tapping into external equity markets. As indicated in Figure 7, most corporations are business-group firms, and the relative number of public corporations using external equity finance decreases as τ decreases.

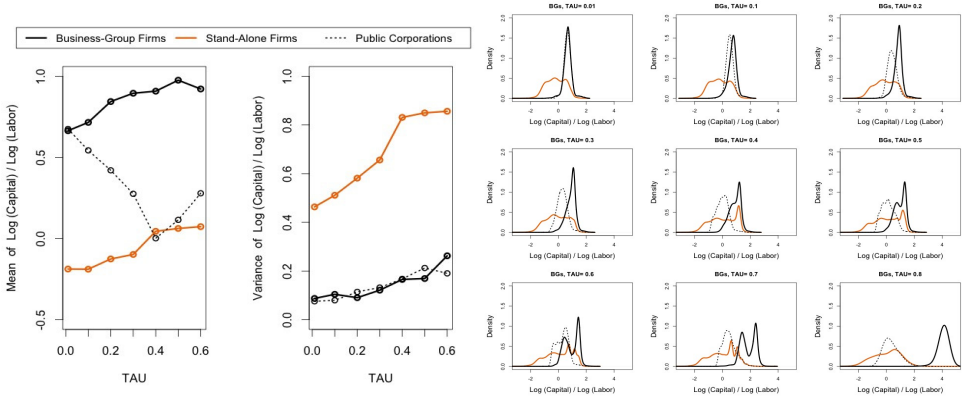

FIGURE 8. DISTRIBUTIONS OF THE CAPITAL-TO-LABOR RATIO

Then, the question is if this asymmetric financial frictions have sizable effects on resource allocation. The following Observation 4 provides an answer to this question.

Observation 4 (Firm Size Distributions). *Business-group firms have a larger mean and variance of employment and also have a larger mean and variance of TFP than stand-alone firms.*

Figure 9 shows that business-group firms are larger than stand-alone firms on average because business-group firms have not only better financial conditions (Figure 8) but also better managerial talent on average (Figure 10).

Business-group firms, however, also have larger variances of employment and managerial talent. Given the persistence of asymmetric financial frictions, a large number of unproductive business-group firms can distort resource allocation in a stationary equilibrium. Note that the distributions of business-group firms are bimodal. Small, unproductive business-group firms coexist with large, productive business-group firms. This observation complies with the occupational choice that the rich but unproductive choose to become business-group entrepreneurs regardless of the degree of financial frictions (Figure 4).

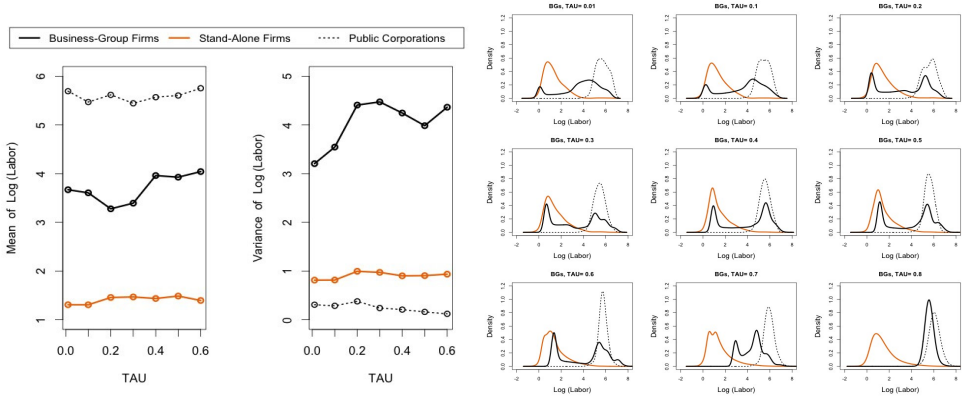

FIGURE 9. FIRM SIZE DISTRIBUTIONS AS MEASURED BY EMPLOYMENT

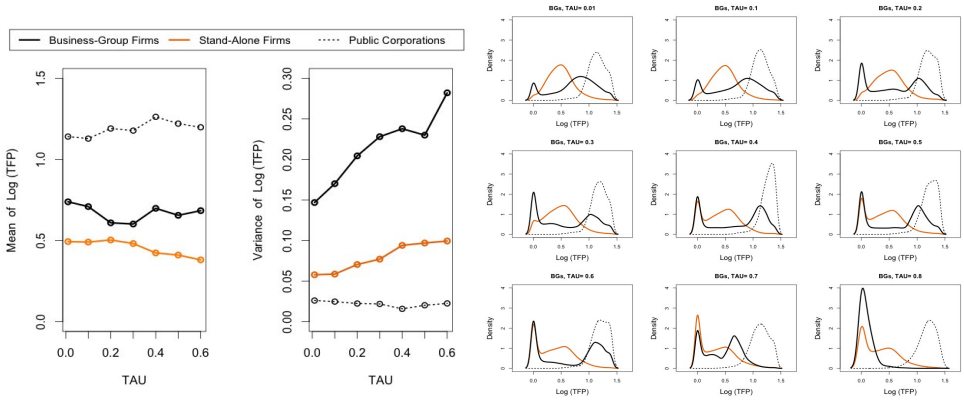

FIGURE 10. DISTRIBUTIONS OF MANAGERIAL TALENT (TFP)

Given that pyramidal business groups have a financial advantage but also have more dispersed productivities, the effects of pyramidal business groups on resource allocation are ambiguous. Their financial advantage makes business-group firms not only raise more capital but also allocate more capital to low-productivity business-group firms. Observation 5 below shows that the net effects of pyramidal business groups depend on the level of financial frictions, τ.

Observation 5 (Factor Prices and Aggregate Inputs). *As the strength of investor protection* $(1-\tau)$ *improves in an economy with business groups, both the rate of return on capital and wages increase monotonically, while both the capital stock and labor force increase first and then decrease.*

Figure 11 captures the correlations between factor prices and aggregate inputs with regard to the degree of financial frictions. It shows that positive correlations between factor prices and aggregate inputs are broken under the prevalence of business groups. The existence of business groups helps an economy achieve a large amount of aggregate input under a moderate level of financial frictions, such as $\tau \in [0.3, 0.7]$. However, a further decrease in financial frictions from $\tau = 0.2$ only pushes up factor prices and results in relatively less aggregate input of an economy. This non-monotonicity contrasts with the strictly positive correlations between factor prices and aggregate inputs in an economy without business groups.

The negative correlation observed in Figure 11 derives from a decrease in savings of the rich. Table 3 below captures savings of the rich,[14] whose wealth is in the top 0.14% in an economy with business groups. It shows that the rich who choose to create business groups save less as financial frictions decrease. Their level of savings decreases from 0.88 to 0.53, and the share of their savings decreases from 52% to 33%. This decrease in savings can be supported by the financial advantage of business-group entrepreneurs, which allows them to substitute external finance for

[14]I choose $a(13) = 398$ as the criteria for the rich because the population of individuals whose wealth is greater than or equal to 398 hardly changes as financial frictions decrease; the population changes from 0.147% with $\tau = 0.5$ to 0.136% with 0.136%.

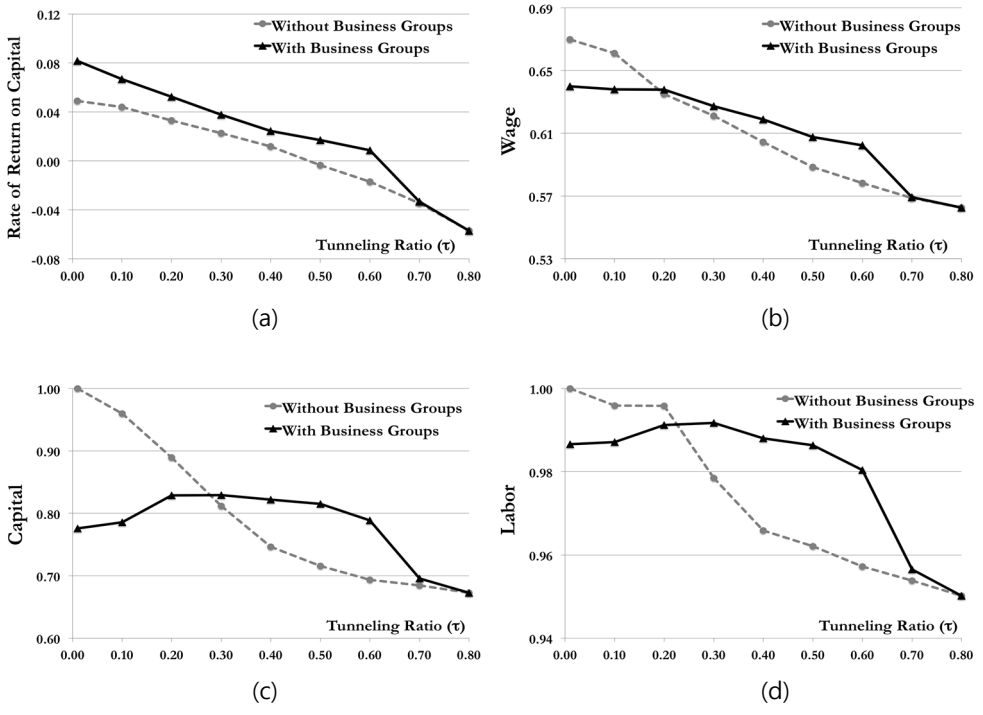

FIGURE 11. FACTOR PRICES AND AGGREGATE INPUTS

TABLE 3—SAVINGS OF THE RICH

The Degree of Financial Frictions	$\tau = 0.1$	$\tau = 0.5$
An Economy with Business Groups		
Savings Share of the Rich (Level)	33% (0.53)	52%(0.88)
Population Share of the Rich	0.14%	0.15%
An Economy without Business Groups		
Savings Share of the Rich (Level)	47% (0.93)	35% (0.52)
Population Share of the Rich	0.21%	0.11%

private finance. With the same amount of wealth, business-group entrepreneurs can consume more and save less by raising more external capital as financial frictions decrease.

It is interesting that the savings of the rich would monotonically increase with investor protection if we shut down the possibility of creating business groups. In an economy without business groups, the savings of the rich increase from 35% to 47% as financial frictions decrease from $\tau = 0.5$ to $\tau = 0.1$. Note that the population of the rich increases,[15] which implies that the lower level of financial frictions help the talented accumulate wealth in an economy without business groups.

[15]Given the criteria of the rich, $a \geq a(13) = 398$, the population of the rich in an economy without business groups increases from 0.11% with $\tau = 0.5$ to 0.21% with $\tau = 0.1$.

TABLE 4—WEALTH OF STAND-ALONE ENTREPRENEURS IN AN ECONOMY WITH BUSINESS GROUPS

The Degree of Financial Frictions	$\tau = 0.1$	$\tau = 0.5$
Wealth Share of SA Entrepreneurs (Level)	18% (0.46)	40% (1.04)
Population Share of SA Entrepreneurs	5.24%	5.78%

In an economy dominated by business groups, however, its stagnating population of the rich suggests that the poor but talented suffer from asymmetric financial frictions and have difficulty in accumulating wealth. Table 4 shows this possibility. The absolute level of stand-alone entrepreneurs' wealth decreases from 1.04 to 0.46 as financial frictions decrease from $\tau = 0.5$ to $\tau = 0.1$, and the share of their wealth also decreases from 40% to 18%. Note that the population of stand-alone entrepreneurs scarcely changes as financial frictions decrease. This implies that the decrease in stand-alone entrepreneurs' wealth derives from a decrease in their wealth on average, not from a decrease in their overall population.

Observation 6 (Aggregate Flotation Costs). *An economy with business groups consumes larger flotations costs than an economy without business groups.*

Observation 6 teaches us that creating a business group can be an efficient choice for an individual, but not for an economy. As shown in Figure 12, the flotation costs of an economy with business groups increase more rapidly than those of an economy without business groups. Recall that the rich but untalented create business groups by paying flotation costs in order to launch productive subsidiaries. Thus, incorporating pyramidal business groups requires larger fixed costs. The problem is that while more parent firms are incorporated, fewer subsidiary firms are launched as financial frictions decrease.

Figure 13 shows that the aggregate flotation costs in an economy with business groups are sizable. The aggregate investment net of flotation costs decreases as τ goes to zero. This is in good agreement with the observation that as τ goes to zero, the capital stock of an economy with business groups declines.

One can ask why net investment declines despite the fact financial frictions decrease and the rate of return on capital continues to rise. Figure 14 gives an

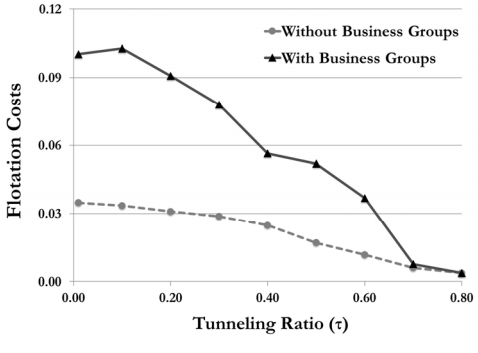

FIGURE 12. FLOATATION COSTS

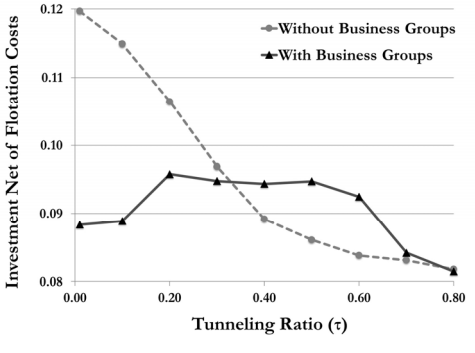

FIGURE 13. INVESTMENT NET OF FLOTATION COSTS

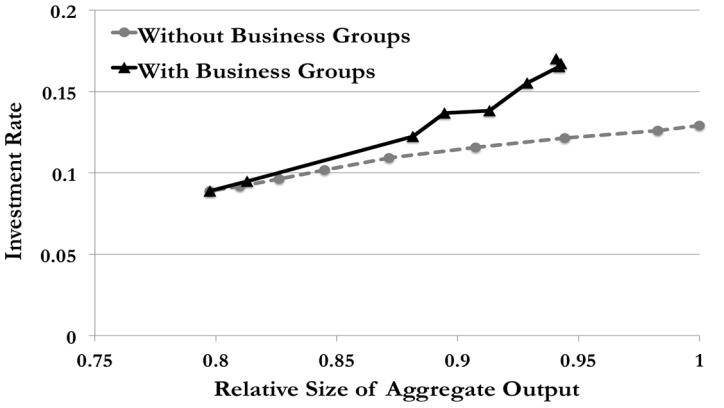

FIGURE 14. INVESTMENT RATES

explanation. It shows that the investment rate of an economy with business groups is not only larger than that of an economy without business groups but that it also increases monotonically. Thus, a decrease in financial frictions indeed increases the investment rate of an economy. The excessive flotation costs used up by business groups, however, overwhelm the increase in investment and result in the decrease in net investment used for replenishing capital depreciation in a stationary state equilibrium as τ goes to zero.

Observation 7 (Aggregate Output). *We define the aggregate output of an economy as the sum of aggregate consumption and aggregate investment. The aggregate output of an economy with business groups thus does not monotonically increase with investor protection. When the level of investor protection is strong enough, such as* $(1-\tau) \geq 0.8,$ *an increase in investor protection does not increase the aggregate output of an economy under the prevalence of business groups.*

Pyramidal business groups cause the aggregate output of an economy to regress toward a moderate level over the degree of financial frictions. Figure 15 shows that business groups can partially nullify the impact of financial frictions on aggregate output. At an early stage of development, where financial frictions are rampant, business groups help an economy produce larger levels of aggregate output.[16] When the tunneling ratio τ goes to zero, however, Figure 15 shows that the aggregate output of an economy with business groups stagnates.

Observation 7 rebuts the argument that the economic impact of business groups would spontaneously vanish if investor protection improves. The stagnating aggregate output rather suggests that achieving good investor protection is not enough to lessen the effects of business groups on an economy and that aggregate output may not grow without restraining the prevalence of business groups. As

[16]Figure 15 shows that a little development of investor protection is required for business groups to help an economy produce more aggregate output. This arises because the internal equity finance of business groups works as leverage for raising capital from external markets. Excessive financial frictions can weaken the efficiency of the financial advantage of pyramidal business groups.

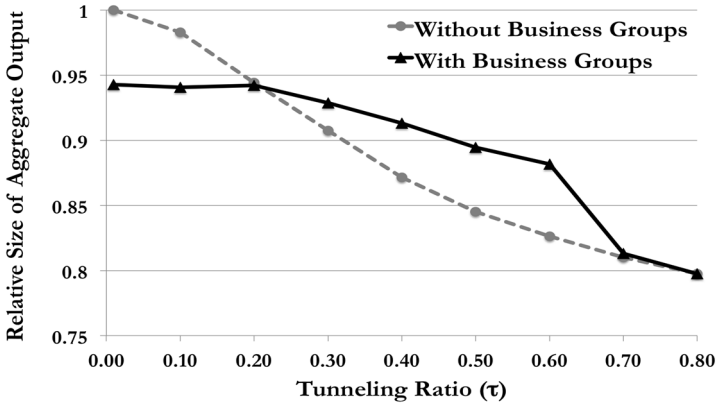

FIGURE 15. AGGREGATE OUTPUT

argued earlier, business groups can asymmetrically benefit from an improvement of investor protection in the model. The stagnating aggregate output of an economy with business groups in Figure 15 suggests that the asymmetric financial frictions become sizable and that the benefits of business groups can be dominated by their costs when the degree of financial frictions is low enough, such as $\tau \leq 0.2$.

The following Observation 8 shows how sizable the asymmetric financial frictions between the business-group and the stand-alone firms are and why dealing with the pyramidal ownership structure is necessary for the development of external capital markets.

Observation 8 (External Capital Markets). *We define the size of external capital markets as the sum of external debt finance and external equity finance used by all firms such that*

$$\begin{aligned} \text{External Capital Markets} = & \int_{o(z,a)=SA} \{1 - P^M(z,a)\} \cdot \{k^D(z,a) + k^E(z,a)\} dF(z,a) \\ & + \int_{o(z,a)=BG} \sum_{i \in \{1,2\}} E_{a_2} \left[k_i^D(z,a \mid z_2(z,a), a_2) + k_i^E(z,a \mid z_2(z,a), a_2) \right] dF(z,a). \end{aligned} \tag{51}$$

Controlling for aggregate output, the external capital markets of an economy with business groups are smaller than those of an economy without business groups.

Figure 16 shows that the underdevelopment of external capital markets can be associated with the prevalence of business groups in equilibrium. However, this does not mean that shutting down business groups increases the sizes of external capital markets. External capital markets of an economy with business groups are larger than those of an economy without business groups given a moderate degree of financial frictions $\tau \in [0.3, 0.6]$, while they are smaller given a low degree of financial frictions $\tau \leq 0.2$.[17] It is a more precise interpretation of the result that

[17]Note that in Figure 16, each point on a line from left to right is connected with two adjacent points of tunneling ratio $\tau \in \{0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1, 0.01\}$.

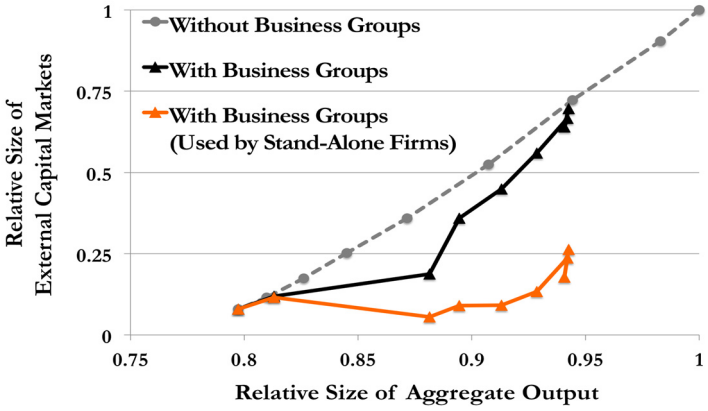

FIGURE 16. EXTERNAL CAPITAL MARKETS

business groups decrease the size of external capital used by stand-alone firms in equilibrium. Figure 16 shows that more than half of external capital is used by business groups and that the external capital used by stand-alone firms is smaller than that by their counterparts in an economy without business groups.

