Corruption and Resource Allocation under China's Dual-Track System

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Abstract

Detailed transaction and price data from 769 Chinese state-owned enterprises reveal that corruption — official diversion of under-priced in-plan industrial goods to the market — was pervasive in China between 1980 and 1989. More important, corruption has a significant impact on the allocation of both in-plan and outside-plan resources in ways that are consistent with implications of an extended version of Shleifer and Vishny's (1993) model of corruption. The empirical findings expose a serious downside of China's gradualist reform strategy — corruption. In addition to distorting the allocation of resources, corruption had been blamed for undermining popular support for the reform in 1989.

JEL classification: L51, L12, P21

1 Introduction

In the spring of 1989, university students, joined later by workers, civil servants and journalists, held massive demonstrations in Tiananmen Square in Beijing. The demonstrators shouted slogans and carried banners with texts "Long live democracy" and "Down with corruption." While there was little agreement on what democracy really meant, all demonstrators reportedly wanted an end to pervasive corruption.[1] Despite the apparent success of the economic reform in rapidly raising the standards of living for the vast majority of Chinese, by the late 1980's, there was a growing public perception that the reform had led to rampant corruption. In particular, the dual-track system, the hallmark of the Chinese reform, was widely believed to have fueled official corruption (Yang and Li, 1993).[2] On June 4, 1989, a bloody crackdown brought the demonstrations to an abrupt end.

The dual-track system was a hybrid economic system under which traditional central planning (the plan track) and the emerging product market (the market track) coexisted as means of resource allocation. Under the system, an identical good would often be allocated on both the plan track and the market track. But the good would typically be sold at a substantially higher price in the market than in the plan. Officials who had the discretion over the allocation of in-plan resources could and allegedly did divert in-plan resources to the market and pocketed the profits. This corruption was widely known in China as "guandao" or official diversion.

Corruption, defined in Shleifer and Vishny (1993) as the sale by government officials of government-produced goods or services for personal gain, has specific implications on resource allocation. Shleifer and Vishny (1993) show that if a corrupt official has the opportunity to restrict the quantity that a government-produced good is sold, he would behave as a bribe-maximizing monopolist. In the case without theft, the corrupt official actually turns over the official government price for that good. The official price is then part of the marginal cost that the corrupt official faces. An increase in the official price would reduce corruption and the spread of corruption. Corruption would be highly distortionary

[1] See Adi Ignatius, "Summit Fails to Deter Students from Mounting Criticism of Deng," the *Wall Street Journal*, May 17, 1989.

[2] Corruption is perceived as pervasive not only in China but in many other countries. From surveys of businessmen and local populations as well as expert opinions, China and some other developing and transition economies are consistently perceived as among the most corrupt in the world (Transparency International, 1999). In dozens of countries, public outrage over corruption have forced discredited governments out of office.

if complementary government-produced goods are sold by a chain of independent corrupt officials. The distortions, the restricted supply of government-produced goods and services (such as electricity generated by government-owned utilities, building permits and business licenses) that are essential to the functioning of the economy, would in turn impede economic development.

Although corruption has both microeconomic and macroeconomic implications, recent empirical work so far has focused on the macroeconomic implications using available cross-country aggregate data. For example, Mauro (1995) and World Bank (1997) confirm a link between higher *perceived* corruption and lower investment and growth,[3] while (Johnson, Kaufmann, McMillan and Woodruff, 1999) find evidence that links corruption as reported by firms to unofficial activity in post-communist countries. Using aggregate data, these studies cannot empirically test the microeconomic mechanisms through which corruption distorts resource allocation, particularly the impact of the official price on corruption. Microeconomic data that document the details on prices and quantities at which corruption transactions took place are therefore difficult to collect since sales of government-produced goods and services for private gain are in general unobserved.

However, some needed firm-level data are available, thanks to China's experimentation of the dual-track system in the 1980s. Under China's dual-track system, certain transactions, say, the moving of in-plan goods off the plan track, were illegal and hence unobserved. Other transactions, say the procurement of quota output from a state enterprise and the selling of inputs acquired off the plan track to the state enterprise at market prices, were not illegal *per se* and could leave paper trails. The accounting and reporting rules in force in the 1980s for state-owned enterprises, still borne strong socialistic characteristics, were meticulous about recording and tracking the flow of physical materials. Under the rules, the state-owned enterprise would record, for each transaction, the price, the quantity, and other relevant attributes, such as whether the transaction is in-plan or outside-plan.

In this paper, I use available accounting data provided by a sample of 769 Chinese state-owned enterprises that describe their participation in the dual-track system. The data provide detailed information on both the plan and market prices that the firms face

[3]A variety of mostly subjective measures of corruption are available. The widely used Corruption Perception Index (CPI) published by Transparency International (1999) is a "poll of polls" drawing upon numerous distinct surveys of (non-domestic) expert and general public views of the extent of corruption in many countries around the world.

and quantities of output sold and input purchased at those prices. In addition to being microeconomic, the accounting data have a much higher degree of objectivity than existing measures of corruption. Using the data, I attempt to answer these questions in the paper: How pervasive was corruption in China in the 1980s and how had the economic significance of corruption changed? How did corruption affect the allocation of both in-plan and outside-plan resources?

