A Tale of Two Reforms

Wei Li[1]
The Fuqua School of Business
Duke University
Box 90120
Durham, NC 27707-0120
E-mail: WL4@mail.duke.edu

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Abstract

I present a unified theoretical framework that attributes output collapse to price liberalization and decentralization of the formerly integrated monopolistic industrial structure in the former Soviet bloc, and output expansion in China to marginal marketization and intramarginal regulation. In the model economy, all industries are interdependent in that they rely on each other for intermediate inputs. This circular dependence in the presence of imperfect competition creates a pecuniary externality in the sense that a price increase or an output reduction by one industry raises other industries' costs and reduces their intermediate demands. Under central planning, the industries are fully integrated, allowing the state to internalize the externality. Big bang reform decentralizes the state monopolized industrial structure. Price or quantity competition among decentralized, concentrated, and circularly dependent industries leads, in a Nash equilibrium, to reduced output, lower profits, and higher prices. The controlled reform in China, however, regulates enterprises intramarginally by forcing them to fulfill planned output quotas at planned prices, and liberalizes only marginally by allowing them to sell above-the-quota outputs at market prices. While the intramarginal regulation reduces the effect of the externality, the marginal liberalization encourages enterprises to produce beyond the quotas. Enterprise-level panel data from China are used to test the theory.

1 Introduction

Since the fall of communism, the centrally planned economies in Eastern Europe and the former Soviet Union (EEFSU) have, one by one, implemented drastic reform packages—variously known as "big bangs" or "shock therapies"—aimed at transforming these economies into free market economies as rapidly as possible.[1] The reform liberalized most prices overnight and decentralized enterprise decision-making. These institutional changes were followed by sharp declines in output and macroeconomic instability.

In contrast, the economic reform in China took quite a different approach.[2] Instead of "leaping to the market," China's reform introduced markets *at the margin*, parallel to planning. State enterprises and peasants were still required to fulfill planned output quotas and deliver them to the state at planned prices, but were allowed to sell their above-the-plan outputs at market prices and to retain part of the earned profits as an incentive. Planning was thus maintained initially in virtually all industries, but it affected mostly *intramarginal* resource allocation; the emerging market was allowed to allocate resources based on marginal calculations (Byrd (1989), Sicular (1988) and Wu (1987)). These controlled institutional changes were followed by rapid economic expansion in China and a relatively stable macroeconomy.

Can the differences in economic performance between EEFSU and China be attributed to the differences in reform strategies? This paper presents a unified theoretical framework that offers a plausible explanation for why output collapse and macroeconomic instability were associated with the "big bang" reform, but not with the controlled marginal reform. Unlike previous studies that relate the differences in economic performance to the speed and the sequence of the reforms (gradualism *vs.* big bang),[3] or to the stage of economic development (Sachs and Woo (1994)), this paper focuses on the inherent differences in the two types of reforms. In a nutshell, the model attributes the economic decline in EEFSU to the overnight price liberalization and the decentralization of decision-making in the formerly integrated monopolistic industries. It attributes the economic expansion in China to *marginal* liberalization and *intramarginal* regulation.

In this paper, I identify the combination of inter-industry interdependence and imperfect competition in the newly created product markets as a structural cause of output contraction under the big bang reform and output expansion under China's reform in the short run. The theoretical

[1] General discussions of the reform in EEFSU can be found in Blanchard *et al* (1991), Lipton and Sachs (1990, 1992), Kornai (1990) and others.

[2] For a general discussion of the reform in China, see Gordon and Li (1991) and Naughton (1994) among others.

[3] See, for example, Singh (1991), McMillan and Naughton (1992), Dewatripont and Roland (1992), and McKinnon (1993).

model developed here demonstrates that the switch from centralized or integrated decision-making under central planning to complete decentralization will, in general, lead to a contraction in output. The idea is similar to the logic of vertical integration in the situation of successive monopoly (*e.g.*, Spengler (1950)), where successive mark-ups by a chain of vertically dependent monopolies restrict output beyond what an integrated monopoly would produce. But the model developed here is different. It analyzes the functioning of markets characterized by circular inter-industry dependence and imperfect competition, rather than that of a single market or a vertical chain of markets.

I also show that in the presence of circular inter-industry dependence and imperfect competition, the big bang reform decreases state industries' aggregate profits relative to the wage rate, while China's reform raises state industries' aggregate profits. Since governments in the reforming economies still collect most of their revenues from state industries, this model also offers a structural explanation for the severe budget crises in the big bang economies and hence the macroeconomic instability.

In order to shed some light on the extremely complex economic problems of transition, I develop an analytical framework that is simple enough to be tractable but not simpler than what is required to highlight the general features of a Soviet-type economy before and after the reforms. I maintain the typical neoclassical assumptions that all agents pursue their own interests and that there is no informational imperfection in the economic environment both before and after the reforms. The cause of the phenomena that I identify is therefore structural.

As a logical start of the analysis, I present in Section 2 a positive theory of the Soviet-type economy—an analytical framework under which the two reforms can be defined and a benchmark against which the effects of the two reforms can be evaluated. The model is strictly neoclassical.[4] Instead of taking any political or economic ideology as an explanation or a justification of the Soviet-type economic system, I examine the pattern of resource allocation that would result given the communist elite's effective ownership of all productive assets and their absolute control of political power, and given that they, as any other agents in the economy, are motivated by self interests.

I then offer a brief discussion of the nature of the reforms in Section 3. Since imperfect competition in the emerging product markets in transitional economies plays an important role in this

[4]This model attempts to offer a neoclassical abstraction of the existing theories and stylized facts of the Soviet-type or socialist economy. (See Janos Kornai (1991) for an authoritative analysis of the socialist economic system.) Such an abstraction is important because it offers a vigorous yet simple theoretical framework under which one can analyze and evaluate various reforms using well-developed toolkit in economics. For a more detailed development of this model, see Li (1994b).

study, I devote Section 4 to the analysis of the emerging market structure. In Section 5, I develop a simple model of a transitional economy under big bang. The consequences of big bang are analyzed by comparing the levels of output, prices and aggregate profits in this reforming economy to those of the corresponding pre-reform Soviet-type economy. The consequences of the Chinese reform are analogously studied in Section 6. The economic and political conditions that are necessary to ensure a successful implementation of the Chinese reform are also discussed. In Section 7, I offer a simple empirical test of one of the implications of Chinese reform using enterprise level panel data from China. Section 8 offers some concluding remarks.

2 The Soviet-Type Economy

Consider a simple stylized Soviet-type economy consisting of a single representative communist dictator/planner, who owns all means of production, and a single representative consumer. The planner operates a civilian industrial sector that produces I consumer goods and services, and a non-civilian sector or a government/military/heavy industrial sector that produces goods and services that he desires. He is motivated by his own interest, which is assumed to be represented by $U_g(\mathbf{Z})$ that defines his preferences over the non-civilian output $\mathbf{Z}$.[5] The consumer consumes a basket of I civilian goods and services, denoted by $\mathbf{D} = (D_1, \ldots, D_I)'$, and supplies labor, L, out of a constant labor endowment H. Let the wage rate be the numeraire and $\mathbf{P}$ the vector of *shadow prices* of consumer goods. Then maximizing utility $U(\mathbf{D}, H - L)$ subject to the budget constraint, $\mathbf{PD} + H - L = H$, yields the consumer's demands $\mathbf{D} = \mathbf{D}(\mathbf{P})$ as a vector function of $\mathbf{P}$ and labor supply $L(\mathbf{P}) = \mathbf{P}'\mathbf{D}(\mathbf{P})$. Assume that the labor supply is increasing with real wage, or $L(\mathbf{P}/t) > L(\mathbf{P})$ for $t > 1$ (for fixed H). The basic economic problem that the planner faces is how to allocate the limited resources in the economy to best serve his self-interest (Figure 1).

Services of physical capital and land, measured in flows, are modeled as intermediate inputs. Other natural resources, such as minerals, are extracted and used naturally as intermediate inputs for further processing. The planner has full control over the use of all physical capital, land, and other natural resources, and hence the allocation of all producer goods. The planner, however, has no direct control over the supply of labor, which increases with the consumer's consumption of civilian goods. He therefore must trade off between allocating labor and natural resources to produce civilian goods so as to induce labor supply, and allocating these resources to produce

[5] The set of the $\mathbf{Z}$ goods and services includes not only countless luxury goods and services that are only available to the privileged, but also the services of a party hierarchy, a police force and armed forces, that protect the leadership's privileges and further their personal, political and geo-political ambitions.

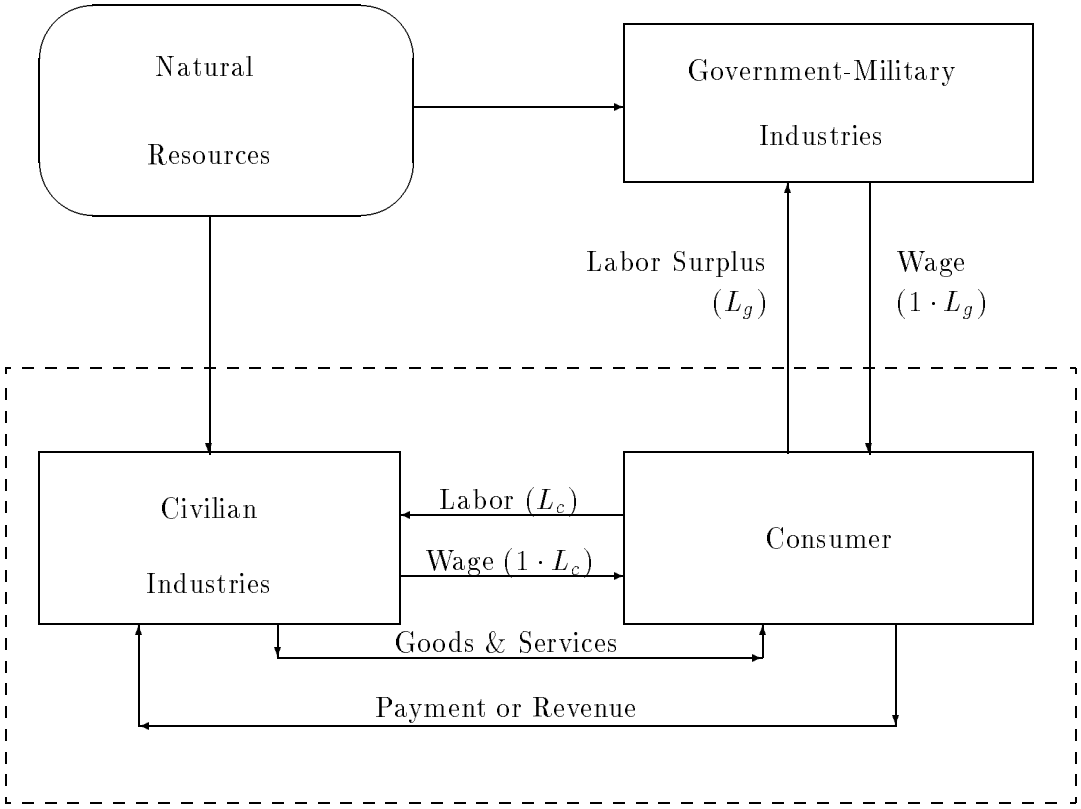

Figure 1: The flow of economic activity in a Soviet-type economy. The planner owns everything except labor. The consumer consumes civilian goods and services and supplies labor L. The wage rate is the numeraire. The planner splits the available labor L into two parts: L_c and L_g. L_c is allocated to the civilian industries that supply just enough consumer goods and services to the consumer so as to induce her to supply labor L. The surplus labor L_g is allocated to the government-military sector that produces the goods and services the central planner wants. Natural resources are harnessed and processed by labor, and then are used as intermediate inputs in production.

non-civilian goods (Figure 1).

The consumer prices $\mathbf{P}$ should be understood as *shadow prices* or implicit market prices that balance demand for consumer goods $\mathbf{D}(\mathbf{P})$ with the actual allocation of those goods $\mathbf{D}^*$, or $\mathbf{D}(\mathbf{P}) = \mathbf{D}^*$. In a typical Soviet-type economy, shadow prices differ from the observed prices. A large proportion of consumer goods are in short supply and are rationed. The difference between the shadow price and the observed price of a good represents the implicit value of ration coupons, or the time wasted in queuing and/or collecting information about the availability and the location of the good. Given the relationships $\mathbf{D}^* = \mathbf{D}(\mathbf{P})$, using shadow prices $\mathbf{P}$ to describe the resource allocation in the economy is equivalent to using the actual allocation $\mathbf{D}^*$. The advantage of using shadow prices rather than the observed prices is tractability.[6] Since markets do not clear under the observed prices in the Soviet-type economy, any description of consumer behavior must explicitly model the quantity rationing that the consumer faces. Modeling rationing explicitly, however, greatly would complicate the analysis without adding further insight to the investigation.