This underdevelopment of external capital markets in an economy with business groups arises due to the asymmetric financial frictions between business-group firms and stand-alone firms in the model. Note that given the same degree of financial frictions, the price of capital is always higher in an economy with business groups than in one without business groups. The higher price of capital impairs stand-alone firms' external financing. Thus, stand-alone firms, which lack internal capital markets, should suffer from tighter financial constraints and cannot but raise less external capital in an economy dominated by business groups.

VII. Concluding Remarks and Future Research

Financial frictions can cause resource misallocation. It is understood as one of the major hindrances to economic development. Although many researchers have shown why and to what extent financial frictions can affect an economy, few macroeconomic models have investigated private institutions that can arise as endogenous reactions against financial frictions. In this paper, I study the endogenous creation of pyramidal business groups and focus on the repercussions of their financial advantage given capital market imperfections.

There are three main implications of the model. First, pyramidal business groups can be efficient private institutions if external capital markets are underdeveloped due to severe financial frictions. Second, the asymmetric financial frictions between business-group firms and stand-alone firms can create inefficiencies that impair stand-alone firms' external financing in equilibrium. Third, the prevalence of business groups does not spontaneously shrink as investor protection improves.

The final implication can be viewed as a limitation of this paper, in that the unvarying number of business-group firms in the model cannot explain why the

prevalence of business groups differs across developed countries. Thus, finding a rationale for the cross-country difference can be an interesting topic for future research. For instance, Kandel, Kosenko, Morck, and Yafeh (2015) argue that U.S. pyramidal business groups have almost disappeared because the U.S. government pursued specific policy measures to regulate business groups, such as the Public Utility Holding Company Act (1935), and the increase in inter-corporate dividend taxation (after 1935). We can use the model developed in this paper to conduct a counter-factual analysis that examines how effectively the regulations adopted in the U.S. can reduce the prevalence of business groups and undo the factor misallocation spawned by the business groups.

Another follow-up research agenda can be to study the effects of pyramidal business groups on wealth inequality and socioeconomic mobility. The model developed in this paper suggests that the rich can entrench their wealth by building up pyramidal business groups, which results in a decrease in the probability of the poor accumulating wealth. Given the assumption that the inequality of entrepreneurial productivity stems from luck, business groups could be an institution that allows the rich to insure their wealth against their bad luck. This entrenchment of the rich implies that the prevalence of business groups can prevent the poor from exploiting their good luck in a general equilibrium. Thus, the model could be used to study how pyramidal business groups can change the patterns of wealth inequality and socioeconomic mobility.

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Easier Set Than Done: Stakeholder Engagement as Public-Private Partnership in Regulatory Policy of South Korea†

By JONGYEARN LEE*

An emphasis on public-private partnership (PPP) in the regulatory policy process can overcome the challenges hindering regulatory effectiveness with the emergence of fast developing technologies and new industries. This study attempts to evaluate quantitatively different aspects of institutional settings of South Korean regulatory policy in terms of stakeholder engagement as PPP, using evidence-based data released by the OECD. From the results of the principal component analysis, South Korea can be evaluated as being at a very good level overall in its institutional establishment. Nevertheless, the fact that the outcome of regulatory reforms in South Korea is still insufficient compared with this well-established system suggests that the country should concentrate on improving system operation. Consequently, this study makes policy suggestions to improve regulatory effectiveness through PPP by supplementing the facets that are well-equipped but not feasible with respect to regulatory policy cycle, regulatory governance, regulatory method, and conflict resolution.

Key Word: Regulatory Policy Process, Public-Private Partnerships, Stakeholder Engagement
JEL Code: K20, L50, H11, H83, D74

I. Introduction

Recently, there are growing concerns over a "regulatory slowdown," which cannot keep pace with the rapid progress of technological advances and the complicated connection of economic activities. One of the biggest causes is that the regulatory authorities are often less well-informed than their counterparts in the private sector. There are situations in which regulatory effectiveness cannot be

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exerted by a government-led "command and control" regulatory framework, unlike as was the case with low levels of technological expertise and the simple economic structure of the past. In particular, when introducing innovative and convergent products that incorporate new technologies, the existing rigid and vertical regulatory system fails to accommodate them, thereby hindering growth engines. Examples include three-dimensional printers that have been confused because they do not fit into specific codes in the existing product classification scheme, and energy storage systems (ESS) which have struggled to clarify their legal status as a power generation equipment by function-based power system classification (see Lee, 2016, pp.151-152 for more details of ESS case).

In addition, there has long been a well-known problem regarding ambitious initiatives of regulatory reform failing to exert a substantial impact. One of the reasons for this is the misconception that improvements in regulations are regarded as a measure that incurs losses for a specific group or groups (Lee and Kim, 2015, p.30). That is, regulatory reform is difficult because it identifies beneficiaries and victims and drives them to a topic of preferential treatment. In the case of a large number of stakeholders surrounding regulatory matters, there may be positive or negative consequences of regulatory improvements. However, it should be recognized that regulatory reform is not used in solving conflict of interests, but in building rational institutions. For example, as the sharing economy, which provides new services by utilizing idle resources, emerges, the introduction and expansion of new business areas such as vehicle sharing and accommodation sharing are accelerated, and conflicts of interest with existing suppliers are inevitable. The focus of regulatory policy should be on maximizing the expected benefits and enhancing the welfare of society as a whole rather than protecting the interests of stakeholders.

The expansion of public-private partnership (PPP) is suggested as a solution to the difficulties of regulatory reform when taking into account an increase in regulatory failures when confronting changing environments and conflicts of interest. However, it is not appropriate to make PPP a policy target. Rather, PPP is a necessary tool for policy formulation and implementation. In regulatory policy, the objective is to eliminate elements of market failure through the introduction and implementation of appropriate regulations and the adjustment of regulations in response to changes in circumstances. If the government fulfills the role of coordinator and achieves the allocative efficiency of resources as the outcome of regulatory policy, PPP is one of the input factors of the policy.

Therefore, the necessity of PPP can be emphasized in two respects. On the one hand, increasingly complex and interconnected economic activities and rapid technological changes in recent years have provided an environment that makes it more difficult for governments to act unilaterally and dominant regulatory policies. On the other hand, it is necessary to consult and coordinate with a wide range of stakeholders for the purpose of eradicating defensive vested interests or rent seeking in accordance with stakeholders' conflict of interests, and misunderstandings such as preferential treatment.

In this regard, the purpose of this study is to determine the areas where PPP should be actively pursued and to suggest ways to improve regulatory effectiveness in South Korea. In so doing, this study attempts to identify areas where effectiveness should be improved by evaluating the system for PPP at the level of overall regulatory

policy, rather than analyzing it for specific industries or sectors. In order to do this, it aims to exploit the relatively weak aspects of regulatory policy in South Korea empirically, using objective data.

PPP in the regulatory policy process can take various forms. It can be divided into the consultation and cooptation of private actors (stakeholders and experts), co-regulation of public and private actors, delegation to private actors, and private self-regulation in the shadow of hierarchy according to the relative size between government control and private autonomy (Börzel and Risse, 2005, p.199, Figure 2).

According to the purpose of this study, an empirical comparison between forms of PPP is not appropriate because the form of PPP is uniquely determined by the specific conditions of the industry or the regulatee. Meanwhile, existing studies are either merely claiming the necessity of promoting PPP in the regulatory policy process due to lack of proper data (Lee, 2014) or presenting conceptual models with cases or results from a survey on a specific area (Shim, 2002; Kim, 2006; Seo, 2009; Kim, 2014a; Choi, 2015). In order to overcome the limitations of the existing literature, this study aims to conduct a quantitative analysis on this matter for the first time using recently published international data.

The OECD surveyed the status of the regulatory system in member states through questionnaires and attempted to increase the credibility of the survey by requiring the provision of evidence in the responses. Using the data from 2014 and 2017, this study attempts to perform the principal component analysis (PCA) for categorical comparisons in methodology, oversight and quality control, systematic adoption, and transparency of stakeholder engagement, a widely applicable modality of PPP.

A result of this analysis showed that the regulatory system of South Korea demonstrated remarkable growth in all four categories in 2017 compared with 2014. In particular, it ranked the highest in transparency. In the case of systematic adoption, the country's system was evaluated highly together with many countries (15 for primary laws and 11 for subordinate regulations). This confirms that the country leads, or at least participates in, the increasing trend of systematic introduction of the participation of stakeholders.

It should be noted, however, that these results do not measure the performance of regulatory reform, but rather assess the excellence of regulatory institutional settings. As seen in many surveys, the impact of regulatory reform in South Korea is low. The results of this study suggest that the PPP system in South Korea's regulatory policy process is well-equipped across all four categories, but it needs improvement in implementation practices. In other words, measures should be taken to increase the practical effectiveness of the regulatory system to take advantage of its original intent in actual operation.

To this end, we examined ways of enhancing PPP in terms of (a) regulatory policy cycle, (b) regulatory governance, which can be applied across all regulations, (c) regulatory methods and (d) coordination of stakeholders' opinions, which are applicable to individual cases.

Consequently, this study points out that (a) it is necessary to strengthen the consultation process with stakeholders in the regulatory impact analysis (RIA) so as to promote PPP from the design stage of the regulation, and (b) regulatory governance needs to be supplemented to utilize a PPP scheme such as listening to experts to enhance regulatory effectiveness. Moreover, it suggests that (c) it is

necessary to apply output-based regulatory methods instead of input-based ones to properly ensure the autonomy of the private sector. Finally, it proposes that (d) the public deliberation process should be introduced to overcome challenges in the case of regulatory issues where discussions are stalled by stark opposition between stakeholders.

The rest of this paper is structured as follows. Section II summarizes existing debates and discussions on the necessity and controversy of PPP in the regulatory policy process in South Korea. Section III attempts to identify the aspects of stakeholder engagement in the regulatory policy process in South Korea that should be emphasized when pursuing PPP in the regulatory policy process by conducting an empirical analysis to determine the categories that are weaker compared to other countries. Section IV derives improvement measures based on the results of the previous analysis. Finally, Section V is devoted to the concluding remarks.

II. Existing Debates and Discussions

The regulatory system in South Korea has been led by the government, and recently a review of the transition to the private-led system was proposed (Lee, 2014, p.5). In this section, we will examine the details to find a breakthrough by means of joint efforts of the government and the private sector in the process of regulatory policy in South Korea. In so doing, we focus on existing debates and discussions on the need for PPP as a practical alternative.

A. *Regulatory Culture and Need for PPP*

Sagong (2005) defined three specific characteristics of South Korea's regulatory culture. First, there is regulatory universalism or excessive dependence on regulations, meaning that people believe anything can be done through regulatory measures. Second, there is a distrust of market and competition principles. Third, there is a patriarchal regulatory culture which advocates government protection of specific industries by means of regulations (Sagong, 2005, pp.45-47). The reasons for this include Confucian culture, a tradition of bureaucracy, experience of government-led economic development, and regulatory needs through lessons learned from negative cases (Sagong, 2005, pp.47-50). While the empirical explorations and relative comparisons of these arguments are beyond the scope of this study, this section seeks to identify the limitations of government's direct command and control and the characteristics and difficulties of private participation in light of the specificity of the regulatory culture in South Korea.

First, there is a problem of "disagreement with the field" which is pointed out as a limitation of excessive regulatory dependency and government's peremptory behavior. When regulation is regarded as a public good, the application of regulations by the government is beyond the regulatory demands needed by the industry. Among reasons for such problems, we will highlight the incentive and capacity of regulators.

The regulatee-oriented "active administration" is often referred to as one of the essential elements of regulatory reforms, but in fact, passive administrative treatment

issues have been brought about by regulators. Passive administration is caused by the incentive of the regulator to follow precedents or to conduct the task in a conservative manner to avoid any chance of reprimand in the evaluation of the work, such as auditing. Therefore, regulators tend to avoid blame in the process of drafting and enforcing regulations. As distinguished by Hinterleitner and Sager (2017), blame avoidance can be classified into "anticipatory blame avoidance" acting in preparation for future criticism and "reactive blame avoidance" behaving counteractively after an accusation. While the former behavior occurs mainly in the design of regulations, the latter behavior is observed mainly in the regulatory enforcement process.

The regulator's overbearing blame avoidance behavior can be a burden for the regulatees. From the perspective of anticipatory blame avoidance, the regulator may act to increase the so-called "inter-departmental barrier," work only on those elements that can directly affect the accused, and offer incentives to facilitate the management of accusations in the future. A different stance of the relevant regulatory authorities due to such a particularism may incur unnecessary additional costs and time expenditures to the regulatee (Kim, 2014a, p.50). In case of infrastructure PPP projects, it was pointed out that the market was not activated in the early days after the enactment of the PPP Act due to the tendency of public officials to avoid any hint of suspicion regarding favoritism for large conglomerates, namely the *Chaebol* (Kim *et al*., 2011, p.7). Moreover, until recently, the trend toward regulatory strengthening has been maintained due to the burden of liability for the failure of the infrastructure PPP project (Hong and Kim, 2018, p.300) and the tendency to avoid public criticism (Kim, 2015, p.27).

On the other hand, so-called "shadow regulation" is a representative example of reactive blame avoidance behavior during the enforcement of regulations, which means irregular discretionary actions by the regulator which are not based on laws or through excessive interpretation of laws. For example, in the case of self-regulatory matters, which are forms of PPP, regulatory authorities have introduced restrictive opinions in practice at the time of revision of self-regulatory rules and regulations of the private associations (Financial Services Commission and Financial Supervisory Service, 2015, p.3).

Second, the capacity of regulators is worthwhile to look at whether there is sufficient expertise and scale. For both, maintaining the government's own direct command and control regulatory framework does not seem desirable. On the one hand, it is difficult to accumulate expertise due to the civil service's application of frequent job rotations of its staff. We will not deal with this topic in depth since it is a problem for the overall administration, not only for regulations, and there are advantages to the acquisition of comprehensive knowledge in the training of senior officials and in anti-corruption programs. However, in the case of the RIA, which is mandated to recognize *ex ante* the impact of a newly introduced or strengthened regulation on the society, it is worth pointing out that public officials are not able to make a fully rigorous analysis due to the limitations of job expertise and analytical techniques (Lee, 2014, p.3).

On the other hand, the insufficient number of regulatory personnel has also been pointed out frequently. For example, as shown in Table 1, regulatory personnel in the field of occupational safety in South Korea is in short supply when compared to the major countries.

TABLE 1—HUMAN RESOURCE ASSIGNED TO OCCUPATIONAL SAFETY

Classification		South Korea (2015)	United Kingdom (2012)	Germany (2011)	United States (2010)	Japan (2010)
Number of regulatory enforcement staff		406	2,432	4,405	3,878	1,400
Number of industries	Total number (in thousands)	2,367	2,149	3,734	8,571	2,622
	Number of industries per regulatory enforcement staff	5,830	884	848	2,210	1,873
Number of employees	Total number (in thousands)	17,969	29,721	37,475	127,820	52,488
	Number of employees per Regulatory enforcement staff	44,258	12,221	8,507	32,960	37,491

Source: OECD (2017), p.33, Table 1 (Original Data Source: Ministry of Employment and Labor (South Korea), Health and Safety Executive (United Kingdom), Federal Ministry of Labor and Social Affairs (Germany), Occupational Safety and Health Administration (United States), and Statistics Bureau (Japan)).

B. *Forms of PPP and Their Problems*

Next, we will look at what kind of PPPs are in South Korea's regulatory policy process and what kind of problems are raised. First, in the context of the shortage of regulatory personnel, as in the case of occupational safety, co-regulation, in which a private self-regulation organization (SRO) regulates its members under the legal framework, has been in operation. Choi (2015) conducted a survey of regulatory officials, SROs such as business associations, member companies affiliated with them, and civic groups. The survey found that the greater the degree of government involvement in SROs, the greater the link between SRO and civil society, and the more rational the operation of SRO, the higher the effectiveness of co-regulation. Accordingly, he suggested (1) to establish a role-sharing system in terms of regulatory governance; (2) to seek measures to secure the effectiveness of co-regulation; (3) to introduce screening and differentiated cooperation measures; (4) to secure public interest in, and the independence of, SRO; (5) to secure transparency in the operation of SRO; and (6) to expand participation of civil society for co-regulation (Choi, 2015, p.286).

The question raised here pertains to the imbalance between the external control of the government on the SRO and the internal control of the SRO on the member companies. Problems include a lack of competence and representation of the SRO, the unilateral dependence of the SRO on the government, complaints by members about the invalidity and unfairness of self-regulation due to the vertical relationship between the government and the SRO, the lack of substantial sanctions due to the SRO's limited ability to control member companies, and the dual attitude of various interest groups (Choi, 2015, p.301).

Second, by ensuring the participation of the private sector in regulatory reform governance, the government is taking measures to reflect the opinions of regulatees and stakeholders. Table 2 summarizes the transition of the regulatory reform implementation system and the private participation method in South Korea. Most notable is that the methods are oriented toward trouble shooting and complaint

TABLE 2—REGULATORY REFORM IMPLEMENTATION SYSTEM AND PRIVATE PARTICIPATION METHOD IN SOUTH KOREA

Private participation	"Participation administration"	"Lee Myung-bak administration"	"Park Geun-hye administration"	"Moon Jae-in administration"
Resolution, deliberation, and consultation on regulation bills	• RRC (DG for Regulatory Reform)	• RRC (DG for Regulatory Reform) - Centered on review for new and strengthened regulation bills	• RRC (DG for Regulatory Policy)	• RRC (DG for Regulatory Policy) - Operation of advisory organizations (NIRIC, TRC, CAC)
Requesting trouble shooting and complaint processing	• Ministerial meeting on regulatory reform - Chaired by PM	• PCNC - Assisting president on lump regulatory reform and regulatory policy	• Ministerial meeting on regulatory reform - Chaired by president • On-site inspection meeting for regulatory reform - Chaired by PM	• Meeting for coordinating state affairs - Chaired by PM • On-site conversation for regulatory reform - Chaired by PM
	• RRB - Lump regulatory reform	• PPJRAI - field's trouble shooting	• PPJRAI - Field's trouble shooting such as RTUF	• PPJRAI - Job creation and field's trouble shooting
			• RRS - Complaint processing	• RRS - Complaint processing • Regulatory sandbox - Testing new technology

Note: RRC=regulatory reform committee, DG=director general, NIRIC=new industry regulatory innovation committee, TRC=technical regulation committee, CAC=cost analysis committee, PM=prime minister, PCNC=presidential council on national competitiveness, RRB=regulatory reform board, PPJRAI=public-private joint regulation advancement initiative, RTUF=removal of the thorn-under-the-fingernail, RRSMG=regulatory reform *Sinmungo.*

Source: The author's augmentation to Regulatory Reform Committee (2018), p.4.

processing handling regulatory difficulties and complaints typically through corporate site visits or by receiving opinions through online systems except the participation of private experts in the regulatory reform committee (RRC) to conduct reviews and decisions on new and strengthened regulation bills and provide consultation to the government. The OECD (2017) also assessed that the regulatory quality management in South Korea is demand-driven and guided by a complaint-driven process (OECD, 2017, p.15).

To reform unreasonable regulations, resolving complaints on a regular basis should be fully appreciated. For example, an online petition program for trouble shooting, namely "regulatory reform *Sinmungo*," is regarded as an innovative case to expedite the processing time by limiting the response deadline to 14 days from the receipt date and effectively prevent regulators' blame avoidance for regulatory issues by adopting a real-name system (OECD, 2017, p.27). However, allowing private participation based on such an *ad hoc*, case by case basis can be hardly seen as the central form of PPP under the fundamental regulatory reform governance. Therefore, it is necessary to pay more attention to PPP within the regulatory reform committee under the Office for Government Policy Coordination.

In accordance with the Framework Act on Administrative Regulations, South Korea established "the RRC under the jurisdiction of the president to deliberate upon and coordinate the government's regulatory policies as well as comprehensively carry out matters concerning the examination and revision of regulations" (Article 23 of the Act). Located at the top of the regulatory reform implementation governance, the RRC has two subcommittees depending on the characteristics and relevance of each sector: the economic division and the administrative/social division. The fact that it cannot fully utilize the expertise of private members who participate in each subcommittee has been identified as one of the biggest problems of the RRC (Choi, 2002, pp.27-28). In addition, it is clear that the range of authority to control regulatory contents is ambiguous, there is a problem with the composition and conflict of interests of committee members, and it is difficult to examine the regulations in various fields within only two subcommittees (Kang, 2013, pp.1-2). Some scholars argue that it is necessary to strengthen the status of the RRC or even further to establish it as an independent governmental organization (Choi, 2002; Kim, 2017), and that it should be given a stronger accountability and control measures (Kang, 2013).

