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Justin Yifu Lin and Pengfei Zhang

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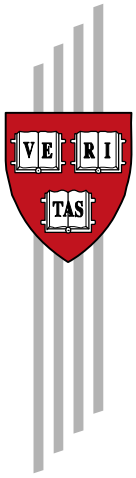

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Development Strategy and Economic Institutions in Less Developed Countries*

Justin Yifu Lin
China Center for Economic Research, Peking University
jlin@ccer.pku.edu.cn

Pengfei Zhang
CCER Peking University, CID Harvard University and NBER
pengfei_zhang@ksg.harvard.edu

(Still Preliminary, Comments Welcome)

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Abstract

In this paper, we construct a three-sector model to explore the politically determined development objectives and the intrinsic logic of government intervention policies in less developed countries (LDCs). We argue that many interventionist and distorted institutional arrangements in China, socialist countries, and other LDCs after the World War II can be largely explained by their governments' adoption of an inappropriate development strategy. Motivated by nation building, most LDCs, both socialist and non-socialist, adopted a Catch-up type comparative advantage-defying (CAD) strategy to accelerate the growth of capital-intensive, advanced sectors in their countries. Many firms in the priority sectors of this strategy were nonviable in open, competitive markets because the priority sectors were not their economies' comparative advantages. The model shows that the government's interventions, including distorted prices for products and essential factors of production, highly centralized planned resource allocation system and a micro-management mechanism in which firms were deprived of autonomy, are endogenous to the needs of maximizing resource mobilization for building up the priority sectors and to support non-viable firms in those sectors. Thus, given the government's motivation, i.e., pursuing Catch-up type CAD strategy, these distorted economic institutions and interventionist policies existing in the LDCs were desirable. Without addressing the firms' viability issue and giving up the Catch-up type CAD strategy, the implementation of price liberalization, privatization, and elimination of other distortions would result in poorer economic performance in the LDCs than that before the reform.

Keywords: Development Strategy, Factor Endowments, Incomplete Contract, Institution, Regulation, Trinity System
JEL Classification: D23, D45, H21, L25, L33, L5, O2, P3.

1. Introduction

After the World War II the governments in the less developed countries (LDCs), including socialist and non-socialist, instituted a complicated set of regulations and distortions that suppressed the functions of markets, such as financial depression, trade restriction, rationing of capital and foreign exchange, licensing of investments, administrative monopoly and state ownership. It has been recognized now that, no matter what the motivation might be, these policies often led to poor economic performance, low living standards, and even frequent crises in the LDCs. However, there is no consensus about what cause an LDC's government to adopt such polices, and what the relations are among various policies in the complicated set.

The classical theory for the government's regulations (Pigou, 1938) has been called the helping-hand view. Seeing the adverse effects of the government's regulations and distortions in the LDCs, economists have proposed an alternative grabbing-hand view (Grossman and Helpman, 1994; Shleifer and Vishny, 1994; Sokoloff and Engerman, 2000; Acemoglu, 2007). The latter proposed that the government interventions are pursued for the benefits of politicians and bureaucrats, for example, favoring friendly firms and other political constituencies so as to obtain their self benefits such as campaign contributions and votes[1], or for benefiting selected groups within a country who have unusually strong political influences.

Suppose that the government's regulations and distortions in the LDCs arise from the rent extraction of the government or political elites. The unsolved question in the literature is how to understand the complexity of those policies. In the LDCs, the institutional arrangements shaped by the government's interventions are quite complicated. What are the government's incentives to institute such a complicated system, which increases the costs of expropriations and political control and diminishes the gains of grab? Corruptions induced by the special interest groups might not be a good answer for this question either, because the benefited groups are often taxed or suppressed alongside with the protections and (or) subsidies. Actually, many interventions do not have obvious beneficiary groups (Lin, et al. 2006).

Beyond the arguments from the helping- and grabbing-hand categories, some recent theoretical works suggest that the government's regulations and distortions in the LDCs might be designed to alleviate the problems of tax collections. Gordon and Li (2005a, 2005b) argue that the tax enforcement depends heavily on the availability of information from outside a firm about the scale of any firm's economic activities. Such information, largely comes from the firm's recorded transactions through the financial sector. Most production activities in an LDC are in the informal economy that rely on cash transactions and are virtually impossible to monitor and tax. They argue that tariff protection is used to compensate for firms in the formal sectors that face high effective tax rates, control of lending is used to redirect credit to heavily taxed sectors, inflation is used as a tax on firms that rely on cash to avoid tax, and red tape and fees are used to impose non-tax costs on businesses that in practice pay little or no taxes. Esfahani (2000) proposes that, as the administrative weakness is exaggerated, the government is likely to control the production capacity directly by the state ownership. While the argument captures the intrinsic difficulty of taxation in LDCs, it offers few insights on the government's purpose of collecting taxes and why

[1] A recent paper presented by Djankov, et al. (2002) provided an empirical test on the theories of grabbing hand, and suggested that the barrier for business entry might arise from the corruption of bureaucrats.

the government would not create a policy environment to allow the informal sectors to grow into formal sectors so as to enlarge the tax base.

In this paper, we will propose an alternative explanation for the root and their internal logics of the complicated interventionist policies in the LDCs. Motivated by the dream of national building, most the LDC governments, both socialist and non-socialist alike, pursued development plans that attempted to accelerate the development the then-advanced capital-intensive industries after World War II. However, an economy's optimal industrial structure is endogenously determined by that economy's endowment structure (Lin and Xu, 2007; Zhang 2006). The firms in the government's priority industries are not viable in an open, competitive market because these industries do not match the comparative advantage of their particular economy. As such, it is imperative for the government to introduce a series of regulations and interventions in the international trade, financial sector, labor market, and so on so as to mobilize resources for setting up and supporting the continuous operation of the non-viable firms. This kind of development mode can be found in a Soviet-type economy before the transition in 20th century as well as in China before 1980s, in which the economic institution is distorted as a coherent whole with its own inherent logic, necessary components, and natural interaction of those components (Ericson 1991; Kornai, 1992). This type of economy might be good at mobilizing the scarce resources and concentrating on a few clear, well-defined priority sector (Ericson, 1991), but will deteriorate the economy-wide welfare (Sah and Stiglitz, 1987b) and will be highly costly for the long-run growth (Acemoglu, et al. 2006).

The model in the paper, motivated by Lin, et al. (1994, 1996, 1999, and 2003), will reveal the intrinsic logic of various institutional components in a three-sectors with the consideration of the government's motivation for national building. The inefficient regulations and distortions in our model resemble to those inefficient institutions in Acemoglu (2007). Whereas Acemoglu's model emphasize the elite's use of political power to institute policies for increasing their income through directly or indirectly transfer of resources from the rest of the society to themselves, we emphasize the governments' aim of building up advanced sectors at the early stage of their development with a benevolent purpose of national building.

The remainder of the paper is organized as follows. In section 2 we review the development strategy in the LDCs after the World War II and its impact on the observed intervention and distorted institutions in LDCs. Section 3 presents the basic economic model and characterizes the equilibrium without governmental distortion, i.e., under laissez-faire. Section 4 extends the basic model to analyze the formation of the distorted prices for products and essential factors of production, highly centralized planned resource-allocation system and a micro-management mechanism in which firms had no autonomy. Section 5 concludes.

2. CAD Strategy and Economic Institutions in the LDCs[2]

Prior to the World War II, only a few governments (most notably the Soviet Union) regarded economic growth as their direct responsibility and adopted policies for which economic growth was the primary stated objective, nor was the development economics a separate field of study (Krueger, 1995). After the World War II, a large number of colonial or semi-colonial countries

[2] The institution in our paper refers to an "institution arrangement" which is a set of behavioral rules that govern behavior in a specified domain, not to an "institutional structure" which is the totality of institutional arrangements in an economy, including its organizations, laws, customs, and ideology (Lin, 1989; Lin and Nugent, 1995).

won their political independence. The emergence of previous colonies or semi-colonies as newly independent states in Asia and the Middle East, and later in Africa, was accompanied by strong nationalist sentiments. However, compared with developed countries (DCs), these LDCs had an extremely low economic growth rate and per capita GNP, high birth and death rates, a low average educational attainments, and very little infrastructure, and they were heavily specialized in the production and export of primary commodities and imported most of their manufactured goods. Thus, independently developing their economies so as to achieve a rapid economic take-off and eliminate poverty was central to every LDC government's national agenda and a lot of governments in the LDCs regarded economic growth as their direct and priority responsibility.

Since then, economic development became a conscious goal within and outside academic circles, and the field of economic development has been an interesting and challenging one. The new field of development economics was regarded as covering underdevelopment because "conventional economics" did not apply (Hirschman, 1982). Early trade and development theories and policy prescriptions were based on some widely accepted stylized facts and premises about the LDCs (Krueger, 1997). These stylized facts and (or) premises include: (1) Developing economies' production structures were heavily oriented toward primary commodity production;[3] (2) If LDCs adopted policies of free trade, their comparative advantage would forever lie in primary commodity production; (3) Both the global income and price elasticities of demand for primary commodities were low; (4) Capital accumulation was crucial for growth, and in early stage of development it could occur only with the importation of capital goods.[4] Based on these stylized facts and premises, it was a straight step to believe that the process of development was that of industrialization, and industrialization consists primarily in the substitution of domestic production of manufactured goods for imports (Chenery, 1958). Under the influence of the Keynesianism and the belief in the economic success of the Soviet Union, the mainstream theories in the development economics at that time held that the market encompasses insurmountable defects and the government was a powerful supplementary means to accelerate the pace of economic development. Many development economists at that time advocated the implementation of centralized and detailed planned management so that the national economy could operate smoothly.

Most of the leaders of government in the LDCs, which used to be colonies or semi-colonies, were deeply influenced by the above radical view of economic development at that time and Keynesian theory. Jawaharlal Nehru advocated that India gives priority to heavy-industry and stressed that "No modern nation can exist without certain essential articles which can be produced only by big industry. Nor to produce these is to rely on imports from abroad and thus to be subservient to the economy of foreign countries… Big industry must be encouraged and developed as rapidly as possible, but the type of industry thus encouraged should be chosen with care. It should be heavy and basic industry, which is the foundation of a nation's economic strength and on which other industries can gradually be built up." (Quoted from Srinivasan, 1994). The above quote from Nehru, whose own thought was influential not only for India but for all concerned with development, aptly reflect the strong desire at that time that taking heavy industries or import substitution as a basic development path and hoped this could help to reach a higher level of industrialization and leap over some stages of economic development. Meanwhile,

[3] Many observers went further and attributed the low living standards in the LDCs to dependence on primary commodity production and export.

[4] Please see Krueger (1997) for the details of these stylized facts and premises.

the academic exchanges-including the hiring of economists from DCs as economic adviser, and the participation of international organizations such the World Bank-also greatly affected the LDCs' choice of development strategy (Lin, et al. 2003). Motivated by ambition of nation building and influenced by the prevailing social knowledge at that time[5], most LDCs-whether socialist, such as China, the former USSR and those in Eastern Europe, or non-socialist, such as India and those in Asia and Central and South America, adopted a government promoted Catch-up type CAD strategy to accelerate the growth of capital-intensive, advanced sectors in their countries.[6] The development strategies chosen then by the governments in the LDCs, whether "heavy-industry-oriented development strategy" in China and India,[7] or "import-substitution strategy" in Latin America are in essence the same. The Catch-up type CAD strategy is a type of comparative-advantage defying (CAD) strategy, which sought to develop certain advanced capital-intensive industries which are not consistent with the comparative advantage determined by their factor endowments as they all had scarce capital while had a rich labor pool or natural resource endowment (Lin, et al. 2003).[8]

For a LDC that pursues a Catch-up type CAD strategy, the advanced heavy-industry has three basic characteristics: (1) a long gestation, (2) the need to import most equipment at least at the early stage, and (3) a large initial investment (Lin, et al. 2003). After the World War II, capital was in short supply in the LDCs; hence the market interest rate was naturally high, while the cost of labor was low. Developing capital-intensive heavy industries was extremely costly, and such industries could not hope to be viable in an open, free market.[9] Given that resources are allocated by the market mechanism, producers will decide what to produce and what technology to adopt according to market prices of products and production factors, thus, investment would not have flowed into heavy-industry sectors. Rather, industrialization featuring light industry would have occurred, which would have been contradictory to the goal of implementing the Catch-up type CAD strategy. Therefore, to maximize resource mobilization for building up the priority heavy-industry sectors and to support non-viable firms in those sectors, the distorted institutional arrangements, i.e., a system of distorted economic institutions and interventionist policies, were obliged to be established in the LDCs to lower the barriers of investment to heavy-industry development. Such a system was characterized by the trinity of a macro-policy environment of distorted prices for products and essential factors of production (e.g. interest rate, wage, and prices for energy and raw materials, etc.), highly centralized planned resource allocation system and a micro-management mechanism in which firms had no decision-making power.

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[5] It is difficult now to image how much of these inappropriate development strategy was influenced by the prevailing social knowledge at that time. Nevertheless, Schultz (1977) found that the alteration and establishment of various political and economic institutional arrangements in the last three centuries of England and other Western economies were induced or shaped by the dominant social thought in those times.

[6] The expression "Catch-Up" could vividly reflect the ambitious and fanatic goals of the LDCs' government at that time, which could be well illustrated by the national slogan in China "Catch up with the United State and overtake Britain" in the 1950s.

[7] After the economic recovery of 1950-52, the development strategy was first fully manifested in the First Five-year Plan for national economic development. Fuchun Li, the then vice premier and head of the State Planning Commission, pointed out explicitly in the Five-year Plan report that "socialist industrialization is the primary task of our country in the transitional period. The key component of socialist industrialization is giving priority to the development of heavy industries." (CPC Central Committee 1955). Please see Lin, et al. (2003) for the details about the "heavy-industry-oriented development strategy" in China.