In Section 2, I describe briefly the dual-track system and present evidence that documents corruption as the official diversion of in-plan goods procured at the lower plan prices in the market. To derive testable implications of corruption on resource allocation in the context of the Chinese economy, I present in Section 3 an extended version of Shleifer and Vishny's (1993) model to analyze the interaction between state-owned firms and planning officials. The model also extends Li's (1999) analysis of China's dual-track pricing system by endogenizing the determination of quotas. The extended model differs from Shleifer and Vishny (1993) in the industrial organization of corruption. Since state-owned enterprises are allowed to sell outside-plan output in the market, corrupt officials who sell in-plan goods face competition from state enterprises in product markets. In this more complicated model, an increase in the plan price would still decrease corruption as in Shleifer and Vishny (1993). But other model predictions differ. In particular, while the marginal cost of production, borne by the enterprise, remains immaterial to the corrupt official, it reduces the enterprise's production, softens the competition, and therefore tends to increase corruption by increasing the procurement of output quota and decreasing the distribution of input quota.

In Section 4, I present additional evidence of corruption based on the available firm-level data. The estimates of corruption proceeds range from 8% of GDP in 1980 to 11% in 1988, suggesting that corruption in China was pervasive both before and after the market price liberalization in 1985. Econometric analysis reveals that corruption has a significant impact on the allocation of both in-plan and outside-plan resources in ways that are consistent with the implications of the theory. Fixed-effects Tobit regressions of output and input quotas confirm the theoretical prediction that the procurement of output quota and the distribution of input quota are endogenous. In particular, the plan price is found to lower the procurement of output quota, while the marginal cost of production is found to increase the procurement of output quota. Regression analysis of market pricing reveals that after controlling for the implied endogeneity, the output quota is found to decrease the market

price of output and hence to increase the total output.

The findings also suggest it is not the dual-track system *per se* that bred corruption. The culprit is the continued reliance of planning. By introducing the market track, the dual-track system represents a half-way move from the plan toward the market. Economic benefits of such a move have been studied in depth (see for example Byrd, 1991; Li, 1994; Lau, Qian and Roland, 1997; Li, 1999; Lau, Qian and Roland, forthcoming). The evidence in this paper shows a serious downside of this reform strategy — corruption. The dual-track system allowed corruption to continue to exert an allocative role in the economy. This allocation is distorted since corrupt officials would procure and divert more resources the larger the gaps between market and plan prices. Given the arbitrariness of the plan price, some goods may be over-procured and hence over-produced while others under-produced. In addition, corruption also undermined popular support for the reform and was reportedly one of the triggers of the massive demonstrations in 1989. Section 5 makes some concluding remarks.

2 The Dual-Track System and Corruption

Like many reforms in China, the dual-track system was not created by design, rather it grew out of informal trading of goods outside planning channels. Beginning in 1979, the government gradually allowed state-owned industrial enterprises to sell their extra, outside-plan output at higher "floating or negotiated prices." The "negotiated prices" were regulated and were typically not allowed to exceed plan prices by more than 20 percent. On January 1, 1985, the government lifted the limit on market prices and officially ushered in the dual-track system.[4]

Under the dual-track system, a state-owned enterprise must still fulfill its compulsory output quota, and deliver it to a relevant branch of the Material Supply Bureau (MSB) at the plan price. In return, the enterprise may be allocated some of the needed material inputs, as input quota, through plan channels at plan prices. Once it fulfills its plan obligations, the enterprise is allowed to produce more, outside-plan, output and sell it in the emerging product market, typically at a higher "negotiated" or market price.[5] But it must buy

[4] Accounts of the development of the dual-track system can be found in Byrd (1991) and Naughton (1995).

[5] For brevity, I will use the term market price to refer to both the "negotiated" price before 1985 and the true market price after 1985.

any additional material inputs in the product market, typically at a higher "negotiated" or market price. The plan prices of both output and inputs, however, continue to be set centrally by the State Price Bureau, and are often substantially lower than would-be market clearing prices (*i.e.*, in-plan resources are often in short supply).

The allocation of in-plan resources is handled by officials in the Material Supply Bureau. As the economy becomes more decentralized, an increasing amount of in-plan resources is allocated by officials in local branches of the Material Supply Bureau. These officials have the government mandate and often superior ranks in the bureaucracy than managers of firms under their supervision. In most cases, they have discretion over the allocation of in-plan goods (Byrd, 1992).

[Table 1 about here.]