Third, there are cases where a formal or informal public consultation body is formed to overcome complex and intertwined interests and to derive optimal regulation alternatives by consensus. Typical examples include local councils to resolve regional issues, and temporary public consultation bodies to collect opinions and achieve consensus when the government plans to implement specific measures. In the process of regulatory policy, the mode of operation of public consultation bodies is mainly to encourage the participation of stakeholders by holding meetings to gather opinions, or to disclose information and gather opinions through public hearings.

When the level of uncertainty or confrontation is high, it may be advisable to have a more formal and regular public consultation body. A representative example is the Bioethics Public Consultation Council, in which the government as well as private scientific, medical, industrial, legal and religious experts from the private sector participate to review the social and ethical issues of policy and regulatory matters on new technologies and to discuss countermeasures. The purpose of the Council is to discuss revisions to the bioethics law, when for example there is a demand for deregulation, such as the decision on whether to allow embryo research and gene therapy research, or in scope setting, so as to make decisions within the scope of ethical issues. To achieve this purpose, the establishment and operation of "deliberative governance," which intends to resolve conflict by mutual understanding and cooperation, is necessary (Hong and Lee, 2009, p.25). However, deliberative governance in South Korea is not yet mature. For example, the Bioethics Public Consultation Council held a public hearing followed by eight discussions in 2017, but a researcher who attended the hearing had a negative assessment:

"It was frustrating to see the opinion gap between field researchers and law and ethics experts. The level of discussion was also rudimentary considering that a public consultation body was formed and that counter measures were discussed" (*Chosun Ilbo,* 2017b).

Meanwhile, one of the main controversies over sharp conflicts of interest is dissension over the protection of vested interests. In many cases, a change in regulations may result in a group experiencing a decrease in the benefits previously enjoyed by new entrants. As the purpose of the public-private joint consultation is to resolve conflicts and to reach consensus through discussions among stakeholders, the public-private joint consultation body is often required to resolve conflicts between a group that seeks to minimize the reduction of its vested interests and another group that pursues newly created benefits. In this case, regulators can constitute a public-private joint consultation body to use it as a tool for blame avoidance. They may choose to postpone or discard a decision that could be criticized by at least one of the groups regardless of the conclusion, rather than use it as a measure of deliberative governance.

III. Evaluating Stakeholder Engagement in Regulatory Policy of South Korea

Bearing the above-mentioned stylized facts in mind, we attempt to diagnose how well the system for stakeholder engagement, as one of key modalities of PPP, is constructed in South Korea's regulatory policy process. It is important to note that the main focus of this study is not to find the determinants of regulatory reform performance. Although the purpose of regulatory policy process improvement is to enhance the performance of regulatory reform, it is very difficult to examine the effects of a certain reform in the regulatory policy process in which various factors are combined and affect performance both directly and indirectly. Therefore, it attempts to diagnose the areas where increased efforts to improve should be made by understanding the relative weaknesses of current PPP implementation in the regulatory policy. In order to carry out such a determination, it is possible to adopt either a method of examination of the domestic regulatory policy process, or an international comparison of the regulatory policy processes.

On the one hand, if only the regulatory policy process of South Korea is targeted, it is possible to comprehend the problems of each stage, but it is difficult to compare different stages. For example, it is incorrect to simply compare the number of stakeholder consultations between the regulation design stage and the stage of selecting the final regulatory alternative. This is because there are many things specific to a stage such as scope, form, and level of discussions, the scope of participants, and duration and cycle of meetings. Moreover, certain methods are not always the best alternative depending on the situation. Therefore, this type of research methodology is often applied to a specific case or a similar case group, and there is a limitation in generalizing the result.

On the other hand, an international comparison of the regulatory policy processes poses difficulties in finding the best system for a specific country due to contextual differences in each country. The formation and settlement of the regulatory institution is highly path-dependent. However, it is possible to grasp the relative strengths and weaknesses of a country's institutional setting compared to a generally acceptable setting at the global standard. For example, it is generally recognized that securing transparency in the decision-making process is something to be pursued

systematically. It will thus be meaningful to examine whether a country is appropriately equipped with such an institutional device when being compared to other countries.

In this section, therefore, we attempt to identify the relative strengths and weaknesses of South Korea through comparisons based on credible data between the OECD member countries in various areas of a representative PPP scheme, namely stakeholder engagement, in the regulatory policy process.

A. *Data*

The OECD published a report on the indicators of regulatory policy and governance (iREG) of each member country in 2015 and 2018 through a questionnaire administered to central government officials and secondees to the OECD Regulatory Policy Committee (RPC). The data are as of the end of the previous years (i.e. 2014 and 2017), and include the survey results of national level regulatory institutions, except those at the sub-national level. The data for 2014 and 2017 pertain to 34 OECD member countries and the European Union (EU) and for 38 OECD member and accession countries and the EU, respectively. To secure the credibility of the data, the respondents were required to submit supporting data and/or documents, with which an evidence-based index was constructed.

In so doing, the indices cover three important areas of regulatory policy: stakeholder engagement, RIA, and *ex post* evaluation. The indices on stakeholder engagement and RIA focuses exclusively on the central government's regulatory policy practices for both primary laws and subordinate regulations. The *ex post* evaluation index, on the other hand, deals with post-regulatory assessments at all national regulations, regardless of whether they were initiated by parliament or the executive branch (Arndt *et al*., 2015, p.10). Let us focus on the iREG for stakeholder engagement, which is the main interest in this study.

The indicators are composed of those that can be evaluated objectively, and those in which the indicator value changes in response to the change of actual regulation policy. They are classified into four categories: (1) methodology, (2) oversight and quality control, (3) systematic adoption, and (4) transparency. First, "methodology" investigates information on the methods used, for example, how often various forms of stakeholder consultation and feedback are made, and which forms are used for the consultation. Second, "oversight and quality control" includes the role of supervisory authorities and the feedback level of the evaluation results. Third, "systematic adoption" investigates the formal requirements, and how frequently these regulations were enforced. Finally, "transparency" examines information related to the principles of open government, including whether government decision processes and results are publicly available (Arndt *et al*., 2015, p.11). Table 3 shows the number of iREG indicators for stakeholder engagement in the regulatory policy process and the list of questions for calculating the corresponding indicator values can be found at the OECD website (https://www.oecd.org/gov/regulatory-policy/Methodology-of-the-iREG-composite-indicators.pdf, accessed May 30, 2019).

Therefore, the indicators used in the iREG are composed of those for judging the adequacy and rationality of the system established for the implementation of the regulatory policy process, and those for evaluating quantitatively the inclusiveness

TABLE 3—INDICATORS OF iREG FOR STAKEHOLDER ENGAGEMENT

Year	Category	Methodology	Oversight and quality control	Systematic adoption	Transparency	Total
2014	Primary laws	36	12	7	25	80
	Subordinate regulations	36	12	7	24	79
2017	Primary laws	34	12	5	25	74
	Subordinate regulations	34	12	5	25	74

Source: Arndt *et al.* (2015) and OECD website (http://www.oecd.org/gov/regulatory-policy/ireg-source.htm, accessed Nov. 13, 2018).

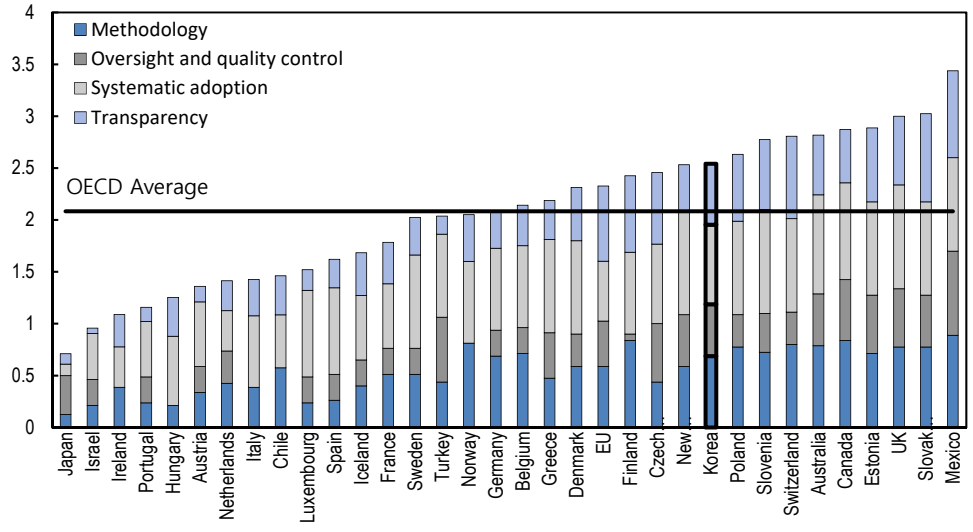
and appropriateness of the operation and execution of the system. It should be noted, however, that such indicators do not attempt to measure the performance achieved through changes in individual regulations. In other words, we can only judge the excellence of the system installed and operated in the regulatory policy process in terms of each category. Thus when interpreting the data, care should be taken to avoid misinterpreting or overstating the results as the performance of regulatory reform since the superior system does not necessarily guarantee excellent regulatory reform performance.

The questions typically ask whether a system was constructed or enforced to obtain a binary response of "yes" or "no" and assign the values of 1 and 0 for "yes" and "no," respectively. If not, it asks about the scope of application or the frequency of execution. In this case, a value is given according to the strength of the response in a range between 0 and 1. For example, in response to a question about whether each government department operates a homepage for ongoing stakeholder consultations, a value of 1 was assigned to the response of "all departments" and "all ongoing consultations" and a value of 0 was assigned to the response of "not operating." At this time, a value of 0.5 was given to the response of "some departments" and "some ongoing consultations." When asked if they have obtained statistics on stakeholder engagement, the survey obtained responses with "secured and open to the public," "secured, internally kept" and "not secured," whose assigned value is 1, 0.4, and 0, respectively. That is, if the implementation of the system is partial implemented as in the former example but the details are unclear, or if it is difficult to judge whether the partial implementation is biased in a specific direction, a value of 0.5 was given for the partial implementation. However, as in the latter example, the value assignment attempted to properly accommodate the situation in cases where partial enforcement is relatively close to "doing nothing."

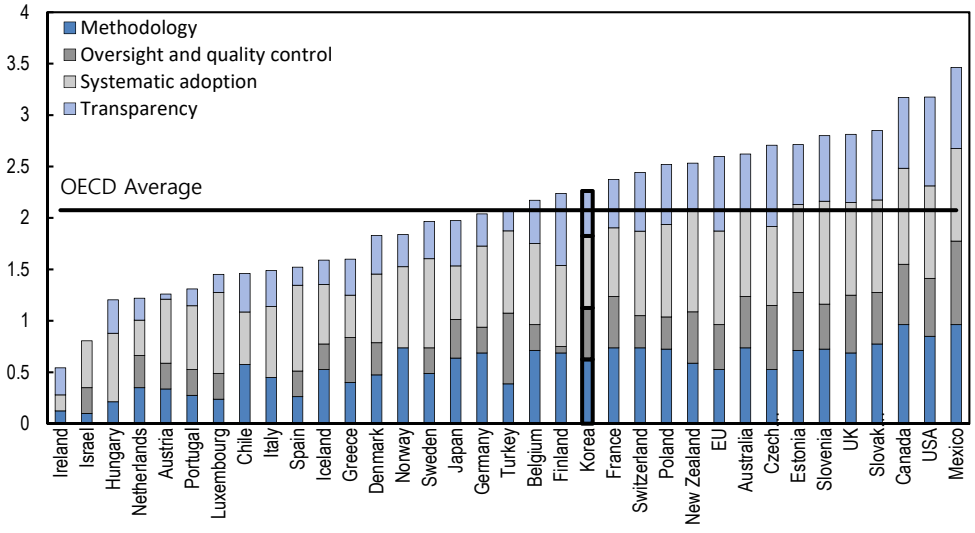
In this way, an average of indicators with a value between 0 and 1 was calculated, and the scores of the four categories were obtained, and the scores of these categories were added together to constitute the final index value. Figure 1 and Figure 2 show the results of the scores by category and index values thus constructed, obtained from the data for 2014 and 2017, respectively. Notably, the rankings of South Korea had significantly improved in 2017 when compared to 2014: 10th to 5th and 15th to 7th for primary laws and subordinate regulations, respectively. However, this simple summation of scores in four categories may be misleading, as will now be discussed in greater detail below.

B. *Method*

Let us look at two premises in dealing with the data. First, the division of the four categories of indicators is accepted as it is. This distinction is a result of deliberate determination of experts in the OECD RPC and its advisory body, the steering group on measuring regulatory performance over several years (see Arndt *et al*., 2015, pp.35-36 for an introduction to the index development process).



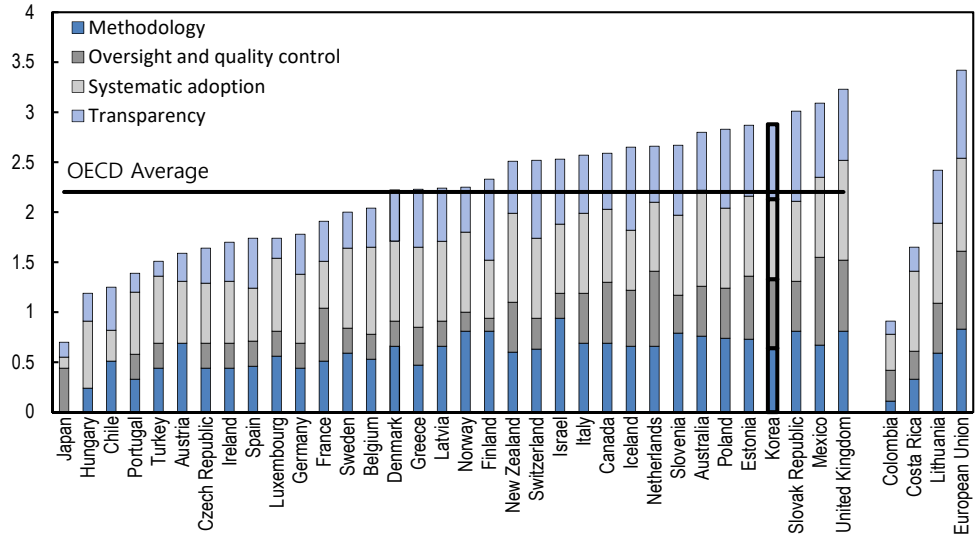
(a) Primary Laws



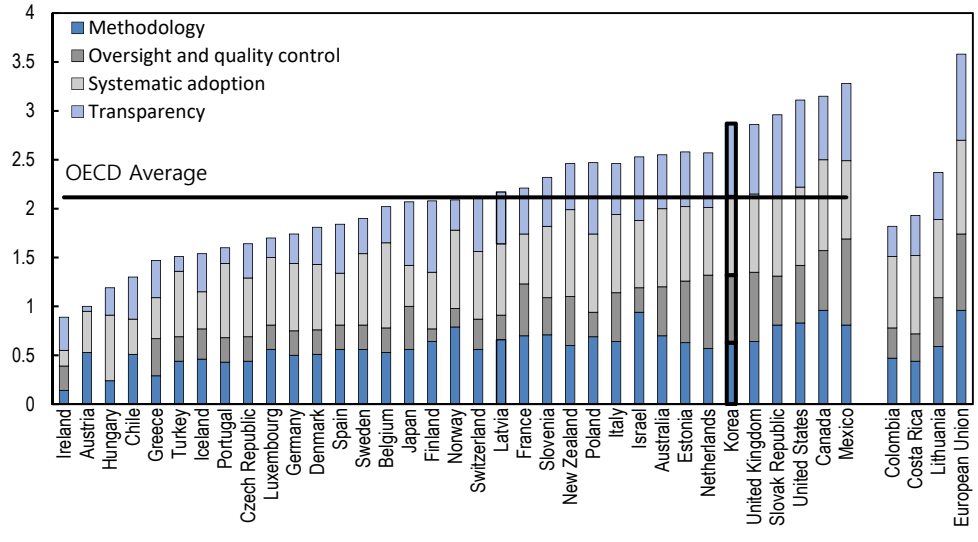
(b) Subordinate Regulations

FIGURE 1. COMPOSITE INDICATORS FOR STAKEHOLDER ENGAGEMENT IN 2014

Source: OECD (2015), p.74, Figure 3.1 and Figure 3.2.



(a) Primary Laws



(b) Subordinate Regulations

FIGURE 2. COMPOSITE INDICATORS FOR STAKEHOLDER ENGAGEMENT IN 2017

Source: OECD (2018), pp.48-49, Figure 2.6 and Figure 2.7.

Second, taking average of indicator values with a value between 0 and 1 is considered an imperfect but realistic option to calculate the score for each category. The disadvantage of this approach is that it limits the relative importance by giving the same weight to the indicators in the category. However, this is an acceptable alternative because it is very difficult to accurately grasp the relative importance of more than 30 indicators, and in fact the relative importance is likely to be similar.

Notice that it is obviously not correct to use the sum instead of the average because

the number of indicators included in each category is different. There are, however, cases where questions within the category, or between them, are not mutually exclusive or collectively exhaustive due to the nature of the data. In such cases, a simple comparison of the average values (scores) of different categories has two problems.

First, there is the problem of double counting information represented by highly correlated indicators in the category. As the number of indicators in each category is large, as shown in Table 3, some questions are repeatedly asked about the establishment and implementation of essentially the same system. For example, the survey obtained a series of binary responses by asking about whether each of the listed forms of stakeholder engagement is used. In countries that actively engage in stakeholder engagement activities, it is likely that they use various forms. In this case, since the information is reflected in the average calculation, it exerts an excessive influence on the score of each category.

Second, it is necessary to properly reflect the correlation between categories. The current indicator composition admits that indicators included in a particular category also indicate characteristics of the other category, but are not included in both categories. In this case, comparing the average using only the indicators in each category excludes the correlation between the two categories, and vice versa. For example, the questions about whether the government operates an interactive website for stakeholder consultation is similarly included in the methodology and transparency categories because the operation of it has meaning in both categories, rather than it being a problem with the structure of the questionnaire. On the other hand, operating such a website may be meaningful in terms of systematic operation, but it is not included in the systematic adoption category. In this case, the problem is that the correlation between methodology and transparency is exaggerated compared to their interaction and systematic adoption.

In order to avoid such problems, we adopt a method of comparing the new parsimonious index value calculated so as to minimize any loss of information contained in the data. For this purpose, the principal component analysis (PCA), which is a typical method of feature extraction, is used. The PCA is a method in which the principal components are sorted in the order that best describes the variation of the original indicators through a combination of the variance-covariance relationship of the original indicators, from which some are taken. As a result, the analysis can facilitate the interpretation by reducing the dimension using the linear relationship of the data.

In general, when there are four categories as in this study and category i consists of n_i indicators to constitute $n = \sum_{i=1}^{4} n_i$ indicators in total, the *k*th principal component C_k^0 is a linear combination of all the indicators $I_{ij_i} \cdot i = 1, \cdots, 4$ and $j_i = 1, \cdots, n_i$, weighted by a_{ij_ik} as follows:

$$C_k^0 = \sum_{i=1}^{4} \sum_{j_i=1}^{n_i} a_{ij_ik} I_{ij_i}, \quad k = 1, 2, \cdots, n. \tag{1}$$

The results of the PCA are reliable if the number of observations is sufficiently larger than the number of indices. Shaukat *et al*. (2016) noted that in spite of previous

studies that require more than 100 data points to obtain good results, it is difficult to obtain much data due to the nature of the object in many cases. Moreover, Forcino (2012), using a number of observations between 25 to 50, found that insufficient numbers of data points generated a bias, but that there is also a diminishing marginal effect of improving the result as the number of observations increased. Dochtermann and Jenkins (2011) showed that satisfactory results can be obtained even when the number of observations is only 19. If the correlation structure is high, the ratio of the number of observations to that of indicators is more important than the number of observations itself. The proposal of the previous study is to secure the number of observations at least twice to six times that of indicators (Shaukat *et al*., 2016, p.176).