2.1 Civilian Production

The civilian sector consists of I industrial branches. Each branch has an intermediate industry producing a single intermediate good and a consumer industry producing a single consumer good. The industrial branches are interdependent: production in any one industry requires the use of intermediate industries' outputs as inputs. Figure 2 describes the interdependence among two intermediate industries and two consumer industries.

The analysis focuses on the planner's current decisions, taking as given the stocks of physical and human capital and the technology.[7] Assume that constant returns to scale prevails in each industry.[8] For the fixed constant-returns-to-scale technology, the interdependence among industries can be conveniently represented by two input-output matrices (Samuelson's (1951) substitution

[6] This study is concerned with the patterns of resource allocation under Soviet-type central planning in the absence of informational problems, not with the actual implementation of planning. Weitzman (1974) demonstrated that the choice of employing prices vs. quantities as control instruments has welfare consequence only when there is private information.

[7] See Li (1994b) for a discussion of the central planner's choice of technology and presumably its embodiment—capital stocks.

[8] This amounts to assuming that there is an abundance of natural resources in the economy and that there are no scale economies or diseconomies in integrated production given the fixed technology. When natural resources are limited, however, decreasing returns to scale may be inevitable given the fixed technology. Scale economies in production may arise from, say, division of labor. Extending the model here to account for non-CRTS technology is not a trivial exercise, but can be done within the conceptual framework developed here.

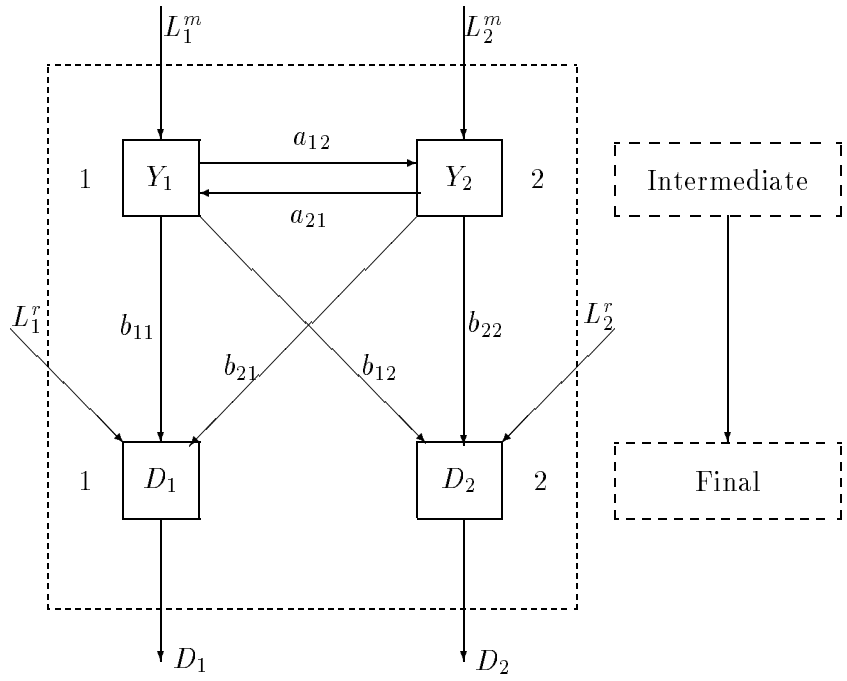

Figure 2: A simple 2×2 configuration of civilian industries.

theorem):

$$A = \{a_{ik}\}_{I\times I}, \quad B = \{b_{ij}\}_{I\times I}$$

a_{ik} = intermediate industry k's unit demand for intermediate industry i's output

b_{ij} = consumer industry j's unit demand for intermediate industry i's output

I assume that this input-output system is productive (Leontief (1986)), *i.e.*, $(I - A)^{-1}$ is a non-negative matrix; and that consumer industries use positive amounts of all intermediate inputs in their production, or B is a strictly positive non-singular matrix. The measure of an intermediate industry's gross output does not include the industry's own consumption of its own output, so that $a_{ii} = 0$ for $i = 1, \ldots, I$. The unit demand for labor by intermediate industry i is L_i^m and by consumer industry j is L_j^r.[9]

Given the vector of consumer demands $\mathbf{D}$, demands for intermediate industries' outputs by consumer industries is $X_i = \sum_{j=1}^{I} b_{ij} D_j$ (for all i) or $\mathbf{X} = B\mathbf{D}$. Due to the circular nature of the interdependence among intermediate industries, each intermediate industry also faces demands by other intermediate industries for its output. Let Y_i denote intermediate industry i's derived total

[9]I adopt the following notational convention: superscript ^{m} denotes intermediate industries and ^{r} consumer industries; subscripts $_i$ and $_k$ denote intermediate industries i and k while subscript $_j$ is reserved for consumer industries.

demand. Then by definition, $Y_i = X_i + \sum_{k=1}^{I} a_{ik} Y_k$ $(i = 1, \ldots, I)$, or $\mathbf{Y} = \mathbf{X} + A\mathbf{Y}$. Solving for $\mathbf{Y}$ yields $\mathbf{Y} = (I - A)^{-1} B\mathbf{D}$. For constant matrices A and B, $\mathbf{Y}$ is a vector function of consumer prices $\mathbf{P}$.

Let M_i denote the *shadow price* of intermediate input i (in terms of labor), $\mathbf{M} = (M_1, \ldots, M_I)'$, and $\mathbf{M}_{-i} = (M_1, \ldots, M_{i-1}, M_{i+1}, \ldots, M_I)'$. Intermediate industries' marginal costs and consumer industries' marginal costs are, respectively,

$$C_i^m = L_i^m + \sum_{k=1}^{I} a_{ki} M_k, \quad \forall i; \quad C_j^r = L_j^r + \sum_{i=1}^{I} b_{ji} M_i, \quad \forall j \tag{1}$$

or $\mathbf{C}^m = \mathbf{L}^m + A'\mathbf{M}$ and $\mathbf{C}^r = \mathbf{L}^r + B'\mathbf{M}$. Intermediate industry i's profits are $\pi_i^m = (M_i - C_i^m) Y_i$, and consumer industry j's profits are $\pi_j^r = (P_j - C_j^r) D_j$.

The aggregate profits that the planner collects are simply $\Pi = \sum_i \pi_i^m + \sum_j \pi_j^r$, which can be simplified as $\Pi = \mathbf{P}'\mathbf{D} - (\mathbf{L}^m)'\mathbf{Y} - (\mathbf{L}^r)'\mathbf{D}$ after some algebraic manipulations,[10] where $\mathbf{L}^m$ and $\mathbf{L}^r$ are vectors of unit labor demands. Since the worker's expenditure on civilian goods $(\mathbf{P}'\mathbf{D})$ must equal wage income (L), the aggregate profits can be written as $\Pi = L - (\mathbf{L}^m)'\mathbf{Y} - (\mathbf{L}^r)'\mathbf{D}$, which is simply the aggregate labor surplus in the civilian sector. This is intuitive: the aggregate profits should be equal to the net revenues of the integrated structure minus the net costs. In Figure 2, the aggregate profits are simply the "final outputs" of the dashed box minus the "primary inputs." Relating to the flow chart of the economy (Figure 1), the civilian sector's use of labor is simply $L_c = (\mathbf{L}^m)'\mathbf{Y} + (\mathbf{L}^r)'\mathbf{D}$. The surplus labor allocated to the non-civilian sector is simply $L_g = \Pi$.

Let S_i^m and S_j^r denote the *social marginal costs* of producing, respectively, one unit of *intermediate* input i and one unit of *consumer* good j, or the marginal costs that would prevail if all inputs were priced at marginal costs. Let $\mathbf{S}^m$ and $\mathbf{S}^r$ denote corresponding vectors of social marginal costs. By definition, $\mathbf{S}^m = \mathbf{L}^m + A'\mathbf{S}^m$, and $\mathbf{S}^r = \mathbf{L}^r + B'\mathbf{S}^m$. Solving for $\mathbf{S}^m$ and $\mathbf{S}^r$ yields

$$\mathbf{S}^m = (I - A')^{-1}\mathbf{L}^m, \quad \mathbf{S}^r = \mathbf{L}^r + B'(I - A')^{-1}\mathbf{L}^m \tag{2}$$

$\mathbf{L}^r$ is the *direct* marginal labor costs of producing consumer goods, and $B'(I - A')^{-1}\mathbf{L}^m$ is the *indirect* marginal labor costs embodied in the intermediate inputs that are required in the production of

[10] Recall that $\mathbf{Y} = A\mathbf{Y} + B\mathbf{D}$, $\mathbf{C}^m = \mathbf{L}^m + A'\mathbf{M}$ and $\mathbf{C}^r = \mathbf{L}^r + B'\mathbf{M}$. It follows immediately,

$$\begin{aligned} \Pi &= \mathbf{M}'\mathbf{Y} - (\mathbf{C}^m)'\mathbf{Y} + \mathbf{P}'\mathbf{D} - (\mathbf{C}^r)'\mathbf{D} \\ &= \mathbf{P}'\mathbf{D} - (\mathbf{L}^m)'\mathbf{Y} - (\mathbf{L}^r)'\mathbf{D} + \mathbf{M}'(\mathbf{Y} - A\mathbf{Y} - B\mathbf{D}) \\ &= \mathbf{P}'\mathbf{D} - (\mathbf{L}^m)'\mathbf{Y} - (\mathbf{L}^r)'\mathbf{D} \end{aligned}$$

consumer goods. It can be easily verified that $\mathbf{S}^m = \mathbf{C}^m$ and $\mathbf{S}^r = \mathbf{C}^r$, when intermediate prices $\mathbf{M} = \mathbf{C}^m$ (Appendix A). The aggregate profits can also be expressed as

$$\Pi = (\mathbf{P} - \mathbf{S}^r)'\mathbf{D}(\mathbf{P}) \tag{3}$$

For the fixed technology, the aggregate profits are a function of $\mathbf{P}$ and independent of $\mathbf{M}$.

2.2 Non-Civilian Production

The planner diverts the surplus labor $L_g = \Pi$ to finance the production of the $\mathbf{Z}$-goods that he desires. Let a well defined transformation function $G(\mathbf{Z}, \Pi) = 0$ define the set of feasible $\mathbf{Z}$, where $\partial Z_i / \partial \Pi \geq 0$, for all i on the transformation frontier. The non-civilian sector is assumed to be completely separate from the civilian sector for simplicity. Given his preferences for $\mathbf{Z}$, $U_g(\mathbf{Z})$, the planner's own welfare function can be written as

$$V_g(\Pi) = \max_{\mathbf{Z}} U_g(\mathbf{Z}) \quad \text{st.} \quad G(\mathbf{Z}, \Pi) = 0 \tag{4}$$

It follows that the planner's welfare increases with the resources he has at his disposal, or $V_g'(\Pi) \geq 0$. The planner, acting in self-interest, will want to allocate resources in the economy in a way such that maximum economic surplus can be extracted from the civilian sector.

Since extracting economic surplus from the civilian sector is tantamount to taxing the civilian sector, the planner's problem is quite similar to the optimal tax problem in the public finance literature. Following the convention in that literature (Diamond and Mirrlees (1971)), I exclude the possibility that the planner can directly tax the consumer's fixed labor endowment H. The planner is restricted to taxing only explicit purchases but not the *consumption* of leisure. The resulting resource allocation is second-best (Li (1994b)).

2.3 Centralized Equilibrium

The economy is in a centralized equilibrium when the planner's actions maximize Π. The first order condition from maximizing Π defined by (3) is,

$$\frac{P_j^s - S_j^r}{P_j^s} = \frac{1}{|\epsilon_{jj}|} + \sum_{n \neq j} \frac{P_n^s - S_n^r}{P_j^s} \frac{\epsilon_{nj} D_n}{|\epsilon_{jj}| D_j}, \quad (j = 1, \ldots, I) \tag{5}$$

where $\mathbf{P}^s$ is the vector of *shadow prices* of consumer goods that underlies the equilibrium physical allocation $\mathbf{D}(\mathbf{P}^s)$, and $\epsilon_{nj} = (\partial D_n / \partial P_j^s)(P_j^s / D_n)$ is the cross-price elasticity. Under the assumption that $\Pi(\mathbf{P})$ is strictly concave in $\mathbf{P}$, the equilibrium exists and is unique. The equilibrium labor

surplus $\Pi^s = (\mathbf{P}^s - \mathbf{S}^r)\mathbf{D}(\mathbf{P}^s)$ is used to produce the $\mathbf{Z}$-goods. The equilibrium production of intermediate inputs is determined by $\mathbf{Y}^s = (I - A)^{-1}B\mathbf{D}(\mathbf{P}^s)$ and the net intermediate output in the equilibrium is $\mathbf{X}^s = B\mathbf{D}(\mathbf{P}^s)$.