To see how the dual-track system worked in practice, I present some aggregate statistics on the pricing and allocation of a few key industrial goods. Table 1 shows the plan and market prices of four industrial goods between 1987 and 1989. Because of inflation, both plan and market prices were rising during the period. But market prices were rising much faster than plan prices. In the late 1980s, the government, in an effort to curb inflation, limited the increase in plan prices. As a result, the gaps between market and plan prices, which were quite sizable in 1987, had widened further during the three year period.

[Table 2 about here.]

Table 2 shows that the emerging product market allocated a substantial proportion of resources under the dual-track system. On the supply side, producers of these commodities reported that they sold between 22% to 66% of their output at market prices. On the demand side, enterprises using these commodities as inputs reported that they paid market prices for between 52% to 85% of their inputs. An interesting point to note here is that for each commodity with available data, the volume of market transaction reported by buyers was always substantially more than the volume supplied by producers to the market. For example, given that the domestic steel production was 56.26 million metric tons (MMT) and net import was 12.02 MMT in 1987 (State Statistical Bureau, 1989a), the quantity *purchased* at market price was approximately $(56.26 + 12.02) \times .55 = 37.56$ MMT while the quantity *sold* by domestic steel producers to the market was only $56.26 \times .22 = 12.38$ million metric

tons. Even if all imported steel, totaling 12.40MMT, were allocated through the market, reported market purchases would still exceed imputed market sales by 12.78MMT. The large discrepancy between the quantities sold and purchased at the prevailing market price is puzzling.

The apparent discrepancy cannot simply be a small sample bias, since the evidence I present later in the paper will show that it is present for a diverse set of industrial goods (see Table 3). The discrepancy also seems too big to be explained by the exclusion of imports as an additional source of market supply since imports accounted for only 14% of GDP in 1987. As discussed, even the sizeable steel import in 1987 was not sufficient to close the discrepancy. A possible explanation is that the proportion of market sales did not include or underestimated the market sales made by non-state firms. But this cannot explain the large discrepancy for steel either, since state-owned enterprises supplied nearly all domestic steel.[6] A more plausible explanation is that a sizeable portion of the procured output quota was diverted. If this explanation is correct, the early discussion implies that perhaps 12.78 MMT of steel was diverted from the plan to the market in 1987. Given the large price gap reported in Table 1, this diversion could generate as much as 7.32 billion yuan in profits, an astronomical amount considering that the annual salary of an average worker was 1,459 yuan in 1987.

This explanation is supported by a growing popular perception that government officials who controlled the allocation of in-plan resources diverted in-plan resources to the market.[7] *Guandao*, or official diversion, was coined to describe this form of corruption. It was reported (Huang, 1996, p.191) that in-plan steel were sold at between 500 to 1000 yuan per metric ton above the plan price in the late 1980s. By 1988, official diversion had become so apparent and pervasive, a few Chinese economists undertook the daring task of estimating the potential rents from diversion — rents embodied in all in-plan resources. Published estimates vary from 150 to 300 billion yuan in 1988 or 10% to 20% of GNP.[8]

[6] In 1987, township and village enterprises' gross industrial output in primary metal industries (comparable to the 1987 US SIC 2 digit code 33) accounted for less than 5.5 percent of the total (State Statistical Bureau, 1989b, p. 387–389).

[7] There is a large body of newspaper reports, journal articles and books in China that document the pervasiveness of corruption under the dual-track system. For a couple published in policy journals in China, see Li Maoshen, "Ten Policy Recommendations to Solve the Current Economic Problems," *Financial and Trade Economics*, 1989, No. 7; and Zhi Muxing and Gai Shi, "To Where is the Dual-Track System Leading China?" *Economics Weekly*, March 26, 1989.

[8] A short summary of the estimates is reported in Huang and Li (1991) (p. 225). The most widely cited

As a form of corruption, diversion of in-plan resources is punishable by law if exposed. To evade detection, corrupt officials often invest heavily in "diversion technologies." An elaborate scheme, quite commonly observed (Huang and Li, 1991), is to create a chain of the so-called *pibao gongshi* or briefcase companies. A briefcase company is a shell company that does not have a fixed office and most of its tangible assets — consisting of company registration, company seal and stationary, and business cards — fit into a briefcase. Briefcase companies are often registered as collectives or subsidiaries to state-owned firms to provide corrupt officials added protection. Each briefcase company acts as a middleman passing the diverted goods for a small and inconspicuous markup. At the end of the chain, the price eventually reaches the market clearing level. To ensure that rents from diversion are captured, these companies are often controlled by the official's relatives and friends.

Although it is difficult to come up with an accurate estimate of the number of briefcase companies in a given year, these is evidence that the number is large. The widespread use of briefcase companies led to a proliferation of "trading" and "*kaifa* (development)" companies. In 1986, there were some 328,893 registered "companies" (Huang, 1996, p. 177). A government crack-down on briefcase companies 1986 reduced the number to 173,000 by the end of the year. But by 1989, the number of "companies" had risen to 477,400. It is estimated that briefcase companies in 1988 directly employed 48,000 officials who held full-time government appointments in county or higher level offices (Huang and Li, 1991, p. 228).