Generally, dozens of observations are obtained in comparative studies. The data in this study, numbered 34 to 40, may hence not be relatively too small. However, since the number of indicators reaches from 74 to 80, which is greater than the number of observations, the method of equation (1) cannot be used. Arndt *et al*. (2015), which used 2014 data for similar attempts to this study, tried to solve this problem by dividing each category into subcategories and using these subcategories as an indicator to conduct the PCA. However, as the authors have noted, the reliability of the results is limited due to the relatively large number of indicators compared to the number of observations (Arndt *et al*., 2015, p.21). Also, it is necessary to reduce the reallocation of indicators across categories as much as possible given the purpose of this study to find the relative strengths and weaknesses of South Korea among the four categories proposed by the OECD.

Therefore, we adopt a method of taking the average value of indicators I_i in each category $i = 1, \cdots, 4$ to find the principal component C_k as the linear combinations of them such that

$$C_k = e_k' I = \sum_{i=1}^{4} e_{ik} I_i, \ k = 1, 2, 3, 4, \tag{2}$$

where $e_k = (e_{1k}, \cdots, e_{4k})'$ is an eigenvector corresponding to an eigenvalue λ_k obtained by the spectral decomposition of the variance-covariance matrix of the indicators. All principal components are independent of, or orthogonal to each other and the proportion of the *k*th principal component C_k explaining the variation of the data is $\lambda_k / (\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4)$. By arranging the eigenvalues according to their size $(\lambda_1 \geq \lambda_2 \geq \lambda_3 \geq \lambda_4)$, the principal components can be listed in the order of magnitude to describe the variation of the data. Among these listed (C_1, C_2, C_3, C_4), we can select several principal components starting from C_1 that explain most of the total variation. The method of selecting the number of principal components includes the Kaiser criterion, the scree plot and the parallel analysis.

The converted regulatory policy index of the countries included in the data can be calculated based on the $m(<4)$ selected principal component scores. This is a method of approximating the 4-dimensional index value by the principal component score of the *m*-dimension, because the information is lost at a ratio of $(\lambda_{m+1} + \lambda_{m+2} + \cdots + \lambda_4) / (\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4)$. as much as the dimension decreases.

Finally, the converted regulatory policy index can be interpreted using the biplots proposed by Gabriel (1971) and the Cleveland dot plots of all principal components based on the discussion of Cleveland and McGill (1984).

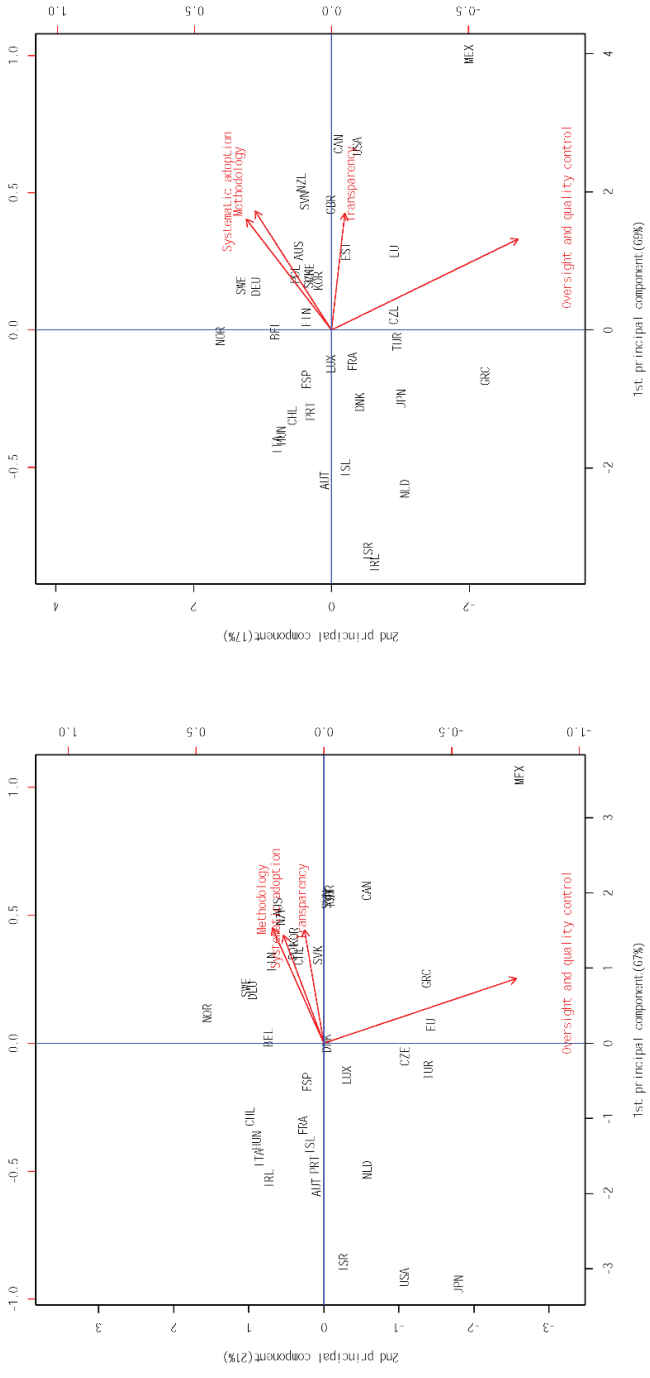
C. *Results and Discussion*

As a result of the PCA, two principal components were selected by all three of the above-mentioned criteria for primary laws and subordinate regulations in both of the 2014 and 2017 data. The first and second principal components accounted for 64-67 percent and 17-21 percent of the total variation, respectively.

The biplots are shown in Figure 3 and Figure 4. All categories have the same direction on the basis of the first principal component, that is, as the size of the first principal component increases, the size of each category also increases. However, with the exception of the 2014 primary laws, the direction of the second principal component was divided into two groups in all cases; "methodology" and "systematic adoption" move in the same direction and "oversight and quality control" and "transparency" have the same direction. Based on these results and the questions contained in each category, it can be inferred that "methodology" and "systematic adoption" are related to the establishment of the system, while "oversight and quality control" and "transparency" are toward the implementation of the institution.

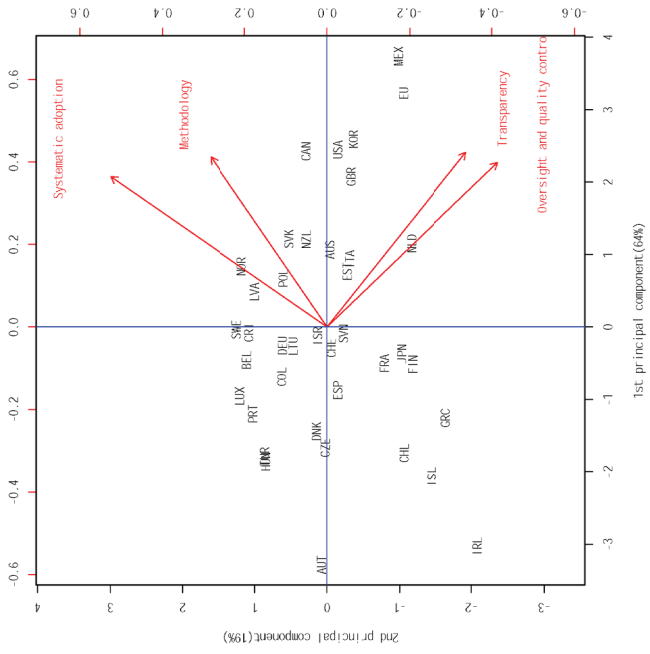
The distribution of countries' index values by category is shown as the Cleveland plots in Figure 5 to Figure 8. Also, the results of the PCA are summarized in Table 4. From the distributions, averages, and medians of index values, countries can be evaluated to be equipped with good practices in the following order: systematic adoption, transparency, methodology, and oversight and quality control. To be more precise, we used the Wilcoxon rank sum test and the two-sample Kolmogorov-Smirnov test to determine whether there is a difference in the median of categories and in the distribution of indicator values, respectively. The results are shown in Table 5 and Table 6, respectively. The order of the median values in each category is generally similar to that of the previous at-a-glance observations, but there was no statistically significant difference between "methodology" and "transparency" at the 0.05 significance level. Similarly, all the distributions of indicator values by category are statistically significantly different at the 0.05 significance level, and it is confirmed that there is no statistically significant difference between "methodology" and "transparency" except the 2014 primary laws.

Moreover, from the coefficient of variation (CV) and Gini coefficient in Table 4, we can determine how countries' index values are evenly distributed. In five cases (four cases in 2017 and one case in 2014) out of eight cases, countries are evenly evaluated in the order of systematic adoption, methodology, transparency, and oversight and quality control. In the remaining three cases, the rankings of two categories, methodology and transparency, are swapped. Together with the above results, this result suggests that systematic adoption is overall highly evaluated while oversight and quality control appears poorly across countries with respect to point evaluation and even distribution..

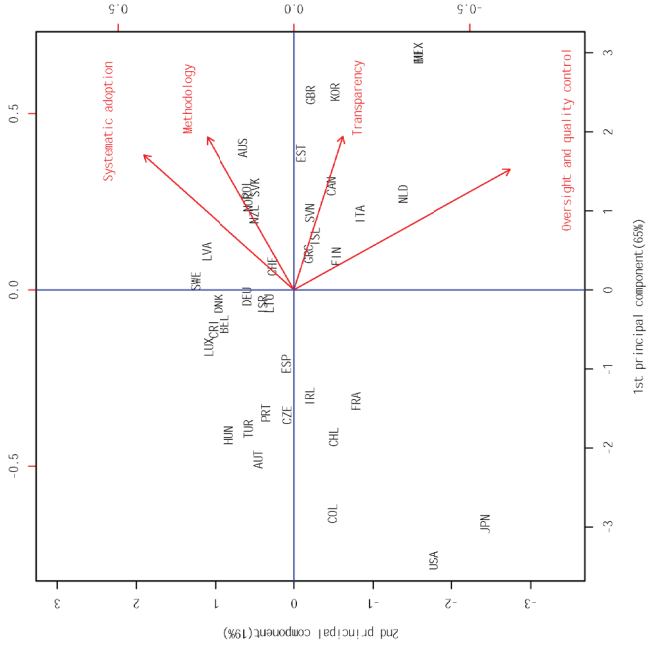


(a) Primary Laws (b) Subordinate Regulations

FIGURE 3. BIPLOTS OF THE PRINCIPAL COMPONENT ANALYSIS I: AS OF 2014



(b) Subordinate Regulations



(a) Primary Laws

FIGURE 4. BIPLOTS OF THE PRINCIPAL COMPONENT ANALYSIS II: AS OF 2017

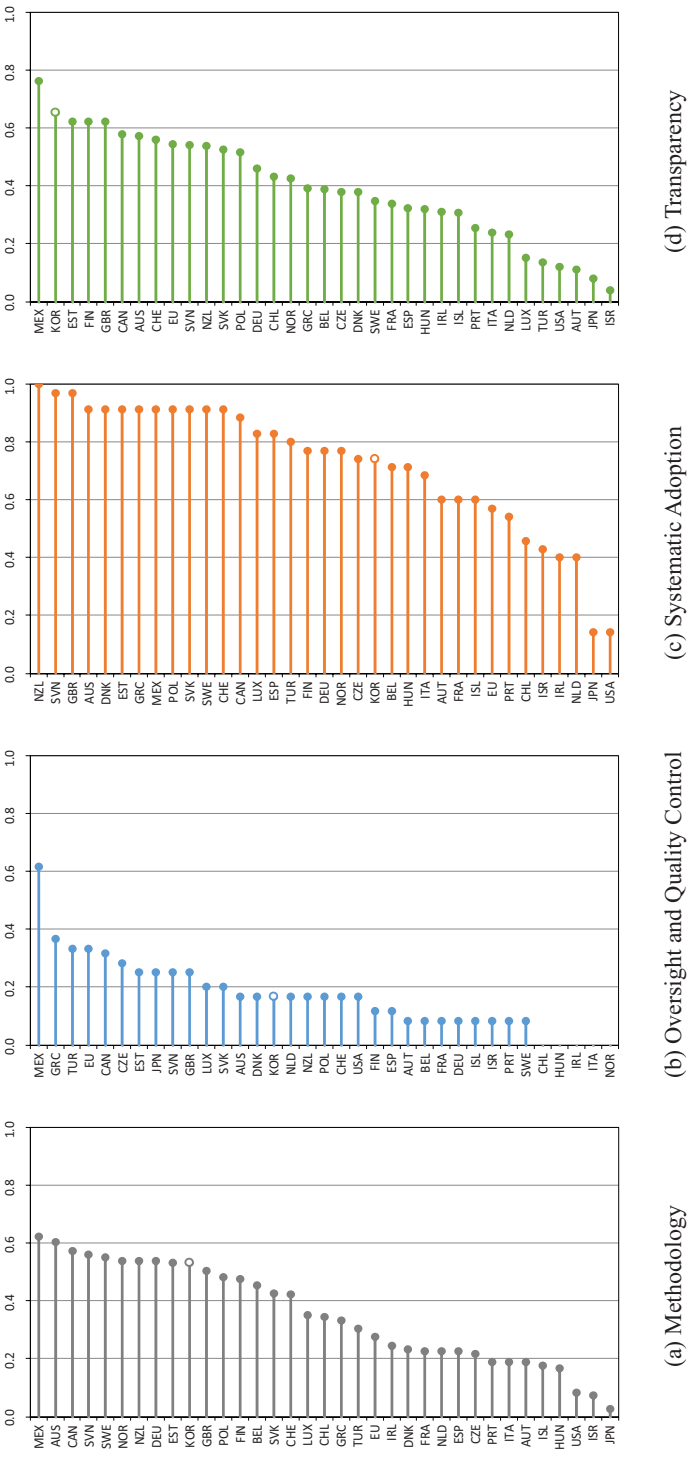
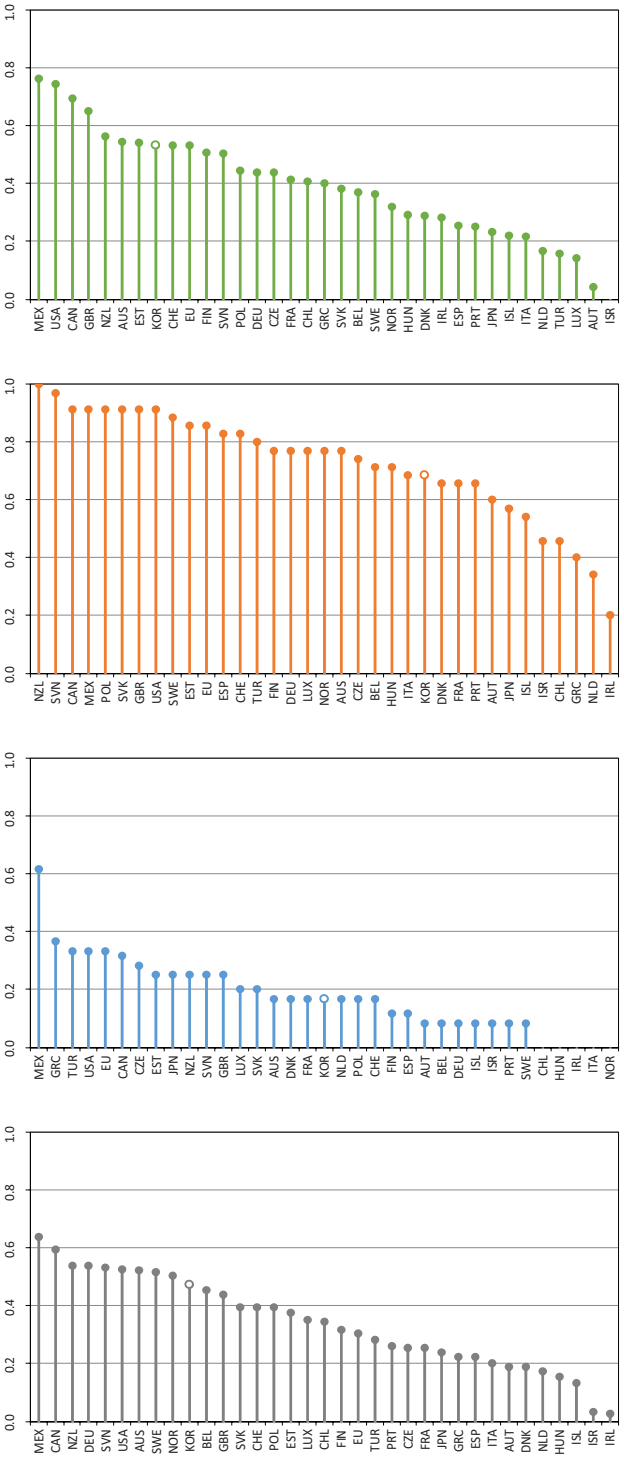


FIGURE 5. CLEVELAND PLOTS OF THE PRINCIPAL COMPONENT ANALYSIS I: PRIMARY LAWS IN 2014

Note: When countries are tied, they are ordered alphabetically.



(a) Methodology (b) Oversight and Quality Control (c) Systematic Adoption (d) Transparency

FIGURE 6. CLEVELAND PLOTS OF THE PRINCIPAL COMPONENT ANALYSIS II: SUBORDINATE REGULATIONS IN 2014

Note: When countries are tied, they are ordered alphabetically.

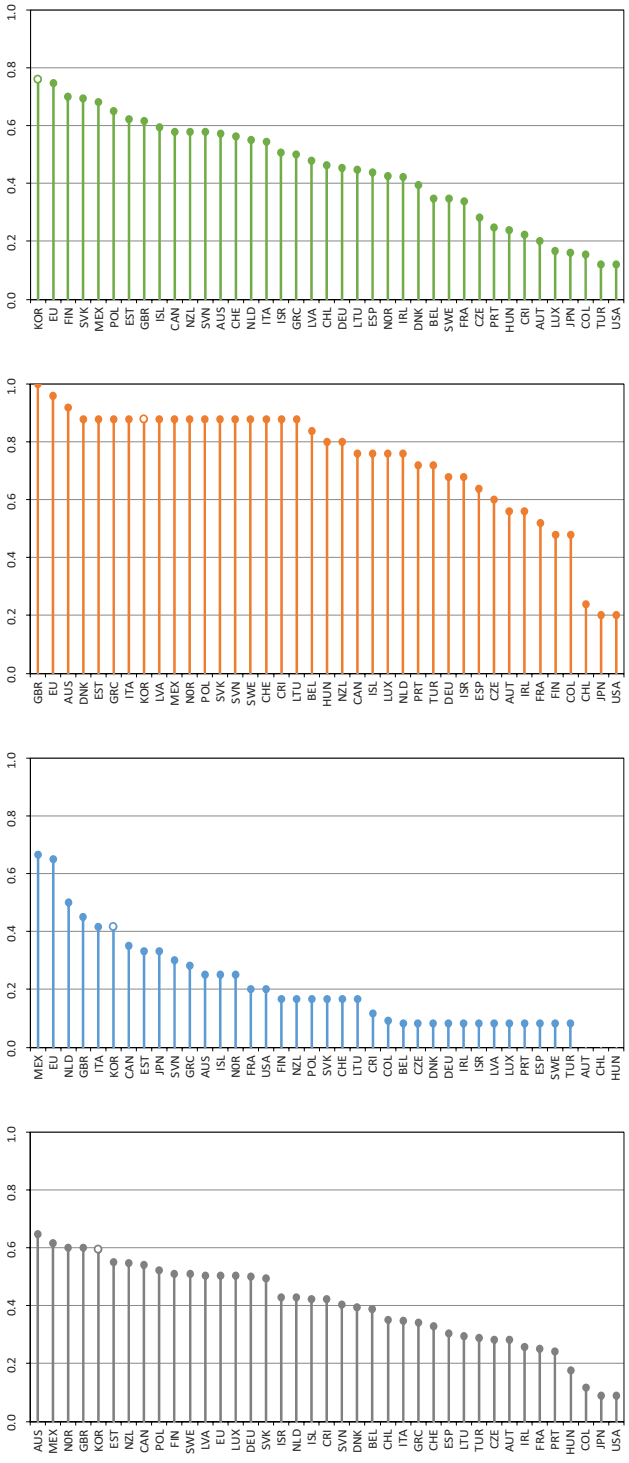


FIGURE 7. CLEVELAND PLOTS OF THE PRINCIPAL COMPONENT ANALYSIS III: PRIMARY LAWS IN 2017

Note: When countries are tied, they are ordered alphabetically.