Condition (5) shows that the planner will attempt to systematically distort the allocation in the economy by behaving as an integrated multi-product monopoly. Li (1994b) demonstrates that necessities (*e.g.*, food and basic housing) tend to be subsidized while luxury goods (*e.g.*, private cars) tend to be taxed heavily in the centralized equilibrium. This implication is consistent with the stylized facts.

In the centralized equilibrium, the intermediate prices $\mathbf{M}$ may be set arbitrarily *given the fixed technological parameters* A *and* B,[11] since they are simply transfer prices within an integrated monopoly where decisions are made centrally. This observation is consistent with the stylized fact that producer prices in the Soviet-type economies are merely used for the purpose of financial accounting and play little allocative role.

In the centralized equilibrium, decisions are made based on the social marginal costs $\mathbf{S}^r$, rather than the private costs $\mathbf{C}^r$. Since $\mathbf{C}^r$ exceed $\mathbf{S}^r$ except under perfect competition (Appendix A.1) or complete centralization, the centralized equilibrium necessarily achieves production efficiency at any given levels of output. The following proposition summarizes the results.

Proposition 1 *Acting in self interest, the planner will attempt to organize production efficiently but will systematically introduce allocative distortions in the economy by extracting surplus from the civilian sector as an integrated monopoly.*

Even though the observed intermediate prices have little role in resource allocation, one can still identify *shadow intermediate prices* $\mathbf{M}^s$ to represent the centralized equilibrium. Suppose that the planner were to shift all profits to the intermediate industries by imposing marginal-cost-pricing in consumer industries and cost-plus pricing in intermediate industries, *without altering the physical allocation of resources*—$\mathbf{Y}^s$ or $\mathbf{X}^s$ or $\mathbf{D}(\mathbf{P}^s)$. Let $\mathbf{P}^c = \mathbf{C}^r = \mathbf{L}^r + B'\mathbf{M}$ denote the marginal costs that consumer industries face. Then aggregate profits can be rewritten as

$$\Pi = (\mathbf{P}^c - \mathbf{S}^r)'\mathbf{D}(\mathbf{P}^c) = (\mathbf{M} - \mathbf{S}^m)'B\mathbf{D}(\mathbf{L}^r + B'\mathbf{M}) \tag{6}$$

Since the first order derivatives have a linear relationship ($\partial\Pi^m/\partial\mathbf{M} = B(\partial\Pi/\partial\mathbf{P})$), the intermediate price vector $\mathbf{M}^s = (B')^{-1}(\mathbf{P}^s - \mathbf{L}^r)$ must satisfy the first order conditions $\partial\Pi^m/\partial\mathbf{M} = 0$. Given that $\mathbf{P}^s$ maximizes Π expressed in $\mathbf{P}$, $\mathbf{M}^s$ must maximize Π expressed in $\mathbf{M}$.

[11] Li (1994b) demonstrates that when technology is itself a choice variable, the planner will want to choose the lowest-cost technology by setting the shadow intermediate prices equal to the marginal social costs of production.

3 The Reforms

The reforms in EEFSU and China introduced a myriad of changes. One can isolate, however, certain key stylized features of the reforms that had a significant impact on these economies. In this study, I focus on the changes in the *real* economy only. I also limit the scope of the investigation to the analysis of the *short-run* impact of the reforms, because the two stylized facts—output collapse and macroeconomic instability—are short-run phenomena.

3.1 Big Bang

Central planning in EEFSU was effectively dismantled with the collapse of Communist governments. Decisions about what to produce, how much of each good to produce, from whom to buy intermediate inputs, and to whom to sell outputs, were *de facto* decentralized down to enterprises. The post-Communist governments vowed to establish market economies based on private ownership through "big bang" or "shock therapy." The official "big bang" typically started with overnight price liberalization on most goods, accompanied by some measures to liberalize international trade and finance, to stabilize the macroeconomy and to privatize state industries.

The analysis of "big bang" in this study will focus only on two of its salient features—price liberalization and decentralization. I won't attempt to analyze the effects of price stabilization, privatization and trade liberalization programs on output and macroeconomic stability. While limiting the focus makes the analysis more tractable, there are good economic reasons to do so as well. First, stabilization programs were instituted in response to the macroeconomic instability, which is one of the phenomena that this study attempts to explain in addition to output collapse. Even though monetary and fiscal austerity programs had a negative impact on output, it is logically unsatisfactory to treat them as a *cause* of output contraction without asking why macroeconomic instability occurred and persisted in the first place. Given that output collapse and macroeconomic instability occurred simultaneously in almost every reforming economy, research should attempt to identify factors that offer a unified explanation for both stylized facts, rather than relying on one to explain the other.

Second, privatization programs were often instituted after price liberalization and the realization of output collapse and macroeconomic instability. It is also unclear how privatization would have changed the firms' objectives dramatically in the short-run, because it often favored the incumbent managers and workers who already gained effective control of their enterprises after the demise of central planning.

Third, evaluating the impact of international trade during the transition is a far more complicated issue than it appears. While trade with the West grew dramatically after the liberalization, trade among CMEA countries (Council for Mutual Economic Assistance) collapsed. Although the collapse of CMEA trade is often taken as a cause of output contraction, there isn't yet a logical explanation as to why CMEA countries would curtail intra-CMEA trade, which was more or less mutually beneficial. To sharpen the focus here, I relegate the analysis of trade liberalization to future studies.

3.2 China's Reform

The Chinese reform is conventionally described as gradual and piecemeal, often with a pessimistic connotation. The conventional wisdom, however, misses the central point of China's reform, which is to create markets *on the margin* and to regulate the emerging markets *intramarginally*. The most celebrated and controversial feature of China's reform is the "dual-track system," in which planning is firmly maintained but markets are allowed to expand on the margin, parallel to planning. This feature can be found in virtually all reform schemes in China, including the highly successful agricultural reform, the somewhat controversial industrial, fiscal and banking reforms, and even trade and foreign exchange reforms with the introduction of dual exchange rates (planned and swap market rates) and dual currencies (RMB and Foreign Exchange Certificate). Under China's reform, the government plays an active role in the economy and in the reform process. However, central planning is relegated to controlling mostly intramarginal economic decisions, while the emerging markets are allowed to grow on the margin.

In this paper, the analysis of China's reform will focus on the controlled reform in agricultural and industrial sectors that affects the functioning of product markets. Under the "dual-track system," peasants and state industries are still required to fulfill planned output quotas and deliver them to the state at planned prices, but are allowed to sell their above-the-quota outputs at market prices and retain part of the earned profits as an incentive. Central planning is vigorously maintained initially in virtually all industries, but it affects mostly *intramarginal* resource allocation; the emerging product markets are allowed to allocate resources based on marginal calculations.

4 The Emerging Market Structure

In a Soviet-type economy, concentration in industries is of little consequence because allocation decisions are made by the planner, not by enterprises. As the reform decentralized decision-making

down to enterprises, enterprise behavior will be shaped by the structure of the emerging product markets, which in turn will depend on the inherited Soviet-type industrial structure.

In a Soviet-type economy, the planner considers the entire economy as a giant "factory" under centralized hierarchical management. In this integrated factory, production and distribution processes are usually divided into narrowly defined territories along both product and geographic lines. Each territory or market segment is often served by a single enterprise in order to take advantage of specialization in production and to simplify the daunting task of coordinating the production of millions of goods.[12] Each enterprise is outfitted with specialized technology to churn out specific products using specific intermediate inputs. Outputs of each enterprise are procured and the required inputs are delivered by the state wholesale trade monopoly, *e.g.*, *Gossnab* in the former Soviet Union. While it is endogenous and natural to the command economic environment, this rigid and specialized industrial structure is exogenous and alien to decentralized market institutions.[13]

According to the World Bank (1992), outputs of 77 percent of the 7,664 *Gossnab* product groups in the former Soviet Union are supplied by single enterprises.[14] These statistics can be even more striking if geographic considerations are added. The Soviet industrial structure, therefore, appears highly specialized and concentrated at the *Gossnab* product level. However, when industrial concentration in the former Soviet Union is examined at the 2- or 4-digit SIC level, a much broader market definition,[15] it is in fact comparable to that in the US (Brown *et al.* (1994) and Joskow *et al.* (1994)).

Clearly, characterization of the emerging market structure will depend crucially on the definition of relevant markets. An appropriate definition of markets in this study must account for substitution possibilities among goods and services supplied by both existing enterprises and new/potential entrants in the environment of a transitional economy.

Consider first the emerging markets for intermediate products. Due to specialization, two enterprises located in the same 4-digit industry may well be producing intermediate products that

[12]For a classic analysis of the design of factories in the Soviet metal fabrication industry, see Granick (1967). For more recent discussions of the Soviet industrial structure, see Brown *et al* (1994) and Joskow *et al* (1994).

[13]In contrast, firms in a market economy interact primarily through markets. In the presence of significant transaction costs or market imperfection, firms may choose either to integrate vertically (Williamson (1989) and Perry (1989)), to enter into binding contracts that impose vertical restraints (Katz (1989)), or to form a *kiretsu*—a strategic alliance among interdependent firms (Aoki (1989)). The boundary of the firm, *e.g.*, its size and its scope of business, in a market economy is thus endogenously determined.

[14]See also Kroll (1991) among others for more evidence.

[15]For a comparison, the degree of classification of the *Gossnab* product groupings is somewhere between the US 5-digit SIC and 7-digit SIC. The 1972 U.S. Census of Manufacturers covered 1,293 5-digit industries and 11,500 7-digit industries.

are not close substitutes to user enterprises outfitted with highly specialized technology. Substitution possibilities among existing intermediate products should be quite limited. But with the demise of central planning, can enterprises diversify their product mixes and compete with each other? The answer depends on, among other things, the time frame. In the short-run, the rigidity and specificity in technology is a major barrier to diversification. To enter other market segments, enterprises may have to make costly specific investment—purchasing new equipment, retooling existing equipment, designing new products, retraining workers, and establishing business links with new customers and suppliers, and so on. The needed investment funds may not be forthcoming. In EEFSU, the collapse of government revenue has forced governments to cut investment spending and bank lending as part of the stabilization policy. In addition, the economic environment is very uncertain. It is questionable whether the current enterprise directors will make decisions based on long-run considerations.[16]

While domestic private entrepreneurs could, in principle, enter the intermediate markets, they face additional entry barriers, particularly in their access to capital and technology, in light of the fact that intermediate industries tend to be capital and technology intensive. Entry by foreign competitors into the emerging intermediate product markets isn't barrier free either, even with trade liberalization. Aside from the inherited explicit and implicit bureaucratic barriers, many intermediate products supplied by Western firms are often incompatible with existing technology in transitional economies due to the lack of commercial exchanges between the East and the West in the past. Rationally expecting that transitional economies will "westernize" or "return to Europe," Western firms have little incentive to customize their intermediate products to accommodate the outmoded technology in transitional economies. And yet, upgrading technology in transitional economies requires massive amounts of capital and a large infusion of managerial talents, which cannot easily be mobilized in the short run. In sum, markets for intermediate products in reforming economies are perhaps not as contestable as previously thought.

Turn now to the emerging markets for consumer goods and services. Here, economic liberalization can bring about rapid entry by both domestic entrepreneurs and foreign firms, and along with it, active competition. Since the capital and technological requirements for entry into many consumer goods and service industries are relatively low,[17] price liberalization would lead to the

[16] If the directors are uncertain about whether they will be reappointed or how much ownership they will retain once the enterprises are privatized, they may well prefer current consumption to investment.

[17] For example, it requires no more than a single family's savings and some entrepreneurial spirit to set up a food kiosk on a street corner.

emergence of private and collective sectors in a matter of weeks. Even state enterprises may diversify their product mixes quickly. With trade liberalization, foreign consumer goods producers can instantly bring to bear the competition of the rest of the world on domestic enterprises (Lipton and Sachs (1991)).

The above analysis thus suggests that at least in the short-run,[18] markets for intermediate products in the transitional economies should be defined narrowly, perhaps in line with the planners' product classification, while markets for consumer products should be defined much more broadly. Based on these market definitions, concentration is typically quite high in intermediate product markets, but not in consumer product markets.

5 Transitional Economy Under Big Bang

Consider a transitional economy under big bang where control over civilian state enterprises is effectively transferred to enterprises' managers and yet the inherited non-civilian sector that remains under state control cannot be converted to civilian use in the short run. In order to isolate the short-run inefficiency brought about by big bang, I assume that the government finances the inherited non-civilian sector by continuing to levy lump-sum taxes on monopoly profits in the civilian sector, thereby imposing no additional distortions in the economy.[19] To further simplify the analysis, I assume that the lump-sum taxes siphon off all monopoly profits from every state enterprise, so that no monopoly profits are used to pay for civilian consumption.[20] The representative consumer continues to receive labor income $\mathbf{P}'\mathbf{D}(\mathbf{P})$ only and demand $\mathbf{D}(\mathbf{P})$ quantities of consumer goods and services. All equilibrium prices are market clearing after price liberalization.[21]

Following the analysis on the merging market structure (Section 4), I assume that each intermediate industry has only one enterprise—a monopoly, while each consumer industry is perfectly

[18] Of course, given a long enough time period, private entrepreneurs, state enterprises, and foreign firms should be able to overcome many of the limitations discussed above. But then given a long enough time period, the transition to market economies will be complete no matter what reform strategies are followed initially.