There is additional survey evidence that the allocation of in-plan resource is consistent with official corruption. In detailed case studies of the Anshan Iron and Steel Company and the Second Moter Vehicle Manufacturing Plant, Byrd (1992, pp. 323 and 392) found that the Material Supply Bureau (MSB) would raise procurement quotas for steel and trucks when demands for them were strong and force the firms to direct market on their own when demands were weak. Byrd (p. 392) concluded that "[S]upervisory authorities acted largely as self-interested entities promoting their own benefits and protecting their own interests, with little regard for [the producer]. MSB in particular seems to have acted primarily to protect itself from losses that might result from its inability to sell the output it procured. Not surprisingly, when market conditions firmed up . . . , MSB became an advocate of a high share of mandatory planning."

study is Hu (1989), which estimates that the potential rents in 1988 are worth at least 150 billion yuan.

3 The Model

To derive implications of corruption on resource allocation that are testable using the Chinese data, I extend Shleifer and Vishny's (1993) model of corruption by incorporating the institutional context of the Chinese economy. The model also extends Li's (1999) analysis of China's dual-track pricing system by endogenizing the determination of quotas. Following Shleifer and Vishny (1993), I focus on the impact of corruption on the allocation of resources, taking as given the principal-agent relationships between the state (the principal) and its agents — officials and managers of state-owned firms. As a result of economic decentralization in China, the officials have effective property rights over the allocation of in-plan resources, and enterprise managers can make market decisions on the margin after they fulfill their in-plan obligations.

Consider a state-owned enterprise that produces a marketable output using a simple decreasing average cost technology: After incurring a fixed cost $F \geq 0$ in capital, each additional unit of output requires a units of a single intermediate input and l units of labor. If the firm pays wage rate W and buys its input, on the margin, at the market price M, its marginal cost of production is simply $aM + lW$. I assume that the firm, as one of many users of the input, has no market power in the input market; so it takes M as given. But because of the legacy of state monopolization under central planning, the firm may enjoy some market power in its product market. Allowing for the possibility that the enterprise is a price maker, I hypothesize that the enterprise faces a downward sloping demand curve $D(P)$ for its output, where P is the market price, $D'(P) < 0$. This hypothesis will be tested in the paper against the null that product markets are perfectly competitive.

Under the dual-track system, the firm must fulfill its mandatory output quota, Q, at the plan price, p. In return, the firm may be allocated an input quota, X, at the plan price, m. But it has to buy any additional input at the market price M. The output and input quotas, Q and X, are set, procured and allocated by officials in the Material Supply Bureau. In general, the quotas, Q and X, may be set by more than one official. For simplicity, I assume that the quotas are set by a single official.[9]

The plan prices, p and m, are determined by the State Price Bureau, based on historic production costs according to a set of cost-plus rules.[10] Plan prices cannot be changed

[9]The theory can be easily extended to the perhaps more realistic case where there are more than one corrupt official, without changing the qualitative implications of corruption on resource allocation.

[10]These rules, issued in government circulars and decrees, are documented in "Wujia Wenjian Xuebian:

arbitrarily by each individual official or firm alone. It is thus reasonable to assume that individual officials and firms take plan prices as given.[11] Plan prices in China were typically lower than market clearing prices under the dual-track system (Table 1). The wage rate, W, is defined as the base wage rate that excludes bonuses tied to the firm's financial performance. The base wage rate is controlled by the government and apply to all regular employees of state-owned enterprises.[12]

The gap between market and plan prices offers the official a strong incentive to divert plan resources and pocket the proceeds. However, with the planning bureaucracy still functioning, the official may be required to transfer some of the procured quota to the plan track. For simplicity, I assume that the official transfers a fixed fraction, $1-\delta$, of the output quota to the plan, where $\delta \in (0,1)$, and diverts the remainder of the quota, δQ, to the market.[13] Once in the plan track, the in-plan output δQ may be diverted by other officials who control its allocation. The amount of the output that is actually sold to final customers at the plan price is likely to be smaller than δQ.

Similarly, diversion may occur as the official allocates the in-plan input. Let $(1-\delta^*)Q^*$ denote the amount of the input available in the plan track, where Q^* is the output quota imposed on the input producer and δ^* is the fraction diverted to the market. The amount of in-plan input that the official controls is usually a fraction $f \leq 1$ of the total amount on the plan track or $X^s = f(1-\delta^*)Q^*$. By giving X to the enterprise at plan price m, the official diverts $X^s - X$ to the market. The incremental corruption proceeds collected by the official are then $(P-p)\delta Q + (M-m)(X^s - X)$.

Diverting plan resources for private gains is costly. In addition to any direct costs of selling the diverted goods, the official faces punishment in the event that the corruption is

1979–1983" (*Selected Pricing Regulations*), Price Research Institute, State Price Bureau, 1984.