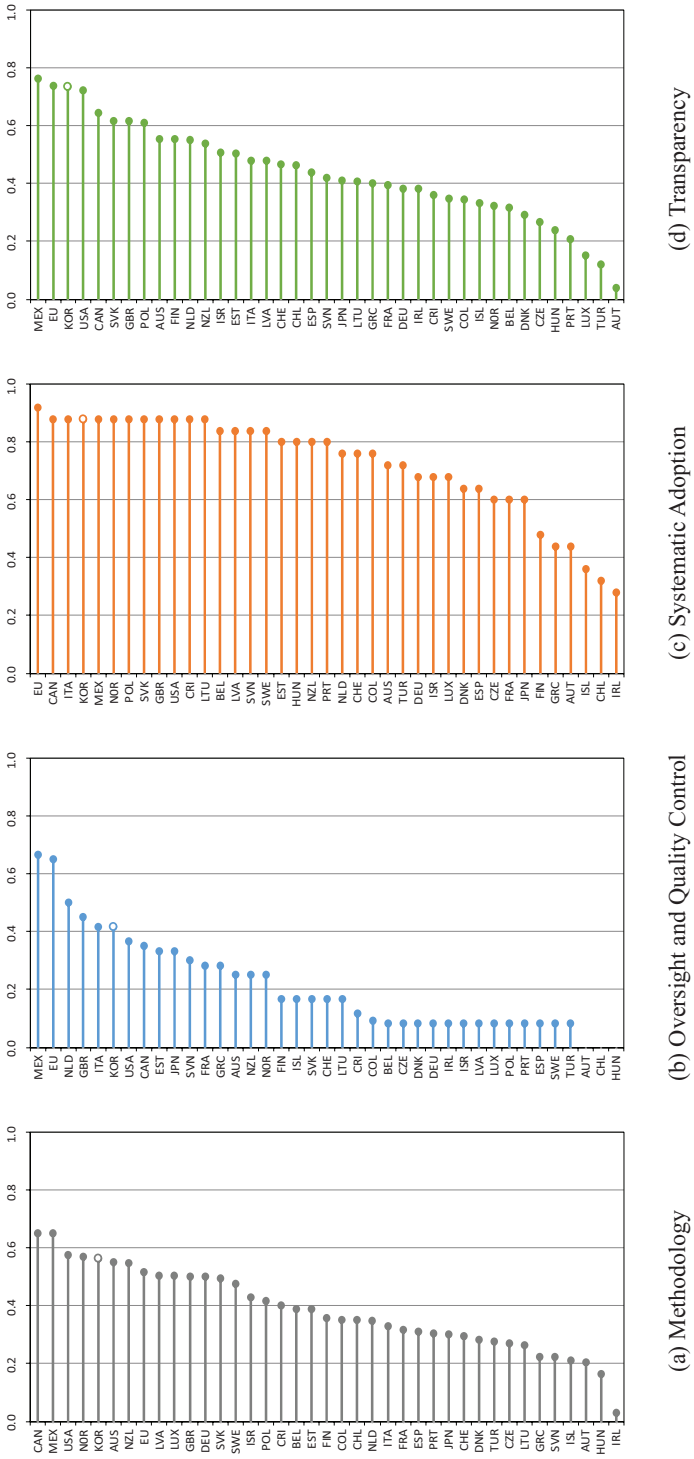


FIGURE 8. CLEVELAND PLOTS OF THE PRINCIPAL COMPONENT ANALYSIS IV: SUBORDINATE REGULATIONS IN 2017

Note: When countries are tied, they are ordered alphabetically.

TABLE 4—SUMMARY OF THE PRINCIPAL COMPONENT ANALYSES

Year		Primary laws				Subordinate regulations			
		M	OQC	SA	T	M	OQC	SA	T
2014	Average	.3557	.1681	.7233	.3958	.3429	.1776	.7274	.3898
	Median	.3444	.1667	.7714	.3880	.3444	.1667	.7714	.4000
	Min	.0278	0	.1429	.0400	.0278	0	.2000	0
	Max	.6222	.6167	1	.7640	.6389	.6167	1	.7625
	Std. dev.	.1728	.1287	.2258	.1852	.1603	.1314	.1887	.1877
	IQR	.3111	.1667	.3143	.2608	.2667	.1667	.2143	.2813
	CV	.4858	.7659	.3122	.4679	.4675	.7399	.2594	.4817
	Gini	.2673	.3711	.1782	.2641	.2576	.3645	.1639	.2407
2017	Average	.4026	.2066	.7395	.4499	.3863	.2109	.7262	.4397
	Median	.4235	.1667	.8000	.4640	.3588	.1667	.8000	.4200
	Min	.0882	0	.2000	.1200	.0294	0	.2800	.0400
	Max	.6471	.6667	1	.7600	.6529	.6667	.9200	.7640
	Std. dev.	.1497	.1667	.2039	.1863	.1429	.1702	.1752	.1722
	IQR	.2206	.2083	.2200	.2680	.2147	.2333	.2400	.2160
	CV	.3718	.8070	.2758	.4140	.3700	.8070	.2413	.3916
	Gini	.2408	.3960	.1658	.2927	.1982	.4003	.1806	.2142

Note: M=methodology, OQC=oversight and quality control, SA=systematic adoption, T=transparency, IQR=interquartile range, CV=coefficient of variation, and Gini=Gini coefficient.

TABLE 5—RESULTS OF THE WILCOXON RANK SUM TESTS

z value		Methodology		Oversight and quality control		Systematic adoption	
		2014	2017	2014	2017	2014	2017
Oversight and quality control	PL	4.34	4.91				
	SR	4.25	4.42				
Systematic adoption	PL	-5.49	-5.95	-6.62	-7.00		
	SR	-6.19	-6.32	-6.95	-7.09		
Transparency	PL	*-0.98*	*-1.26*	-4.79	-5.12	5.35	5.49
	SR	*-1.04*	*-1.41*	-4.66	-4.97	5.67	5.55

Note: Looking at the difference between the row and the column, the positive numbers indicate that the median of the column is greater than the median of the column, and vice versa. The numbers in italics mean that they are not statistically significantly different at the 0.05 significance level. PL=primary laws and SR=subordinate regulations.

TABLE 6—RESULTS OF THE TWO-SAMPLE KOLMOGOROV-SMIRNOV TESTS

z value		Methodology		Oversight and quality control		Systematic adoption	
		2014	2017	2014	2017	2014	2017
Oversight and quality control	PL	.311	.300				
	SR	.267	.256				
Systematic adoption	PL	.888	.451	.971	.713		
	SR	.455	.441	.664	.669		
Transparency	PL	.541	*.130*	.647	.352	.677	.380
	SR	*.157*	*.160*	.379	.313	.407	.380

Note: The critical values in 2014 and 2017 are 0.2242 and 0.2102, respectively. The numbers in italics mean that they are not statistically significantly different at the 0.05 significance level. PL=primary laws and SR=subordinate regulations.

We can now discuss individually the results for the countries overall and for South Korea. First, the countries have systematically adopted the stakeholder consultation process at a high level in the overall regulatory policy process, but the status of the system for oversight and quality control is relatively inferior to other categories. Methodology and transparency are located between them, but there is no statistically significant difference between methodology and transparency. However, interpretation of the results, in which the private participation is relatively insufficient in the oversight and quality control category, requires caution. It would be misleading to conclude that there is a need to promote stakeholder engagement in oversight and quality control, especially in the course of regulatory operations. This is because the role of government in the oversight and quality control of regulation may be relatively more important than in other categories.

Second, the assessment results for the regulatory policy process in South Korea compared with OECD member countries are shown in Table 7, in which the country rankings by the simple average of indicator values are also compared. Overall, the rankings by the PCA in 2017 are higher than those in 2014. These results can be inferred from the fact that the regulatory system in South Korea has been improved by intensive regulatory reform efforts. In particular, it is encouraging to see that the

TABLE 7— RANKING OF OECD IREG BY CATEGORY OF STAKEHOLDER ENGAGEMENT IN SOUTH KOREA

	Year	Methodology		Oversight and quality control		Systematic adoption		Transparency	
		PL	SR	PL	SR	PL	SR	PL	SR
PCA	2014	9 (T2)	10	13 (T8)	15 (T7)	20 (T2)	23 (T2)	2	8 (T3)
	2017	5	5	5 (T2)	5 (T2)	4 (T15)	2 (T11)	1	3
Simple average	2014	13 (T2)	17	7 (T4)	8 (T5)	21 (T2)	22	11	17
	2017	19	16 (T2)	5	5	6 (T15)	5 (T11)	7	5

Note: The numbers indicate the ranking of South Korea. The numbers in parentheses means the number of countries (including EU) that have the same value (e.g. T2 means two countries are ranked the same), and if there are no parentheses, there is no other country with the same rank. PL=primary laws and SR=subordinate regulations.

systematic adoption of stakeholder engagement, which was relatively insufficient at the end of 2014, has greatly improved in 2017.

By year, the categories are evaluated in the order of transparency, methodology, oversight and quality control, and systematic adoption in 2014. Considering the result that the countries were highly evaluated altogether in terms of systematic adoption at that time, the lowest evaluation for South Korea in the category suggests that there is more room to improve the systematic stakeholder engagement in the country's regulatory policy process.

On the other hand, in 2017, South Korea ranked relatively high overall, especially in transparency. For systematic adoption, a large number of countries (15 for primary laws and 11 for subordinate regulations) ranked the same. In this regard, it would be more meaningful to interpret that South Korea is effectively leading the trend of systematically adopting stakeholder engagement by many countries rather than ranking itself. In addition, the fact that the ranking of South Korea in the oversight and quality control category in 2017, which has been generally evaluated at low levels across countries, is relatively weak compared to other categories and may suggest that more attention be paid to its promotion. However, this need not be emphasized since the relative gap with other categories is insubstantial.

Finally, considering the simple average of the indicators in each category as implicitly shown in Figures 1 and 2, the rankings for South Korea in 2014 were in the order of oversight and quality control, transparency, methodology, and systematic adoption, while those in 2017 were in the order of oversight and quality control, systematic adoption, transparency, and methodology. This method should be avoided as discussed above, and remarkably there is a significant difference between the results of the PCA in this study and the simple average of indicators.

In sum, the institutional basis of stakeholder engagement in the regulatory policy process in South Korea is considerably better than OECD member countries in all four categories from the quantitative perspective. This result cannot fulfill the original purpose of this study to identify relatively strong and weak categories.

However, the well-established stakeholder engagement foundation within the regulatory policy process as an input element does not mean that the actual results of regulatory reform will increase. Ultimately, it will be necessary to identify the output according to the purpose of the regulatory policy. However, the effect of regulatory reform is directly related to the behavior of economic agents as mentioned above, and it is difficult to measure because it is the result of the interactions of various external factors.

Alternatively, it is possible to gauge the divergence between supply and demand of regulatory reforms through the subjective assessment of the regulatory burden experienced by the economic agents. To this end, we collected the regulatory indicators from the Global Competitiveness Index (GCI) annually announced by the World Economic Forum (WEF). The indicators are based on the results of the Executive Opinion Survey conducted on entrepreneurs in each country, in which the subjective responses to questions on regulatory policy ranged between 1 and 7 are collected. For South Korea, the 2018 indicator is a weighted average of 45 percent and 55 percent of the responses of 100 entrepreneurs in 2017 and 2018, respectively (Schwab, 2018, p.626).

As shown in Table 8, the regulatory burden and efficiency perceived by South

TABLE 8— RESULT OF WEF EXECUTIVE OPINION SURVEY FOR SOUTH KOREA

Code	Classification	Question	Scoring	Score	Ranking
1.08	Efficiency of legal framework in challenging regulations	"In your country, how easy is it for private businesses to challenge government actions and/or regulations through the legal system?"	1 = extremely difficult; 7 = extremely easy	3.5	57
1.10	Burden of government regulation	"In your country, how burdensome is it for companies to comply with public administration's requirements (e.g. permits, regulations, reporting)?"	1 = extremely burdensome; 7 = not burdensome at all	3.3	79
1.11	Efficiency of legal framework in settling disputes	"In your country, how easy is it for private businesses to challenge government actions and/or regulations through the legal system?"	1 = extremely difficult; 7 = extremely easy	4.0	50
8.02	Hiring and firing practices	"In your country, to what extent do regulations allow for the flexible hiring and firing of workers?"	1 = not at all; 7 = to a great extent	3.7	87
8.07	Ease of hiring foreign labor	"In your country, how restrictive are regulations related to the hiring of foreign labor?"	1 = highly restrictive; 7 = not restrictive at all	3.7	104

Note: "Ranking" refers to the ranking of South Korea among the 140 countries surveyed.

Korean entrepreneurs is unsatisfactory compared with the superiority of the system established in the regulatory policy process. Furthermore, despite the ongoing regulatory reform efforts, the past decade's trend in regulatory compliance burdens has been even more frustrating. As shown in Figure 9, the regulatory compliance burden of South Korea on the 7-point scale has fallen by 1.2 points over a decade, which is the largest drop (increasing burden) in OECD member countries. During the same period, the value increased by 1.7 points in Germany showing the highest increase (burden reduction). The results are, of course, not precise due to the limitation of the fixed effect of cultural differences or attitudes among countries. However, we can at least observe the sizable gap between the well-established system for PPP in the regulatory policy process found in this study and the

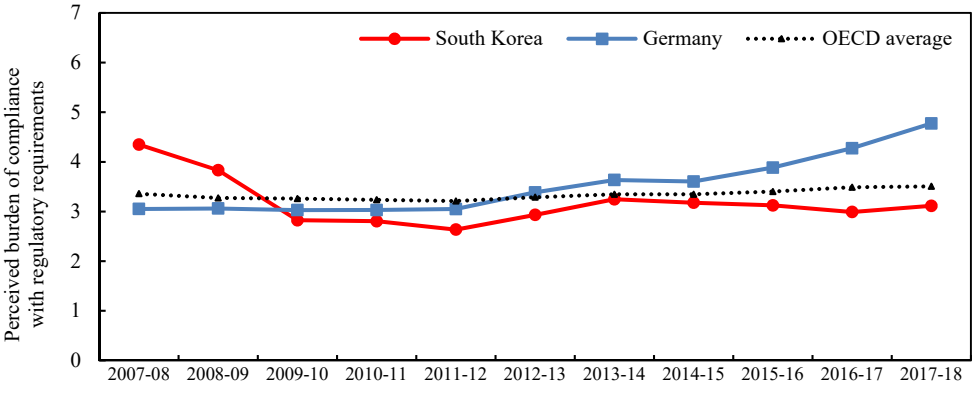


FIGURE 9. PERCEIVED BURDEN OF COMPLIANCE WITH REGULATORY REQUIREMENTS

Source: OECD (2018), p.23, Figure 1.1.

regulatees' unsatisfactory perceptions of the "quality" of regulatory policy implementation in South Korea.

The result of this study is in line with previous studies pointing out the gap between institution building and practical implementation in South Korea. For example, Lee and Kim (2015) and Lee (2014) stated that:

"The government, which was more agile than any other in establishing the regulatory system, paid the least attention to securing resources to actually operate the system" (Lee and Kim, 2015, p.22), and

"South Korea has not been able to utilize the regulatory information system, established better than any other country, so it has failed to establish a virtuous cycle of regulatory policy that widely informs regulatory consumers of the status of government regulations and the performance of the regulatory reforms and uses public opinion on them as a driving force for another regulatory reform" (Lee, 2014, p.2).

Kim (2014b) also found inadequacies in the government's implementation of stakeholder engagement in South Korean regulatory reforms. One of the three reasons for the low perception of regulatory reform was the "passive collection of opinions" in the survey results regarding the perception of regulatory reform conducted by the RRC, the Federation of Korean Industries, the Korea Chamber of Commerce and the Korea Development Institute (KDI). The "extent to which the government gathers public opinions" marked the third lowest satisfaction level in the survey by the RRC. In the KDI survey, the lowest level of satisfaction with regulatory reform was seen in "communication with companies." Among the problems of the government regulatory reforms viewed from the standpoint of the corporation, the second most common problem was a "lack of field communication and feedback."

In conclusion, the results of this study reaffirm the gap between the institutional setting and practical implementation of regulatory policy process. That is, the regulatory system in South Korea is overall well-organized in a quantitative sense, but it is necessary to raise the satisfaction level of regulatory targets by improving the quality of stakeholder engagement and consequently enhancing the operation more compliance-friendly.

IV. Measures to Enhance Regulatory Effectiveness in View of Public Private Partnerships

In this section, we propose measures to improve regulatory satisfaction and compliance by promoting PPP within the regulatory policy process. In particular, based on the results of the analysis, we look for measures to enhance the regulatory effectiveness through complementing operational issues that are under-performing while the system has already been established from the viewpoint of stakeholder engagement and further PPP. In so doing, the division of categories used in the analysis shall not be followed because, since they are all highly evaluated, comparing their relative superiority in the South Korean regulatory system is not critical.

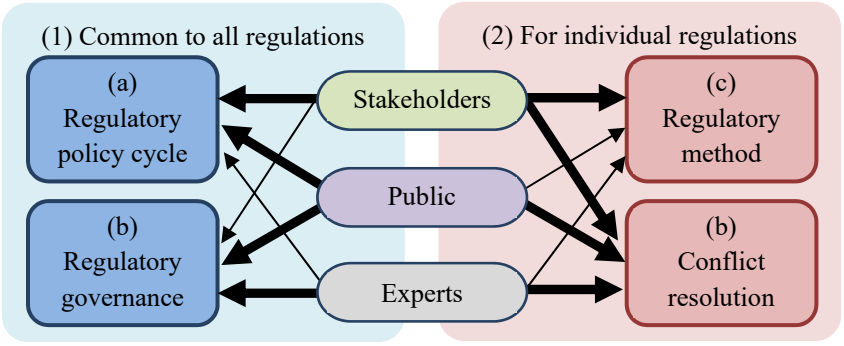


FIGURE 10. PUBLIC-PRIVATE PARTNERSHIPS WITHIN THE REGULATORY POLICY PROCESS

Note: Bold arrows indicate that participation and cooperation are more emphasized.

Instead, we have divided a number of measures that can be applied to (1) all regulatory areas in common, and to (2) some individual cases, as needed. We also considered the partnership with stakeholders, public, and experts for each of these.

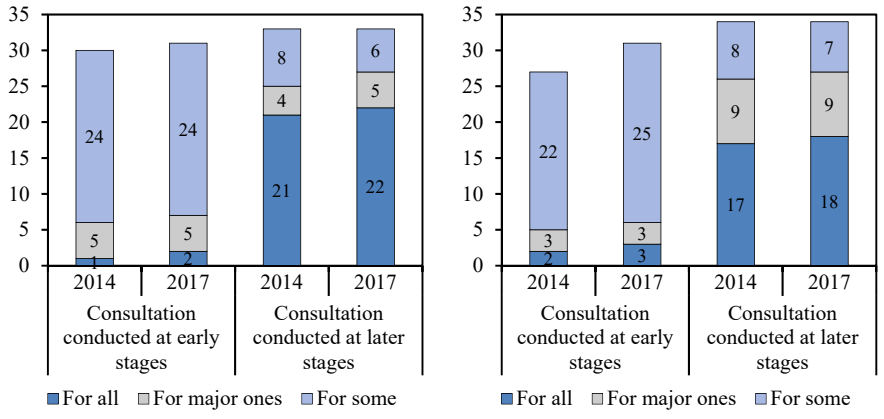
On the one hand, common measures that can be applied across the regulations in general are classified into (a) a horizontal view of the regulatory policy cycle, and (b) a vertical view of governance encompassing regulations. On the other hand, the measures that can be applied to case-by-case are separated by (c) the method of regulation, and (d) conflict resolution for cases where the conflict of stakeholders' opinions is sharp. Figure 10 shows the private participation in these activities.

A. *Activating PPP as Early as the Regulatory Design Stage*

To enhance regulatory effectiveness and compliance, it is necessary to actively introduce PPP from the design stage of regulations in the regulatory policy cycle. In fact, as shown in Figure 11, most OECD member countries listen to stakeholders toward the later stages of the regulatory setting (i.e. after the preparation of the draft). South Korea is also classified as listening to stakeholder opinions only in some primary laws and some subordinate regulations in the early stages (i.e. before the preparation of the draft). This suggests that it is necessary to listen to stakeholder opinions more actively in the early stages if there is a gap between the excellence of the regulatory system established and the actual unsatisfactory experience.