[8] The other type of CAD strategy adopted mostly in DCs is to support certain obsolete labor-intensive or resource-intensive industries for the purpose of protecting jobs. The Catch-up type CAD strategy can be referred as CAD strategy-type I, whereas the job-protecting CAD strategy can be referred as CAD strategy-type II.

[9] A normally managed firm is viable if this firm earns a socially acceptable expected profit without external subsidies or protections. Please see the definition of viability in Lin and Tan (1999) and Lin (2003) for details.

Had the government in the LDCs relied on direct fiscal subsidies to finance heavy industrial projects, it would have had to distort relative prices for output by collecting heavy explicit taxes from the other economic sectors. Taxes could come only from the light industrial sectors as well as the small and scattered agricultural sector, and tax collection from these sectors is difficult and costly. As a matter of fact, heavy explicit tax collection was impossible in the LDCs then (Gordon and Li 2005 a,b). Clearly, a macro-policy environment which completely suppresses the functions of market mechanisms, distort relative prices for outputs as well as depress artificially the relative prices of factors was needed to encourage the development of heavy industries. Such a policy environment includes the following: (1) A low-interest-rate policy; (2) A low-exchange-rate policy; (3) A policy of low nominal wage and low prices for energy and raw materials; and (4) A policy of low prices for agricultural products and other essential goods and services (Lin, et al. 2003).[10]

Under the circumstances described above, low interest rate reduced people's incentive to save, thus decreasing the source of funds. At the same time, the low interest rates also increased enterprises' demand for funds. Moreover, the low exchange rate suppressed the incentive to export but stimulated the impulse to import. And the low prices of energy and raw materials also resulted in a short supply and excessive demand. A large gap was thus created between the supply and demand of funds, foreign exchange, and energy and raw materials. If the market had been allowed to direct resource allocation, the policy of suppressing prices could not have ensured that these resources would flow into strategic sectors. As a result, the government needed to create an order of priority for industrial development and investment projects. Meanwhile, it had to replace the market mechanism with a series of planned administrative means in resource allocation to ensure the limited resources will be allocated to the priority industries (Lin, et al. 2003).

The macro-policy environment with distorted relative prices for products and depressed relative prices of factors, as well as a highly centralized planned resource-allocation system, did create the necessary conditions for heavy industrial construction at the early stage of economic development. However, these policies alone were not sufficient to make the heavy-industry-oriented industrial development successful. If enterprises were owned and run by private agents, such profit-oriented private enterprises would allocate their resources not to heavy-industry sectors but to the sectors that yielded the highest returns, providing that they had the right to allocate profits and choose investments. Therefore, for the purpose of securing policy-distortion-induced profits for heavy-industry projects, the state had to establish a compulsory production planning system and a unified revenue and expenditure system, as well as nationalize private enterprises to the greatest possible extent. Under the circumstance of distorted relative prices and lack of competition, the profitability of an enterprise is not determined by its performance. If the enterprise has been granted the autonomy, owing to the information asymmetries between the government and the manager, managers and workers would inevitably prey upon its profit and assets. To avoid the investment arbitrage and the erosion of profits and state assets, the state has to deprive enterprises of autonomy (Lin, et al. 2003).

From the above discussions, it is evident that many distortions in the LDCs are endogenous to their governments' adoption of a Catch-up type CAD strategy. The planning economy in the socialist countries is an extreme version of a Catch-up type CAD strategy with all the distorted institutions described above (Lin et al. 2003). In other non-socialist LDCs, the government's

[10] Such essentials included food, daily-use articles, housing, medical care, education, fuels for domestic use, and various living services.

control may not as strong as the socialist countries, some of the above described distorted institution may be missing. However, as long as an LDC government adopts a Catch-up type CAD strategy, the government will at least artificially suppress interest rate, over-value exchange rate, set up high tariff, and control the capital allocation and investments (Krueger 1997).

3. The Basic Model

3.1 Model Setup

Our analysis is based upon a simple three-sector model of a dual economy. We consider a small LDC that trades three final goods, i.e., rural goods, labor-intensive industrial goods, and capital-intensive industrial goods at exogenously given world prices. The exogenously given world prices (shadow prices) for rural goods, labor-intensive goods, and capital-intensive goods are p_a, p_l and p_c respectively. We assume that rural goods and labor-intensive goods can only be used for consumption, while capital-intensive goods can only be used for investment.[11] And the consumption goods are assumed to be normal.

In rural sector, natural resource (rural land) and rural labor are combined to produce rural output. The rural production function which exhibits constant returns to scale is as follows:

$$Y_a = F(T, H^1)$$

The variables Y_a, T, and H^1 refer to rural output produced, total natural resource which is owned within rural sector, and total rural labor employed in rural sector a. As that in Sah and Stiglitz (1984), the role of incentives in the rural sector is also emphasized in our model.[12] We assume rural sector's population to be N^1, thus $H^1 / N^1 \equiv h^1$ denotes the hours worked by each rural worker and $T / N^1 \equiv t$ denotes natural resource per rural worker. We denote a rural worker's consumption of the rural and labor-intensive goods to be (c_a^1, c_l^1). The surplus of the rural good per rural worker is given by $S \equiv F(t, h^1) - c_a^1$. The utility function and budget constraint of a rural worker is represented by $U^1 = U(c_a^1, c_l^1, h^1)$ and $p_a S \geq p_l c_l^1$ respectively.

The urban population is N^2, and an urban worker supplies h^2 hours of work inelastically. We normalize $h^2 = 1$ for simplicity, thus, the total urban labor supply in this LDC is equal to urban population, i.e., $H^2 \equiv N^2$. We denote an urban worker's consumption of the rural and labor-intensive goods to be (c_a^2, c_l^2). The utility function and budget constraint of an urban

[11] We ignore the possibility of labor-intensive industrial being used for consumption and investment to avoid undue complexity. But the model in this paper could be easily expanded to include this possibility.

[12] Lin (1990) emphasizes the role of incentives in the rural sector owing to the difficulty in supervising rural work.

worker is given by $U^2 = U(c_a^2, c_l^2)$ and $p_a c_a^2 + p_l c_l^2 \le w$ respectively, where w is the wage of an urban worker per hour.

Capital and urban labor are combined to produce industrial output both in labor-intensive sector and capital-intensive sector. The total capital stock in the LDC is $\overline{K}$, and $k \equiv \overline{K} / N^2$ is capital stock per urban worker.

The production function for labor-intensive sector l is as follows:

$$Y_l = A_l K_l^{\beta} H_l^{1-\beta} \tag{1}$$

Production of capital-intensive product requires $(1-\delta)\Gamma$ units of capital-intensive goods as fixed input firstly,[13] i.e., requires paying a sunk entry cost $(1-\delta)\Gamma$, where δ is a constant which satisfies $\delta \in (0,1)$, and then allows variable input, i.e., capital and urban labor, to produce final output according to following production function:

$$Y_c = A_c K_c^{\alpha} H_c^{1-\alpha} \tag{2}$$

Here the subscript l denotes labor-intensive sector, and c denotes capital-intensive sector. Because sector c is more capital intensive than sector l, we have $\alpha > \beta$. The variables A_j, Y_j, K_j, and H_j refer to total factor productivity, output produced, capital, and urban labor employed in sector $j = l, c$. The Cobb-Douglas form of production functions is adopted for tractability.

For analytical convenience, as that in Hansen and Prescott (2002), we also assume that firm operating in each sector is competitive, i.e., the firms in sector $j = l, c$ are price takers, and we also assume that there is at most one firm (if this firm is viable) in each sector. Like that in Shleifer and Vishny (1994), we assume that σ_j of the firm's profits π_j is owned by the manager m_j, and fraction $1-\sigma_j$ is owned by the Treasury which is assumed to be passive in our paper, where $j = l, c$.[14] For the sake of simplicity, we do not distinguish between the manager and the shareholders of the firm because we assume that the manager and the shareholders share common interests. And we also assume that both labor-intensive firm's

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[13] We introduce fixed input or sunk entry cost $(1-\delta)\Gamma$ in the process of producing capital-intensive goods to reflect the basic characteristics of heavy industry in the LDCs at their early stage of development summarized in Lin, et al. (2003).

[14] In our model, σ_j describes the ownership of cash flows of the firm, which is close to zero in a publicly owned firm and close to one in a private firm.

manager m_l and capital-intensive firm's manager m_c are risk-neutral, thus, the utility function of the manager m_l can be expressed by

$$U_{m_l} = \sigma_l \pi_l$$

And the utility function of the manager m_c is given by

$$U_{m_c} = \sigma_c \pi_c$$

3.2 Competitive Equilibrium without Government's Intervention

Throughout this paper, we consider a LDC whose capital stock per urban worker equals to $\delta \underline{k}$, and $\underline{k}$ is a constant which satisfies $\underline{k} = \left[\frac{p_c A_c}{p_l A_l} \left(\frac{1-\alpha}{1-\beta} \right)^{1-\alpha} \left(\frac{\alpha}{\beta} \right)^{\alpha} \right]^{\frac{1}{\beta-\alpha}}$.[15] Given rural population N^1, urban population N^2, natural resource per rural worker t, working hours of urban labor $h^2 \equiv 1$, total capital stock $\overline{K}$ in this LDC, and the exogenously given world prices (shadow prices) for rural goods p_a, labor-intensive goods p_l, and capital-intensive goods p_c, a competitive equilibrium without government's intervention consists of a combination of firm's allocations, $\{K_l, L_l, K_c, H_c\}$, rural worker's allocations, $\{c_a^1, c_l^1, h^1\}$, urban worker's allocations, $\{c_a^2, c_l^2\}$, a tuple of the net exports of rural goods, labor-intensive goods and capital-intensive goods $\{E_a, E_l, E_c\}$, a (nominal) wage rate w for urban labor, a (nominal) rental rate r for capital, such that the following conditions are satisfied:

(1). Given output prices and factor prices $\{p_a, p_l, p_c, w, r\}$, the j firm's allocation $\{K_j, L_j\}$ solves the following profit maximization problem:

$$\max_{K_j, L_j} \quad \pi_j \tag{3}$$

where $\pi_l = p_l A_l K_l^{\beta} H_l^{1-\beta} - rK_l - wH_l$ and $\pi_c = p_c[A_c K_c^{\alpha} H_c^{1-\alpha} - (1-\delta)\Gamma] - rK_c - wH_c$.

(2). Given the output prices and wage rate for urban worker $\{p_a, p_l, w\}$, rural worker's allocations maximize $U^1 = U(c_a^1, c_l^1, h^1)$ subject to $p_a S \geq p_l c_l^1$, and urban worker's

[15] In our model, the extent of the scarcity in capital endowment in the LDC is an increasing function of $\delta \in (0,1)$.

allocations maximize $U^2 = U(c_a^2, c_l^2)$ subject to $p_a c_a^2 + p_l c_l^2 \le wh^2$.

(3). Markets clear:

$$K_l + K_c = \bar{K}$$

$$H_l + H_c = H^2$$

$$N^1 S = N^2 c_a^2 + E_a$$

$$q_l = N^1 c_l^1 + N^2 c_l^2 + E_l$$

(4). Trade balance:

$$p_a E_a + p_l E_l + p_c E_c = 0$$

(5). Investment Equation:

$$I = \begin{cases} -E_c + q_c - (1-\delta)\Gamma, & \text{if} \quad q_c - (1-\delta)\Gamma > 0 \\ -E_c, & \text{if} \quad q_c - (1-\delta)\Gamma \le 0 \end{cases}$$

Given output prices (p_l, p_c), factor prices (w, r), the cost function of labor-intensive firm is $\varphi_l(q_l) = \frac{q_l}{A_l}\left(\frac{w}{1-\beta}\right)^{1-\beta}\left(\frac{r}{\beta}\right)^{\beta}$, and the variable cost function of capital-intensive firm is $\varphi_c(q_c) = \frac{q_c}{A_c}\left(\frac{w}{1-\alpha}\right)^{1-\alpha}\left(\frac{r}{\alpha}\right)^{\alpha}$,[16] where q_l and q_c is the output produced by labor-intensive firm and capital-intensive firm respectively. Summarizing the analysis above, we have the following proposition.

PROPOSITION 1: For a LDC whose capital stock per urban worker equals to $k = \delta \underline{k}$, the capital-intensive firm would have incurred a loss if it had been employed,[17] thus, only the labor-intensive production process is employed in this LDC.

PROOF: Given output prices $\{p_l, p_c\}$, the diversification cone of production functions $Y_l = A_l K_l^{\beta} H_l^{1-\beta}$ and $Y_c = A_c K_c^{\alpha} H_c^{1-\alpha}$ is $[\underline{k}, \bar{k}]$, where $\bar{k} = \left[\frac{p_c A_c}{p_l A_l}\left(\frac{1-\alpha}{1-\beta}\right)^{1-\beta}\left(\frac{\alpha}{\beta}\right)^{\beta}\right]^{\frac{1}{\beta-\alpha}}$.

Thus, capital-intensive production process would not be employed in a LDC whose capital stock per urban worker equals to $k = \delta \underline{k}$ even without the fixed costs $(1-\delta)\Gamma p_c$, and only the labor-intensive production process is employed in this LDC. *Q.E.D.*

[16] The form of total cost function of the capital-intensive firm in our paper resembles that in Bernard, et al. (2007).
[17] We may say a firm is nonviable when it incurs net loss in the current paper without uncertainty.