[11]This assumption does not rule out the possibility that a coalition of officials can influence plan prices. It has been argued (Shleifer and Vishny, 1992) that officials have an incentive to set plan prices at below market clearing levels so as to profit from the resulting shortage by selling shortage goods for favors or bribes.

[12]In the 1980s, the government determined the wage structure for both managers, technicians and workers, and set the base wage rate for each wage grade. Except for maintaining some small regional differences, the base wage rate for each wage grade applied to all state-owned enterprise employees. State employees in major cities or in remote (*hardship*) regions were given a slightly higher base wage rate for a given wage grade. The wage grade for each employee was determined, according to rules set by the central government, based the employee's skill, education, and seniority.

[13]The model can be generalized by endogenizing δ without changing the derived testable implications. Since δ is unobserved, such a generalization is superfluous.

exposed. To evade detection, the official invests in diversion technologies, by for example creating a chain of "briefcase companies." Although the diversion technologies reduce the expected cost of punishment, they are expected to increase the transaction costs of selling diverted goods. The total cost of corruption, denoted by $G(\delta Q)+H(X^s-X)$, is expected to increase with the amount of output and input diverted, *i.e.*, $G' > 0$ and $H' > 0$. Given the usually high "progressivity" of punishment for corruption and the increasing complexity in managing a longer chain of briefcase companies, the cost function is expected to be convex or $G'' > 0$ and $H'' > 0$. For simplicity, I have assumed that the cost function is separable, so that an increase in output diversion has no impact on the marginal cost of the input diversion and vice versa. The separability implies that there are no economies or diseconomies in scope in diversion activities.[14]

The official chooses Q and X to maximize his proceeds from corruption,

$$R = (P-p)\delta Q + (M-m)(X^s - X) - G(\delta Q) - H(X^s - X) \tag{1}$$

This specification implies that the bureaucrat must pay the plan price p to procure Q and that the firm must pay the plan price m to the official for X. In other words, there is no theft of in-plan resources.[15]

After it fulfills its quota Q, the firm faces a residual demand for its outside-plan output. In the absence of market friction and government restrictions on reselling quota allocations, the residual demand would simply be $d(P) = \max\{D(P) - Q, 0\}$ regardless of how Q is allocated (Tirole, 1988, p. 213). The earlier discussion suggests that reselling (*i.e.*, diverting) quota allocations is illegal and hence costly. If some of the quota, as required under the plan, is allocated to and consumed by low valuation customers whose willingness to pay for the good is below the market clearing price P, the residual demand will be higher than $\max\{D(P) - Q, 0\}$. In general, the residual demand can be expressed as a function of P, Q and δ, or $d = d(P, Q, \delta)$. Assume that $d(P, Q, \delta)$ is continuously differentiable with $\partial d/\partial P < 0$ and $\partial d/\partial Q < 0$. Since the official and the firm are competitors in the product

[14] The cost function would be separable if output diversion and input diversion are each done by a different official. Since responsibility over the allocation of in-plan resources is often divided along product lines, it is quite possible that output and input are diverted by different officials. But it can be easily verified that a change in the model setup that replaces the single official with an "output official" and an "input official" does not change model predictions.

[15] In the case with theft, plan prices would be immaterial to the official and the firm, and would therefore not affect the allocation of resources (Shleifer and Vishny, 1993).

market, it is expected that an increase in Q raises the price elasticity of the residual demand or $\partial^2 d/\partial P \partial Q \leq 0$.

To meet the output quota and the residual market demand, the enterprise produces $Y = Q + d(P, Q, \delta)$. Its profits from production are

$$\Pi = (P - C)d(P, Q, \delta) + (p - C)Q + (M - m)X - F \tag{2}$$

where $C = Ma + Wl$ is the marginal cost of production. Since the reform offers the enterprise financial incentives to be profit oriented, I assume here that the enterprise sets P so as to maximize Π.[16]

By producing beyond the quota, the firm competes against the official in the product market. Actions taken by the official and the enterprise jointly determine the quota and the market price. In what follows, I model the interaction between the official and the enterprise as a two stage game. In the first stage, the official, acting as a Stackelberg leader,[17] sets Q and X. After receiving the mandatory quotas, the enterprise sets the market price P in the second stage.

Consider first the pricing decision of the enterprise. For given (Q, X), the firm would set its optimal price according to the standard monopolist pricing rule:

$$\frac{P - C}{P} = -\frac{1}{e} \tag{3}$$

where $e = P(\partial d/\partial P)/d$ is the elasticity of the residual demand. The optimal price P will be a function of the quotas, input prices and plan prices. Assuming that the profit function is strictly concave in P, then given the presumed properties of the residual demand curve d, the following comparative statics properties can be easily shown by differentiating the

[16] This is a simplifying assumption. What matters here is that the firm doesn't ignore the profit motive in making decisions. For case studies on Chinese firms' profit and other objectives during the 1980s, see Byrd (1992).