At the regulatory design stage, the RIA is a tool that serves as a basis for judgment in the decision making process. It is a scientific and systematic method of analyzing the effects of regulatory changes on various stakeholders to find the optimal regulatory alternative when introducing or strengthening regulations. It is an important step in regulatory design, which is considered recently to be essential for promoting inclusive growth through better regulation (Deighton-Smith *et al*., 2016).

Since 1998, South Korea has also been using the results of an RIA in the review of new and strengthened regulations at the RRC. From the perspective of PPP, the RIA in the country introduced a description of cost-benefit analysis (CBA) results, the results of the collection of stakeholder opinions, and the possibility of regulatory compliance. However, the present way is incompatible with the purpose of each of the above, and needs to be improved.



(a) Primary laws (b) Subordinate regulations

FIGURE 11. PUBLIC-PRIVATE PARTNERSHIPS WITHIN THE REGULATORY POLICY PROCESS

Source: OECD (2018), p.51, Figure 2.9.

First, while carrying out the CBA, the future costs and benefits for each stakeholder incurred by the impact of the regulatory alternatives should be calculated, but they are not performed extensively. At this time, regulatory alternatives are supposed to include non-regulatory alternatives which exclude direct regulatory features that limit or oblige the rights of the people. The non-regulatory alternatives include (1) economic incentives such as subsidies, tax reductions, and low interest loans, (2) social movements such as campaigns and public service advertisements, and (3) private self-regulation through associations (Office for Government Policy Coordination, 2018, p.24). In practice, however, there are few cases in which non-regulatory alternatives in the form of PPP are compared. This is related to the timing of, and the practical use of, an RIA. In many cases, an RIA is produced simply to provide the logical support for a specific regulatory alternative that the government has already chosen. Therefore, under the current practice, it is not possible to systematically review PPP alternatives.

Second, most RIAs either state the outcome of the stakeholder comments very briefly, state that it will collect opinions through legislative notice, or do not write it at all. In the case of a legislative notice, it is difficult for a wide range of stakeholders, including the general public, to recognize the fact that the regulation will change due to the inherent limitations of the announcement method.

By contrast, the Guidelines for the Preparation of RIAs issued by the Office of Government Policy Coordination states that it is necessary to identify all affected groups that will be influenced by the regulation prior to stakeholder feedback, and to be careful not to exclude each of them. Opinions from each of them should be collected through various methods such as round-table meetings, public hearings, and legislative notices, and be presented in concrete results (Office of Government Policy Coordination, 2018, p.26).

Third, although it is required to describe the compliance possibility (predicted

compliance) of the regulatees to ascertain the effectiveness of the regulation, in many cases this item is also only a brief description and does not meet the original purpose. For example, when strengthening the conditions of the license, it is often the case that a statement may say something to the effect of "the compliance is high because the license can be granted only if the changed conditions are met." However, to meet the original purpose of determining the appropriateness of the changed conditions from the perspective of regulatory compliance, it is necessary to predict the complaints or market contractions that can be caused by the enhanced conditions. If the new conditions impose unnecessary licensing costs on the producers, some of the producers may give up the acquisition of licenses due to high costs and eventually the market will shrink.

Similar to the above, the system for this is also well designed. The Guidelines for this item require one to "scrutinize the regulatory compliance based on the circumstance to the regulatees and the compliance to regulatory affairs in similar area, and describe possible obstacles and their solutions" (Office of Government Policy Coordination, 2018, p.43).

To improve the RIA system, it is necessary to establish a device that can actively consider non-regulatory alternatives, including PPP alternatives, and strengthen stakeholder engagement. Considering the practice of RIA in South Korea, the following alternatives can be considered.

First, carrying out the CBA on non-regulatory alternatives, including PPP alternatives, can be strengthened to be compulsory. The RIA may mandate regulatory authorities to demonstrate superiority over non-regulatory alternatives as a basis for selecting a regulatory alternative. If no CBA is performed on non-regulatory alternatives, it should be noted that it is impossible to set the alternatives and its validity should be reviewed at the regulatory review.

Second, to derive an effective and compliance-friendly PPP regulatory alternative, it can be made mandatory to specify the contents of consultation with the relevant SROs or civil society. As a result of the survey by Choi and Lee (2009), South Korea has established a total of 136 SROs in 122 laws. Moreover, it is also worth considering implementing a requirement to state in the RIA the plans for stakeholder engagement for interim and/or *ex post* evaluations of highly influential regulations.

Third, the results of stakeholder opinion gathering, including the regulatory compliance possibility, may be required to be based on quantitative figures. That is, it is necessary to induce concrete PPP by quantitatively presenting specific consultation results such as the rate of approval for alternatives, the number of times public hearings are held, the number of participants, and the number of opinions collected online. Accumulating these data may also help procure feedback in the future.

B. *Improving Regulatory Governance through Substantial PPP*

As noted above, South Korea has installed the RRC as the highest body to deliberate and resolve regulations. The RRC operates the New Industry Regulatory Innovation Committee, Technical Regulatory Committee, and Cost Analysis Committee as its advisory body. It is hard to find countries with regulatory reform bodies like the RRC, with the exception of those advanced in regulatory reforms

such as Germany, the United Kingdom and the United States (Lee and Kim, 2015, p.17). In addition, self-regulatory reform committees have been established and operate in the central government departments and municipalities. They all appear to be formally organized as a desirable form of PPP, the public-private joint committee.

However, there remain problems related to the RRC, such as ambiguity of authority, conflicts of interest, and difficulties in the professional deliberation of regulations in various fields. It has also been pointed out that there are ups and downs in the status of the RRC due to a shortage of the necessary physical and human resources compared with the authority of the Committee (Lee and Kim, 2015, p.10). Rather than continuing a discussion on the status of the RRC, let us focus on possible improvements regarding PPP and regulatory governance.

First, to compensate for the lack of resources of the RRC, it is necessary to establish a partnership with private experts and work closely together. Of course, it is the bureaucrats who actually lead the highest regulatory reform implementation mechanism, including the RRC. However, in reality, it is desirable to utilize the center of excellence capable of carrying out complementary consultation in situations where it is difficult to accumulate expertise of bureaucrats due to the job rotation system of public officials. A partnership for regulatory reform between the RRC and the Centers for Regulatory Studies installed in KDI and the Korea Institute of Public Administration should be expanded by reinforcing the functions of the centers, going beyond the verification of the results of RIA, including education and consultation for bureaucrats, support for experts in stakeholder consultations on important issues, and finding and evaluating regulatory maintenance tasks. For central government ministries and municipalities, similar systems can be constructed through partnerships with closely related and/or affiliated research institutes. In this case, it may be necessary to set up a center for regulatory analysis in each research institute to facilitate similar support. For example, the Korea Rural Economic Institute has established a Regulatory Impact Assessment Team which contributes substantially to the quality enhancement of RIAs of the Ministry of Agriculture, Food and Rural Affairs.

Second, it is necessary to subdivide the subcommittees within the RRC, which is currently only two, to carry out a specialized review on various regulations. If it is practically difficult to increase the number of subcommittees, it should be ensured that a pool of private specialists is established for each subcommittee, and if necessary, consultations can be carried out intermittently to ensure professionalism.

Third, if inter-ministerial consultations and coordination are needed, it is necessary to utilize private experts who can express neutral opinions. A system for listening to the opinions of private experts who have been granted independence can help in rational decision-making for important regulatory matters that have a broad scope and thus require coordination among ministries.

C. *Applying an Output-based Regulatory System to Strengthen the Autonomy of the Private Sector*

While it is undeniable that regulation is dominated by bureaucracies, the purpose of regulation is minimizing unnecessary burdens on regulatees and stakeholders, and

ultimately maximizing social benefits. The regulatory approach in South Korea is set on the basis of the input criteria to list and comply with the requirements for achieving the purpose of regulation, which is centered on regulatory authorities (i.e. the supplier of regulations). However, from the perspective of regulatory consumers, it is possible to give autonomy to regulatees to take a less costly approach, provided that the purpose of regulation is achieved. Such a way is an "output-based" regulating system in which the aim or achievement pursued by the regulator is presented, and the method for achieving the result is left to the autonomy of the regulatees.

In the mid-2000s, for example, the deregulation of siting restrictions for the planned management area of the Seoul Metropolitan Area caused a serious increase in pollutant emissions. As long as the "input-based" permit conditions were met, a factory could be established in the area. Consequently, sites are overcrowded with small factories that did not install pollution control facilities or were unable to manage the pollutants (for more information, refer to *Chosun Ilbo*, 2017a).

On the other hand, the regulatory approach of the Health and Safety Executive (HSE) in the occupational safety field in the United Kingdom is a representative example of applying the "output-based" control method. HSE has stated its regulatory approach as follows:

> *"An important part of HSE's regulatory approach is the choice and development of the most appropriate interventions to improve the management of health and safety risks. These could include; influencing and engaging with stakeholders and others in the industry, influencing large employers, creating knowledge and awareness of health and safety risks and encouraging behaviour change, promoting proportionate and sensible health and safety, inspection, investigation, enforcement, engaging with the workforce and working with other regulators and government departments"* (Armitage, 2016, p.9).

That is, through PPP, they conduct investigations of accidents and risk factors at workplaces, establish appropriate output standards, and encourage the application of the private sector's creativity and efficiency by entrusting private autonomy to the way of achieving such goals. As a result, the number of fatal and major accidents in the construction industry has decreased remarkably. The number of deaths in the industry in 2012/13 decreased by 62 percent from 2000/01, before the system was introduced, and the number of serious accidents decreased from 4,410 to 2,161, to less than half (Armitage, 2016, p.22).

For the application of such an output-based regulatory approach, appropriate supervision measures should be prepared. As shown in Table 1, however, there are many areas of weakness with regard to regulatory personnel in South Korea. To supplement this, it is possible to consider ways of strengthening the authority and responsibility of the SROs and giving them supervision and oversight functions.

D. *Promoting PPP for Progress in Discussions on Regulatory Issues with Sharp Conflicts of Interest*

It is often the case that stakeholders' opposition to changes in regulations is so

sharp that making progress in discussions is not easy. In particular, for deregulation in newly emerging technologies and industries, some may oppose change due to a fear of the inherent uncertainties involved, or for the protection of their vested interest, which may in turn hinder technological and industrial developments. Considering the uncertainties, of course, it is necessary to review the risks associated with life, safety or the environment.

In practice, to advance the discussions, there are many cases in which a public-private consultation body is formed to coordinate opinions as we have seen in Section II. Nonetheless, there are a considerable number of cases in which progress in discussions, or outcomes resulting in consensus, has been poor. For example, expanding the service area of gene analysis firms by extending the range of allowed items for direct to consumer (DTC) genetic tests has long been discussed. In this case, consistent to the results of this study, a variety of stakeholder consultation systems and procedures were utilized but the actual outcome was insufficient. To consult with stakeholders, a public-private joint consultation body was installed and it held 11 public consultation meetings in which 15 experts from fields such as medicine, industry, ethics, science, and law participated. Public hearings were held to announce the results of the discussions and collect opinions. It formally provided sufficient opportunities for discussion, including with broad stakeholders, but the decision was delayed due to sharply conflicting opinions; sometimes the opinions of specific stakeholders were entirely excluded. As a result, it is clear that the international competitiveness of South Korean companies has weakened considerably in a global market that is expected to grow substantially in the future (*Edaily*, 2018).

This is a case where discussions fail to make progress due to acute confrontations of stakeholders, and the government's will to formulate better regulations and limit interventions proves insufficient. A possible approach to overcome this problem is to introduce a process of public deliberation, in which a "deliberate governance" is established to enable the formation of consensus through the participation of a wide range of stakeholders. Equipped with a neutral consultation mechanism, the deliberate governance enables consensus-oriented discussions based on the mutual trust of participants.

The recently introduced "regulatory sandbox" allows for the testing or release of new products or services that do not exist in the market by not applying or deferring regulations under certain conditions, so that they will not be delayed or stymied by existing regulations. A regulatory case that presents a clear-cut conflict of interest may be tested with the use of the regulatory sandbox. To raise the institution's effectiveness, it is necessary for such a case to apply the public deliberate process to the regulatory sandbox.

Finally, as in the case of DTC genetic testing, consultation bodies for resolving conflicts in South Korea are typically formed after the conflicts have already progressed considerably and tend to be formed under pressure by a third party with strong political influence (Kim *et al*., 2018, p.237). Therefore, the government should be faithful in its role as mediator, and it will be necessary to manage various stakeholder claims based on fairness and rationality.

V. Concluding Remarks

With the emergence of fast developing technologies and new industries, the traditional government-led "command and control" regulatory framework is no longer valid in the design and implementation of rational and effective regulation. Therefore, this study sought to find ways to promote PPP in the process of regulatory policy to enhance regulatory effectiveness.

To fulfill this purpose, it attempted to determine areas for improvement in the South Korean regulatory policy process using a quantitative analysis of evidence-based data for the first time by identifying the relatively weak categories out of methodology, oversight and quality control, systematic adoption, and transparency in stakeholder engagement, one of the key modalities of PPP. From the results of the PCA, South Korea is evaluated as being at a very good level in terms of institutional setting in all categories as a result of recent intense regulatory reform efforts. Nevertheless, the fact that the outcomes of regulatory reform are still inadequate when compared to established systems suggests that the country should concentrate on improving system operations.

Therefore, this study made policy suggestions to improve regulatory effectiveness from the viewpoint of PPP by supplementing the issues that are well-equipped but not feasible. First, it suggested the strengthening of the PPP from the stage of regulatory design by encouraging more participation of stakeholders in RIA. Second, it raised the need for improving regulatory governance to take advantage of substantial PPP with a wide range of private expert groups supplementing the lack of physical and human resources in the public sector. Third, it proposed the utilization of the private sector's creativity and efficiency by applying the output-based regulatory method and discarding the existing input-based method. Given the importance of supervisory oversight, it also pointed out the need to strengthen the roles and responsibilities of SROs. Fourth, it suggested the introduction of a public deliberation process to come up with solutions to challenging cases in which progress in discussions proved difficult due to conflicting opinions of stakeholders.

Finally, in order to guarantee objectivity, the analysis conducted in this study compares only quantitatively the contents of the regulatory system related to PPP (stakeholder engagement, more precisely) due to the limitations of the data. Therefore, it should be noted that the qualitative aspect of the regulatory system in terms of PPP was not fully evaluated. In addition, a comparison between the excellence of the established regulatory system and the performance of actual regulatory reforms in view of PPP is beyond the scope of this study, and it is left for a future study.

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International Trade and Directed Technical Change in Developing Countries†

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This paper examines the relation between the skill premium and international trade given differences in the relative supply of skills across countries while allowing the South (developing countries) to develop its appropriate technology. Typical assumptions put forward in the literature state that either technology is exogenously given, or technical change is allowed only in the North (developed countries). I present a model of international trade with endogenous growth by allowing the South to direct its technology. The results show that more R&D is directed towards skill-augmenting technology in the North than in the South, in sectors with the same skill-intensity. Technical change induced by lowering trade costs can increase the skill premium in both the North and the South. This result can explain the empirical observation that the skill premium has increased within many developing countries after they experienced trade liberalization. Finally, the model predicts larger gains from trade compared with the model where technical change is either not allowed, or allowed only in the North.

Key Word: Directed Technical Change, Globalization, Economic Growth, Skill Premium
JEL Code: F16, F43, O33, O41

I. Introduction

There is a strand of literature which attempts to explain the observed increase in wage inequality between skilled and unskilled workers within developing countries (the South) after they become more open to trade.[1] However, the Heckscher-Ohlin model, a standard general equilibrium model of trade, predicts that the South will experience a decrease in wage equality since the demand for its unskilled labor, the relatively abundant factor in the South, will increase after opening to trade. This prediction is known as the Stolper-Samuelson theorem. The

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contradicting evidence to the prediction prompted trade economists to come up with alternative models. For example, Zhu and Trefler (2005) present a model that can yield an increase in inequality in the South depending on the rate of productivity catch-up by the South. Acemoglu (2003) develops a model by endogenizing technical change towards a particular factor (skill-biased technical change) and studies the skill premia and the direction of technical change when there is an increase in international trade. In a world economy consisting of the United States and multiple developing countries, a relatively more skill-abundant developing country can experience an increase in the skill premium when there is more trade. Acemoglu (2002; 2003) provides analyses on conditions that shape the direction of technical change. What is common in this area of literature is that technical change is performed by the skilled labor in the North, where skilled labor is relatively more abundant than the South. The South adopts the technology developed in the North. This technology, however, may not be suitable since it is developed to suit the factor endowments in the North. There is a long-standing view of technology adaptation of the North (or world) technology in the South including Parente and Prescott (1994) and Barro and Sala-i-Martin (1997).

In this paper, I argue that the South can engage in technical change and utilize their best-fitted technology to produce goods, rather than adopting technology developed in the North. This view may be more appropriate for many developing countries where the economy is not stagnant. The notion of 'appropriate technology' is not novel.[2] Basu and Weil (1998) introduce 'appropriate technology' which can be developed for a given capital-labor ratio. However, the difference between countries originates from the difference in (exogenously given) saving rates which are isomorphic to productivity levels. Countries do not differ in their factor endowments and there is no international trade. The model that I present in this paper examines the relation between the skill premium and international trade while allowing the South to develop its appropriate technology, given a different relative supply of skills across countries. Acemoglu (2003) is closely related to my paper since it focuses on studying the impact of international trade on the skill premium. The key difference is that, in the Acemoglu paper, producers in the South will always adopt U.S. (the North) technology under the somewhat strong condition that their technologies are always less productive than U.S. technologies. My model allows the South to develop its own technology and, as a result, the direction of technical change in the South can be different compared to the North. This result is more in line with the "appropriate technology" literature in which countries choose disparate technologies that are more appropriate to their factor endowments.

I present a simple endogenous growth model with international trade. In the general equilibrium set up, I study how technology advancement is directed towards a particular factor of production when there is international trade between the North and the South. The North has endowed with a relatively higher fraction of skilled labor to unskilled labor than the South. Cross-country differences in factor

[1]Zhu and Trefler (2005) show the evidence of rising inequality in the South using the Freeman and Oostendrop (2001) occupational wage database which covers 20 developing countries. See also Meschi and Vivarelli (2009) which use the UTIP-UNIDO database covering 65 developing countries.

[2]The literature on the appropriate technology starts at least with Atkinson and Stiglitz (1969). Acemoglu and Zilibotti (2001) paper is more relevant to this paper since it focuses on differences in skill scarcity across countries.

endowments and sectoral productivities affect the incentive to invest in R&D toward each factor. The main result shows that more R&D is directed towards skill-augmenting technology in the North than in the South in the sector with the same skill-intensity. This means that the South uses unskilled labor more efficiently than the North. Trade allows the North to focus on more skill-intensive sectors not only in production but also in technology advancement. Moreover, innovation is directed toward skill-augmenting technology as the skill intensity of sector increases.

I examined the impact of trade on the skill premium. As trade costs change, there is a reallocation of resources in both production and innovation, which leads to a change in the skill premium. The skill premium in the South can increase when trade costs are lowered because the demand for skilled labor increases for R&D in technologies related to labor-intensive products. Although the result is not directly comparable to the Acemoglu (2003) paper due to differences in model specification, there is a difference in the mechanism that leads to an increase in the skill premium in the South. The South does not hire skilled labor for R&D in Acemoglu (2003). More than two developing countries should exist and their relative skill scarcity should differ enough to prompt an increase in the skill premium in the South. When trade opens up, the skill premium increases in a relatively skill-abundant developing country and decreases in skill-scarce developing countries. Another important result of my paper is that gains from trade exist not only due to specialization but also from endogenous directed technical change. This extra channel of gains from trade is closed when the technical change only happens in the North.

Several empirical studies find that the directions of technology differ as their factor endowments vary across the income-levels of the countries in question. Caselli and Coleman (2006) perform a cross-country analysis and find that lower-income countries use unskilled labor more efficiently than higher-income countries. Romalis (2004) uses detailed trade data between the United States and several other countries to analyze how factor proportions determine the structure of commodity trade. The sectors are ranked by skill intensity, which is approximated by the ratio of nonproduction workers to total employment in each industry. Alternatively, average wages can be used to measure skill-intensity. Romalis finds that the northern country has larger shares of more skill-intensive industries. Bloom, Draca, and Van Reenen (2016) have done empirical work measuring technical change by IT, patent counts and citations, and TFP. Using a panel of over to 200,000 European firms, they find a positive impact of increased Chinese import competition on technical change. The European countries included in their analysis corresponds to the North. They found that the share of unskilled workers declined with the rise in Chinese import competition. Motivated by these empirical findings, this paper gives a theoretical background on the cross-country differences in the direction of technical change toward the factors of production.