[19] The fact that transitional governments must rely on distortionary taxes to raise needed revenue may in fact strengthen the qualitative implications of big bang, since taxing monopolists' sales in general reduces social welfare. However, as the economics of the second-best has taught us, the incremental effect of levying distortionary taxes in an already distorted economic environment may be ambiguous, and analyzing it can be taxing.

[20] In the case that profits are indeed shared by the representative worker/consumer, one can equivalently assume that the consumer's demands are independent of the level of her income as implied by a quasi-linear utility function. Extending this model to the more general situation where a fraction of monopoly profits is consumed is beyond the scope of this study.

[21] This implies that the real wage clears the labor market. One can, however, easily generate unemployment in the model by introducing wage rigidity and/or imperfection in the labor market (*e.g.*, monopsonies and labor unions).

competitive.[22] In order to utilize the usual tools in neoclassical economics, I make an additional simplifying assumption that the objective of monopolistic enterprises can be approximated as maximizing its individual short-run profits (subject to lump-sum taxation).[23]

In this setup, allocation of resources in the transitional economy is determined by actions taken by individual industries. For simplicity, I model the behavior of the decentralized industries as either a two-stage price game or a two-stage quantity game. In the price (quantity) game, the I intermediate industries simultaneously and independently name intermediate prices $\mathbf{M}$ (quantities $\mathbf{Y}$) first; perfect competition in consumer goods markets then leads to marginal cost pricing in all consumer industries.[24] Whether price or quantity is the "correct" decision variable is certainly debatable. One may argue that setting quantities is more natural in the context of this study because enterprises traditionally set and accepted quantity quotas in the past. However, as I will demonstrate below, the qualitative results of this analysis do not depend on the choice of price vs. quantity as the decision variable.

5.1 Decentralized Equilibria

Consider first the price game. Suppose that in the first stage the intermediate industries announce $\mathbf{M}$. From this point on, the consumer industries enter a proper subgame in which perfect competition leads to marginal cost pricing in all consumer industries in the equilibrium. The unique equilibrium consumer prices in the subgame are $P_j^c(\mathbf{M}) = L_j^r + \sum_i b_{ij} M_i$ for all j, or $\mathbf{P}^c(\mathbf{M}) = \mathbf{L}^r + B'\mathbf{M}$. The derived demands for intermediate products are then

$$\mathbf{X}(\mathbf{M}) = B\mathbf{D}(\mathbf{P}^c(\mathbf{M})), \quad \text{and} \quad \mathbf{Y}(\mathbf{M}) = (I - A)^{-1} B\mathbf{D}(\mathbf{P}^c(\mathbf{M})) \tag{7}$$

Note that it is possible that $D_j(\mathbf{P}^c(\mathbf{M})) = 0$ for high enough $\mathbf{M}$, if the consumer's reservation price for good j is finite. In this case the derived demands $\mathbf{X}(\mathbf{M})$ will not be continuously differentiable with respect to $\mathbf{M}$. In order to use standard techniques in economics that rely on first and second order conditions, I restrict the study here to interior equilibria where all consumer industries produce positive output for any finite producer prices $\mathbf{M}$. This restriction amounts to assuming

[22] This simplifying assumption may not be as restrictive as it appears. First, welfare implications of other imperfect market configurations, say oligopoly, are in general quite similar *qualitatively* to that of monopoly. Second, extending the model to allow for some imperfectly competitive consumer industries can be done in the same conceptual framework by relating it to the vertical integration literature pioneered by Spengler (1950).

[23] Alternatively, one may model the monopolistic enterprise as a labor-managed firm. Given that a labor-managed firm can always be approximated by a profit-maximizing firm facing an above-market wage rate, the model can be easily modified and its results reinterpreted.

[24] Since consumer markets are assumed to be perfectly competitive, it is inconsequential whether the second stage game is modeled as a price game or as a quantity game.

that the consumer demand $D_j(\mathbf{P})$ can be approximated as if it never touches the price axis P_j but asymptotically approaches the axis at a rate faster than $1/P_j$.[25] That is,[26] $D_j(\mathbf{P}) > 0$ and $\lim_{P_j \to \infty} P_j D_j(\mathbf{P}) \to 0$ for all $\mathbf{P} \geq 0$ and $j = 1, \ldots, I$. This assumption implies that the derived demands $\mathbf{X}$ and $\mathbf{Y}$ also have this property with respect to $\mathbf{M}$. Any equilibrium in this model setup is, therefore, necessarily an interior equilibrium where all industries produce positive output.

Proposition 2 *The derived demand functions have the following properties.*

a) $X_i(\mathbf{M})$ *is downward sloping* ($\partial X_i/\partial M_i \leq 0$)*, if all consumer goods are normal.*

b) The intermediate goods are complements ($\partial X_i/\partial M_k \leq 0$ *or* $\partial Y_i/\partial M_k \leq 0$ *for* $i \neq k$)*, if the substitutability among consumer goods is sufficiently small, or*

$$\frac{\partial D_j(\mathbf{P}^c(\mathbf{M}))}{\partial M_i} = \sum_{k=1}^{I} b_{ik} \frac{\partial D_j}{\partial P_k} \leq 0, \quad \forall j \tag{8}$$

c) Y_i *is downward sloping* ($\partial Y_i/\partial M_i \leq 0$)*, if (8) holds.*

A proof is given in Appendix A.2. Condition (8) is sufficient but not necessary (see the proof). It states that the substitution effects (or positive cross-price effects) are dominated by the negative own-price effects and by the complimentary effects (or the negative cross-price effects).

Substitution possibility among consumer goods produced by state enterprises is usually limited. In the short run immediately after the reform, state enterprises, constrained by their highly specialized technology and their lack of marketing and product development expertise, usually produce the same set of consumer goods that they produced before the reform. And these consumer goods typically lack variety and hence demand substitutability.

In the beginning of the game, intermediate industries rationally anticipate the dependence of consumer prices on intermediate prices, $\mathbf{P}^c(\mathbf{M})$. Their profits are $\pi_i^m(\mathbf{M}) = [M_i - C_i^m(\mathbf{M}_{-i})]Y_i(\mathbf{M})$ for all i. A pure strategy subgame perfect equilibrium in the price game can be defined by two price vectors $\mathbf{M}^p$ and $\mathbf{P}^p$ such that $\pi_i^m(\mathbf{M}^p) \geq \pi_i^m(M_i, \mathbf{M}_{-i}^p)$ for all $M_i \geq 0$ and $i = 1, \ldots, I$, and $\mathbf{P}^p = \mathbf{P}^c(\mathbf{M}^p)$. Under the assumption that $\pi_i^m(\mathbf{M})$ is concave and continuously differentiable in M_i, a pure strategy equilibrium exists in this price game and must satisfy the first order condition:

[25] Extending the model to arbitrary demand systems may complicate the exposition by introducing possible discontinuity in intermediate industries' reaction functions in the first stage. But it will not add much insight to the investigation, since any industry that ceases production in the more general model can be approximated as producing an arbitrarily small quantity in this model. Given that this study is concerned with the *qualitative* changes in the economy, this simplification seems warranted.

[26] A demand system derived from a CES indirect utility function, $V(\mathbf{P}, H) = (P_1^r + P_2^r + 1)^{-1/r} H$, satisfies this requirement for $r = \rho/(1-\rho) < -1$, where ρ is the constant elasticity of substitution.

$\partial \pi_i^m / \partial Y_i = Y_i + (M_i^p - C_i^m) \partial Y_i / \partial M_i^p = 0$. The equilibrium is unique if the following inequality holds for all i[27]

$$\frac{\partial^2 \pi_i^m}{\partial {M_i}^2} + \sum_{k \neq i} \left| \frac{\partial^2 \pi_i^m}{\partial M_i \partial M_k} \right| < 0 \tag{9}$$

Since $\partial Y_i / \partial M_i^p < 0$, the interior equilibrium intermediate price M_i^p must exceed cost C_i^m.

Turn now to the quantity game. Suppose that in the first stage, the intermediate producers name $\mathbf{Y}$. Let $\mathbf{M}(\mathbf{Y})$ denote implicit market prices that clear the intermediate markets at given quantities $\mathbf{Y}$. Then perfect competition in consumer markets leads to marginal cost pricing $\mathbf{P}^c = \mathbf{L}^r + B' \mathbf{M}(\mathbf{Y})$. Full utilization of intermediate goods by competitive consumer industries implies

$$B \mathbf{D}(\mathbf{L}^r + B' \mathbf{M}(\mathbf{Y})) = (I - A) \mathbf{Y} = \mathbf{X} \tag{10}$$

This equation defines a vector of inverse *total* demand for intermediate goods $\mathbf{M}(\mathbf{Y})$ and a vector of inverse *net* demand for intermediate goods $\mathbf{M}(\mathbf{X})$.[28] Expressed in inverse demand functions, complementarity among intermediate goods is implied by $\partial M_i / \partial X_k \geq 0$, which is assumed to hold for all $k \neq i$.

In the first stage, the intermediate goods producers anticipate the market price response $\mathbf{M}(\mathbf{Y})$ to their quantity offerings $\mathbf{Y}$. Their profit functions can be written as $\pi_i^m(\mathbf{Y}) = [M_i(\mathbf{Y}) - C_i^m(\mathbf{M}_{-i}(\mathbf{Y}))] Y_i$ for all i. A pure strategy subgame perfect equilibrium in the quantity game can be defined by $\mathbf{Y}^q$ and $\mathbf{P}^q$ such that $\pi_i^m(\mathbf{Y}^q) \geq \pi_i^m(Y_i, \mathbf{Y}_{-i}^q)$ for all $Y_i > 0$ and $i = 1, \ldots, I$, and $\mathbf{P}^q = \mathbf{L}^r + B' \mathbf{M}(\mathbf{Y}^q)$. Under the assumption that $\pi_i^m(\mathbf{Y})$ is concave and continuously differentiable in Y_i, a pure strategy equilibrium exists in this quantity game and must satisfy the first order conditions $\partial \pi_i^m / \partial Y_i = 0$ for all i. The equilibrium is unique if the following inequality holds for all i (Friedman (1977, Ch. 7)):

$$\frac{\partial^2 \pi_i^m}{\partial {Y_i}^2} + \sum_{k \neq i} \left| \frac{\partial^2 \pi_i^m}{\partial Y_i \partial Y_k} \right| < 0 \tag{11}$$

In the interior equilibrium, it must be that $M_i(\mathbf{Y}^p) > C_i^m$ for all i.

In order to simplify the analysis of the qualitative implications of the reforms and to focus the attention on economics in the remainder of the paper, I will take as given the existence and the uniqueness of both the price equilibrium and the quantity equilibrium.

[27] See Friedman (1977, Ch. 7). This condition guarantees that each industry's reaction mapping is a contraction. It is related to a stability condition of the equilibrium.

[28] Since $\partial \mathbf{M} / \partial \mathbf{X}' = [B(\partial \mathbf{D} / \partial \mathbf{P}) B']^{-1}$, a sufficient condition for the existence of the inverse demand functions $\mathbf{M}(\mathbf{X})$ and $\mathbf{M}(\mathbf{Y})$ is that the Jacobian $\partial \mathbf{D} / \partial \mathbf{P}$ is nonsingular (or the inverse consumer demands $\mathbf{P}(\mathbf{D})$ exit) since the matrix B is nonsingular by assumption.

5.1.1 Interdependence and Externality

The industrial structure under study is characterized by circular interdependence among intermediate industries and by vertical dependence between intermediate industries and consumer industries. A price increase or an output reduction in one intermediate industry will necessarily increase other intermediate industries' costs and lower their demands (due to demand complementarity), and increase consumer industries' costs. The industrial structure thus exhibits pecuniary externality,[29] which can be classified into two different types. The circular externality arises due to the circular dependence among intermediate industries, whereas the vertical externality arises due to the vertical dependence between intermediate industries and consumer industries. Like any other pecuniary externality, the circular (vertical) externality has no welfare implications if all intermediate industries (either all intermediate industries or all consumer industries) are perfectly competitive. In other words, the circular (vertical) externality matters only when intermediate industries (intermediate and consumer industries) are imperfectly competitive. While vertical externality has been analyzed extensively in the vertical integration literature, the circular externality identified here is entirely new. Although it recalls the vertical externality in successive monopoly, it is more general and more complex. It encompasses the vertical externality in successive monopoly (Spengler (1950)) and the externality in complementary monopoly (Cournot (1838) and Sonnenschein (1968)) as special cases.[30]

Given that the industrial structure under consideration consists of monopolist intermediate industries and perfectly competitive industries, this study is limited to the analysis of the welfare implications of circular externality only. There are good reasons for doing so. First, it makes economic sense (Section 4) and helps highlight the key problems that a transitional economy faces. Second, the welfare implications of vertical externality are well-known and need not be repeated here. And finally, to the extent that some or all consumer industries are imperfectly competitive, the model can in principle be extended within the same conceptual framework.