[17] Here it is implicitly assumed that the official can credibly commit to his setting of Q and X. One may argue that this is a strong assumption for a transition economy where even contracts are difficult to enforce. In a case study, Byrd (1992, p. 321) documented that Anshan, a large steel maker, complained about delayed announcement of plan targets, insufficient deliveries of in-plan inputs. If neither the official nor the firm can credibly pre-commit, it would be appropriate to model the interaction between them as a game in which both parties move simultaneously. It can be shown that this change will not alter the model's qualitative results.

first order condition, $\partial\pi/\partial P = 0$.

$$\partial P/\partial Q < 0, \qquad \partial P/\partial X = 0, \tag{4}$$

$$\partial P/\partial M > 0, \qquad \partial P/\partial W > 0, \tag{5}$$

$$\partial P/\partial p = 0, \qquad \partial P/\partial m = 0. \tag{6}$$

Reflecting the fact that the official and the firm are competitors in the imperfectly competitive product market, (4) shows that the official can influence the market price by exercising its control over Q. By increasing the quota, the official "steals" some of the enterprise's customers and limits its market power. This result reveals that the dual-track system creates competition between corrupt officials and state firms. The "intra-marginal regulatory" benefit of the dual-track system identified in Li (1999) is present even under corruption.[18] However, since the enterprise has no market power in the input market, allocating X to the enterprise is tantamount to giving it a lump-sum subsidy $(M - m)X$. A change in X has no impact on P. As expected, in (5) the optimal price P increases with M and W that make up the marginal cost of producing the outside-plan output. However, since plan prices affects only intramarginal resource allocation, they should not affect the optimal market price, as stated in (6).

Anticipating the enterprise's pricing decision $P(Q, M, W)$, the official sets Q and X in Stage 2 to maximize its net payoff from corruption R. Since the official cannot impose a negative output quota or procure the input that the firm does not produce, he faces the constraints $Q \geq 0$ and $X \geq 0$. Consider first an interior equilibrium where $Q > 0$ and $X > 0$. The equilibrium can be characterized by the following first order conditions.

$$P + \frac{\partial P}{\partial Q}Q = p + G'(\delta Q) \tag{7}$$

$$M = m + H'(X^s - X) \tag{8}$$

The official equates his marginal benefit of an increase in quota diversion to the marginal cost. In choosing Q, the official, acting as a Stackelberg leader, takes into account the anticipated decrease in P as he increases Q, as if he faced a downward sloping demand curve for Q. As is in Shleifer and Vishny (1993), the official prices p and m contribute to

[18] A necessary condition for this property to hold is that there are conflicts of interest between the official and the firm.

his marginal costs. Because the market price is decreasing in Q, the official has no incentive to procure beyond the optimal Q defined by (7). The official has no incentive to ratchet up the procurement.

In general, factors that raise the marginal benefit or reduce the marginal cost of corruption increase corruption. Consider first the comparative statics on Q. Differentiate (7) with respect to each exogenous variable $Z = p, m, W,$ and M, and solve for $\partial Q/\partial Z$. The results are summarized below.

$$\frac{\partial Q}{\partial p} < 0 \tag{9}$$

$$\frac{\partial Q}{\partial m} = 0 \tag{10}$$

$$\text{sign}\left(\frac{\partial Q}{\partial M}\right) = \text{sign}\left(\frac{\partial \text{MR}_Q}{\partial M}\right) \tag{11}$$

$$\text{sign}\left(\frac{\partial Q}{\partial W}\right) = \text{sign}\left(\frac{\partial \text{MR}_Q}{\partial W}\right) \tag{12}$$

where $\text{MR}_Q = P + Q\partial P/\partial Q$ is the marginal revenue from diverting output quota Q.

(9) shows the Shleifer and Vishny's (1993) effect of the official price on the allocation of in-plan resources. An increase in p raises the marginal cost of diversion, and should reduce diversion of the procured output. (10) states that m has no effect on Q, under the separability assumption imposed on the diversion cost function, which effectively excludes m from the output quota equation. Equations (11) and (12) indicate that additional assumptions are needed to sign the effects of M and W on Q. Since $\partial P/\partial M > 0$ and $\partial P/\partial W > 0$ (from (5)), if the marginal revenue $(P+Q\partial P/\partial Q)$ has the same monotonicity properties of the average revenue, $P(Q, W, M)$, with respect to M and W, we would have $\partial \text{MR}_Q/\partial M > 0$ and $\partial \text{MR}_Q/\partial W > 0$. If this condition holds, an increase in M or W that causes the enterprise to raise P will shift the official's marginal revenue curve upward, thereby inducing him to raise Q. In sum, the analysis suggests that the equilibrium output quota, $Q = Q(p, M, W)$, is decreasing in p, and increasing in M and W, under certain conditions.