From proposition 1, we know the equilibrium (real) wage and (real) rental rate of capital (labor-intensive good as numeraire) in the LDC are

$$\frac{r^*}{p_l} = A_l \beta k^{\beta-1} \tag{4}$$

$$\frac{w^*}{p_l} = A_l (1-\beta) k^{\beta} \tag{5}$$

The utility of the manager m_l is $U_{m_l} = 0$, and the utility of the manager m_c is $U_{m_c} = 0$. As a matter of fact, we can denote the reservation utility of the manager m_l and manager m_c to be $\underline{U}_{m_l} = 0$ and $\underline{U}_{m_c} = 0$ respectively.

The indirect utility function of the rural worker is obtained from

$$V^1(p_a/p_l, t) = \max_{c_a^1, c_l^1, h^1} U(c_a^1, c_l^1, h^1) + \lambda^1 \left\{ \frac{p_a}{p_l}[F(t, h^1) - c_a] - c_l^1 \right\}$$

where λ^1 is the rural worker's positive marginal utility of (real) income (labor-intensive good as numeraire). From the envelope, we have

$$\frac{\partial V^1}{\partial (p_a/p_l)} = \lambda^1 S > 0$$

which means that the rural worker's utility is an increasing function of rural output price p_a and a decreasing function of labor-intensive output price p_l. We assume there is a lower bound value $\underline{p}_{al}$ for the relative price of rural product to labor-intensive product p_a/p_l such that $V^1\left(\underline{p}_{al}, t\right) = \underline{V}^1$, where $\underline{V}^1$ is the subsistence level for rural worker. That is to say we assume an agricultural crisis would break out if the relative price of rural product to labor-intensive product were less than the threshold value $\underline{p}_{al}$.[18]

The indirect utility function of the urban worker is obtained from

$$V^2(p_a/p_l, w/p_l) = \max_{c_a^2, c_l^2} U(c_a^2, c_l^2) + \lambda^2 [\frac{w}{p_l} - \frac{p_a}{p_l} c_a^2 - c_l^2]$$

where λ^2 is the urban worker's positive marginal utility of (real) income (labor-intensive good

[18] Please see Lin (1990) as well as Lin and Yang (2000) for the details of China's agricultural crisis and Chinese famine in 1959-1961. As a matter of fact, the problem of apparent food shortage emerged acutely and visibly in India in the late 1950s, and was experienced elsewhere as well (Krueger, 1995).

as numeraire). From the envelope theorem, we have $\frac{\partial V^2}{\partial (w/p_l)} = \lambda^2 > 0$ and $\frac{\partial V^2}{\partial (p_a/p_l)} = -\lambda^2 c_a^2 < 0$, which means that the urban worker's utility is an increasing function of the real wage rate w/p_l (labor-intensive good as numeraire) and a decreasing function of the relative price of rural product to labor-intensive product p_a/p_l. We also assume for a given relative price of rural product to labor-intensive product $\underline{p}_{al}$, there exists a threshold value $\underline{w}_l$ for the real wage rate w/p_l (labor-intensive good as numeraire) such that $V^2\left(\underline{p}_{al}, \underline{w}_l\right) = \underline{V}^2$, where $\underline{V}^2$ is the subsistence level for urban worker. Thus, the minimum (real) wage (labor-intensive good as numeraire) in the LDC should not be less than $\underline{w}_l$, or else, the urban worker could not afford to buy adequate rural products or (and) labor-intensive goods.

The additive Bergson-Samuelson social welfare function is given by

$$\psi = N^1 W^1\left[V^1\left(p_a/p_l, t\right)\right] + N^2 W^2\left[V^2\left(p_a/p_l, w/p_l\right)\right] \tag{6}$$

where $W^i(.)$ is a concave and increasing function of $V^i(.)$, $i = 1, 2$.

The amount of investment in this LDC without government's intervention is

$$I = \frac{1}{p_c}\left\{p_a[N^1 F(t, h^1) - N^1 c_a^1 - N^2 c_a^2] + p_l(A_l H^2 k^\beta - N^1 c_l^1 - N^2 c_l^2)\right\}$$

From the analysis above, it is obvious that given that resources are allocated by the market mechanism, producers will decide what to produce according to market prices of outputs and factors, and they would not produce capital-intensive goods in the LDC whose capital stock per urban worker equals to $k \equiv \delta \underline{k}$. Consequently, if resources had been allocated by the market mechanism, capital would not have flowed to capital-intensive heavy-industry sector. Rather, industrialization featuring light industry would have occurred, which would have been contradictory to the goal of implementing the Catch-up type CAD strategy (heavy-industry-oriented development strategy) in the LDCs. And therefore, without a cluster of intervention policies being enforced, the government in the LDC could not successfully enforce the Catch-up type CAD strategy.

4. The Trinity of the Economic Institutions under CAD Strategy

Now we analyze the intrinsic logic of government intervention policies in the LDC and how

these intervention policies are generated by the governments' adopting Catch-up type CAD strategy. For this reason, we need define the utility function of the government (politicians) in the LDCs. Suppose that the government in the LDCs benefits from adopting Catch-up type CAD strategy, i.e., the government g in the LDCs could gain utility $B(q_c)$ from the output of capital-intensive product q_c produced in his country, where $B(q_c)$ is twice continuously differentiable, with $B'(q_c)>0$ and $B''(q_c)<0$ for all $q_c>0$ as well as $\lim_{q_c\to 0^+} B'(q_c)=\infty$. We assume the utility function of the government g in the LDCs is given by

$$U_g = \psi + \rho I + B(q_c)$$

where I is the investment in the LDC, ρ denotes the marginal social value of the investment, and ψ is given by (6).[19]

4.1 Distorting Relative Prices

4.1.1 Output Price Distortion

In order to set up heavy industrial projects, the government in the LDC could rely on collecting taxes form the rural sector and labor-intensive sector to subside capital-intensive sector.[20] We denote the tax rate in rural sector and labor-intensive sector to be τ_a and τ_l respectively, and the subsidy rate in capital-intensive sector to be τ_c. Now the prices faced by rural sector, labor-intensive sector, and capital-intensive sector are $p_a-\tau_a$, $p_l-\tau_l$ and $p_c+\tau_c$ respectively. The total tax revenue raised from rural sector and labor-intensive sector is denoted to be $\Re_a$ and $\Re_l$ respectively, and the total subsidy to capital-intensive sector is denoted to be $\Re_c$. Like that in Acemoglu (2007), we also introduce two parameters $\phi_j\in[0,1]$ to measure how much of the tax revenue raised from sector $j=a,l$ can be redistributed to capital-intensive sector.[21] Now the Treasury's budget constraint is

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[19] In the above utility function of LDC's government U_g, $\psi+\rho I$ is borrowed from Sah and Stiglitz (1987a), and $B(q_c)$ is similar in form to $B(L)$ in Shleifer and Vishny (1994). But the utility function used in our paper emphasizes the government in the LDC's strong motives of reaching a higher level of industrialization and leaping over some economic development phases by taking capital-intensive (heavy) industries or import substitution as a basic development path after these LDCs achieving political independence, which is totally neglected in Sah and Stiglitz (1987a). Unlike that in Shleifer and Vishny (1994), the LDC's government in our paper is benevolent, not leviathan.

[20] We assume there are no non-distortionary lump- sum taxes available in the LDCs.

[21] The parameter $\phi\in[0,1]$ in Acemoglu (2007) captures "state capacity", i.e., the ability of the states to penetrate and regulate the production relations in a society, while in our paper, $\phi_j\in[0,1]$ was interpreted as the efficiency of the states to collect tax from sector j.

$$\phi_a \Re_a + \phi_l \Re_l + (1-\sigma_l)\pi_l + (1-\sigma_c)\pi_c \geq \Re_c$$

We assume that $\phi_a = 0$ to reflect the fact that making tax collection from the small and scattered rural sector in the LDC was so difficult and costly that all tax revenue just covers the cost of collecting tax.[22] Now the Treasury's budget constraint is given by

$$\phi_l \tau_l q_l + (1-\sigma_l)\pi_l + (1-\sigma_c)\pi_c \geq \tau_c q_c \tag{7}$$

Given output prices $\{(p_l - \tau_l), (p_c + \tau_c)\}$, now the diversification cone of labor-intensive and capital-intensive production functions is $[\Delta \underline{k}, \Delta \bar{k}]$, where $\Delta \equiv \left[\frac{(p_l - \tau_l)p_c}{(p_c + \tau_c)p_l}\right]^{\frac{1}{\alpha-\beta}}$. After output prices distortion, when $k < \Delta \underline{k}$, capital-intensive firm c will still be non-viable and $U_{m_c} < 0$ provided that $q_c > 0$; when $k > \Delta \bar{k}$, labor-intensive firm l would be non-viable and $U_{m_l} < 0$ provided that $q_l > 0$. Summarizing analysis above gives following lemma.

LEMMA 1: As long as capital-intensive production process is employed, the output prices after distortion should guarantee that the factor endowments in the LDC belong to the new diversification cone $[\Delta \underline{k}, \Delta \bar{k}]$, i.e., we must have $k \in (\Delta \underline{k}, \Delta \bar{k})$, which means

$$\Delta < \delta < \frac{1-\beta}{1-\alpha}\frac{\alpha}{\beta}\Delta \tag{8}$$

From inequality (8), we know that as long as capital-intensive production process is employed, we must have $\tau_l > 0$ and $\tau_c > 0$. Thus, at the root of output price distortion in our paper is the government's pursuing Catch-up type CAD strategy in the LDCs, i.e., taxing labor-intensive firm to subsidize and set up capital-intensive firm.

4.1.2 Depressing Factor Prices

Given the distorted output prices $(p_c + \tau_c, p_l - \tau_l)$, the market clearing equilibrium (if equilibrium exists) wage and rental rate of capital in the LDC when capital-intensive production process is employed must be

$$r' = (p_c + \tau_c)A_c \alpha (K_c')^{\alpha-1}(H_c')^{1-\alpha} = (p_l - \tau_l)A_l \beta (K_l')^{\beta-1}(H_l')^{1-\beta} \tag{9}$$

$$w' = (p_c + \tau_c)A_c (1-\alpha)(K_c')^{\alpha}(H_c')^{-\alpha} = (p_l - \tau_l)A_l (1-\beta)(K_l')^{\beta}(H_l')^{-\beta} \tag{10}$$

where K_j' and H_j' are capital and urban labor used in the firm $j = l, c$ respectively after

[22] We assume $\phi_a = 0$ to avoid undue complexity, even the main results in our paper holds when $\phi_a \in (0,1]$.

output price distortion.[23]

Comparing the equilibrium real wage rate w^*/p_l and real interest rate r^*/p_l (labor-intensive good as numeraire) before output prices distortion with the market clearing equilibrium (if equilibrium exists) real wage rate $w'/(p_l-\tau_l)$ which is determined by (10) and real interest rate $r'/(p_l-\tau_l)$ which is determined by (9) after output prices distortion yields following lemma.

LEMMA 2: Whenever the capital-intensive sector is employed in the LDC, the market clearing equilibrium (if equilibrium exists) real wage rate (labor-intensive good as numeraire) $w'/(p_l-\tau_l)$ after output prices distortion must be less than the equilibrium real wage rate w^*/p_l without distortion. And the market clearing equilibrium (if equilibrium exists) real interest rate $r'/(p_l-\tau_l)$ after output prices distortion must be greater than the equilibrium real interest rate r^*/p_l without distortion.

PROOF: Substituting (5) into (10), we obtain $\dfrac{w^*/p_l}{w'/(p_l-\tau_l)}=\left[\dfrac{k}{K_l/H_l}\right]^{\beta}$. And $\dfrac{w^*}{p_l}>\dfrac{w'}{p_l-\tau_l}$ follows from $\dfrac{K_l}{H_l}<k<\dfrac{K_c}{H_c}$ as long as capital-intensive sector is employed. Substituting (4) into (9), we obtain $\dfrac{r'/(p_l-\tau_l)}{r^*/p_l}=\left[\dfrac{k}{K_l/H_l}\right]^{1-\beta}$. By the same reason we have $\dfrac{r'}{p_l-\tau_l}>\dfrac{r^*}{p_l}$. *Q.E.D.*

Given the distorted output prices $(p_c+\tau_c, p_l-\tau_l)$ and the market clearing equilibrium real wage rate $w'/(p_l-\tau_l)$ which is determined by (10) and real interest rate $r'/(p_l-\tau_l)$ which is determined by (9), from Euler's theorem on homogeneous functions, we know that capital-intensive firm would incur a net loss of $(p_c+\tau_c)(1-\delta)\Gamma$ no matter how much τ_c and

[23] When producing capital-intensive product would not require fixed input, i.e., when $\Gamma=0$ or $\delta=1$, the wage rate w' and interest rate r' are the market clearing equilibrium factor prices, and K_j' and H_j' are market clearing equilibrium capital and urban labor used in the firm $j=l,c$ respectively after output price distortion which guarantees that the factor endowments in the LDC belong to the new diversification cone $[\Delta\underline{k},\Delta\bar{k}]$.

τ_l are. And the net loss $(p_c+\tau_c)(1-\delta)\Gamma$ is a decreasing function of the capital stock per urban worker $k=\delta\underline{k}$.[24] The analysis above gives the following result.

PROPOSITION 2: The government could not successfully implement the Catch-up type CAD strategy (heavy-industry-oriented development strategy) in this LDC just by one policy instrument of distorting output prices only.

Therefore, the government of the LDC is obliged to manipulate factor prices as well as distort output prices to enforce Catch-up type CAD strategy successfully, i.e., in addition to distorting output prices, the government in the LDC have no choice but to either reduce interest rate, or keep nominal wage rate down, or depress both to successfully enforce Catch-up type CAD strategy.

We focus here on the role of low-interest-rate policy in the LDC's enforcing Catch-up type CAD strategy in accord with the widespread financial suppression existing in LDCs, and investigate how low-interest-rate policy can arise form the government's inappropriate development strategy. This requires us to specify the mechanism of urban wage determination firstly.