Consider now how circular externality affects individual intermediate industries' profits. In the price game, the effect of a marginal change in M_i on intermediate industry's k's profits can be

[29] The externality is *pecuniary* since it works through the price system.

[30] The vertical externality in the successive monopoly situation where there is an upstream monopoly and downstream monopoly is that the upstream monopoly's raising price or reducing output increases the downstream monopoly's cost. The externality in the complementary monopoly situation where there are two monopolies producing two complementary goods is that one monopoly's raising price or lowering output reduces the other monopoly's demand.

decomposed into two effects,

$$\frac{\partial \pi_k^m}{\partial M_i} = -a_{ik} Y_k + (M_k - C_k^m) \frac{\partial Y_k}{\partial M_i} \tag{12}$$

The first effect, the *cost effect* or the *profit margin effect*, is that a marginal increase in M_i raises intermediate industry k's marginal cost and lowers industry i's profit margin. The second effect, or the *demand effect*, is that a marginal increase in M_i lowers industry k's demand for industry i's output. The drop in demand reduces industry k's profits when $M_k > C_k^m$. Both effects on profits are negative in general. In the quantity game, a marginal decrease in one industry's net output X_i tends to lower industry k's profit margin and decreases industry k's total demand:

$$\frac{\partial \pi_k^m}{\partial X_i} = \frac{\partial (M_k - C_k^m)}{\partial X_i} Y_k + (M_k - C_k^m) a_{ki}^* \tag{13}$$

where a_{ki}^* is the (k,i)th element of $(I-A)^{-1}$.

Previous studies in industrial organization have identified externalities similar to these two effects. The vertical externality in a successive monopoly situation is quite similar to the cost effect of circular externality. The externality in a complementary monopoly situation, which affects only the demand function, is similar to the demand effect of circular externality. But circular externality is different: it is generated and transmitted via two-way dependence rather than one-way dependence as in the case of either successive or complementary monopoly. Circular externality can nonetheless be seen as a generalization of the previous studies. If the decentralized industrial structure degenerates into a long vertical chain of simple upstream-downstream relationships, then circular externality becomes vertical externality. If, on the other hand, all intermediate industries are independent and use labor as their only input, and all consumer industries use intermediate inputs together with labor input, one then gets the externality of complementary monopoly.

A fully integrated industrial structure like the one under central planning is capable of internalizing the externalities. This claim can be demonstrated by examining how circular externality affects aggregate profits. Define the aggregate circular externality in price M_i and in quantity X_i respectively as

$$\mu_i^*(\mathbf{M}) = \frac{\partial \Pi}{\partial M_i}, \qquad \lambda_i^*(\mathbf{X}) = \frac{\partial \Pi}{\partial X_i} \tag{14}$$

Proposition 3 *The aggregate circular externality is fully internalized in the centralized equilibrium, but is present in the decentralized equilibrium under big bang. That is,*

a) $\mu_i^*(\mathbf{M}^s) = 0$ *and* $\lambda_i^*(\mathbf{X}^s) = 0$, *and*

b) $\mu_i^*(\mathbf{M}^p) < 0$ *and* $\lambda_i^*(\mathbf{X}^q) > 0$ *if intermediate inputs are complements.*

See Appendix A.3 for the proof. The intuition here is that the planner, by maximizing aggregate profits, takes into account any external effects of any action taken by one industry on other industries; whereas the decentralized monopolist industries interested only in their own profits will not take into account the external effects of their own actions on other industries. As a result, decentralized industries tend to make decisions that lead to lower output, higher prices and less aggregate profits than the integrated monopoly.

5.2 The Economic Consequences of Big Bang

The big bang reform causes the economy to move from the centralized equilibrium to a decentralized equilibrium. Its economic consequences can be analyzed by comparing the equilibria before and after the big bang.

5.2.1 Impact on Aggregate Profits

Proposition 4 *Big bang reform reduces aggregate profits in the civilian sector.*

Proof. A centralized industrial structure can always implement allocation decisions made by decentralized industries. A centralized industrial structure, therefore, should generate at least the level of aggregate profits earned by decentralized industries. Since the big bang decentralized equilibrium, whether in price ($\mathbf{M}^p$) or in quantity ($\mathbf{X}^q$), is different from the centralized equilibrium, big bang reform generally leads to a strict reduction in aggregate profits. □

This result has important economic implications. Government revenues in former Soviet-type economies depended primarily on aggregate civilian industrial profits. A reduction in aggregate profits as a result of the big bang reform would therefore lead to an immediate fall in government revenues. However, since many expenditure programs (*e.g.*, national defense, social insurance and housing subsidies) could not be cut as quickly as revenues fell for political reasons, almost every government in EEFSU ran into severe budget crises during transition. Lacking other means of financing the budget deficits, governments in this region faced tremendous pressure to resort to money creation that ushered in macroeconomic instability. This model thus identifies a structural cause for the macroeconomic instability in transitional economies under big bang.

5.2.2 Impact on Output and Prices

Analyzing the impact of big bang on output and prices involves comparing two equilibria derived under two different solution concepts—a maximization solution and a Nash equilibrium solution.

This comparison is intrinsically harder than a comparative statics problem, which compares two equilibria derived from the same solution concept under different parameters. Fortunately, it is possible to convert this comparison into a simpler comparative statics problem. The crux of this conversion is the construction of a hypothetical Soviet-type economy where a hypothetical planner maximizes a hypothetical aggregate profit function containing a set of parameters. Under this construction, the hypothetical planner would choose the centralized equilibrium outcomes $\mathbf{M}^s$ and $\mathbf{X}^s$ under one set of values for the parameters and the big bang price equilibrium outcomes $\mathbf{M}^b$ or the big bang quantity equilibrium outcomes $\mathbf{X}^q$ under another set of values for the parameters.

Define two pseudo aggregate profit functions Π^μ and Π^λ as

$$\Pi^\mu(\mathbf{M}) = \Pi - \sum_{i=1}^{I} \mu_i M_i, \qquad \Pi^\lambda(\mathbf{X}) = \Pi - \sum_{i=1}^{I} \lambda_i X_i \tag{15}$$

where $\mu_i^*(\mathbf{M}^p) \leq \mu_i \leq 0$ and $0 \leq \lambda_i \leq \lambda_i^*(\mathbf{X}^q)$ for all i. Let $\mathbf{M}^\mu(\mu)$ denote the price vector that maximizes Π^μ and $\mathbf{X}^\lambda(\lambda)$ denote the output vector that maximizes Π^λ. $\mathbf{M}^\mu(\mu)$ exists and is unique if Π^μ is strictly concave in $\mathbf{M}$. Clearly, $\mathbf{M}^\mu(\mu)$ would be the centralized equilibrium prices, if the planner faced aggregate profit function Π^μ. The same can be said for $\mathbf{X}^\lambda(\lambda)$.

Proposition 5 *Suppose that* $\Pi^\mu(\mathbf{M})$ *and* $\Pi^\lambda(\mathbf{X})$ *are strictly concave and continuously differentiable in* $\mathbf{M}$ *and* $\mathbf{X}$ *respectively. Then*

a) $\mathbf{M}^\mu(0) = \mathbf{M}^s$ *and* $\mathbf{M}^\mu(\mu^*(\mathbf{M}^p)) = \mathbf{M}^p$.

b) $\mathbf{X}^\lambda(0) = \mathbf{X}^s$ *and* $\mathbf{X}^\lambda(\lambda^*(\mathbf{X}^q)) = \mathbf{X}^q$.

Proof. a) By construction, $\mathbf{M}^s$ must maximize Π^μ when $\mu = 0$. When $\mu = \mu^*(\mathbf{M}^p)$, $\mathbf{M}^p$ must satisfy the first order conditions

$$\frac{\partial \Pi^\mu}{\partial M_i} \equiv \frac{\partial \Pi}{\partial M_i} - \mu_i^*(\mathbf{M}^p) \equiv \frac{\partial \Pi}{\partial M_i} - \frac{\partial \Pi}{\partial M_i^p} = 0, \quad \text{for all } i$$

and hence must maximize Π^μ. Since $\mathbf{M}^\mu(\mu)$ is unique under the assumption that Π^μ is strictly concave, it must be that $\mathbf{M}^\mu(0) = \mathbf{M}^s$ and $\mathbf{M}^\mu(\mu^*(\mathbf{M}^p)) = \mathbf{M}^p$. Result b) follows analogously. □

The transition from the centralized equilibrium to the big bang price (or quantity) equilibrium is, therefore, *first-order equivalent in price (or quantity)* to changing μ from 0 to $\mu^*(\mathbf{M}^s)$ (or λ from 0 to $\lambda^*(\mathbf{X}^s)$) for a hypothetical planner whose objective is to maximize Π^μ (or Π^λ). This transformation parameterizes the transition from the centralized equilibrium to a big bang equilibrium. Note that the first-order equivalence is established in price or quantity, but not in profits. The hypothetical

"profits" $\Pi^{\mu}(\mathbf{M}^p)$ (or $\Pi^{\lambda}(\mathbf{X}^b)$) are different from the true aggregate profits $\Pi(\mathbf{M}^p)$ (or $\Pi(\mathbf{X}^q)$) in the big bang equilibrium in price (or quantity).

The parameters $-\mu$ and λ have important economic meanings. They represent, respectively, an anti-Pigovian subsidy on *price* and an anti-Pigovian tax on *quantity* that the hypothetical planner faces. They are so named because their roles here are not to correct circular externality in the decentralized system but to re-introduce the externality to the centralized system. At $\mu = \mu^*(\mathbf{M}^p)$, the hypothetical planner behaves as if he faced a "subsidy" $-\mu_i^*(\mathbf{M}^p)$ on M_i that rewarded him for charging a higher intermediate price. Similarly, at $\lambda = \lambda^*(\mathbf{X}^q)$, the hypothetical planner behaves as if he faced a "tax" $\lambda_i^*(\mathbf{X}^q)$ on X_i. The anti-Pigovian subsidies (taxes) present the hypothetical planner with the marginal *individual* profits of his decisions that decentralized industries would face, hence inducing him to set the prices (quantities) that would be chosen by decentralized industries.

Proposition 6 *a)* $\partial M_i^{\mu}/\partial \mu_i < 0$ *for all* i*, if* Π *is strictly concave in* $\mathbf{M}$*.*

b) $\partial X_i^{\lambda}/\partial \lambda_i > 0$ *for all* i*, if* Π *is strictly concave in* $\mathbf{X}$*.*

c) $[-\mu^*(\mathbf{M}^p)]'(\mathbf{M}^p - \mathbf{M}^s) \geq 0$ *and strict inequality holds if* $\mathbf{M}^p$ *and* $\mathbf{M}^s$ *are unique in their respective equilibrium.*

d) $[\lambda^*(\mathbf{X}^q)]'(\mathbf{X}^q - \mathbf{X}^s) \leq 0$ *and strict inequality holds if* $\mathbf{X}^q$ *and* $\mathbf{X}^s$ *are unique in their respective equilibrium.*

Proof. a) This result can be derived by differentiating the first order condition $\partial \Pi^{\mu}/\partial M_i = 0$ with respect to μ_i and using the fact that the Hessian matrix $\{\partial^2 \Pi^t/\partial M_i \partial M_k\} = \{\partial^2 \Pi/\partial M_i \partial M_k\}$ is negative definite. Result b) can be shown analogously.

c) That $\mathbf{M}^b$ maximizes Π^{μ} when $\mu = \mu^*(\mathbf{M}^p)$ implies,

$$\Pi(\mathbf{M}^b) - [\mu^*(\mathbf{M}^p)]'\mathbf{M}^b \geq \Pi(\mathbf{M}^s) - [\mu^*(\mathbf{M}^p)]'\mathbf{M}^s \tag{16}$$

Similarly, $\mathbf{M}^s$ maximizes Π^{μ} when $\mu = 0$:

$$\Pi(\mathbf{M}^s) \geq \Pi(\mathbf{M}^b) \tag{17}$$

Adding (17) and (16) yields $[-\mu^*(\mathbf{M}^p)]'\mathbf{M}^b \geq [-\mu^*(\mathbf{M}^p)]'\mathbf{M}^s$. Strict inequality will hold if $\mathbf{M}^{\mu}$ uniquely maximizes Π^{μ} at both $\mu = \mu^*(\mathbf{M}^p)$ and $\mu = 0$. Result d) can be shown analogously. □

Parts a) and b) of Proposition 6 state two standard comparative statics results for marginal changes in μ and λ. Intuitively, this result can be interpreted as follows: At any μ (or λ), *i.e.*, at any "point along the path" from the centralized equilibrium to the big bang equilibrium, a marginal

movement toward the big bang equilibrium always causes an increase in price (or a reduction in output). In particular, at $\mu = 0$ and $\lambda = 0$, *i.e.*, at the centralized equilibrium, the initiation of big bang gives each industry an incentive to raise its own price in the price game and to lower its output in the quantity game.