The next section presents the two-country model based on directed technical change. Section III introduces the supply side of new technology by defining the cost of technical change. Section IV characterizes equilibrium and presents an analysis of the balanced growth path (steady-state equilibrium). Section V concludes the paper.

II. The Model

There exist two countries, the North and the South. Each country shares the same production technology and utility function. The difference between the two countries lies in their endowment in skilled labor (h) and unskilled labor (l). These two are the factors of production and they are supplied inelastically. There can be initial sectoral differences in technology. There exists a continuum of sectors on $[0, 1]$. Sector j is arranged to rank sectors by its skilled labor intensiveness. I focus on country N in this analysis. Time subscript t is muted in the following section.

A. *Production Technologies*

A good in sector j is produced with the following production function:

$$(1) \qquad y(j) = A_i \left[\alpha_j^{\frac{1}{\rho}} (z_{h,j} h_j)^{\frac{\rho-1}{\rho}} + (1-\alpha_j)^{\frac{1}{\rho}} (z_{l,j} l_j)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

where A_i is general technology for country i. h_j and l_j are the skilled labor and unskilled labor hired in sector j respectively. $z_h(z_l)$ is a technology augmented to the factor $h(l)$. Innovation is s-augmenting if there is an innovation on z_h and l-augmenting if z_l improves. And $\rho > 0$ is the elasticity of substitution between skilled and unskilled labor. α_j denotes relative importance of skilled labor (e.g. if $\alpha_j = 1$, a firm in sector j hires only skilled labor).

The produced good will be consumed domestically and (or) be exported. And trade cost is expressed as iceberg cost where $D(\geq 1)$ units should be produced in order to export 1 unit of a good. Thus, $y(j) = a(j) + x_j D a^*(j)$ where $a^*(j)$ is the quantity of goods exported to country S. Certain goods are not produced but imported from country S. Goods are imported when the price of the imported good is cheaper than the price of domestically produced good.

The profit of a firm is

$$\pi(j) = \max_{y(j), p_a(j), p_a^*(j), a_j, a_j^*, x_j} p_a(j) a_j + x_j p_a^*(j) a_j^* - s h_j - w l_j$$

where $p_a(j)$ is the price of good j in domestic market and $p_a^*(j)$ is the price of good j in foreign market. s denotes the wage paid for skilled labor while w is the wage for unskilled labor.

Under the resource constraints, outputs are used either in the North or the South, $y(j) = a_j + x_j D a_j^*$. Producers maximize their profits subject to resource

constraints and production technology given by Eq. (1).

B. *Demand for Final Consumption Good*

A non-tradable final consumption good is produced at home and foreign intermediate goods by competitive producers using the following CES aggregate function:

$$Y = \left(\int_0^1 q(j)^{\frac{\sigma-1}{\sigma}} dj \right)^{\frac{\sigma}{\sigma-1}} \tag{2}$$

The final consumption good producer purchases $q(j)$ a quantity of goods j, which is $q(j) = a(j) + x_j^* b(j).$ $a(j)$ is the quantity of goods produced and consumed within the country. $b(j)$ is the quantity of goods produced and imported from country $S.$ $\sigma > 1$ is the elasticity of substitution between sectors. $x_j \in \{0,1\}$ indicates whether the country exports or not for good j. x_j^* is the export decision of a firm j in foreign country. The value is 1 when the firm exports.

The model setup is similar to Atkeson and Burstein (2010), where each firm produces differentiated goods in a measure of operating firms. In their analysis, when a new firm enters the market, it will create new differentiated goods. Here, the new firm replaces the operating firm.

The model in this paper assumes that both skilled labor and unskilled labor are given. Innovation is directed toward the specific factor of production. A directed technology change model is introduced in Acemoglu (2002; 2003). Here, we allow the South to develop its own technology rather than importing technology developed in the North.

Moreover, there are sectoral differences in skill-intensity. Each sector has a different incentive in directing R&D to a specific technology. The model allows us to study how a relative supply of skills affects the structure of trade. The main goal is to analyze how this trade structure interacts with innovation.

C. *Demand for Intermediate Goods*

Final consumption good producers buy intermediate goods from home producers at prices $p_a(j)$ and from foreign producers at prices $p_b(j)$. They will purchase cheaper good j of the two goods. Thus, the price of a good j will be $p(j) = \min\{p_a(j),\ p_b(j)\}.$ Consumption of intermediate goods j is $(j) = a(j) + x_j^* b(j).$ A solution to the final consumption good producer's problem leads to the following demand functions:

Price of final consumption goods is

$$P_t = \left(\int_0^1 p(j)^{1-\sigma} dj \right)^{\frac{1}{1-\sigma}} \tag{3}$$

Demand for intermediate good j is

$$\frac{a_j}{Y_t} = \left(\frac{p_a(j)}{P_t} \right)^{-\sigma}, \quad \frac{b_j}{Y_t} = \left(\frac{p_b(j)}{P_t} \right)^{-\sigma} \tag{4}$$

Demand for intermediate good j in the South is

$$\frac{a_j^*}{Y_t^*} = \left(\frac{p_a^*(j)}{P_t^*} \right)^{-\sigma}, \quad \frac{b_j^*}{Y_t^*} = \left(\frac{p_b^*(j)}{P_t^*} \right)^{-\sigma}$$

Intermediate good producers face this demand curve with elasticity σ. They charge constant markup over their marginal costs. Price of good j is

$$p_a(j) = \frac{\sigma}{\sigma - 1} c_j \tag{5}$$

where unit cost is defined as

$$c_j \equiv \frac{1}{A_i} \left(\alpha_j \left(\frac{s}{z_{h,j}} \right)^{1-\rho} + (1-\alpha_j) \left(\frac{w}{z_{l,j}} \right)^{1-\rho} \right)^{\frac{1}{1-\rho}} \tag{6}$$

Export price of good j reflects trade cost:

$$p_a^*(j) = \frac{\sigma}{\sigma - 1} D c_j \tag{7}$$

Prices of goods in the South are

$$p_b(j) = \frac{\sigma}{\sigma - 1} D c_j^*, \quad p_b^*(j) = \frac{\sigma}{\sigma - 1} c_j^*$$

Good j will be exported when $p_a^*(j) < p_b^*(j)$, which is $\frac{\sigma}{\sigma - 1} D c_j < \frac{\sigma}{\sigma - 1} c_j^*$. Using unit costs in the North and the South (eq. 6), this condition corresponds to

$$(8)\quad \begin{aligned} & D\frac{1}{A_i}\left(\alpha_j\left(\frac{s}{z_{h,j}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w}{z_{l,j}}\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} \\ & <\frac{1}{A_i^*}\left(\alpha_j\left(\frac{s^*}{z_{h,j}^*}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w^*}{z_{l,j}^*}\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} \end{aligned}$$

Firm produces when $p_a(j) < p_b(j)$, which is

$$(9)\quad \begin{aligned} & \frac{1}{A_i}\left(\alpha_j\left(\frac{s}{z_{h,j}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w}{z_{l,j}}\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} \\ & <D\frac{1}{A_i^*}\left(\alpha_j\left(\frac{s^*}{z_{h,j}^*}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w^*}{z_{l,j}^*}\right)^{1-\rho}\right)^{\frac{1}{1-\rho}} \end{aligned}$$

The exporting firm also produces for domestic good since condition in Eq. (9) is satisfied whenever condition in Eq. (8) holds. We define $\bar{\alpha}_j$ and $\underline{\alpha}_j$ as threshold values that make Eq. (8) and Eq. (9) hold in equality respectively.

III. Endogenous Technical Change

The previous section presented the basic environments in which goods are produced. The environments determine the demand for innovation. This section introduces production functions for innovation.

A. *Direction of Technical Change*

Research is done by hiring skilled labor only. Research can be directed toward improving on either z_h or z_l (or both). Profit is a function of $z_{h,j}$ and $z_{l,j}$.

$$\begin{aligned} \pi_j = & \frac{1}{(\sigma-1)^{1-\sigma}\sigma^{\sigma}}(Y_t P_t^{\sigma}+x_j D^{1-\sigma}Y_t^* P_t^{*\sigma})\cdot \\ & A_i^{\sigma-1}\left(\alpha_j\left(\frac{s}{z_{h,j}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w}{z_{l,j}}\right)^{1-\rho}\right)^{\frac{1-\sigma}{1-\rho}} \end{aligned}$$

Innovator chooses $z_{h,t+1}$ and $z_{l,t+1}$. However, research costs increase with distance $z_{h,t+1} - z_{h,t}$. Following the knowledge-based R&D specification from Acemoglu (2002), productivity in creating new technology is dependent on the current state of both s-augmenting and l-augmenting technology.

$$(10) \qquad \frac{z_{h,j,t+1} - z_{h,j,t}}{(z_{h,j,t})^{\frac{1+\delta}{2}} (z_{l,j,t})^{\frac{1-\delta}{2}}} = B\zeta h_{h,j,t}^{\theta}, \quad \frac{z_{l,j,t+1} - z_{l,j,t}}{(z_{h,j,t})^{\frac{1-\delta}{2}} (z_{l,j,t})^{\frac{1+\delta}{2}}} = h_{l,j,t}^{\theta}$$

where $0 \le \theta \le 1$, $0 \le \delta \le 1$ and $B \le 1$. θ governs the returns to scale in technology production. δ is the degree of state dependence. When $\delta = 1$, each technology advancement depends only on their own state of technology and does not affect cost of developing the other. I allow the costs in innovating the two technologies to differ with parameter B. When $B < 1$, it costs more to innovate on s-augmenting technology.

Empirical data finds a higher relative wage for the skilled to the unskilled in the North compared to the South. To incorporate this feature I use parameter ζ in s-augmenting technology where $\zeta \ge 1$. Parameter ζ is equal to 1 in the South. All analysis goes through when we set his parameter ζ equal to 1 in the North as well.

Entrant needs to pay fixed cost, f_e, to initiate research. The fixed cost can be interpreted as wages paid to specialized labor which exists only for R&D, as in Aghion and Howitt (1992). Specialized labor has to be hired proportional to skilled labor hired in R&D.

Entry cost makes the ex-ante profit of the entrant equal to zero. The number of entrants is indeterminate but there is always one entrant who succeeds in innovation. Thus, the entrant is indifferent in which sector to innovate on. Entrant decides the employment level of the skilled labor in innovating each technology. The entrant reaps all profit as she becomes the monopolist selling the innovated good for the next period.

The entrant's problem is

$$\max_{h_{h,j,t}^{E}, h_{l,j,t}^{E}} \pi_{j,t+1}(z_{h,j,t+1}, z_{l,j,t+1} \mid z_{h,j,t}, z_{l,j,t}) - s_t(h_{h,j,t}^{E} + h_{l,j,t}^{E}) - f_e$$

subject to innovation technology constraint, Eq. (10).

Optimal technology in the next period, $z_{h,j,t+1}$ and $z_{l,j,t+1}$, are solved from the first order conditions equations.[3] Then, the number of employees hired for innovation on s-augmenting and l-augmenting technology ($h_{h,j,t}$ and $h_{l,j,t}$) is easily traced with innovation technology constraint of Eq. (10). There is a free entry condition equalizing profit and costs of innovation. I also assume that a constant fraction of profit is paid as wages to the skilled labor hired in research.[4]

[3]The first order conditions are expressed in Appendix A.

[4]The equations for the free entry condition and wages paid to the skilled labor in research are in the appendix.

IV. Equilibrium Analysis

This section defines the equilibrium of the model and provides an analysis of the balanced growth path. I focus on the effects of change in trade costs to study the implications for the skill premium in the North and the South when trade costs fall.

A. *Equilibrium*

Definition 1.

Equilibrium of the economy is composed of a sequence of aggregate prices $\{P_t, P_t^*, s_t, s_t^*, w_t, w_t^*\}$, aggregate quantity $\{Y_t, Y_t^*, H_t, H_t^*, L_t, L_t^*\}$, sector prices for domestic good and export good $\{p_{a,t}(j), p_{a,t}^*(j), p_{b,t}(j), p_{b,t}^*(j)\}_{j\in[0,1]}$, sector quantities demanded and produced $\{q(j), q^*(j), a_t(j), a_t^*(j), b_t(j), b_t^*(j)\}$, firm's profit, export decisions $\{\pi_{j,t}, \pi_{j,t+1}^*, x_{j,t}, x_{j,t}^*\}$, factor demands for production $\{h_{j,t}, h_{j,t}^*, l_{j,t}, l_{j,t}^*\}$ and for research $\{h_{h,j,t}^E, h_{h,j,t}^{E*}, h_{l,j,t}^E, h_{l,j,t}^{E*}\}$ satisfying (intermediate and final good) producers' and innovators' optimality conditions, while those equilibrium clear factors and goods markets and balance trade in the North and the South.

Using demand functions, firm profit can be expressed as

$$
\begin{aligned}
\pi(j) &= \frac{1}{\sigma-1} y_j c_j \\
&= \frac{1}{(\sigma-1)^{1-\sigma}\sigma^{\sigma}} c_j^{1-\sigma}\left(Y_t P_t^{\sigma} + x_j D^{1-\sigma} Y_t^* P_t^{*\sigma}\right) \\
&= \frac{1}{(\sigma-1)^{1-\sigma}\sigma^{\sigma}} \left(Y_t P_t^{\sigma} + x_j D^{1-\sigma} Y_t^* P_t^{*\sigma}\right) A_i^{\sigma-1} \\
&\qquad \left(\alpha_j \left(\frac{s}{z_{h,j}}\right)^{1-\rho} + (1-\alpha_j)\left(\frac{w}{z_{l,j}}\right)^{1-\rho}\right)^{\frac{1-\sigma}{1-\rho}}
\end{aligned}
\tag{11}
$$

Profit is increasing as the unit cost is decreasing. Thus, profit increases when the technology advances.

Using Eq. (4) and (7), the quantities of domestic demand and foreign demand at equilibrium price are expressed as

$$(12)\quad a_j = Y_t\left(\frac{p_a(j)}{p_t}\right)^{-\sigma} = Y_t P_t^{\sigma} p_a(j)^{-\sigma} = Y_t P_t^{\sigma}\left(\frac{\sigma}{\sigma-1}c_j\right)^{-\sigma} \text{ and}$$
$$a_j^* = Y_t^*\left(\frac{p_a^*(j)}{P_t^*}\right)^{-\sigma} = Y_t^* P_t^{*\sigma} p_a^*(j)^{-\sigma} = Y_t^* P_t^{*\sigma}\left(\frac{\sigma}{\sigma-1}Dc_j\right)^{-\sigma}$$

Using Eq. (12), output produced in sector j is

$$\begin{aligned} y(j) &= a_j + x_j D a_j^* \\ &= Y_t P_t^{\sigma}\left(\frac{\sigma}{\sigma-1}c_j\right)^{-\sigma} + x_j D Y_t^* P_t^{*\sigma}\left(\frac{\sigma}{\sigma-1}Dc_j\right)^{-\sigma} \\ &= \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(Y_t P_t^{\sigma} + x_j Y_t^* P_t^{*\sigma} D^{1-\sigma})c_j^{-\sigma} \end{aligned}$$

Skilled labor and unskilled labor hired in production are, respectively,

$$\begin{aligned} h(j) &= \frac{y(j)}{A_i^{1-\rho}}\alpha_j z_h^{\rho-1}\left(\frac{c_j}{s}\right)^{\rho} \\ &= \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(Y_t P_t^{\sigma} + x_j Y_t^* P_t^{*\sigma} D^{1-\sigma})\frac{1}{A_i^{1-\rho}}\alpha_j z_{h,j}^{\rho-1} s^{-\rho} c_j^{\rho-\sigma} \end{aligned}$$

(13)

and

$$\begin{aligned} l(j) &= \frac{y(j)}{A_i^{1-\rho}}(1-\alpha_j)z_l^{\rho-1}\left(\frac{c_j}{w}\right)^{\rho} \\ &= \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(Y_t P_t^{\sigma} + x_j Y_t^* P_t^{*\sigma} D^{1-\sigma})\frac{1}{A_i^{1-\rho}}(1-\alpha_j)z_{l,j}^{\rho-1} w^{-\rho} c_j^{\rho-\sigma} \end{aligned}$$

From Eq. (13), the relative ratio of the skilled to the unskilled in sector j is

$$\frac{h(j)}{l(j)} = \frac{\alpha_j}{1-\alpha_j}\left(\frac{w}{s}\right)^{\rho}\left(\frac{z_{h,j}}{z_{l,j}}\right)^{\rho-1}$$

Skill premium is expressed as

$$\frac{s}{w}=\left\{\frac{\alpha_j}{1-\alpha_j}\left(\frac{z_{h,j}}{z_{l,j}}\right)^{\rho-1}\frac{l(j)}{h(j)}\right\}^{\frac{1}{\rho}} \tag{14}$$

Trade balance requires that all income is spent on the final non-traded good:

$$PY = sH + wL$$

General equilibrium of this model is described as follows:

Given factor prices $\{s, s^*, w, w^*\}$, unit cost (c_j, c_j^*) is derived from Eq. (6). Prices for intermediate goods are determined by a constant markup over the unit costs from Eq. (5) and Eq. (7). Export decision is made based on condition Eq. (8). Once the production decision is made from Eq. (9), unskilled and skilled labor are hired following Eq. (13). In this step, we use normalized final output. They produce $\alpha_j, \alpha_j^*, b_j, b_j^*$ according to Eq. (12). From Eq. (3), aggregate price and quantity is retrieved using the labor market clearing condition for unskilled labor, Eq. (C2). Profit is given from Eq. (11). Next, Eq. (A1) and Eq. (A2) determines the number of researchers hired in both s-augmenting and l-augmenting R&D for each sector. Equilibrium factor prices should satisfy labor market clearing conditions and balance trade between the North and the South.

B. *Balanced Growth Path*

Definition 2.

Balanced growth path (BGP) is an equilibrium sequence where variables (research labor for each sector and each technology, skilled labor and unskilled labor for each sector) stay constant. Output and consumption grow at a constant rate. Skill premium and the threshold values $\underline{\alpha}_j, \bar{\alpha}_j$ also stay constant.

Under complete specialization, where the North produces goods over $\underline{\alpha}_j$ and exports goods over $\bar{\alpha}_j$, the aggregate equilibrium price is

$$P_t=\left\{\int_0^{\underline{\alpha}_j}\left(\frac{\sigma}{\sigma-1}Dc_{j,t}^*\right)^{1-\sigma}dj+\int_{\underline{\alpha}_j}^1\left(\frac{\sigma}{\sigma-1}c_{j,t}\right)^{1-\sigma}dj\right\}^{\frac{1}{1-\sigma}}.$$[5]

In essence, what we solve in the general equilibrium are $\{s, s^*, w, w^*, Y, Y^*\}$ with labor market clearing conditions, Eq. (C1) and (C2) for each country, and the trade balance for the North and the South, Eq. (D2) and (D3).[6]

On the balanced growth path, sectors requiring more skilled labor, $\alpha_j > \bar{\alpha}_j$,

[5]The aggregate price for the South satisfies Eq. (D1) in Appendix D.

[6]These equations are in Appendix C and Appendix D.

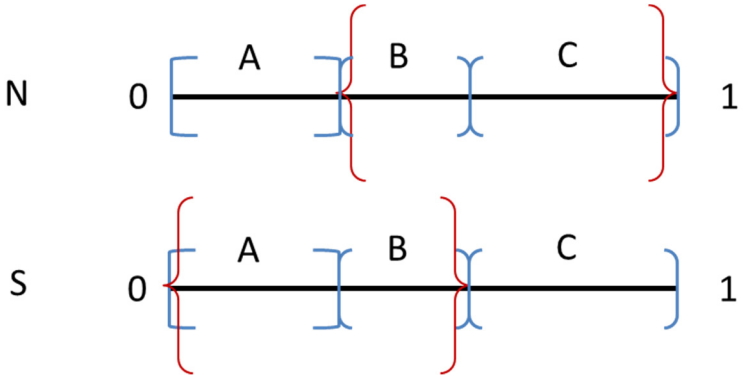

FIGURE 1. SPECIALIZATION PATTERNS

Note: For country N, region A denotes sectors where goods are imported. Sectors in region B produce goods but the goods are consumed within country N. Region C sectors produce and they export to country S.

will export to country S. This corresponds to region C in Figure 1. And sectors requiring more unskilled labor, $\alpha_j < \underline{\alpha}_j$ imports from country S (region A). In the middle range sectors (region B), $\alpha_j \in [\underline{\alpha}_j, \overline{\alpha}_j]$, goods will be produced and consumed within their country.