By symmetry, the output quota, Q^*, imposed on the input producer should in equilibrium have similar comparative statics. Namely, $Q^* = Q^*(m, M^*, W^*)$ should be decreasing in m, the plan price, increasing in M^*, the market price of another input that the input producer in question needs in production, and in W^*, the base wage rate that the input producer faces. As a result, the amount of in-plan input that the official controls,

$X^s = X^s(m, M^*, W^*)$ should be decreasing in m, increasing in M^* and W^*. And X^s should not be affected by M or W.

To obtain comparative statics results on X, I substitute $X^s = X^s(m, M^*, W^*)$ into (8), then differentiate both sides of the equation with respect to each exogenous variable $Z = p, m, M, W, M^*,$ and W^*, and solve for $\partial X/\partial Z$. The results are summarized below.

$$\frac{\partial X}{\partial p} = 0 \tag{13}$$

$$\text{sign}\left(\frac{\partial X}{\partial m}\right) = \text{sign}\left(1 + H''\frac{\partial X^s}{\partial m}\right) \tag{14}$$

$$\frac{\partial X}{\partial M} < 0 \tag{15}$$

$$\frac{\partial X}{\partial W} = 0 \tag{16}$$

$$\frac{\partial X}{\partial M^*} > 0 \tag{17}$$

$$\frac{\partial X}{\partial W^*} > 0 \tag{18}$$

Here the Shleifer-Vishny effect of m on X is complicated by the effect of quota availability. As shown in (14), the sign of the effect of m on X is ambiguous. An increase in m raises the cost of diversion and therefore should induce the official to transfer more of the in-plan input he controls to the enterprise at m. But an increase in m reduces the procurement of in-plan input and hence the amount of in-plan input that he controls. The two effects offset each other, making it difficult to ascertain the net effect of m on X. The effects of other variables on X are unambiguous and intuitive. (13) shows that an increase in p has no effect on X since p is excluded from (8). (15) shows that M has a negative effect on X. An increase in M raises the marginal revenue from diversion and hence reduces X. An increase in W, however, affects neither the marginal profits from diversion nor the size of X^s, hence has no impact on X (see (16)). An increase in M^* or W^* increases the availability of in-plan input and consequently X ((17) and (18)).

The above comparative statics results are derived based on the interior equilibrium. But if the official cannot profitably set $Q > 0$ or $X > 0$, a boundary equilibrium ($Q = 0$ or $X = 0$) occurs. In a boundary equilibrium, the official would set $Q = 0$ if $P|_{Q=0} < p + G'|_{Q=0}$. Similarly he would set $X = 0$ if $M - m > H'|_{X=0}$. Therefore, factors that decrease Q or X in an interior equilibrium are the ones that raise the likelihood of a boundary equilibrium.

3.1 Perfectly competitive product markets

The implications of corruption on resource allocation, summarized by equations (4)–(6) and (9)–(18) are derived under a set of substantive economic assumptions that describe the institutions under which the firm and the bureaucrat operate. An empirical rejection of a derived implication could mean either a rejection of the theory, or a rejection of one or more of the assumptions. While there are many alternatives, not all of them change model predictions (see the remarks in footnotes 9 and 17). To rule out the possibility that the empirical results in the paper are not driven by a wrong assumption about the product market structure, it will be useful to test implications of corruption derived under alternative assumptions of market structure. An interesting alternative market structure is perfect competition.[19]

In a perfectly competitive product market, both the firm and the bureaucrat are price takers. The market price, P, will therefore not be affected by changes in Q or X. But the price P will affect the allocation of plan resources under corruption. Taking P as given, the bureaucrat, maximizing his payoff from corruption would set Q and X such that,

$$P = p + G'(\delta Q) \tag{19}$$

$$M = m + H'(X^s - X) \tag{20}$$

Under the assumption that $G(\delta Q)$ and $H(X^s - X)$ are convex, one can analogously derive from (19) and (20) a set of comparative statics. These results are summarized below.

$$\frac{\partial Q}{\partial P} > 0 \quad \frac{\partial Q}{\partial p} < 0 \tag{21}$$

$$\frac{\partial Q}{\partial m} = \frac{\partial Q}{\partial M} = \frac{\partial Q}{\partial W} = 0 \tag{22}$$

$$\text{sign}\left(\frac{\partial X}{\partial M}\right) = \text{sign}\left(-1 + H''\frac{\partial X^s}{\partial M}\right) \quad \text{sign}\left(\frac{\partial X}{\partial m}\right) = \text{sign}\left(1 + H''\frac{\partial X^s}{\partial m}\right) \tag{23}$$

$$\frac{\partial X}{\partial P} = \frac{\partial X}{\partial p} = \frac{\partial X}{\partial W} = \frac{\partial X}{\partial M^*} = \frac{\partial X}{\partial W^*} = 0 \tag{24}$$

As expected, (21) shows that the procurement of output quota, Q, is increasing in the market price P and decreasing in the plan price p. The results reveal that the Shleifer-

[19] Some analyses of China's dual-track system have assumed that the emerging product market is perfectly competitive (e.g., Byrd, 1991; Lau et al., 1997).