Given the distorted relative prices of outputs $\{(p_a-\tau_a),(p_l-\tau_l),(p_c+\tau_c)\}$, we denote the manipulated wage and rental rate of capital in the LDC to be w_d and r_d respectively. And the indirect utility function of the urban worker after output prices distortion and factor prices manipulation is obtained from

$$V^2\left(\frac{p_a-\tau_a}{p_l-\tau_l},\frac{w_d}{p_l-\tau_l}\right)=\max_{c_a^2,c_l^2}U(c_a^2,c_l^2)+\lambda^2[\frac{w_d}{p_l-\tau_l}-\frac{p_a-\tau_a}{p_l-\tau_l}c_a^2-c_l^2]$$

where λ^2 is the urban worker's positive marginal utility of (real) income (labor-intensive good as numeraire). We assume that the government in the LDC can exercise a direct control over the urban wage only when the real wage rate of urban workers is above their subsistence levels. When the real wage rate of urban workers equals to their subsistence levels, the government in the LDC could not reduce urban worker's real wage arbitrarily,[25] or else, in order to compensate the loss of urban worker's utility, the government in the LDC is obliged to depress the relative price of rural

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[24] Owing to capital-intensive production process could not be employed after output price distortion without factor price manipulation additionally, the market clearing equilibrium wage and rental rate in the LDC are still determined by $w^{**}=(p_l-\tau_l)A_l(1-\beta)k^{\beta}$ and $r^{**}=(p_l-\tau_l)A_l\beta k^{\beta-1}$ respectively.

[25] In Sah and Stiglitz (1987a), the government in a socialist economy can exercise a direct control over the urban wage without the consideration of urban worker's welfare, while in a mixed economy (non-socialist economy), the urban wage is determined from $V^2(p,w)=\bar{V}^2$, that is, the urban wage will be adjusted, in the face of changing prices, to preserve the welfare of urban workers, and the government in a mixed economy has no right to exercise a direct control over the urban wage.

product to labor-intensive product.[26] The lower bound value $\underline{p}_{al}$ for the relative price of rural product to labor-intensive product assumed above implies that with the purpose of maintaining the utility of the urban workers above their subsistence levels, the minimum real wage rate (labor-intensive good as numeraire) should be no less than $\underline{w}_l$ which satisfies $V^2\left(\underline{p}_{al}, \underline{w}_l\right) = \bar{V}^2$.

Let us assume that urban population N^2 and capital stock $\bar{K}$ in the LDC, productivity parameters (A_c, A_l), fixed input Γ, the subsistence level for urban worker and rural worker $(\bar{V}^1, \bar{V}^2)$, the lower bound value $\underline{p}_{al}$ for the relative price of rural product to labor-intensive product, the minimum (real) wage in the LDC $\underline{w}_l$, and exogenous parameters (α, β, δ) in the LDC satisfy following assumption: In order to guarantee capital-intensive firm to be viable, the government in the LDCs should distort the relative prices of labor-intensive product to capital-intensive product to such an extent that

$$w^{'}/(p_l - \tau_l) < \underline{w}_l \tag{A1}$$

where $w^{'}/(p_l - \tau_l)$ is determined by (10) which is the market clearing equilibrium (if equilibrium exists) real wage in the LDC when capital-intensive production process is employed.

Consequently, depending on whether Assumption (A1) holds, the government in the LDC will have right or no right to exercise a direct control over the urban wage at will. When assumption (A1) holds, the government in the LDC has no right to exercise a direct control over the urban wage arbitrarily after distorting relative prices of outputs $\{(p_a - \tau_a), (p_l - \tau_l), (p_c + \tau_c)\}$, thus, the urban wage faced by labor-intensive firm and capital-intensive firm is $w_d \equiv \underline{w}_l(p_l - \tau_l)$.[27] Throughout, we presume that Assumption (A1) holds which ensure the necessity of depressing interest rate faced by capital-intensive firm further for the governments in the LDCs to enforce Catch-up type CAD strategy successfully, and we denote interest rate faced by capital-intensive firm and labor-intensive to be r_d^c and r_d^l

[26] Though the assumption of $\phi_a = 0$ implies that LDC can not collect tax directly from rural sector to subsidize capital-intensive sector, the government in the LDC still wants to lower the price of rural products to compensate the loss of urban worker's welfare. Thus, a large proportion of the costs of heavy-industry development, through such a mechanism, were transferred to traditional economic sectors such as agriculture (Lin, et al. 2003).

[27] Depending on whether Assumption (A1) holds, there will be a possibility of excess demand or excess supply of urban worker in this LDC. When assumption (A1) holds, the redundant employment in the urban sector would be endogenously resulted from the government's pursuing Catch-up type CAD strategy in the LDC.

respectively. However, considering low interest rate would reduce capital outflow, thus will decrease the source of capital in the LDCs, we assume the (nominal) interest rate faced by firm $j = l, c$ should be no less than $\upsilon_j r^*$ where υ_j is an exogenously given positive parameter, thus we have $\upsilon_j r^* \leq r_d^j$.

Given distorted relative prices of outputs $\{(p_l - \tau_l), (p_c + \tau_c)\}$ and depressed factor prices $\{w_d, r_d^c\}$, the profit function of capital-intensive firm is

$$\pi_c(p_c, \tau_c, r_d^c, w_d) = \\ \text{Max}\left\{\max_{K_c, H_c}(p_c + \tau_c)[A_c(K_c)^{\alpha}(H_c)^{1-\alpha} - (1-\delta)\Gamma] - r_d^c K_c - w_d H_c, 0\right\} \tag{11}$$

The above capital-intensive firm's profit maximization implies that the amount of capital and labor used in this firm must satisfy

$$(p_c + \tau_c)A_c\alpha(K_c)^{\alpha-1}(H_c)^{1-\alpha} \geq r_d^c \text{ or } (p_c + \tau_c)A_c(1-\alpha)(K_c)^{\alpha}(H_c)^{-\alpha} \geq w_d \tag{12}$$

with at least one strict inequality in (12). However, $(p_c + \tau_c)A_c(1-\alpha)(K_c)^{\alpha}(H_c)^{-\alpha} > w_d$ is impossible according to Assumption (A1). Thus, we have $(p_c + \tau_c)A_c\alpha(K_c)^{\alpha-1}(H_c)^{1-\alpha} > r_d^c$ which implies that we have $r_d^c < r^{'}$. Summarizing the analysis above gives the following result.

PROPOSITION 3: In order to enforce Catch-up type CAD strategy successfully, the government of the LDC should resort to depressing interest rate from $r^{'}$ to r_d^c as well as distorting output prices, and the depressed interest rate r_d^c should guarantee capital-intensive firm to be viable, i.e., the RHS in (11) to be non-negative.

4.2 The Planned Resource-Allocation System

Following Bénassy (2006), as we will be studying non clearing markets, we must make an important distinction between demands of factors on the one hand and the resulting allocations of factors on the other. The demands of factors, denoted by $\tilde{n}_{ji}$, are signals of factor $i = H, K$ transmitted by firm $j = l, c$ to the government before exchange/allocation takes place.

Facing the distorted relative prices of outputs $\{(p_l - \tau_l), (p_c + \tau_c)\}$ and the depressed factor prices $\{w_d, r_d^c\}$, the capital-intensive firm's demands of factors $\tilde{n}_{ci}$ satisfy

$$(p_c + \tau_c)A_c\alpha(\tilde{n}_{cK})^{\alpha-1}(\tilde{n}_{cH})^{1-\alpha} = r_d^c$$
$$(p_c + \tau_c)A_c(1-\alpha)(\tilde{n}_{cK})^{\alpha}(\tilde{n}_{cK})^{-\alpha} = w_d$$

Because $r_d^c < r^{'}$ and $w^{'} < w_d$, we have $\tilde{n}_{cK} > K_c^{'}$ and (or) $\tilde{n}_{cH} < H_c^{'}$ where $K_c^{'}$ and $H_c^{'}$ are determined by (9) and (10) simultaneously.

Given distorted relative prices of outputs $\{(p_l - \tau_l), (p_c + \tau_c)\}$ and depressed factor prices $\{w_d, r_d^l\}$, the profit function of labor-intensive firm is

$$\pi_l(p_l, \tau_l, r_d^l, w_d) = \text{Max}\left\{\max_{K_l, H_l}(p_l - \tau_l)A_l(K_l)^{\beta}(H_l)^{1-\beta} - r_d^l K_l - w_d H_l, 0\right\}$$

The above labor-intensive firm's profit maximization implies that the amount of capital and labor used in this firm must satisfy

$$(p_l - \tau_l)A_l\beta(K_l)^{\beta-1}(H_l)^{1-\beta} \geq r_d^l \text{ or } (p_l - \tau_l)A_l(1-\beta)(K_l)^{\beta}(H_l)^{-\beta} \geq w_d$$

From Assumption (A1), $(p_l - \tau_l)A_l(1-\beta)(K_l)^{\beta}(H_l)^{-\beta} > w_d$ could not be true. Thus, we must have $r_d^l \leq r^{'}$ as the result of $(p_l - \tau_l)A_l\beta(K_l)^{\beta-1}(H_l)^{1-\beta} \geq r_d^l$.

Facing the distorted relative prices of outputs $\{(p_l - \tau_l), (p_c + \tau_c)\}$ and the depressed factor prices $\{w_d, r_d^l\}$, labor-intensive firm's demands of factors $\tilde{n}_{li}$ satisfy

$$(p_l - \tau_l)A_l\beta(\tilde{n}_{lK})^{\beta-1}(\tilde{n}_{lH})^{1-\beta} = r_d^l$$
$$(p_l - \tau_l)A_l(1-\beta)(\tilde{n}_{lK})^{\beta}(\tilde{n}_{lH})^{-\beta} = w_d$$

Owing to $r_d^l \leq r^{'}$ and $w^{'} < w_d$, we must have $\tilde{n}_{lK} \geq K_l^{'}$ and (or) $\tilde{n}_{lH} < H_l^{'}$ where $K_c^{'}$ and $H_c^{'}$ are determined by (9) and (10) simultaneously.

Therefore, we must have $\tilde{n}_{cK} + \tilde{n}_{lK} > K_c^{'} + K_l^{'} \equiv \overline{K}$ and (or) $\tilde{n}_{cH} + \tilde{n}_{lH} < H_c^{'} + H_l^{'} \equiv H^2$. Summarizing the analysis above gives the following lemma.

LEMMA 3: When assumption (A1) holds, a shortage of capital and (or) a surplus of urban labor will be created in the LDC due to the introduction of Catch-up type CAD strategy. Thus, some rationing will necessarily occur.[28]

As we know, the forms of rationing include uniform rationing, queuing, priority systems, proportional rationing, etc ... depending on the particular organization of each market (Bénassy, 2006). No matter what form the rationing is, the resulting allocations, denoted by n_{ji}^*, are exchanges/allocations actually made by the government in the LDCs, and the allocation process

[28] Shleifer and Vishny (1992) presents a new theory of pervasive shortages under socialism, based on the assumption that the planners are self-interested, as well as give us an overview of standard explanation of shortages of goods under socialism. However, all these explanations do not include our interpretation of shortages in the LDCs, which is based on the governments' enforcing Catch-up type CAD strategy.

must satisfy the resulting allocations and the supply of factor, denoted by Z_i^*, identically balance on each factor market $i = H, K$, i.e.,

$$N_i^* = \sum (n_{li}^* + n_{ci}^*) = Z_i^* \quad \text{for} \quad i = H, K$$

where $Z_H^* \equiv H^2$ and $Z_K^* \equiv \overline{K}$.

Owing to the surplus of urban labor, either labor-intensive firm, or capital-intensive firm, or both should be forced to purchase/employ more labor than he demands, which is expressed by

$$\tilde{n}_{lH} \le n_{lH}^* \text{ and (or) } \tilde{n}_{cH} \le n_{cH}^*$$

Thus, in our model, the form of rationing chosen by the government in the LDCs violates the first property of rationing schemes in (Bénassy, 2006), i.e., *voluntary exchange* in labor market.

Furthermore, given distorted relative prices of outputs $\{(p_l - \tau_l), (p_c + \tau_c)\}$ and the resulting allocations of capital $n_{ji}^*(i = L, K)$ to firm $j = l, c$ by the government in the LDCs, the MVP of capital in capital-intensive firm is

$$(p_c + \tau_c) A_c \alpha (n_{cK}^*)^{\alpha - 1} (n_{cH}^*)^{1-\alpha} \tag{13}$$

and the MVP of capital in labor-intensive firm is

$$(p_l - \tau_l) A_l \beta (n_{lK}^*)^{\beta - 1} (n_{lH}^*)^{1-\beta} \tag{14}$$

As long as (13) is not equal to (14), there always exist a mutually advantageous exchange between labor-intensive firm and capital-intensive firm by transferring the capital allocated by the government from one firm to another. Consequently, in our model, the form of rationing chosen by the government in the LDCs might violate the second property of rationing schemes in (Bénassy, 2006), i.e., *efficient* in capital market.

Considering that the rationing scheme adopted by the government in the LDCs does (might) not satisfy two properties in Bénassy (2006), we obtain following proposition.

PROPOSITION 4: When assumption (A1) holds, the successful implementing Catch-up type CAD strategy in the LDC implies that the only rationing form could be adopted by the government in the LDC is allocating capital and urban labor to the labor-intensive firm and capital-intensive firm through priority systems.