Parts c) and d) of Proposition 6 are based on finite changes in μ and λ that represent complete movements from the centralized equilibrium to the big bang equilibria. The results are thus more general than the marginal results in parts a) and b). Result c) states that a weighted sum of prices will definitely rise as a result of decentralized price competition under big bang. Result d) states analogously that a weighted sum of output quantities will fall as a result of decentralized quantity competition under big bang. The weights used here are the aggregate circular externalities in prices and in quantities respectively. The expression $[-\mu^*(\mathbf{M}^p)]'(\mathbf{M}^b - \mathbf{M}^s)$ (or $[\lambda^*(\mathbf{X}^q)]'(\mathbf{X}^s - \mathbf{X}^q)$) represents a first-order approximation of the loss in aggregate profits due to big bang in the price game (or in the quantity game).

Proposition 6 demonstrates that big bang tends to raise prices from their centralized levels in the decentralized price equilibrium and tends to lower output quantities in the decentralized quantity equilibrium. But its predictions are ambiguous about whether big bang will cause *all prices* to increase in the price equilibrium or *all output quantities* to fall in the quantity equilibrium. The ambiguity in the prediction about price changes as the economy moves from the centralized equilibrium to the decentralized price equilibrium is not surprising, however. In the presence of circular externality, an increase in M_k increases industry i's costs, and at the same time, lowers its demand. While increased costs tend to induce industry i to raise its price, lowered demand on the other hand tends to force the industry to cut its price. The net effect on each individual price is therefore ambiguous. However, since both effects of the externality tend to induce the industry to lower its output, the impact of big bang on output should be less ambiguous. As it turns out, more insights can be learned by analyzing more closely the transition from the centralized equilibrium to the decentralized quantity equilibrium.

Proposition 7 *The transition from the centralized equilibrium to the decentralized quantity equilibrium is first-order equivalent to increasing the social marginal costs of producing intermediate goods from* $\mathbf{S}^m$ *to* $\mathbf{S}^m + \lambda^*(\mathbf{X}^q)$*, or to increasing the social marginal costs of producing consumer goods from* $\mathbf{S}^r$ *to* $\mathbf{S}^r + B'\lambda^*(\mathbf{X}^q)$*, while maintaining central planning.*

Proof.

$$\Pi^\lambda = (\mathbf{M} - \mathbf{S}^m - \lambda)'\mathbf{X} = (\mathbf{P}^c(\mathbf{M}) - \mathbf{S}^r - B'\lambda)'\mathbf{D}, \quad \square \tag{18}$$

The first-order equivalence established in this proposition is, of course, a product of imagination; big bang does not really alter social costs. But big bang alters the resource allocation in the economy *as if* it raised the social costs in the economy *and yet* maintained central planning.

This result, though trivial mathematically, provides an important insight into why big bang tends to lower output. Under central planning, prices of intermediate inputs are transfer prices in an integrated conglomerate, and hence are effectively set to equal marginal costs. Production in the centralized equilibrium is efficient *in theory*. Under big bang, however, intermediate industries will deviate from marginal cost pricing, thereby distorting production and effectively raising the production costs in the economy. Because the "effective social costs" under big bang are higher than the true social costs due to circular externality and market imperfection, big bang tends to reduce output and raise prices. With additional assumptions, it can be shown that big bang causes contraction in the production of every good.

Consider the case where consumer demand for any good depends only on its own price. Since demands are independent, the hypothetical planner, maximizing $\Pi^\lambda = (\mathbf{M} - \mathbf{S}^m - \lambda)'\mathbf{X} = (\mathbf{P} - \mathbf{S}^r - B'\lambda)\mathbf{D}(\mathbf{P})$, can set each consumer industry's price independently, as if decisions were make by I independent monopolies. Therefore, the increases in marginal costs from S_j^r to $\mathbf{S}_j^r + B'\lambda^*(\mathbf{X}^q)$ will necessarily lead to an increase in price and a decrease in output in each industry: that is, $P_j^q > P_j^s$ and $D_j(P_j^q) < D_j(P_j^s)$. Since $\mathbf{Y}^q = (I - A)^{-1}B\mathbf{D}(\mathbf{P}^q)$, it follows that $Y_i^q < Y_i^s$ for all i.

Proposition 8 *If consumer demands are independent, the transition from the centralized equilibrium to the decentralized quantity equilibrium under big bang raises all consumer prices and lowers the quantities of all consumer as well as intermediate goods.*

This result is an extension of the standard comparative statics result in a single-product monopoly situation. Since the substitution possibility among consumer goods in a transitional economy tends to be small, this result may hold in many situations.

5.3 Impact on Social Welfare

Proposition 9 *If consumer demands are independent, then the transition from the centralized equilibrium to the decentralized quantity equilibrium under big bang reduces social welfare.*

Proof. The fall in output and the rise in consumer prices relative to wages established in Proposition 8 imply a fall in consumer surplus. Since the aggregate profits also fall during the transition, it follows that the big bang transition lowers social welfare by making both the consumer and the state/planner worse off. □

Lipton and Sachs (1990) argue that the big bang in Poland should improve social welfare since it eliminates the economic inefficiency caused by a chronic shortage of consumer goods. While the "big bang" reform certainly has been very effective in eliminating monetary overhang, it has also unleashed circular externality (as well as vertical externality). Under the assumption that both the centralized equilibrium and the decentralized quantity equilibrium are implemented flawlessly, the big bang reform reduces social welfare. To the extent that in reality neither the centralized equilibrium nor the decentralized quantity equilibrium is implemented flawlessly,[31] however, the conclusion of Proposition 9 must be qualified.

6 Transitional Economy Under the Chinese Reform

Byrd (1989) and Sicular (1988) studied China's dual-track plan/market system within the Arrow-Debreu paradigm, assuming that all emerging markets outside of planning are perfectly competitive. But as Section 4 demonstrates, it is more realistic to model the emerging intermediate product markets in a transitional economy as imperfectly competitive. As it turns out, doing so adds new insight into why China's reform has led to output expansion and relative stability in its macroeconomy.

In this section, I apply the Chinese reform to the transitional economy outlined in the beginning of the previous section and study its implications. Under the Chinese reform, in particular, the dual-track plan/market system, state enterprises are given the right to participate in the emerging product markets on the margin, after they fulfill their planned obligations. In order to isolate the impact of this reform, I also assume that the government finances its non-civilian sector by taking away all monopoly profits in the civilian intermediate industries through lump sum taxes. To simplify the analysis further, I will describe the decentralized situation under China's reform only as a price game because the quantity game offers similar qualitative results.

Under the dual-track system, planned prices differ from market prices. Let $\bar{\mathbf{P}}$ denote planned consumer prices and $\bar{\mathbf{M}}$ planned intermediate prices. Considering the chronic shortages in the reforming Chinese economy under the planned prices, I assume that $\bar{\mathbf{P}} < \mathbf{P}$ and $\bar{\mathbf{M}} < \mathbf{M}$, given the market prices $\mathbf{P}$ and $\mathbf{M}$. As a result of the official under-pricing, allocation of resources must be rationed. Let Q_i^m denote intermediate industry i's output quota, and Q_j^r consumer industry j's

[31] For example, the planner may fail to maximize aggregate profits due to informational and incentive problems; and the chronic shortage in consumer goods may create additional distortions in the economy. Similarly, the decentralized industries may also fail to maximize their own profits; and the sudden loss of control in a transitional economy under big bang may in fact encourage enterprise managers and workers to engage in "spontaneous privatization" or outright theft of state property rather than in value-creating commercial activities.

output quota. The quota is assumed feasible and *hard*, that is, the state is capable of coercing the industry to fulfill its quota and deliver it to the state at the planned price. The quota and the planned price are therefore exogenous in this model.

The industry is encouraged to produce beyond the quota and to sell the above-the-quota output at market price. The inputs that are needed to produce just the quota are distributed by the planner to each industry at planned prices. Intermediate industry i, therefore, receives $a_{ki}Q_i^m$ of the kth input for all $k = 1, \ldots, I$; and consumer industry j receives $b_{kj}Q_j^r$ of the kth input for all k. The unit costs of producing quota output are $\bar{\mathbf{C}}^m(\bar{\mathbf{M}}) = \mathbf{L}^m + A'\bar{\mathbf{M}}$ in intermediate industries and $\bar{\mathbf{C}}^r(\bar{\mathbf{M}}) = \mathbf{L}^r + B'\bar{\mathbf{M}}$ in consumer industries. Additional inputs needed to produce above-the-quota outputs must be purchased at market prices. The unit costs of producing above-the-quota outputs are therefore $\mathbf{C}^m(\mathbf{M})$ in intermediate industries and $\mathbf{C}^r(\mathbf{M})$ in consumer industries, given the market prices $\mathbf{M}$.

Industries' residual demands in the emerging marginal markets are assumed to follow the efficient-rationing rule

$$y_i(\mathbf{P}) = \begin{cases} Y_i(\mathbf{P}) - Q_i^m & \text{if } Y_i(\mathbf{P}) > Q_i^m \geq 0, \\ 0 & \text{otherwise;} \end{cases}$$

$$d_j(\mathbf{P}) = \begin{cases} D_j(\mathbf{P}) - Q_j^r & \text{if } D_j(\mathbf{P}) > Q_j^r \geq 0, \\ 0 & \text{otherwise.} \end{cases}$$

for all intermediate industry i and all consumer industry j. This rationing rule amounts to allowing the buyers who value the good the most to buy at the planned price. However, regardless of how the rationing is implemented, each industry will face the residual demand defined above if buyers are able to costlessly engage in arbitrage. In China, rationing of consumer goods has mostly been done through coupons. While trading coupons is formally prohibited, substantial black market activities have nevertheless proliferated. Inter-enterprise trade or swap in intermediate inputs is actually encouraged by the Chinese government.[32] The efficient-rationing rule, therefore, represents a reasonable approximation of the actual market demand under rationing.

Since the planner supplies just enough inputs for each industry to fulfill the quota, we have the following identities: $\mathbf{y} = (I - A)^{-1}B\mathbf{d}$ and $\mathbf{Q}^m = (I - A)^{-1}B\mathbf{Q}^r$, where $\mathbf{y}$, $\mathbf{d}$, $\mathbf{Q}^m$ and $\mathbf{Q}^r$ are respectively, the vectors of residual demands for intermediate goods and for consumer goods, the intermediate quotas and the consumer quotas. Intermediate and consumer industries' profits are

[32] In the mid 1980's, the Chinese government opened several material exchange centers across the country to facilitate inter-enterprise trade in intermediate inputs.

then respectively, $\pi_i^m = (M_i - C_i^m)y_i + (\bar{M}_i - \bar{C}_i^m)Q_i^m$ and $\pi_j^r = (P_j - C_j^r)d_j + (\bar{P}_j - \bar{C}_j^r)Q_j^r$ for all i and all j. Each industry's profits consist of two parts: the profits from selling to the residual market and the profits from fulfilling output quota. Since the quotas and the planned prices are exogenous, industries' own actions affect only the profits from the residual markets.

6.1 Decentralized Equilibrium Under The "Dual-Track System"

A decentralized equilibrium under the "dual-track system" is characterized as a pure strategy Nash equilibrium of a two-stage price-setting game. In the first stage, the I intermediate industries simultaneously name $\mathbf{M}$. In the second stage, perfect competition in the residual consumer markets leads to marginal cost pricing in consumer industries, that is, $\mathbf{P}^c = \mathbf{L}^r + B'\mathbf{M}$. The residual demands for intermediate inputs are then $\mathbf{y}(\mathbf{M}) = \mathbf{y}(\mathbf{P}^c(\mathbf{M})) = (I-A)^{-1}B\mathbf{d}(\mathbf{P}^c(\mathbf{M}))$. Due to the dual-track system, the realized profits in a consumer industry, π_i^r, may be either positive or negative. I assume that the state will not shut down money losing industries, but will support them through lump-sum subsidies.