The difference in technology and relative factor endowments determine the pattern of specialization. I show in the analysis below that range B will be broader when trade cost, D, is higher or when the relative price of skilled labor to unskilled labor is not significantly different in the two countries. Export is more likely when the relative productivity A_i / A_i^* is high.

C. *Analytical Results*

The analytical results in this subsection rely on one parameter assumption as follows:

Assumption 1. Parameter values satisfy $\frac{1}{\theta}(1-\delta)+1-\rho>0$

Parameters δ and θ governs R&D technology. ρ is the elasticity of substitution between skilled labor and unskilled labor. Estimated value on ρ in the literature ranges from 1.2 to 1.4.[7] The following results come under this assumption. When $\frac{1}{\theta}(1-\delta)+1-\rho<0,$ then we cannot pin down relative technology in each sector since $\frac{z_{h,j,t}}{z_{l,j,t}}$ is a convex function of α_j.

Propositions 1 and 2 indicate that the direction of technology change is different

[7]For example, Katz and Murphy (1992) or Acemoglu (2002; 2003).

across countries. The proofs are in Appendix E.

Proposition 1. $\frac{z_{h,j,t}}{z_{l,j,t}}$ is increasing in α_j and $\frac{\partial \frac{z_{h,j}}{z_{l,j}}}{\partial \alpha_j} > \frac{\partial \frac{z^*_{h,j}}{z^*_{l,j}}}{\partial \alpha_j}$ for $\forall j$.

Moreover, when $\delta < 1$, $\frac{h_{h,j,t}}{h_{l,j,t}}$ is increasing in α_j.

The first result shows that as the skill intensity of a sector increases, the ratio of innovation on s-augmenting technology to innovation on l-augmenting technology increases. The second result shows that the North directs more R&D towards skill-augmenting technology relative to labor-augmenting technology than the South in the sector with the same skill-intensity. Put differently, the South uses unskilled labor more efficiently than the North. The final result of Proposition 1 indicates that as skill intensity grows, more skilled labor is employed in the s-augmenting R&D sector to the l-augmenting R&D sector.

Proposition 2. $\zeta^{\frac{1}{\theta}} \frac{h_{h,j}}{h_{l,j}} \geq \frac{h^*_{h,j}}{h^*_{l,j}}$ for $\forall j \in [0,1]$.

The proposition 2 shows that the (efficiency-adjusted) ratio of skilled labor in the s-augmenting R&D sector to the l-augmenting R&D sector is higher in the North than the South.

The following Proposition 3, 4, and 5 present analytical results on specialization and innovation when trade costs change.

Proposition 3. $\frac{\partial \underline{\alpha}_j}{\partial D} < 0$, $\frac{\partial \bar{\alpha}_j}{\partial D} > 0$ and $\frac{\partial \underline{\alpha}_j}{\partial (A_i / A_i^*)} < 0$, $\frac{\partial \bar{\alpha}_j}{\partial (A_i / A_i^*)} < 0$.

Threshold values for domestic production $\underline{\alpha}_j$ and for export $\bar{\alpha}_j$ are a function of trade costs and other parameters. The range of $[\underline{\alpha}_j, \bar{\alpha}_j]$ shrinks as trade costs decrease. Thus, a larger variety of goods are traded when trade costs decrease. As the relative productivity of the North to the South increases, the ranges that the North produces and exports get wider.

Proposition 4. $\frac{\partial (s/w)}{\partial D} < 0$, $\frac{\partial (s^*/w^*)}{\partial D} ? 0$, $\frac{\partial (s/w)}{\partial D} < \frac{\partial (s^*/w^*)}{\partial D}$

The skill premium in the North increases as trade costs decrease. When trade costs drop, the threshold value for domestic production, α_j, increases. This allows the North to focus its resources in more skill-intensive sectors where they hire more skilled labor. Thus, the skill premium increases in the North. Moreover, a decrease in trade costs brings about a drop in the threshold value of domestic production for the South, $\bar{\alpha}_j$. The South will put more resources in labor-intensive sectors. However, a change in the skill premium in the South can be positive or negative

depending on the parameters and differences in general technology and endowments. Two forces are playing against one another in skill premium. On the one hand, production requires more unskilled labor, which will raise wages for the unskilled. On the other hand, demand for skilled labor increases to develop l-augmenting technology and that drives up wages for the skilled. Thus, the answer depends on the magnitude of each effect on the skill premium.

Proposition 5. Gains from trade are magnified due to endogenous directed technical change.

Gains from trade come from specialization based on the Heckscher-Ohlin effect. Trade allows countries to specialize in sectors that intensively use their relatively abundant factors. The gains are magnified by directed technical change. Thus, gains from trade are larger in this model compared to the case where there is no directed technical change or in the case where technical change is only allowed in the North. Endogenous technical change in the South lowers unit costs in the South. This lowers the price of intermediate goods as well as the aggregate price in both the North and the South. Real output increases due to directed technical change spurred by trade.

V. Concluding Remarks

This paper analyses how technology advancement is directed towards a particular factor of production in international trade between the North and the South. Cross-country differences in factor endowments and sectoral productivities affect incentives to invest in R&D toward each factor. The main result shows that more R&D is directed towards skill-augmenting technology in the North than in the South in the sector with the same skill-intensity. Trade allows the North to focus on more skill-intensive sectors not only in production but also in technology advancement. In both countries, technical change is more skill-biased as the skill intensity of sector increases.

As trade costs change, there is a reallocation of resources in both production and innovation. The North gets to produce and export more various goods that are most skill-intensive. The opposite happens with the South. These reallocations lead to a change in the skill premium. As trade costs decrease, skill premium in the North increases. A change of the skill premium in the South can be either positive or negative. The skill premium in the South can increase because the demand for skilled labor increases for R&D in technologies for labor-intensive products. My model can produce this result without relying on an assumption of a third country which is more skill-scarce. Moreover, the results are supported by the empirical findings that countries' technologies make use of their relatively abundant endowment more efficiently.

Finally, there exist gains from trade not only due to specialization but also from endogenous directed technical change. Lowering trade costs allows countries to trade a larger variety of goods and to develop technologies in those added sectors. Thus, my model implies larger gains from trade compared to other models when the South only adopts technology developed by the North. Future interesting work can be undertaken by allowing endowments of skilled and unskilled labor to be endogenous.

APPENDIX

A. *F.O.Cs for Entrants*

In section III, first order conditions of the entrants' problem in innovation market are:

(A1)

$$\frac{1}{\theta}(B\zeta)^{-\frac{1}{\theta}}\left(\frac{z_{h,j,t+1}-z_{h,j,t}}{(z_{h,j,t})^{\frac{1+\delta}{2}}(z_{l,j,t})^{\frac{1-\delta}{2}}}\right)^{\frac{1}{\theta}-1}\frac{s_t}{(z_{h,j,t})^{\frac{1+\delta}{2}}(z_{l,j,t})^{\frac{1-\delta}{2}}}=$$

$$\frac{1}{(\sigma-1)^{-\sigma}\sigma^{\sigma}}(Y_{t+1}P_{t+1}^{\sigma}+x_jD^{1-\sigma}Y_{t+1}^{*}P_{t+1}^{*\sigma})A_i^{\sigma-1}\alpha_j s_{t+1}^{1-\rho}z_{h,j,t+1}^{\rho-2}$$

$$\left(\alpha_j\left(\frac{s_{t+1}}{z_{h,j,t+1}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w_{t+1}}{z_{l,j,t+1}}\right)^{1-\rho}\right)^{\frac{\rho-\sigma}{1-\rho}} \quad \text{and}$$

(A2)

$$\frac{1}{\theta}\left(\frac{z_{l,j,t+1}-z_{l,j,t}}{(z_{h,j,t})^{\frac{1-\delta}{2}}(z_{l,j,t})^{\frac{1+\delta}{2}}}\right)^{\frac{1}{\theta}-1}\frac{s_t}{(z_{h,j,t})^{\frac{1-\delta}{2}}(z_{l,j,t})^{\frac{1+\delta}{2}}}=$$

$$\frac{1}{(\sigma-1)^{-\sigma}\sigma^{\sigma}}(Y_{t+1}P_{t+1}^{\sigma}+x_jD^{1-\sigma}Y_{t+1}^{*}P_{t+1}^{*\sigma})A_i^{\sigma-1}(1-\alpha_j)w_{t+1}^{1-\rho}z_{l,j,t+1}^{\rho-2}$$

$$\left(\alpha_j\left(\frac{s_{t+1}}{z_{h,j,t+1}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w_{t+1}}{z_{l,j,t+1}}\right)^{1-\rho}\right)^{\frac{\rho-\sigma}{1-\rho}}$$

From the first order conditions, for each sector j, the following equality holds.

(A3)

$$(B\zeta)^{-\frac{1}{\theta}}\left(\frac{B\zeta(h_{h,j,t})^{\theta}}{(h_{l,j,t})^{\theta}}\right)^{\frac{1}{\theta}-1}\left(\frac{s_{t+1}}{w_{t+1}}\right)^{\rho-1}\left(\frac{z_{h,j,t}}{z_{l,j,t}}\right)^{2-\delta-\rho}\left\{\frac{B\zeta(h_{h,j,t})^{\theta}\left(\frac{z_{h,j,t}}{z_{l,j,t}}\right)^{\frac{\delta-1}{2}}+1}{(h_{l,j,t})^{\theta}\left(\frac{z_{h,j,t}}{z_{l,j,t}}\right)^{\frac{1-\delta}{2}}+1}\right\}^{2-\rho}=\frac{\alpha_j}{1-\alpha_j}$$

B. *Free Entry Condition and Wages Paid to Research*

Free entry condition equalizes profit obtained from innovation and the costs of innovation as follows:

$$\frac{1}{(\sigma-1)^{-\sigma}\sigma^{\sigma}}(Y_{t+1}P_{t+1}^{\sigma}+x_jD^{1-\sigma}Y_{t+1}^{*}P_{t+1}^{*\sigma})\cdot$$

$$A_i^{\sigma-1}\left(\alpha_j\left(\frac{s_{t+1}}{z_{h,j,t+1}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w_{t+1}}{z_{l,j,t+1}}\right)^{1-\rho}\right)^{\frac{\rho-\sigma}{1-\rho}}=s_t(h_{h,j,t}^{E}+h_{l,j,t}^{E})+f_e$$

Constant fraction φ of profit is paid to skilled labor hired in research. Thus,

$$\varphi\frac{1}{(\sigma-1)^{-\sigma}\sigma^{\sigma}}(Y_{t+1}P_{t+1}^{\sigma}+x_jD^{1-\sigma}Y_{t+1}^{*}P_{t+1}^{*\sigma})\cdot$$

$$A_i^{\sigma-1}\left(\alpha_j\left(\frac{s_{t+1}}{z_{h,j,t+1}}\right)^{1-\rho}+(1-\alpha_j)\left(\frac{w_{t+1}}{z_{l,j,t+1}}\right)^{1-\rho}\right)^{\frac{1-\sigma}{1-\rho}}=s_t(h_{h,j,t}^{E}+h_{l,j,t}^{E})$$

C. Labor Market Clearing Conditions

Labor market clearing conditions for each factor are

(C1)

$$\begin{aligned}H&=\int\{h(j)+h_{h,j}^{E}+h_{l,j}^{E}\}dj\\&=\int\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(Y_tP_t^{\sigma}+x_jY_t^{*}P_t^{*\sigma}D^{1-\sigma})\frac{1}{A_i^{1-\rho}}\alpha_jz_{h,j}^{\rho-1}s_t^{-\rho}c_{j,t}^{\rho-\sigma}\\&\quad+\varphi\frac{1}{(\sigma-1)^{-\sigma}\sigma^{\sigma}}(Y_{t+1}P_{t+1}^{\sigma}+x_jY_{t+1}^{*}P_{t+1}^{*\sigma}D^{1-\sigma})s_t^{-1}c_{j,t+1}^{1-\sigma}dj\\&=\int\left(\frac{\sigma}{\sigma-1}\right)^{-\sigma}(Y_tP_t^{\sigma}+x_jY_t^{*}P_t^{*\sigma}D^{1-\sigma})\frac{1}{s_t}\\&\quad\left(\left(\frac{A_iz_{h,j}}{s_t}\right)^{\rho-1}a_jc_{j,t}^{\rho-\sigma}+\frac{(Y_{t+1}P_{t+1}^{\sigma}+x_jY_{t+1}^{*}P_{t+1}^{*\sigma}D^{1-\sigma})}{(Y_tP_t^{\sigma}+x_jY_t^{*}P_t^{*\sigma}D^{1-\sigma})}\frac{\varphi}{\sigma-1}c_{j,t+1}^{1-\sigma}\right)dj\end{aligned}$$

and

(C2)

$$L = \int l(j)dj$$
$$= \int \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} (Y_t P_t^{\sigma} + x_j Y_t^* P_t^{*\sigma} D^{1-\sigma}) w^{-\rho} (A_i z_{l,j})^{\rho - 1} (1 - \alpha_j) c_j^{\rho - \sigma} dj$$

D. Equilibrium Price and Trade Balance in the BGP

The aggregate price for the South satisfies

(D1)

$$P_t^* = \left\{ \int_0^{\bar{\alpha}_j} \left(\frac{\sigma}{\sigma - 1} c_{j,t}^* \right)^{1-\sigma} dj + \int_{\bar{\alpha}_j}^1 \left(\frac{\sigma}{\sigma - 1} D c_{j,t} \right)^{1-\sigma} dj \right\}^{\frac{1}{1-\sigma}}$$

Trade balance in the North is

(D2)

$$P_t Y_t = s_t H + w_t L$$
$$= \int_{\underline{\alpha}_j}^1 \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} Y_t P_t^{\sigma} \left\{ \left(1 + \frac{Y_{t+1} P_{t+1}^{\sigma}}{Y_t P_t^{\sigma}} \frac{c_{j,t+1}^{1-\sigma}}{c_{j,t}^{1-\sigma}} \frac{\varphi}{\sigma - 1} \right) c_{j,t}^{1-\sigma} \right\} dj$$
$$+ \int_{\bar{\alpha}_j}^1 \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} Y_t^* P_t^{*\sigma} D^{1-\sigma} \left\{ \left(1 + \frac{c_{j,t+1}^{1-\sigma}}{c_{j,t}^{1-\sigma}} \frac{\varphi}{\sigma - 1} \right) c_{j,t}^{1-\sigma} \right\} dj$$

Trade balance in South is

(D3)

$$P_t^* Y_t^* = s_t^* H^* + w_t^* L^*$$
$$= \int_0^{\bar{\alpha}_j} \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} Y_t^* P_t^{*\sigma} \left\{ \left(1 + \frac{Y_{t+1}^* P_{t+1}^{*\sigma}}{Y_t^* P_t^{*\sigma}} \frac{c_{j,t+1}^{*1-\sigma}}{c_{j,t}^{*1-\sigma}} \frac{\varphi}{\sigma - 1} \right) c_{j,t}^{*1-\sigma} \right\} dj$$
$$+ \int_0^{\underline{\alpha}_j} \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} Y_t P_t^{\sigma} D^{1-\sigma} \left\{ \left(1 + \frac{c_{j,t+1}^{*1-\sigma}}{c_{j,t}^{*1-\sigma}} \frac{\varphi}{\sigma - 1} \right) c_{j,t}^{*1-\sigma} \right\} dj$$

E. Proofs

Proof of **Proposition 1.**

The share of expenditure on foreign goods is

$$\frac{\int_0^{\underline{\alpha}_j} p_b(j)b(j)dj}{PY} = P_t^{\sigma-1}\int_0^{\underline{\alpha}_j}\left(\frac{\sigma}{\sigma-1}Dc_{j,t}^*\right)^{1-\sigma} dj$$

On the balanced growth path, technology grows at a constant rate

(E1)

$$\frac{z_{h,j,t+1}-z_{h,j,t}}{z_{h,j,t}} = \frac{z_{l,j,t+1}-z_{l,j,t}}{z_{l,j,t}} \equiv \lambda_j \Leftrightarrow \frac{B\zeta h_{h,j,t}^{\theta}}{h_{l,j,t}^{\theta}} = \left(\frac{z_{h,j,t}}{z_{l,j,t}}\right)^{1-\delta}$$

Using Eq. (E1) on Eq. (A3), we have

(E2)

$$(B\zeta)^{-\frac{1}{\theta}}\left(\frac{z_{h,j,t}}{z_{l,j,t}}\right)^{\frac{1}{\theta}(1-\delta)+1-\rho}\left(\frac{s_{t+1}}{w_{t+1}}\right)^{\rho-1} = \frac{\alpha_j}{1-\alpha_j}$$

Combining (E2) with Eq. (14), skill premium is

$$\frac{s}{w} = (B\zeta)^{-\frac{1}{\theta}}\left(\frac{z_{h,j,t}}{z_{l,j,t}}\right)^{\frac{1}{\theta}(1-\delta)+1-\rho}\frac{l(j)}{h(j)}$$

The first result of Proposition 1 is derived from equation Eq. (E2). When $\delta < 1$, equation Eq. (E1) proves the second result. ■

Proof of **Proposition 2.**

I prove Lemma 1 and 2 below first.

Lemma 1. $\dfrac{\partial \dfrac{z_{h,j}}{z_{l,j}}}{\partial \alpha_j} > \dfrac{\partial \dfrac{z_{h,j}^*}{z_{l,j}^*}}{\partial \alpha_j}$ if and only if $\dfrac{s}{w} < \zeta^{\frac{1}{\theta(\rho-1)}}\dfrac{s^*}{w^*}$ for $\forall j,t.$

From Eq. (E2), we have

$$\frac{\partial \dfrac{z_{h,j,t}}{z_{l,j,t}}}{\partial \alpha_j} = \frac{1}{\dfrac{1}{\theta}(1-\delta)+1-\rho}\left(\frac{\alpha_j}{1-\alpha_j}\right)^{\frac{1}{\frac{1}{\theta}(1-\delta)+1-\rho}-1}\frac{1}{(1-\alpha_j)^2}(B\zeta)^{\frac{1}{(1-\delta)+(1-\rho)\theta}}\left(\frac{s_{t+1}}{w_{t+1}}\right)^{\frac{1-\rho}{\frac{1}{\theta}(1-\delta)+1-\rho}}$$

Comparing same equation for $\frac{\partial \frac{z^*_{h,j}}{z^*_{l,j}}}{\partial \alpha_j}$ proves Lemma 1. ■

Lemma 2. In equilibrium, $\frac{s}{w} < \zeta^{\frac{1}{\theta(\rho-1)}} \frac{s^*}{w^*}$ should be satisfied.

Suppose not. Then we have $\frac{\partial \frac{z_{h,j}}{z_{l,j}}}{\partial \alpha_j} \leq \frac{\partial \frac{z^*_{h,j}}{z^*_{l,j}}}{\partial \alpha_j}$. This implies that $\frac{z^*_{h,j}}{z^*_{l,j}} \geq \frac{z_{h,j}}{z_{l,j}}$ for all sectors. This is not compatible with the assumption that $H / L \geq H^* / L^*$. There should exist some sectors in the North where they hire more skilled labor to unskilled labor than in the South. ■

Using Lemma 2, $\zeta^{\frac{1}{\theta}} \left(\frac{s^*_{t+1} / z^*_{h,j,t}}{w^*_{t+1} / z^*_{l,j,t}} \right)^{\rho-1} > \left(\frac{s_{t+1} / z_{h,j,t}}{w_{t+1} / z_{l,j,t}} \right)^{\rho-1}$.

Skilled labor hired in each R&D is $h^E_{h,j} = \left\{ \frac{1}{B\zeta} \lambda_j \left(\frac{z_{h,j,t}}{z_{l,j,t}} \right)^{\frac{1-\delta}{2}} \right\}^{\frac{1}{\theta}}$ and $h^E_{l,j} = \left\{ \lambda_j \left(\frac{z_{h,j,t}}{z_{l,j,t}} \right)^{\frac{\delta-1}{2}} \right\}^{\frac{1}{\theta}}$. Combining these equations with Lemma 1 proves Proposition 2. ■

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