As a matter of fact, the resource allocation in reality is extremely complex and difficult owing to the information asymmetry between the government and the firms. We assume the factor markets were visited sequentially (in an order which give priority to capital-intensive firm) and effective demands of factors $\tilde{n}_{ci}(i = L, K)$ were expressed by capital-intensive firm firstly, after the resulting allocations of factors $n_{ci}^*(i = L, K)$ to capital-intensive firm having been realized, then the remaining factors were allocated to labor-intensive firm which means

$n_{li}^{*}=Z_{i}^{*}-n_{ci}^{*}(i=L,K)$.[29]

Moreover, in view of the possibility of manager m_j to transfer resource outside from firm j to firm $-j$, we should make a critical distinction between the resulting allocations of factors to firm $j=l,c$, denoted by $n_{ji}^{*}(i=L,K)$, on the one hand and the equilibrium amount of factors used in firm j, denoted by $\tilde{n}_{ji}^{*}(i=L,K)$, on the other. The equilibrium amount of factors used in firm j is the quantity of factor i finally used in firm j where all economic forces are balanced and in the absence of external shocks $\tilde{n}_{ji}^{*}$ will not change.

4.3 Depriving Firm of Autonomy

Under the conditions that prices were distorted and factors were allocated to the firms by the governments through priority systems, profits and losses could no longer reflect management performance. Because of information asymmetry, monitoring costs for the government was prohibitively high.[30] Thus, how to guarantee the factors allocated by the governments to be used in priority sector, i.e., capital-intensive firm, and to avoid the investment arbitrage is of vital importance to the governments' enforcing Catch-up type CAD strategy successfully. As in the pioneer work of Grossman and Hart (1986) as well as Hart and Moore (1990), we assume all of the factors used in capital-intensive and labor-intensive firm are ex ante nonverifiable and noncontractible. That is to say we suppose that it is costly for the government and the managers to write detailed long-term contracts that precisely specify exact uses of factors allocated to firms by the governments as a function of every possible eventuality and that, as a result, the contracts written between governments and managers are incomplete (Hart and Moore, 1990), so that control rights over the use of factors allocated by the governments in the LDCs rather than incentive contracts become the critical determinant of the equilibrium of resource allocation with non clearing markets.

Following Shleifer and Vishny (1994), we distinguish firms based on who owns their cash flows (the Treasury or the manager m_j of the firm $j=l,c$) and who has control rights over the use of factors (the governments in the LDCs or the manager m_j).[31] In terms of the model above, parameter σ_j describes the ownership of cash flows of the firm $j=l,c$, while the exact use of the resulting allocations of factors n_{ji}^{*} can be controlled by either the governments or the manager. The allocation of cash flow rights and of the control rights in our model also has an economic interpretation like that in Shleifer and Vishny (1994), which means that in a conventional SOEs, the governments control the exact use of the resulting allocations of factors

[29] The equilibrium of resource allocation with non clearing markets in our paper reached through non-tâtonnement process in (Bénassy, 1977).

[30] In the present model, there will be no asymmetries of information between the government and the manager.

[31] Grossman and Hart (1986) define a firm consist of those assets that it owns or over which it has control; and do not distinguish between ownership and control and virtually define ownership as the power to exercise control.

n_{ji}^{*}, and the cash flow is mostly owned by the Treasury (σ_j is low), and what is more, the allocation of the control rights in our model also has a new economic interpretation, i.e., when the governments in the LDCs had full control over the exact use of the resulting allocations of factors n_{ji}^{*}, the firms would have been deprived the autonomy in production and management.

In order to prove that the government in the LDCs prefers to deprive firm of autonomy, we need to compute the equilibrium of resource allocation with non clearing markets where the manager and the government has the control right respectively, and then contrast these two equilibria. For the sake of model's tractability, we assume the resulting allocations of labor in capital-intensive firm n_{cH}^{*} equals to $\Xi \equiv H_c^{'} + \varepsilon$ both under government control and under manager control, and Ξ is a exogenously given constant for simplicity, where ε is a scalar, i.e., we have $n_{cH}^{*} = \Xi$ for simplicity. Thus, the resulting allocations of labor in labor-intensive firm n_{lH}^{*} equals to $H^2 - \Xi$, i.e., $n_{lH}^{*} = H^2 - \Xi$. To highlight the mechanism of depriving firm of autonomy in the simplest possible way, let us assume that managers cannot transfer labor outside from one firm to another.[32]Now the unresolved question is to determine who, i.e., the government or the manager m_j, has the control right over the exact use of the resulting allocations of capital n_{jK}^{*} in firm $j = l, c$.

Before proceeding to compute the equilibrium, as a matter of convenience, we need describe the utility function of the government in the LDCs once more. Given the distorted output prices $(p_a - \tau_a, p_c + \tau_c, p_l - \tau_l)$ and the depressed wage rate $w_d \equiv \underline{w}_l(p_l - \tau_l)$, the utility function of the government can be expressed by

$$U_g = \psi + \rho I + B(q_c) \tag{15}$$

where

$$\psi = N^1 W^1 \left[V^1 \left(\frac{p_a - \tau_a}{p_l - \tau_l}, t \right) \right] + N^2 W^2 \left[V^2 \left(\frac{p_a - \tau_a}{p_l - \tau_l}, \frac{w_d}{p_l - \tau_l} \right) \right]$$

$$V^1 \left(\frac{p_a - \tau_a}{p_l - \tau_l}, t \right) = \max_{c_a^1, c_l^1, h^1} U(c_a^1, c_l^1, h^1) + \lambda^1 \left\{ \frac{p_a - \tau_a}{p_l - \tau_l} [F(t, h^1) - c_a] - c_l^1 \right\}$$

$$V^2 \left(\frac{p_a - \tau_a}{p_l - \tau_l}, \frac{w_d}{p_l - \tau_l} \right) = \max_{c_a^2, c_l^2} U(c_a^2, c_l^2) + \lambda^2 [\frac{w_d}{p_l - \tau_l} - \frac{p_a - \tau_a}{p_l - \tau_l} c_a^2 - c_l^2]$$

[32] This assumption may seem very extreme at first glance, but it could be true in some LDCs, e.g. China which carried out strict personnel control policy through census registry (*hukou*) institution.

$$I=\frac{p_l-\tau_l}{p_c+\tau_c}\left[\frac{p_a-\tau_a}{p_l-\tau_l}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+\left(q_l-N^1c_l^1-N^2c_l^2\right)\right]+q_c-(1-\delta)\Gamma$$

Furthermore, assumption (A1) implies we have $(p_a-\tau_a)/(p_l-\tau_l)\equiv \underset{-}{p}_{al}$ and $w_d/(p_l-\tau_l)\equiv \underset{-}{w}_l$ as well as

$$V^1\left(\underset{-}{p}_{al},t\right)=\bar{V}^1,\ \text{and}\ V^2\left(\underset{-}{p}_{al},\underset{-}{w}_l\right)=\bar{V}^2$$

Thuswise, the utility function of the government can be expressed by

$$U_g=N^1W^1\left(\bar{V}^1\right)+N^2W^2\left(\bar{V}^2\right)+B(q_c)+$$
$$\rho\left\{\frac{p_l-\tau_l}{p_c+\tau_c}\left[\underset{-}{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+\left(q_l-N^1c_l^1-N^2c_l^2\right)\right]+q_c-(1-\delta)\Gamma\right\} \quad (16)$$

We first compute the equilibrium under government control, i.e., the government has the control right over the exact use of the resulting allocations of capital n_{jK}^* in firm $j=l,c$, then solve out the equilibrium under manager control i.e., the manager m_j has the control right over the exact use of the resulting allocations of capital n_{jK}^* in firm j. Finally, we compare the equilibrium under government control with that under manager control.

4.3.1 Equilibrium under Government Control

When the governments in the LDCs have control rights over the exact use of the resulting allocations of capital n_{jK}^* in firm $j=l,c$, there is no possibility for the manager m_j to transfer capital outside from firm j to firm $-j$, thus, we must have $\tilde{n}_{ji}^*\equiv n_{ji}^*$, i.e., the resulting allocations of factors to firm $j=l,c$ will always be equal to the equilibrium amount of factors used in that firm. In this way, the government can choose distorted output prices $(p_a-\tau_a,p_c+\tau_c,p_l-\tau_l)$, depressed interest rate (r_d^c,r_d^l) faced by capital-intensive firm and labor-intensive firm respectively, the resulting allocations of capital n_{jK}^* in firm j to maximize his utility which was expressed in (16) subject to the Treasury's budget constraint (7) as well as the constraints that the manager m_j be kept to his reservation utility of zero:

$$U_{m_j}\equiv\sigma_j\pi_j\geq 0$$

Given distorted output prices $(p_c+\tau_c,p_l-\tau_l)$, depressed factor prices (r_d^c,r_d^l,w_d), the

resulting allocations of factors $n_{ji}^{*}(i=K,H)$ in firm $j=l,c$[33], the utility of manager m_c is given by

$$U_{m_c} \equiv \sigma_c[(p_c+\tau_c)A_c(n_{cK}^{*})^{\alpha}(\Xi)^{1-\alpha} - r_d^c n_{cK}^{*} - w_d\Xi - (p_c+\tau_c)(1-\delta)\Gamma] \tag{17}$$

and the utility of manager m_l is given by

$$U_{m_l} \equiv \sigma_l[(p_l-\tau_l)A_l(n_{lK}^{*})^{\beta}(H^2-\Xi)^{1-\beta} - r_d^l n_{lK}^{*} - w_d(H^2-\Xi)] \tag{18}$$

It is evident that the constraints that the manager m_j be kept to his reservation utility of zero are binding which implies that $\pi_j = 0$. Owing to $\pi_j = 0$, the Treasury's budget constraint can be expressed by

$$\phi_l\tau_l q_l \geq \tau_c q_c \tag{19}$$

The government's utility maximization problem above can be solved as follows:

- Given output price $(p_l-\tau_l, p_c+\tau_c)$, the resulting allocations n_{ji}^{*} and depressed wage rate w_d, the government in the LDCs set the depressed interest rate r_d^j faced by firm $j=l,c$ to maximize the profits of firm j. It is evident that the equilibrium interest rate r_d^{*jg} under government control in firm j equals to $\upsilon_j r^{*}$, i.e., we have $r_d^{*jg} = \upsilon_j r^{*}$.

- Given the resulting allocations of labor to capital-intensive firm $n_{cH}^{*} = \Xi$ and the resulting allocations of labor to labor-intensive firm $n_{lH}^{*} = H^2 - \Xi$, if the equilibrium amount of capital used in capital-intensive firm is n_{cK}^{*}, then the equilibrium amount of capital used in the labor-intensive firm is $n_{lK}^{*} = \bar{K} - n_{cK}^{*}$, and the equilibrium output of labor-intensive product and capital-intensive product produced in the LDCs satisfy

$$q_l = A_l\left(\bar{K} - n_{cK}^{*}\right)^{\beta}(H^2-\Xi)^{1-\beta} \quad \text{and} \quad q_c = A_c\left(n_{cK}^{*}\right)^{\alpha}\Xi^{1-\alpha} \tag{20}$$

- Plugging the equilibrium output of labor-intensive product and capital-intensive product in (20) into (16), where $N^1W^1\left(\bar{V}^1\right) + N^2W^2\left(\bar{V}^2\right)$ is a constant and can be passed

[33] We have $n_{cH}^{*} = \Xi$ and $n_{lH}^{*} = H^2 - \Xi$ based on the assumption that we made above.

over, the utility function of the government in the LDCs can be expressed by

$$\tilde{U}_g = B\left(A_c\left(n_{cK}^*\right)^{\alpha}\Xi^{1-\alpha}\right)+\rho\frac{p_l-\tau_l}{p_c+\tau_c}\underset{-}{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+$$

$$\rho\frac{p_l-\tau_l}{p_c+\tau_c}\left(A_l\left(\bar{K}-n_{cK}^*\right)^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right)+\rho\left[A_c\left(n_{cK}^*\right)^{\alpha}\Xi^{1-\alpha}-(1-\delta)\Gamma\right]$$

- Finally, the government in the LDCs chooses the distorted extent of relative prices of labor-intensive product to capital-intensive product $(p_l-\tau_l)/(p_c-\tau_c)$ and the resulting allocations of capital to capital-intensive firm n_{cK}^* to maximize $\tilde{U}_g$ subject to the constraint that the manager m_j be kept to his reservation utility of zero and the Treasury's budget constraint, which can be expressed by

$$\phi_l\tau_lA_l\left(\bar{K}-n_{cK}^*\right)^{\beta}(H^2-\Xi)^{1-\beta}\geq\tau_cA_c\left(n_{cK}^*\right)^{\alpha}\Xi^{1-\alpha}$$

Solving the government's utility maximization problem yields the following first-order conditions:

$$\begin{aligned}
&-\frac{\rho}{p_c+\tau_c}\underset{-}{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+\\
&\frac{-\rho}{p_c+\tau_c}\left(A_l\left(\bar{K}-n_{cK}^*\right)^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right)+\\
&\hbar^g\phi_lA_l\left(\bar{K}-n_{cK}^*\right)^{\beta}(H^2-\Xi)^{1-\beta}-\lambda_l^g\sigma_lA_l(\bar{K}-n_{cK}^*)^{\beta}(H^2-\Xi)^{1-\beta}=0
\end{aligned}\tag{21}$$

$$\begin{aligned}
&-\rho\frac{p_l-\tau_l}{(p_c+\tau_c)^2}\underset{-}{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+\\
&-\rho\frac{p_l-\tau_l}{(p_c+\tau_c)^2}\left(A_l\left(\bar{K}-n_{cK}^*\right)^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right)\\
&-\hbar^gA_c\left(n_{cK}^*\right)^{\alpha}\Xi^{1-\alpha}+\lambda_c^g\sigma_c[A_c(n_{cK}^*)^{\alpha}(\Xi)^{1-\alpha}-(1-\delta)\Gamma]=0
\end{aligned}\tag{22}$$

$$\begin{aligned}
&B'\left(A_c\left(n_{cK}^*\right)^{\alpha}\Xi^{1-\alpha}\right)A_c\alpha\left(n_{cK}^*\right)^{\alpha-1}\Xi^{1-\alpha}+\\
&-\rho\frac{p_l-\tau_l}{p_c+\tau_c}A_l\beta\left(\bar{K}-n_{cK}^*\right)^{\beta-1}(H^2-\Xi)^{1-\beta}+\rho A_c\alpha\left(n_{cK}^*\right)^{\alpha-1}\Xi^{1-\alpha}\\
&+\hbar^g\left[-\phi_l\tau_lA_l\beta\left(\bar{K}-n_{cK}^*\right)^{\beta-1}(H^2-\Xi)^{1-\beta}-\tau_cA_c\alpha\left(n_{cK}^*\right)^{\alpha-1}\Xi^{1-\alpha}\right]\\
&+\lambda_c^g\sigma_c[(p_c+\tau_c)A_c\alpha(n_{cK}^*)^{\alpha-1}(\Xi)^{1-\alpha}-r_d^c]\\
&+\lambda_l^g\sigma_l[-(p_l-\tau_l)A_l\beta(\bar{K}-n_{cK}^*)^{\beta-1}(H^2-\Xi)^{1-\beta}+r_d^l]=0
\end{aligned}\tag{23}$$

where $\hbar^g$, λ_c^g and λ_l^g are the Lagrange multipliers under government control for the Treasury's budget constraint and the constraint that the manager m_c and m_l being kept to his

reservation utility of zero respectively.