It is possible that a consumer industry's marginal cost exceeds the reservation price of its most eager buyer in the residual market. In this case, the consumer industry produces only the quota and demands no above-the-quota allocation of inputs. The equilibrium will then be a boundary equilibrium and the residual demands for intermediate inputs $\mathbf{d}(\mathbf{M})$ will not be continuously differentiable. In order to use the usual tool of first order and second order conditions in this analysis, I study first the characteristics of an interior equilibrium where all consumer industries produce strictly more than their quotas, *i.e.*, $d_j(\mathbf{P}^c(\mathbf{M})) > 0$ for all i. In an interior equilibrium, the intermediate industries must also produce strictly more than their quotas since $\mathbf{y}(\mathbf{M}) = (I-A)^{-1}B\mathbf{d}(\mathbf{P}^c(\mathbf{M})) > 0$.

In order for $(\mathbf{M}^g, \mathbf{P}^g)$ to be an interior pure strategy subgame perfect equilibrium of this price game, it is necessary that $\mathbf{M}^g$ satisfy the following first order conditions:

$$\frac{\partial \pi_i^m}{\partial M^g} = (M_i^g - C_i^m(\mathbf{M}_{-i}^g))\frac{\partial Y_i}{\partial M_i^g} + Y_i(\mathbf{M}^g) - Q_i^m = 0, \quad \text{for all } i \tag{19}$$

and that $\mathbf{P}^g = \mathbf{L}^r + B\mathbf{M}^g$. Under the assumptions that $\pi^m(\mathbf{M})$ is concave in M_i and satisfies the uniqueness condition (9), the subgame perfect equilibrium $(\mathbf{M}^g, \mathbf{P}^g)$ exists and is unique.

6.1.1 Boundary Equilibria

If an intermediate industry ever chooses not to produce more than its quota, then other industries that are either directly or indirectly dependent on its output will not be able to supply their residual

markets, since the extra input they need is not available and there are no substitutes in the short run. All affected industries, therefore, will produce only the quotas. If the input-output matrix A is indecomposable, meaning that every intermediate industry depends on all other industries for inputs, either directly or indirectly, then no industry will produce more than its quota. The resulting decentralized equilibrium is degenerate. This could occur if the planner were to set output quotas on intermediate industries high enough such that there was no residual demand in one of the intermediate goods markets. Such an equilibrium is uninteresting because it has never been observed in China, as most goods in China had excess demand under planned prices, and quotas in China were often set at or below their pre-reform levels.

A consumer industry may choose not to produce more than its quota, if the marginal cost it faces is higher than the reservation price of the most eager buyers in the residual market. This consumer industry faces a binding output quota. The resulting equilibrium is then a boundary equilibrium where some consumer industries face binding quotas. To simplify the analysis, this paper will focus on the interior equilibrium. The qualitative results derived from a boundary equilibrium where some consumer industries face binding quotas will be similar to those derived from the interior equilibrium.

6.2 Reduced Externalities

With the dual-track system, decision-making by decentralized industries is limited to the *residual markets*. The pecuniary externality that affects decentralized decision-making, therefore, will be generated only from the interaction among decentralized and interdependent industries in the residual markets.

Compare the circular externality under the dual track system

$$\frac{\partial \pi_k^m(\mathbf{M})}{\partial M_i} = -a_{ik}(Y_k(\mathbf{M}) - Q_k^m) + (M_k - C_k^m)\frac{\partial Y_k}{\partial M_i}$$

with (12). It is apparent that the dual-track system reduces externality because the output quota reduces the market demand, which in turn reduces the unit-cost effect of the pecuniary externalities. Therefore, by forcing industries to produce at least their output quotas, the controlled reform reduces the pecuniary externality that has proven extremely injurious in other transitional economies.

6.3 Consequences of China's Reform

Equation (19) defines for each intermediate industry a reaction function, $\mathbf{M}_i^g(\mathbf{M}_{-i}, Q_i^m)$. It is apparent that each industry's reaction function is only affected by its own quota. By appealing to the second order condition implied by concavity, one can easily verify the following comparative statics results.

Proposition 10 *An increase in an intermediate industry's output quota leads to a downward shift in the industry's reaction curve; therefore it tends to lower the industry's market price and increase its output.*

In contrast, however, a marginal increase in quota in a competitive consumer industry, holding all other quotas fixed, will not have any impact on the market price in the industry.

This proposition implies that the government can influence prices in imperfectly competitive markets by exercising control over output quotas. When every industry is producing beyond its quota, controlling output quotas amounts to regulating decentralized industries *intramarginally*. The main advantage of the quantity regulation over price regulations is that it forces enterprises to face markets at the margin, thereby giving them an incentive to minimize costs. The information required to implement this reform is minimal, since the government knows each industry's output before the reform and can simply set the output quota at its pre-reform level.

The equilibrium outcome in a typical intermediate industry is depicted in Figure 3. The industry must produce its output quota, Q^m. But when it produces more than the quota, it is allowed to sell its additional output at the market clearing price M^g and earn monopoly profits on its additional sales. Since the additional sales do not lower the planned price on its quota output, the industry has an incentive to produce beyond the quota. Thus when output quotas are initially set at the pre-reform levels ($Q_i^m = Y_i^s$), the Chinese style reform raises output in every industry. In addition, since each industry is forced to produce at least its pre-reform output, it must generate at least its pre-reform profits in real terms. Each industry then must earn additional profits when it engages in market transactions by producing output in excess of the quota. Therefore, aggregate profits will necessarily increase in real terms.

By allowing industries to sell their above-the-quota outputs at higher market clearing prices, the reform in effect permits industries to "price discriminate."[33] This reform should lead to an efficiency gain since the residual demands, which were untapped prior to the reform, are now being

[33]But this type of price discrimination is different from the usual price discrimination where buyers with high reservation prices are the targets of discrimination. Here the more eager buyers are charged low prices, while the less eager buyers are charged high prices.

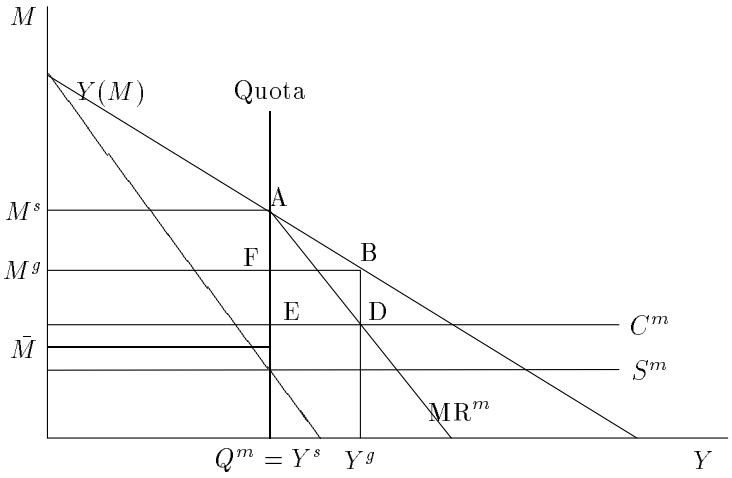

Figure 3: Equilibrium Under the Dual-Track System.

served. In Figure 3, the trapezoidal area ABDE represents such an efficiency gain. This gain is shared between the industry and its customers. The additional profits earned due to the reform are represented by the rectangle BDEF. The additional consumer/customer surplus is represented by the triangle ABF. The following proposition summarizes the results.

Proposition 11 *If the output quotas are set at the centralized equilibrium levels (or the pre-reform levels), the introduction of the dual-track system raises output and profits in every industry in the interior equilibrium. The decentralized equilibrium under the controlled reform is a Pareto improvement over the centralized equilibrium.*

The Chinese reform may also be likened to a welfare improving tax reform. Since government revenues come from monopoly profits both before and after the reform, the monopoly profit margins can be considered commodity tax rates. Under the Chinese reform, the pre-reform tax rates are maintained through mandatory quotas, and the pre-reform taxes are effectively turned into lump-sum taxes. Sales in the residual markets meanwhile are taxed at the reduced rates ($\mathbf{M}^g - \mathbf{S}^m$). The Chinese reform is thus equivalent to a tax reform that moves from a second best tax regime towards a lump-sum tax regime. As a result of the reduction in marginal tax rates, industries increase production and their demands for labor; the representative consumer/worker is offered a higher after-tax real wage rate (or more consumption) and hence supplies more labor. The reform, therefore, increases the human resources available in the economy.

However, since the reform relies on the use of quotas or lump-sum taxes, it certainly raises the question of what is required to implement the reform. While China's reform has clear advantages

over the big bang reform in the short run, one should be aware of the stringent political and economic prerequisites for its success.

6.4 Prerequisites for Successful Implementation

In order for the Chinese reform to bring about Pareto improving changes in the economy, it is necessary that the quotas be be strictly enforced. To see why, consider an extreme case where the quotas are indicative only and the government has no authority in enforcing them. Since market prices exceed planned prices, every industry has an incentive to completely ignore the quotas in its operation. The resulting equilibrium will be no different from a big bang decentralized equilibrium, because the big bang reform is no different from a Chinese-style controlled reform with *zero* quotas after all. In order to implement the dual-track system successfully, it is therefore necessary to have a strong government that is capable of coercing industries into complying with output quotas and of policing quality standards for quota outputs.

The government must also be aware of the rent-seeking opportunities that the divergence of planned and market prices creates for its officials. Many officials in China who were entrusted with the power to oversee quota allocations abused their power to elicit bribes. Such widespread official corruption could undermine the political support for the reform. Therefore it is necessary for the government to uphold tight bureaucratic oversight and effective law enforcement in order to limit the political and economic damages caused by official arbitrageurs. The Chinese government in the 1980s certainly had the authoritarian capability and the political will to plug enough loopholes in the dual-track system to make it work.

The ability of a government to exert such far reaching control is certainly constrained by the openness of the economy. When the reform began in the late 1970's, China was a closed and self-sufficient economy. Changes in the world economy had little impact on China. The state control over the economy was nearly absolute. Under these conditions, the Chinese reformers had both the opportunity and the means to implement the controlled reform successfully.[34]

In contrast, the EESFU countries were integrated under the CMEA (Council for Mutual Economic Assistance) trade framework prior to the reform. Economies in this region were highly interdependent and foreign trade planning was an integral part of central planning (Kenen (1991)). No one country's central planning authority had complete control over resource allocations within

[34] I should caution the reader that the Chinese people paid dearly for these prerequisites. After more than two decades of isolation, internal turmoils and mismanagement, the Chinese economy in the late 1970's was stagnant with the majority of the population living in abject poverty.

its own border. For the controlled reform to succeed in EEFSU, it would be necessary for all or most of the EEFSU countries to coordinate and synchronize their implementations of the controlled reform. It is doubtful that any one EEFSU country could reverse its own economic decline by unilaterally adopting the controlled reform while other EEFSU countries, say Poland, already implemented big bang reform. Furthermore, most post-communist governments in EEFSU had lost much of their authoritarian capability as the central planning and Communist party apparatus crumbled. Given the political reality in EEFSU, it would be a bit naive to advocate China's reform for each individual EEFSU country.[35]

The Soviet Union under Gorbachev attempted to implement a Chinese-style dual-track system between 1988–91. This Soviet experiment is now widely viewed as a failure. Murphy, Shleifer and Vishny (1992) offer a compelling explanation of the Soviet experience based on a simple model of supply diversion. In their model, the failure of Soviet authority to enforce delivery quotas between enterprises is a major cause of economic decline before the breakup of the Soviet Union. Their explanation is certainly supported and extended by the more formal theory presented in this paper. While the decline in the power of the state over industries is certainly a major cause of the failed reform, the waning Soviet influence in maintaining the cohesiveness of the CMEA trade arrangement is perhaps another cause, especially after 1989 when Poland and other Eastern European countries one by one abandoned central planning and governmental trade coordination among CMEA countries.

6.5 The Prospect of Deregulation

An economy implementing the controlled reform is operating neither as a centrally planned economy nor as a market economy. In order to complete the move to a market economy, the output quotas must be lowered for most industries as the reform deepens and be eliminated eventually. In China, the government was able to reduce output quotas over time without reducing output because entry had intensified competition in most industries (Li (1994a)). As industries became more and more competitive, the justification for intramarginal regulation in the emerging product markets became less and less relevant. To see why, consider a situation where there are several competitors producing close substitutes in each industry. This situation can be modeled as if each industry were a monopoly facing a more elastic demand curve. As the demand becomes more elastic (without any reduction in quantity demanded), the government can loosen the regulation by reducing output

[35] Blanchard *et al* (1991), Lipton and Sachs (1990) and Kornai (1990) among many others argued that the fall of communist governments in EEFSU made it politically impossible not to implement the big bang reform.

quotas without reducing output.

7 Empirical Evidence

Proposition 10 offers a clear prediction about the relationship between changes in output quota and changes in output price. Since the proposition involves only observable variables, it is an ideal candidate for empirical testing.

I use data from an enterprise survey conducted by the Chinese Academy of Social Sciences (CASS) in 1990; see Li (1994a). Annual data from 1980 to 1989 were collected from 769 state-owned enterprises. Trimmed of missing data, the available data on changes in output price and quota form an enterprise level balanced panel data set consisting of 274 enterprises spanning 1981-1989.

I estimate the following two-way fixed effects model,

$$\triangle \ln P_{it} = \beta_t \triangle \ln Q_{it} + \alpha_i + \gamma_t + \epsilon_{it} \tag{20}$$

where Q_{it} is the value of the output quota in planned prices, corrected for inflation using enterprise-specific planned price inflation rates. The error terms are decomposed into three parts. The first part, α_i, indexed by enterprise only, captures the effect of enterprise specific factors on prices—the presumed heterogeneity among sample enterprises in technology, location, market structure, government regulation, and so on. The second part, γ_t, indexed by time only, captures the effect of macroeconomic factors that affected all enterprises at the same time, *e.g.*, the general inflation shocks and general shifts in demands. The third effect, ϵ_{it}, represents factors affecting pricing decisions that are idiosyncratic to enterprise i and time t. Examples of the idiosyncratic shock might include striking a favorable deal with a supplier or buyer, a random shift in customers' taste, and the like.

The enterprise- and time-specific effects are observable to the enterprise managers and are likely to be observable to the government, although not to the researchers. The government may set the quota Q_{it} based on the observed values of α_i and γ_t. The two specific effects are, therefore, likely to be correlated with the explanatory variable $\triangle \ln Q_{it}$. However, the idiosyncratic shock ϵ_{it}, while observable to enterprise managers, is usually unobserved by the government. Therefore, the government's choice of quota is unlikely to be affected by the idiosyncratic shocks, or $E(\epsilon_{it} \triangle \ln Q_{it}) = 0$. This is an important identifying condition: by eliminating time- and enterprise-specific factors that may affect output price inflation and endogenously affect output quota, the fixed effects model allows consistent estimation of β.

Table 1: A Test of Proposition 10

β	Estimates	t Ratios
1980–89	-.065	(-11.23)**
1980–81	-.049	(-3.38)**
1981–82	-.033	(-1.58)
1982–83	-.025	(-1.39)
1983–84	-.048	(-2.16)*
1984–85	-.059	(-2.79)*
1985–86	-.034	(-1.89)
1986–87	-.027	(-1.85)
1987–88	-.068	(-4.38)**
1988–89	-.158	(-10.89)**

The model is first estimated under the restriction that the coefficients on output quota are identical for all years and across all enterprises. Then in a second regression I allow β to vary across time. According to Proposition 10, β is expected to be negative.

The within estimation results, which appear in Table 1, offer strong support for the hypothesis. In the first regression, the single estimate for β is both negative and significant. The yearly estimates of β_t in the second regression are consistently negative, and five out of nine of the coefficients are statistically significant. An F test was unable to reject the hypothesis that β is constant over time. The empirical evidence thus strongly supports the model's prediction.

8 Conclusion

Any theory that is capable of explaining a substantial part of output decline in EEFSU must also be capable of explaining output expansion in China. In addition, the theory must be consistent with the major stylized facts concerning the developments in prices and aggregate profits (government revenue) relative to wage rates under both reforms. The theory developed in this paper seems to meet these requirements. This theory identifies the combination of inter-industry dependence and imperfect competition as a primary cause of output contraction under the big bang reform in the short-run, and of output expansion under the controlled reform. These two factors are also shown to increase (decrease) prices and decrease (increase) aggregate profits relative to wage rates under the big bang reform (controlled reform). Since governments in the reforming economies derive most of their revenues from enterprise income, this theory also offers an explanation for the severe budget

crises in the "big bang" economies and hence the pressure to monetize.

This theory is strictly neoclassical. I have demonstrated that while the economic problems of transition are extremely complicated and puzzling, they can be understood within the neoclassical paradigm. Specifically, the theory developed here studies the functioning of markets that are characterized by circular interdependence and imperfect competition. This type of market structure, which has been studied under perfect competition in the input-output analysis literature (Leontief (1986)), has not been analyzed under imperfect competition. This study perhaps represents an attempt to broaden the scope of industrial economics, which traditionally studies the functioning of a single market or vertically/horizontally dependent markets under imperfect competition.

The theory presented here focuses on the behavior of the planner and the decentralized industries in the *real* economy. It ignores any impact that financial variables may have on output. It is, therefore, not inconsistent with the theories that focus on the role of credit, stabilization policy and the like (McKinon (1993) among others).

So far, the analysis focuses on inter-industry dependence. It can be extended to analyzing *inter-regionally* dependent markets in the presence of imperfect competition, since the inter-industry dependence translates directly into inter-regional dependence, when regional economies specialize. In particular, this theory, when extended, may offer an economic explanation as to why trade among the countries in the Council for Mutual Economic Assistance (CMEA) collapsed as a result of the big bang reform.

In this paper, I have demonstrated that the driving force behind the success of China's reform is not the gradual, piecemeal, or partial nature of the reform *per se*, but rather the ingenious combination of marginal liberalization and tight intramarginal regulation that took into account the special economic structure of a transitional economy. The "dual-track system" as an institutional innovation is completely Chinese. One therefore should not equate China's reform with the failed partial reforms in EEFSU.

A Appendix

A.1 Private Costs Exceed Social Costs

Let $v_i = M_i - \mathbf{C}_i^m$ denote the absolute price markup by intermediate industry i, $v_i \geq 0$ for all i and $v_i > 0$ for some i. Denote $\mathbf{v} = (v_1, \ldots, v_I)'$. From $\mathbf{C}^m = \mathbf{L}^m + A'\mathbf{M}$, it follows that $\mathbf{C}^m = \mathbf{L}^m + A'(\mathbf{C}^m + \mathbf{v})$. Solving $\mathbf{C}^m$ yields $\mathbf{C}^m = (I - A')^{-1}(\mathbf{L}^m + A'\mathbf{v}) \geq \mathbf{S}^m$.

By the definition of consumer industries' costs, I have $\mathbf{C}^r = \mathbf{L}^r + B'\mathbf{M}$, or $\mathbf{C}^r = \mathbf{L}^r + B'(\mathbf{C}^m + \mathbf{v})$.

Substituting in $\mathbf{C}^m$ yields $\mathbf{C}^r = \mathbf{L}^r + B'(I - A')^{-1}\mathbf{L}^m + B'[(I - A')^{-1}A' + I]\mathbf{v}$, or $\mathbf{C}^r = \mathbf{S}^r + B'(I - A')^{-1}\mathbf{v} \geq \mathbf{S}^r$. Clearly, private marginal costs will equal social marginal costs only under the condition of perfect competition in the intermediate markets where $\mathbf{v} = 0$.

A.2 Proof of Proposition 2

a) Differentiating X_i with respect to own price M_i yields

$$\frac{\partial X_i}{\partial M_i} = \sum_{j=1}^{I}\sum_{k=1}^{I} b_{ij}b_{ik}\frac{\partial D_j}{\partial P_k} \tag{21}$$

The slope of the derived demand X_i is thus a quadratic form of the matrix $\{\partial D_j/\partial P_k\}$. Substituting the Slutsky equation

$$\frac{\partial D_j}{\partial P_k} = \frac{\partial \bar{D}_j}{\partial P_k} - \frac{\partial D_j}{\partial H}D_k \tag{22}$$

into (21) yields

$$\frac{\partial X_i}{\partial M_i} = \sum_{j=1}^{I}\sum_{k=1}^{I} b_{ij}b_{ik}\left(\frac{\partial \bar{D}_j}{\partial P_k} - \frac{\partial D_j}{\partial H}D_k\right) \tag{23}$$

where $\bar{D}_j$ is the compensated demand. Since the compensated substitution matrix $\{\partial \bar{D}_j/\partial P_k\}$ is negative semidefinite, it follows that the derived demand is always downward sloping (*i.e.*, $\partial X_i/\partial M_i \leq 0$), if all consumer goods are normal goods (*i.e.*, $\partial D_j/\partial H > 0$ for all j). In matrix form, the differentiation of $\mathbf{X}$ with respect to intermediate prices $\mathbf{M}'$ can be written neatly as

$$\frac{\partial \mathbf{X}}{\partial \mathbf{M}'} = B\frac{\partial \mathbf{D}}{\partial \mathbf{P}'}B' = B\frac{\partial \bar{\mathbf{D}}}{\partial \mathbf{P}'}B' - B\frac{\partial \mathbf{D}}{\partial H}\mathbf{D}'B' \tag{24}$$

The $I \times I$ matrix $\partial \mathbf{X}/\partial \mathbf{M}'$ thus has a nonpositive diagonal.

2) The cross price response is

$$\frac{\partial X_i}{\partial M_n} = \sum_{j=1}^{I} b_{ij}\frac{\partial D_j(\mathbf{P}^c(M))}{\partial M_n} = \sum_{j=1}^{I}\sum_{k=1}^{I} b_{ij}b_{nk}\frac{\partial D_j}{\partial P_k} \tag{25}$$

If the consumer demand functions depend only on own prices (hence no substitutability), then (25) becomes

$$\partial X_i/\partial M_n = \sum_{k=1}^{I} b_{ik}b_{nk}\frac{\partial D_k}{\partial P_k} < 0, \tag{26}$$

and intermediate goods are necessarily complements.

When D_j depends on $\mathbf{P}_{-j}$, and more specifically when consumer goods are substitutes, the sign of $\partial \mathbf{X}_i/\partial M_k$ cannot be determined unambiguously without knowing the particular structure

of the consumer demands. However if the substitutability among consumer goods is limited, or if condition (8) is satisfied, then

$$\frac{\partial X_i}{\partial M_k} = \sum_{j=1}^{I} b_{ij} \frac{\partial D_j(\mathbf{P}^c(M))}{\partial M_k} \leq 0 \tag{27}$$

Hence $\{\partial X_i/\partial M_k\}$ is a negative matrix. Intermediate inputs are therefore complements.

c) The price response of the derived total demand $\mathbf{Y}$ is simply

$$\frac{\partial \mathbf{Y}}{\partial \mathbf{M}'} = (I - A)^{-1} \frac{\partial \mathbf{X}}{\partial \mathbf{M}'} \tag{28}$$

which is certainly a nonpositive matrix if intermediate goods are complements, or if condition (8) is satisfied, since $(I - A)^{-1}$ is a nonnegative matrix.

A.3 Proof of Proposition 3

a) They are simply the first order conditions of the centralized equilibrium.

b) Since $M_k^p > C_k^m$ for all k and $\partial \pi_i^m / \partial M_i^p = 0$ in the price equilibrium and since all intermediate goods are complements, it follows

$$\mu_i^*(\mathbf{M}^p) = \frac{\partial \pi_i^m}{\partial M_i^p} + \sum_{k \neq i}^{I} (M_k^p - C_k^m) \frac{\partial Y_k}{\partial M_i^p} < 0$$

To show the second inequality, recall first that $\mathbf{Y}^q = (I - A)^{-1} \mathbf{X}^q$ or $Y_i^q = \sum_{k=1}^{I} a_{ik}^* X_k^q$, where a_{ik}^* is the (i,k)th element of the nonnegative Leontief inverse $(I - A)^{-1}$. Next expand producer i's first order condition in the quantity equilibrium,

$$\frac{\partial \pi_i^m}{\partial X_i^q} = \frac{\partial M_i}{\partial X_i^q} Y_i^q - \sum_{k \neq i} a_{ki} \frac{\partial M_k}{\partial X_i^q} Y_i^q + (M_i - S_i^m) a_{ii}^* + (S_i^m - C_i^m) a_{ii}^* = 0$$

where S_i^m is the unit social cost. Now solve for $(M_i - S_i^m)$ from the first order condition and substitute it into the expression $\lambda^*(\mathbf{X}^q)$ to get

$$\begin{aligned} \lambda_i^*(\mathbf{X}^q) &= M_i - S_i^m + \sum_{k=1}^{I} \frac{\partial M_k}{\partial X_i^q} X_k^q \\ &= C_i^m(\mathbf{M}_{-i}(\mathbf{X}^q)) - S_i^m + \sum_{k \neq i}^{I} \frac{\partial M_k}{\partial X_i^q} X_k^q - \frac{\partial M_i}{\partial X_i^q} \left(\frac{Y_i^q}{a_{ii}^*} - X_i^q \right) + \sum_{k \neq i}^{I} a_{ki} \frac{\partial M_k}{\partial X_i^q} \frac{Y_i^q}{a_{ii}^*} \end{aligned}$$

Since $C_i^m(\mathbf{M}_{-i}(X^q)) - S_i^m > 0$, $Y_i^q / a_{ii}^* > X_i^q$, the inverse demand curve is downward sloping and intermediate goods are complements, it follows that $\lambda_i^*(\mathbf{X}^q) > 0$.

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