From the first-order conditions above, we can solve out the equilibrium tax rate in labor-intensive firm τ_l^{*g}, equilibrium subsidy rate in capital-intensive firm τ_c^{*g} and the resulting allocations of capital n_{jK}^{*g} in firm $j = l, c$,[34] which are equal to the equilibrium amount of capital used in that firm $\tilde{n}_{jK}^{*g}$ under government control. And the equilibrium tax rate in rural sector τ_a^{*g} and equilibrium (nominal) urban wage w_d^{*g} under government control are determined by

$$\tau_a^{*g} = p_a - \underline{p}_{al}(p_l - \tau_l^{*g})$$

$$w_d^{*g} = \underline{w}_l(p_l - \tau_l^{*g})$$

Finally, the other equilibrium endogenous variables under government control, e.g., equilibrium surplus of the rural good per rural worker S^{*g}, equilibrium investment I^{*g}, equilibrium output of capital-intensive product q_c^{*g} and equilibrium output of labor-intensive product q_l^{*g} under government control, can be determined after τ_a^{*g}, τ_l^{*g}, τ_c^{*g}, $\tilde{n}_{ji}^{*g}$, w_d^{*g} and r_d^{*jg} having been solved out.

Moreover, the constraint that the manager m_j being kept to his reservation utility of zero implies that we can replace Lagrange multipliers λ_c^g and λ_l^g in (21), (22) and (23) with $\lambda_c'^g = \lambda_c^g \sigma_c$ and $\lambda_l'^g = \lambda_l^g \sigma_l$ without changing the equilibrium under government control. Thus, we have the following proposition.

PROPOSITION 5: The equilibrium with non clearing markets under government control is independent of σ_j, i.e., independent of the ownership of firm's cash flow.[35]

4.3.2 Equilibrium under Manager Control

Now we need to compute the equilibrium with non clearing markets under manager m_j control of the exact use of the resulting allocations of capital n_{jK}^* in firm j. Under manager

[34] The equilibrium under the circumstances is identical to the case of complete contracts for the government in the LDCs (the "first best" equilibrium from the point of the government's view).

[35] Similar empirical results can be found in Morck and Yeung (2004) which emphasizes political influence is proportional to what one controls, not one actually owns, notwithstanding the precise meaning of control in our paper is not identical to that in Morck and Yeung (2004).

control, as long as manager m_j has an incentive to transfer capital allocated by the government outside from firm j to firm $-j$, the resulting allocations of capital to firm $j = l, c$ could not be equal to the equilibrium amount of capital used in that firm, i.e., $n^*_{jK} \neq \tilde{n}^*_{jK}$.

However, like that in Shleifer and Vishny (1994), in our model, the fact that the manager m_j has control rights over the use of capital allocated by the governments does not mean he will transfer all of the resource outside from firm j to firm $-j$. Indeed, the government could try to convince the manager m_c and m_l to produce acceptable quantity of capital-intensive products q_c and desirable quantity of labor-intensive products q_l by means of changing the distorted extent of the relative output prices $(p_c + \tau_c)/(p_l - \tau_l)$, whereby the government might affect capital's relative return between labor-intensive firm and capital-intensive firm. Thus, based on the cooperative game theory, the government g, manager m_c and manager m_l could bargain to a superior allocation by producing appropriate quantity of capital-intensive products and of labor-intensive products and distorting the relative output prices $(p_c + \tau_c)/(p_l - \tau_l)$ to an appropriate extent simultaneously.

Following Hart and Moore (1990), in the model presented below, we assume the relationship among the government g, the manager m_c and manager m_l could be described and analyzed by an incomplete contract and we also assume that the ex post distribution of payoff is governed by a (multilateral bargaining) coalitional form game. The solution concept that we adopt for the coalitional game is the Shapley Value(see Shapley, 1953; Osborne and Rubinstein, 1994; Winter, 2002).[36]

The chronology of all agents' main events and their decisions is shown as follows:

- The government distorts the relative output prices $(p_c + \tau_c)/(p_l - \tau_l)$ and gives priority to capital-intensive firm by allocating capital with price r^c_d and urban labor with price w_d to this firm. The amount of capital and urban labor allocated to capital-intensive firm is n^*_{cK} and $n^*_{cH} = \Xi$ respectively. After the resulting allocations of factors $n^*_{ci}(i = L, K)$ to capital-intensive firm having been realized, then the remaining factors with price r^l_d and w_d were allocated to labor-intensive firm

[36] The application of the Shapley value to impute joint costs or interrelated revenues was first suggested by Shubik (1962).

which means $n_{li}^{*}=Z_{i}^{*}-n_{ci}^{*}(i=L,K)$.

- Manager $j=l,c$ decides how much of the resulting allocations of capital to be diverted from firm j to the other firm $-j$. We denote the amount of the resulting allocations of capital diverted from firm j to firm $-j$ to be χ. In fact, there is only one possible direction of capital transfer, i.e., either from capital-intensive firm to labor-intensive firm or reverse. If χ is permitted to be negative, the above decision problem of manager m_l and (or) manager m_c can be always equivalently described as manager m_c decides how much of the resulting allocations of capital, denoted by χ, to be diverted from his firm to labor-intensive firm. When manager m_c has an incentive to transfer capital outside from his firm to labor-intensive firm, we have $\chi>0$, and when manager m_l has an incentive to transfer capital outside from his firm to capital-intensive firm, we have $\chi<0$. Thus, there is a wedge, denoted by χ, between the equilibrium amount of capital used in capital-intensive firm, denoted by $\tilde{n}_{cK}^{*}$, and the resulting allocations of capital to this firm, denoted by n_{cK}^{*}, i.e., $\tilde{n}_{cK}^{*}=n_{cK}^{*}-\chi$.

- The government, the manager m_l and manager m_c decide the division of payoff by a (multilateral bargaining) coalitional form game.
- Output is produced and the payoff is distributed according to their Shapley values.

We will use a subgame perfect equilibrium (SPE) to characterize the non-market clearing equilibrium under manager control, and the payoff distributed in all subgames are determined by the Shapley values. Borrowing some notations used in Winter (2002), in the present model we can describe the coalitional game among the government g, the manager m_c and manager m_l in an explicit way, i.e., a coalitional game on a finite set of 3 players, is a function ν from the set of all $2^3=8$ coalitions to the set of real numbers $\mathbb{R}$ with $\nu(\varnothing)=0$. $\nu(S)$ represents the total payoff the coalitions S could get in the coalitional game ν. A value is an operator ϕ that assigns to each game ν a vector of payoffs $\phi(\nu)=(\phi_g,\phi_{m_c},\phi_{m_l})$ in $\mathbb{R}^3$. $\phi_\iota(\nu)$ stands for player ι's ($\iota=g,m_c,m_l$) payoff in the game.

Each player ι's Shapley value is an operator that assigns her the expected marginal contributions or the average of his contributions to all coalitions S that consists of players

($\iota = g, m_c, m_l$) ordered in all feasible permutations. More specifically, we denote Π be a permutation on the set of players and $\overline{\Pi}$ the set of all feasible permutations. Let us imagine the players appearing one by one to collect their payoff according to the order Π (Winter, 2002), then the marginal contribution of player ι with respect to that order Π is $\nu(\perp_{\Pi}^{\iota} \cup \iota) - \nu(\perp_{\Pi}^{\iota})$ if we denote by $\perp_{\Pi}^{\iota} = \{\kappa : \Pi(\iota) > \Pi(\kappa)\}$ the set of players preceding player ι in the order Π for each player ι. Under these circumstances, the player ι's Shapley value in the coalitional game ν is

$$\phi_{\iota}^{\text{Shapley}}(\nu) = \frac{1}{3!} \sum_{\Pi \in \overline{\Pi}} [\nu(\perp_{\Pi}^{\iota} \cup \iota) - \nu(\perp_{\Pi}^{\iota})] \tag{24}$$

Like that in Shubik (1962), we can give the characteristic function for the above coalitional game as below in an explicit way:

$$\nu(\{\varnothing\}) = 0$$

$$\nu(\{g\}) = \underset{\tau_l, \tau_c, n_{cK}^*, r_d^l, r_d^c}{\text{Max}} N^1 W^1 \left(\bar{V}^1 \right) + N^2 W^2 \left(\bar{V}^2 \right) + B(A_c (n_{cK}^* - \chi)^{\alpha} \Xi^{1-\alpha}) +$$

$$\rho \left\{ \begin{array}{c} \dfrac{p_l - \tau_l}{p_c + \tau_c} p_{al} \left\{ N^1 [F(t, h^1) - c_a^1] - N^2 c_a^2 \right\} + A_c (n_{cK}^* - \chi)^{\alpha} (\Xi)^{1-\alpha} - (1-\delta)\Gamma \\ + \dfrac{p_l - \tau_l}{p_c + \tau_c} \left[A_l (\bar{K} - n_{cK}^* + \chi)^{\beta} (H^2 - \Xi)^{1-\beta} - N^1 c_l^1 - N^2 c_l^2 \right] \end{array} \right\}$$

$$\nu(\{m_c\}) = \text{Max}\{\sigma_c [(p_c + \tau_c) A_c (n_{cK}^*)^{\alpha} (\Xi)^{1-\alpha} - r_d^c n_{cK}^* - w_d \Xi - (p_c + \tau_c)(1-\delta)\Gamma], 0\}$$

$$\nu(\{m_l\}) = \text{Max}\{\sigma_l [(p_l - \tau_l) A_l (\bar{K} - n_{cK}^*)^{\beta} (H^2 - \Xi)^{1-\beta} - r_d^l (\bar{K} - n_{cK}^*) - w_d (H^2 - \Xi)], 0\}$$

$$\nu(\{m_c, m_l\}) = \underset{\chi}{\text{Max}} \left\{ \begin{array}{c} \sigma_c (p_c + \tau_c) A_c (n_{cK}^* - \chi)^{\alpha} (\Xi)^{1-\alpha} - \sigma_c r_d^c (n_{cK}^* - \chi) - \sigma_c w_d \Xi \\ - \sigma_c (p_c + \tau_c)(1-\delta)\Gamma + \sigma_l (p_l - \tau_l) A_l (\bar{K} - n_{cK}^* + \chi)^{\beta} (H^2 - \Xi)^{1-\beta} \\ - \sigma_l r_d^l (\bar{K} - n_{cK}^* + \chi) - \sigma_l w_d (H^2 - \Xi) \end{array} \right\}$$

$$\nu(\{g, m_c\}) = \underset{\tau_l, \tau_c, n_{cK}^*, r_d^c}{\text{Max}} N^1 W^1 \left(\bar{V}^1 \right) + N^2 W^2 \left(\bar{V}^2 \right) + B(A_c (n_{cK}^*)^{\alpha} \Xi^{1-\alpha}) +$$

$$\rho \left\{ \begin{array}{c} \dfrac{p_l - \tau_l}{p_c + \tau_c} \left[p_{al} \left\{ N^1 [F(t, h^1) - c_a^1] - N^2 c_a^2 \right\} + \left(A_l (\bar{K} - n_{cK}^*)^{\beta} (H^2 - \Xi)^{1-\beta} - N^1 c_l^1 - N^2 c_l^2 \right) \right] \\ + A_c (n_{cK}^*)^{\alpha} (\Xi)^{1-\alpha} - (1-\delta)\Gamma \end{array} \right\}$$

$$+ \sigma_c [(p_c + \tau_c) A_c (n_{cK}^*)^{\alpha} (\Xi)^{1-\alpha} - r_d^c n_{cK}^* - w_d \Xi - (p_c + \tau_c)(1-\delta)\Gamma]$$

$$\nu(\{g, m_l\}) = \underset{\tau_1, \tau_c, n^*_{cK}, r^l_d}{\text{Max}} N^1 W^1 \left(\bar{V}^1 \right) + N^2 W^2 \left(\bar{V}^2 \right) + B(A_c (n^*_{cK})^{\alpha} \Xi^{1-\alpha}) +$$

$$\rho \left\{ \begin{array}{c} \dfrac{p_l - \tau_l}{p_c + \tau_c} \left[\underset{-}{p_{al}} \left\{ N^1 [F(t, h^1) - c^1_a] - N^2 c^2_a \right\} + \left(A_l (\bar{K} - n^*_{cK})^{\beta} (H^2 - \Xi)^{1-\beta} - N^1 c^1_l - N^2 c^2_l \right) \right] \\ + A_c (n^*_{cK})^{\alpha} (\Xi)^{1-\alpha} - (1-\delta)\Gamma \end{array} \right\}$$

$$+ \sigma_l [(p_l - \tau_l) A_l (\bar{K} - n^*_{cK})^{\beta} (H^2 - \Xi)^{1-\beta} - r^l_d (\bar{K} - n^*_{cK}) - w_d (H^2 - \Xi)]$$

$$\nu(\{g, m_c, m_l\}) = \underset{\tau_1, \tau_c, n^*_{cK}, r^l_d, r^c_d, \chi}{\text{Max}} N^1 W^1 \left(\bar{V}^1 \right) + N^2 W^2 \left(\bar{V}^2 \right) + B(A_c (n^*_{cK} - \chi)^{\alpha} \Xi^{1-\alpha}) +$$

$$\rho \left\{ \begin{array}{c} \dfrac{p_l - \tau_l}{p_c + \tau_c} \underset{-}{p_{al}} \left\{ N^1 [F(t, h^1) - c^1_a] - N^2 c^2_a \right\} + \\ \dfrac{p_l - \tau_l}{p_c + \tau_c} \left[A_l (\bar{K} - n^*_{cK} + \chi)^{\beta} (H^2 - \Xi)^{1-\beta} - N^1 c^1_l - N^2 c^2_l \right] + A_c (n^*_{cK} - \chi)^{\alpha} (\Xi)^{1-\alpha} - (1-\delta)\Gamma \end{array} \right\}$$

$$+ \sigma_l [(p_l - \tau_l) A_l (\bar{K} - n^*_{cK} + \chi)^{\beta} (H^2 - \Xi)^{1-\beta} - r^l_d (\bar{K} - n^*_{cK} + \chi) - w_d (H^2 - \Xi)]$$

$$+ \sigma_c [(p_c + \tau_c) A_c (n^*_{cK} - \chi)^{\alpha} (\Xi)^{1-\alpha} - r^c_d (n^*_{cK} - \chi) - w_d \Xi - (p_c + \tau_c)(1-\delta)\Gamma]$$

Now we can solve out the SPE by means of backward solution as follows:

- Facing the given output prices ($p_c + \tau_c, p_l - \tau_l$), the given factor prices (w_d, r^c_d, r^l_d), and the resulting allocations of factors $n^*_{ji} (i = L, K)$ to firm j, manager m_c decides χ to maximize $\nu(\{m_c, m_l\})$, which implies that we have following FOC:[37]

$$\begin{array}{c} -\sigma_c \left[(p_c + \tau_c) A_c \alpha (n^*_{cK} - \chi)^{\alpha - 1} (\Xi)^{1-\alpha} - r^c_d \right] \\ +\sigma_l \left[(p_l - \tau_l) A_l \beta (\bar{K} - n^*_{cK} + \chi)^{\beta - 1} (H^2 - \Xi)^{1-\beta} - r^l_d \right] = 0 \end{array} \tag{25}$$

- The government chooses the distorted relative output prices ($p_c + \tau_c, p_l - \tau_l$), interest rate faced by capital-intensive firm and labor-intensive firm (r^c_d, r^l_d), the resulting allocations of factors $n^*_{ji} (i = L, K)$ to firm $j = l, c$ to maximize $\nu(\{g, m_c, m_l\})$ subject to the Treasury's budget constraint which can be expressed by

$$\begin{array}{c} (1-\sigma_l)[(p_l - \tau_l) A_l (\bar{K} - n^*_{cK} + \chi)^{\beta} (H^2 - \Xi)^{1-\beta} - r^l_d (\bar{K} - n^*_{cK} + \chi) - w_d (H^2 - \Xi)] \\ +(1-\sigma_c)[(p_c + \tau_c) A_c (n^*_{cK} - \chi)^{\alpha} (\Xi)^{1-\alpha} - r^c_d (n^*_{cK} - \chi) - w_d \Xi - (p_c + \tau_c)(1-\delta)\Gamma] \\ +\phi_l \tau_l A_l (\bar{K} - n^*_{cK} + \chi)^{\beta} (H^2 - \Xi)^{1-\beta} \geq \tau_c A_c (n^*_{cK} - \chi)^{\alpha} (\Xi)^{1-\alpha} \end{array} \tag{26}$$

It is obvious that that the equilibrium interest rate r^{*jm}_d under manager control in firm j

[37] There is an implicit assumption which is $\sigma_j \neq 0, \ \forall \ j = l, c$ in (25).

equals to $\upsilon_j r^*$, i.e., we have $r_d^{*jm} = \upsilon_j r^*$. Furthermore, the government's decision should satisfy following FOCs:

$$\begin{aligned}
&\frac{\rho}{p_c+\tau_c}\left\{\begin{array}{c} \underline{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+ \\ \left[A_l(\bar{K}-n_{cK}^*+\chi)^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right]\end{array}\right\} \\
&\quad +\sigma_l A_l(\bar{K}-n_{cK}^*+\chi)^{\beta}(H^2-\Xi)^{1-\beta} \\
&-\vartheta^m\left\{\begin{array}{c}\phi_l A_l(\bar{K}-n_{cK}^*+\chi)^{\beta}(H^2-\Xi)^{1-\beta}- \\ (1-\sigma_l)[-A_l(\bar{K}-n_{cK}^*+\chi)^{\beta}(H^2-\Xi)^{1-\beta}]\end{array}\right\}=0
\end{aligned} \tag{27}$$

$$\begin{aligned}
&-\rho\frac{p_l-\tau_l}{(p_c+\tau_c)^2}\left\{\begin{array}{c} \underline{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+ \\ \left[A_l(\bar{K}-n_{cK}^*+\chi)^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right]\end{array}\right\} \\
&\quad +\sigma_c[A_c(n_{cK}^*-\chi)^{\alpha}(\Xi)^{1-\alpha}-(1-\delta)\Gamma] \\
&\vartheta^m\left\{(1-\sigma_c)[A_c(n_{cK}^*-\chi)^{\alpha}(\Xi)^{1-\alpha}-(1-\delta)\Gamma]-A_c(n_{cK}^*-\chi)^{\alpha}(\Xi)^{1-\alpha}\right\}=0
\end{aligned} \tag{28}$$

$$\begin{aligned}
&B'(A_c(n_{cK}^*-\chi)^{\alpha}\Xi^{1-\alpha})A_c\alpha(n_{cK}^*-\chi)^{\alpha-1}\Xi^{1-\alpha}+ \\
&\rho\left\{\begin{array}{c}-\frac{p_l-\tau_l}{p_c+\tau_c}A_l\beta(\bar{K}-n_{cK}^*+\chi)^{\beta-1}(H^2-\Xi)^{1-\beta} \\ +A_c\alpha(n_{cK}^*-\chi)^{\alpha-1}(\Xi)^{1-\alpha}\end{array}\right\} \\
&+\sigma_l[-(p_l-\tau_l)A_l\beta(\bar{K}-n_{cK}^*+\chi)^{\beta-1}(H^2-\Xi)^{1-\beta}+\upsilon_l r^*] \\
&+\sigma_c[(p_c+\tau_c)A_c\alpha(n_{cK}^*-\chi)^{\alpha-1}(\Xi)^{1-\alpha}-\upsilon_c r^*] \\
&\vartheta^m\left\{\begin{array}{c}-\phi_l\tau_l A_l\beta(\bar{K}-n_{cK}^*+\chi)^{\beta-1}(H^2-\Xi)^{1-\beta}+ \\ (1-\sigma_l)[-(p_l-\tau_l)A_l\beta(\bar{K}-n_{cK}^*+\chi)^{\beta-1}(H^2-\Xi)^{1-\beta}+\upsilon_l r^*] \\ +(1-\sigma_c)[(p_c+\tau_c)A_c\alpha(n_{cK}^*-\chi)^{\alpha-1}(\Xi)^{1-\alpha}-\upsilon_c r^*] \\ -\tau_c A_c\alpha(n_{cK}^*-\chi)^{\alpha-1}(\Xi)^{1-\alpha}\end{array}\right\}=0
\end{aligned} \tag{29}$$

where ϑ^m is the Lagrange multiplier under manager control for the Treasury's budget constraint.

In SPE under manager control, the equilibrium amount of capital used in capital-intensive firm, denoted by $\tilde{n}_{cK}^{*m}$, must equal to the resulting allocations of capital to this firm, denoted by n_{cK}^{*m}, i.e., $\tilde{n}_{cK}^{*m} = n_{cK}^{*m}$. Thus, in SPE, the amount of the capital diverted outside from capital-intensive firm to labor-intensive firm should be equal to 0, i.e., $\chi^* = 0$.

Plugging $\chi^* = 0$ in equation (26), (27), (28) and (29), we can solve out the equilibrium tax rate in labor-intensive firm τ_l^{*m}, equilibrium subsidy rate in capital-intensive firm τ_c^{*m}, the

resulting allocations of capital n_{jK}^{*m} in firm $j=l,c$, which are equal to the equilibrium amount of factors used in that firm $\tilde{n}_{ji}^{*m}$ under manager control.

And the equilibrium tax rate in rural sector τ_a^{*m} and equilibrium (nominal) urban wage w_d^{*m} under manager control are determined by

$$\tau_a^{*m} = p_a - \underline{p}_{al}(p_l - \tau_l^{*m})$$

$$w_d^{*m} = \underline{w}_l(p_l - \tau_l^{*m})$$

The other equilibrium endogenous variables under manager control, e.g., equilibrium surplus of the rural good per rural worker S^{*m}, equilibrium investment I^{*m}, equilibrium output of capital-intensive product q_c^{*m} and equilibrium output of labor-intensive product q_l^{*m} under manager control, can be determined after τ_a^{*m}, τ_l^{*m}, τ_c^{*m}, $\tilde{n}_{ji}^{*m}$, w_d^{*m} and r_d^{*jm} having been solved out.

Finally, based on the characteristic function for the above coalitional game, applying the Shapley value in (24), we obtain

$$\phi_g^{\text{Shapley}} = \frac{1}{3!}\left\{\begin{array}{c} 2\nu(\{g\}) + \left[\nu(\{g,m_c\}) - \nu(\{m_c\})\right] + \\ \left[\nu(\{g,m_l\}) - \nu(\{m_l\})\right] + 2\left[\nu(\{g,m_c,m_l\}) - \nu(\{m_c,m_l\})\right] \end{array}\right\}$$

$$\phi_{m_c}^{\text{Shapley}} = \frac{1}{3!}\left\{\begin{array}{c} 2\nu(\{m_c\}) + \left[\nu(\{g,m_c\}) - \nu(\{g\})\right] + \\ \left[\nu(\{m_c,m_l\}) - \nu(\{m_l\})\right] + 2\left[\nu(\{g,m_c,m_l\}) - \nu(\{g,m_l\})\right] \end{array}\right\}$$

$$\phi_{m_l}^{\text{Shapley}} = \frac{1}{3!}\left\{\begin{array}{c} 2\nu(\{m_l\}) + \left[\nu(\{g,m_l\}) - \nu(\{g\})\right] + \\ \left[\nu(\{m_c,m_l\}) - \nu(\{m_c\})\right] + 2\left[\nu(\{g,m_c,m_l\}) - \nu(\{g,m_c\})\right] \end{array}\right\}$$

Comparing the equilibrium under manager control with that under government control yields the following proposition (proof in the Appendix).

PROPOSITION 6: To successfully enforce Catch-up type CAD strategy in his country, the governments in the LDCs always prefer their control over the exact use of the resulting allocation of capital to the firm $j=l,c$, denoted by n_{jK}^{*}, to that of the manager m_j, i.e., the governments in the LDCs would like to deprive firm of autonomy.

Though we obtain Proposition 6 in a very complex way, the idea in it is quite simple, i.e., under the conditions that prices were distorted and factors were allocated to the firms by the governments through priority systems, accompanied with the information asymmetry between the government and the managers, whereby profits and losses could no longer reflect management performance as well as monitoring costs for the government was prohibitively high, therefore, by giving the government the control right over all resource allocated to the firms, the classic hold up

problem for the government can be alleviated to the maximum extent.[38]

Finally, from the proof of proposition 6, we know the root that the equilibrium under manager control is inferior to that under government control from the viewpoint of the government in the LDCs is the arbitrage opportunity of diverting capital from one firm to the other, i.e., FOC in (25). Had arbitrage opportunities of diverting capital from one firm to the other disappeared, the equilibrium under manager control would be identical to that under government control for the government in the LDCs. However, these arbitrage opportunities could not exist provided that either $\sigma_l = 0$ or $\sigma_c = 0$. Therefore, we have following corollary.

COROLLARY 1: The equilibrium with non clearing markets under manager control depends on the exact value of σ_j, i.e., depends on the ownership of firm's cash flow. Moreover, the government prefers the exact value of σ_j to be zero under manager control, i.e., $\sigma_j = 0$.[39]

5. Concluding Remarks

There exist widespread distorted institutional arrangements and intervention policies such as price distortion, financial depression, trade restriction, rationing of capital and foreign exchange, licensing of investments, administrative monopoly and state ownership in plenty of LDCs, whether they are socialist countries such as former Soviet Union and Eastern Europe countries as well as China, or non-socialist countries such as India and many Latin American countries. The main purpose in this paper is to construct a simple three-sector model to explore the root of these distorted institutional arrangements and intervention policies in the LDCs.

Based on Lin, et al. (1994, 1996, 1999, 2003), the distorted institutional arrangements in the LDCs after the World War II can be largely explained by their governments' adoption of a Catch-up type CAD strategy. Though these development strategies seem to be extremely inappropriate and even absurd according to the point of the today's view, however, they were initiated by idealistic nationalists behaving as benevolent guardians with bounded rationality. Deeply influenced by the radical view of economic development and Keynesian theory at that time, as well as motivated by the dream of nation building and the successful experience of Soviet Union, most LDCs, both socialist and non-socialist, adopted a Catch-up type CAD strategy to accelerate the growth of capital-intensive, advanced sectors in their countries. Many firms in the priority sectors of this strategy were nonviable in open, competitive markets because the priority sectors were not their economies' comparative advantages. The model shows that the government's interventions, including distorted prices for products and essential factors of production, highly centralized planned resource allocation system and a micro-management mechanism in which firms were deprived of autonomy, are endogenous to the needs of maximizing resource mobilization for building up the priority sectors and to support non-viable

[38] The justification for government's depriving firm of autonomy in LDCs is analogous with the case in Burkart, Panunzi, and Shleifer (2003) which examine whether entrepreneurs want to surrender control of firms they found by comparing the potential benefits of owner control with the forgone benefits of rendering control to capable outside professional managers, though the role of capable outside professional managers is ignored for tractability in our model.

[39] In a purely public firm, we have $\sigma_j = 0$.

firms in those sectors. Thus, given the government's motivation, i.e., pursuing Catch-up type CAD strategy, these distorted economic institutions and intervention policies existing in the LDCs were second-best institutions.[40] Without addressing the firms' viability issue and giving up the Catch-up type CAD strategy, the implementation of price liberalization, privatization, and elimination of other distortions would result in the poorer economic performance in the LDCs than that before the reform.

Any economy that adopted the Catch-up type CAD strategy must have sectors that are consistent with the economy's comparative advantages and were repressed previously. In general those sectors are labor intensive, use matured technologies, require small amount of capital inputs, and have large unsatisfied domestic and (or) international demands. The government should immediately remove its previous regulations and liberalize the entries to those sectors. In fact, the dynamic growth in China, Vietnam, and other transitional economies such as formal Soviet Union and Eastern Europe countries, as well as India, all came mainly from the entries of the small and medium size, labor-intensive enterprises. By this way, the economy can achieve sustained, dynamic growth in its transition process. However, the completion of transition to a well functioning market economy depends on the final resolving of the viability problem that exists in many firms in the priority sectors of the previously adopted Catch-up type CAD strategy. The problem can be solved either by allowing foreign capital to invest in the firms, allowing the firms to shift their productions to sectors consistent with the economy's comparative advantages, or letting the firms to go bankrupt. Each society may have to find its own ways to implement the above recommendation policies. However, the government's commitment to replace the old Catch-up type CAD strategy with a new comparative advantage-following strategy is essential (Lin and Liu, 2004).

[40] We share the same view with that in Krueger (1995), i.e., many of the policies that eventually became so inimical to growth appear to have been adopted for idealistic motives, and not for the narrow self-interest of the groups in the ruling coalition.

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Appendix

Proof of PROPOSITION 6:

Proof by Contradiction: It is obvious that the equilibrium under manager control can be obtained by government control.[41] Thus, the equilibrium under government control weakly dominates the equilibrium under manager control from the viewpoint of the government in the LDCs. If we can prove that the equilibrium under manager control could not always equal to the equilibrium under government control, then the government in the LDCs prefers the equilibrium under government control to that under manager control, which is the result in PROPOSITION 6, i.e., the governments in the LDCs would like to deprive firm of autonomy.

Let us first assume the equilibrium under government control is always identical to that under manager control, i.e., we have $\tau_c^{*m} = \tau_c^{*g}$, $\tau_l^{*m} = \tau_l^{*g}$ and $\tilde{n}_{ji}^{*m} = \tilde{n}_{ji}^{*g}$, etc.

From the FOC in (21), we know that the equilibrium under government control should satisfy

$$\begin{aligned} &\frac{\rho}{p_c + \tau_c^{*g}} \underline{p}_{al} \left\{ N^1[F(t,h^1) - c_a^1] - N^2 c_a^2 \right\} + \\ &\frac{\rho}{p_c + \tau_c^{*g}} \left(A_l \left(\bar{K} - \tilde{n}_{cK}^{*g} \right)^{\beta} (H^2 - \Xi)^{1-\beta} - N^1 c_l^1 - N^2 c_l^2 \right) - \\ &\hbar^g \phi_l A_l \left(\bar{K} - \tilde{n}_{cK}^{*g} \right)^{\beta} (H^2 - \Xi)^{1-\beta} + \lambda_l^g \sigma_l A_l (\bar{K} - \tilde{n}_{cK}^{*g})^{\beta} (H^2 - \Xi)^{1-\beta} = 0 \end{aligned} \tag{30}$$

Substituting $\chi^* = 0$ into (27) implies that in SPE under manager control, we have

$$\begin{aligned} &\frac{\rho}{p_c + \tau_c^{*m}} \left\{ \begin{array}{c} \underline{p}_{al} \left\{ N^1[F(t,h^1) - c_a^1] - N^2 c_a^2 \right\} + \\ \left[A_l (\bar{K} - \tilde{n}_{cK}^{*m})^{\beta} (H^2 - \Xi)^{1-\beta} - N^1 c_l^1 - N^2 c_l^2 \right] \end{array} \right\} \\ &\quad + \sigma_l A_l (\bar{K} - \tilde{n}_{cK}^{*m})^{\beta} (H^2 - \Xi)^{1-\beta} \\ &- \vartheta^m \left\{ \begin{array}{c} \phi_l A_l (\bar{K} - \tilde{n}_{cK}^{*m})^{\beta} (H^2 - \Xi)^{1-\beta} + \\ (1 - \sigma_l)[A_l (\bar{K} - \tilde{n}_{cK}^{*m})^{\beta} (H^2 - \Xi)^{1-\beta}] \end{array} \right\} = 0 \end{aligned} \tag{31}$$

Comparing (30) with (31), under the assumption that the equilibrium under government control is identical to that under manager control, we must have $\hbar^g = \vartheta^m$ and $\lambda_l^g \sigma_l = -\vartheta^m (1 - \sigma_l) + \sigma_l$.

The FOC in (22) implies that the equilibrium under government control should satisfy

[41] The model setup in present paper could guarantee either the equilibrium under government control or the equilibrium under manager control is unique.

$$
\begin{aligned}
&-\rho\frac{p_l-\tau_l^{*g}}{(p_c+\tau_c^{*g})^2}\,\underline{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+\\
&-\rho\frac{p_l-\tau_l^{*g}}{(p_c+\tau_c^{*g})^2}\left(A_l\left(\bar{K}-\tilde{n}_{cK}^{*g}\right)^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right)\\
&-\hbar^g A_c\left(\tilde{n}_{cK}^{*g}\right)^{\alpha}\Xi^{1-\alpha}+\hat{\lambda}_c^g\sigma_c[A_c(\tilde{n}_{cK}^{*g})^{\alpha}(\Xi)^{1-\alpha}-(1-\delta)\Gamma]=0
\end{aligned}
\tag{32}
$$

Replacing $\chi^*=0$ in SPE under manager control into (28) yields

$$
\begin{aligned}
&-\rho\frac{p_l-\tau_l^{*m}}{(p_c+\tau_c^{*m})^2}\left\{\begin{array}{c}\underline{p}_{al}\left\{N^1[F(t,h^1)-c_a^1]-N^2c_a^2\right\}+\\ \left[A_l(\bar{K}-\tilde{n}_{cK}^{*m})^{\beta}(H^2-\Xi)^{1-\beta}-N^1c_l^1-N^2c_l^2\right]\end{array}\right\}\\
&+\sigma_c[A_c(\tilde{n}_{cK}^{*m})^{\alpha}(\Xi)^{1-\alpha}-(1-\delta)\Gamma]\\
&\vartheta^m\left\{(1-\sigma_c)[A_c(\tilde{n}_{cK}^{*m})^{\alpha}(\Xi)^{1-\alpha}-(1-\delta)\Gamma]-A_c(\tilde{n}_{cK}^{*m})^{\alpha}(\Xi)^{1-\alpha}\right\}=0
\end{aligned}
\tag{33}
$$

Make a comparison between (32) and (33) implies that, under the assumption that the equilibrium under government control is identical to that under manager control, we must have $\hbar^g=\vartheta^m$ and $\hat{\lambda}_c^g\sigma_c=\sigma_c+\vartheta^m(1-\sigma_c)$.

Replacing r_d^{*jg} with $\upsilon_j r^*$ in (23) means that under government control, we have

$$
\begin{aligned}
&B'\left(A_c\left(\tilde{n}_{cK}^{*g}\right)^{\alpha}\Xi^{1-\alpha}\right)A_c\alpha\left(\tilde{n}_{cK}^{*g}\right)^{\alpha-1}\Xi^{1-\alpha}+\\
&-\rho\frac{p_l-\tau_l^{*g}}{p_c+\tau_c^{*g}}A_l\beta\left(\bar{K}-\tilde{n}_{cK}^{*g}\right)^{\beta-1}(H^2-\Xi)^{1-\beta}+\rho A_c\alpha\left(\tilde{n}_{cK}^{*g}\right)^{\alpha-1}\Xi^{1-\alpha}\\
&+\hbar^g\left[-\phi_l\tau_l^{*g}A_l\beta\left(\bar{K}-\tilde{n}_{cK}^{*g}\right)^{\beta-1}(H^2-\Xi)^{1-\beta}-\tau_c^{*g}A_c\alpha\left(\tilde{n}_{cK}^{*g}\right)^{\alpha-1}\Xi^{1-\alpha}\right]\\
&+\hat{\lambda}_c^g\sigma_c[(p_c+\tau_c^{*g})A_c\alpha(\tilde{n}_{cK}^{*g})^{\alpha-1}(\Xi)^{1-\alpha}-\upsilon_c r^*]\\
&+\hat{\lambda}_l^g\sigma_l[-(p_l-\tau_l^{*g})A_l\beta(\bar{K}-\tilde{n}_{cK}^{*g})^{\beta-1}(H^2-\Xi)^{1-\beta}+\upsilon_l r^*]=0
\end{aligned}
\tag{34}
$$

Substituting $r_d^{*jm}=\upsilon_j r^*$ and $\chi^*=0$ into (25) implies that the SPE under manager control should satisfy

$$
\begin{aligned}
&\sigma_c\left[(p_c+\tau_c^{*m})A_c\alpha(\tilde{n}_{cK}^{*m})^{\alpha-1}(\Xi)^{1-\alpha}-\upsilon_c r^*\right]=\\
&\sigma_l\left[(p_l-\tau_l^{*m})A_l\beta(\bar{K}-\tilde{n}_{cK}^{*m})^{\beta-1}(H^2-\Xi)^{1-\beta}-\upsilon_l r^*\right]
\end{aligned}
\tag{35}
$$

Plugging (35) and $\chi^*=0$ in (29) delivers

$$
\begin{aligned}
& B'(A_c(\tilde{n}_{cK}^*)^{\alpha}\Xi^{1-\alpha})A_c\alpha(\tilde{n}_{cK}^*)^{\alpha-1}\Xi^{1-\alpha} \\
& +\rho\left\{\begin{array}{c} -\dfrac{p_l-\tau_l^{*m}}{p_c+\tau_c^{*m}}A_l\beta(\bar{K}-\tilde{n}_{cK}^*)^{\beta-1}(H^2-\Xi)^{1-\beta} \\ +A_c\alpha(\tilde{n}_{cK}^*)^{\alpha-1}(\Xi)^{1-\alpha} \end{array}\right\} \\
& \vartheta^m\left\{\begin{array}{c} -\phi_l\tau_l^{*m}A_l\beta(\bar{K}-\tilde{n}_{cK}^*)^{\beta-1}(H^2-\Xi)^{1-\beta}-\tau_c^{*m}A_c\alpha(\tilde{n}_{cK}^*)^{\alpha-1}(\Xi)^{1-\alpha} \\ +[-(p_l-\tau_l^{*m})A_l\beta(\bar{K}-\tilde{n}_{cK}^*)^{\beta-1}(H^2-\Xi)^{1-\beta}+\upsilon_l r^*] \\ +[(p_c+\tau_c^{*m})A_c\alpha(\tilde{n}_{cK}^*)^{\alpha-1}(\Xi)^{1-\alpha}-\upsilon_c r^*] \end{array}\right\}=0
\end{aligned}
\tag{36}
$$

Comparison of (34) with (36) implies that, under the assumption that the equilibrium under government control is identical to that under manager control, we must have $\hbar^g=\vartheta^m$, $\lambda_c^g\sigma_c=\vartheta^m$ and $\lambda_l^g\sigma_l=\vartheta^m$.

Substituting $\lambda_c^g\sigma_c=\vartheta^m$ into $\lambda_c^g\sigma_c=\sigma_c+\vartheta^m(1-\sigma_c)$ gives $\vartheta^m=1$. Combination of $\lambda_l^g\sigma_l=-\vartheta^m(1-\sigma_l)+\sigma_l$ and $\lambda_l^g\sigma_l=\vartheta^m$ yields $\dfrac{\sigma_l}{(2-\sigma_l)}=\vartheta^m$ which means that $\sigma_l=1$ owing to $\vartheta^m=1$. Furthermore, we have $\lambda_l^g\equiv 1$, $\hbar^g\equiv 1$ and $\lambda_c^g\equiv 1/\sigma_c$ after simple arithmetic operation.

It is well known that the Lagrange multiplier has an economic interpretation as the shadow price associated with the constraint. The necessary conditions above that guarantee the equilibrium under government control being always identical to that under manager control, i.e., $\vartheta^m=1$, $\sigma_l=1$, $\lambda_l^g\equiv 1$, $\hbar^g\equiv 1$ and $\lambda_c^g\equiv 1/\sigma_c$, imply that the equilibrium under government control being identical to that under manager control is just a special case only.

Therefore, the government in the LDCs prefers the equilibrium under government control to that under manager control. *Q.E.D.*