Vishny effect of the official price on corruption are present under perfect competition. Since an increase in the official price p raises the marginal cost of corruption regardless of the product market structure, this effect should in general be robust to market structure. As implied by the separability of the cost function, (22) shows that an increase in m has no impact on Q. However, there are marked differences in how M and W affect Q under perfect competition than under imperfect competition. Since both M and W do not enter (19) directly, they should have no impact on Q once the effect of the competitive market price P are taken into account. This is intuitive since under perfect competition, marginal cost pricing implies any increase in M or W would have already been passed completely to customers as increased market price P. Perfect competition in the output market thus implies that $Q = Q(P, p)$ is increasing in P and decreasing in p. By symmetry, perfect competition in the input market implies that $X^s = X^s(M, m)$ is increasing in M and decreasing in m.

As implied by the separability of the cost function, (24) shows that the output prices P and p have no effect on X. The effect of m on X is ambiguous as in the case under imperfect competition for the same reason discussed earlier. But there are differences in how M and W affect X. Under perfect competition, M has an ambiguous effect on X. The reason is that X^s is an increasing function of M under perfect competition. An increase in M raises the amount of in-plan input available and hence the amount that would be given to the enterprise at m, thereby counteracting the negative effect identified earlier under imperfect competition. Under perfect competition, neither W, M^*, nor W^* should have any effect on X since neither influences the availability of in-plan input X^s.

4 Empirical Evidence

In this section, I first describe the available data and assemble evidence that documents the presence of official diversion. Then, I estimate corruption proceeds from diversion. Finally, after a brief discussion of the econometric specifications, I present and discuss the empirical results.

4.1 The Data

The data come from a survey of 769 Chinese state-owned enterprises conducted in 1990 by the Chinese Academy of Social Sciences (CASS) in collaboration with Western economists. Annual data between 1980 and 1989 are collected. The sample covers a diverse selection of state enterprises. Located in four provinces (Jiangsu, Jilin, Shanxi, and Sichuan), these enterprises represent 36 (out of a total of 40) two-digit industries in mining, logging, utilities, and manufacturing.[20] The data set is particularly rich in information on the enterprise's participation in the dual-track system, giving details on the planned prices and market prices as well as the volumes of outputs and inputs transacted at these prices. Adopting the procedures (and computer codes) developed by Li (1994) and Li (1997), I construct price and quantity variables that are relevant to this study. Below I give a brief description of the procedures and the measured variables.

A. Prices

Under the dual-track system, sales and purchases are recorded in mixed prices—weighted averages of market prices and plan prices. The data contain detailed price information, which allows the construction of enterprise-specific indexes of mixed prices for output, material inputs, as well as ratios of market prices to mixed prices and plan prices for output and for material inputs. Using the price information, I construct, for each enterprise n, time series indexes of market prices of output, $P^i_{nt} \equiv P_{nt}/P_{n,80}$, market prices of material inputs, $M^i_{nt} \equiv M_{nt}/M_{n,80}$, plan prices of output, $p^i_{nt} \equiv p_{nt}/p_{n,80}$, and plan prices of material inputs, $m^i_{nt} \equiv m_{nt}/m_{n,80}$. Here 1980 is the base-year and $P_{n,80}$, $M_{n,80}$, $p_{n,80}$ and $m_{n,80}$ are the (unknown) enterprise-specific base-year prices. Before the price liberalization in January 1985, the "market" prices are measured as the "negotiated" prices, which remained under price control. The weighted average annual rates of market price inflation and the gaps between market prices and plan prices for both output and material inputs are reported in Table 3.

[Table 3 about here.]

The market price inflation for both output and material inputs accelerated after 1985, when price control was lifted. The material price inflation was higher, on average, than output price inflation, reflecting the structural changes in resource allocation that were

[20] Adopted in 1985, China's industry classification is comparable to the ISIC.

undoing the underpricing of material inputs imposed by central planning. Consistent with the aggregate statistics in Table 1, the gaps between market prices and plan prices widened considerably between 1985 and 1989. But the price gaps reported here are much smaller than those in Table 1. Given our highly diverse sample of enterprises, it appears that the goods in Table 1 were in more severe shortage at plan prices than most other industrial goods.

B. Output quota and input quota

For each enterprise, a time series of output quota Q_{nt}, measured in 1989 market prices,[21] is constructed by first converting quota sales in current year plan prices to 1989 plan prices and then multiply the resulting series by the ratio of 1989 market price to 1989 plan price. A time series of input quota X_{nt}, measured in 1989 market prices, is constructed analogously for each enterprise. Enterprise n's total real sales in year t, Y_{nt}, is then the sum of Q_{nt} and the enterprise sales to the market in year t measured in 1989 market prices. Total real purchases of inputs for enterprise n in each year are constructed analogously.

Zero output quota accounts for 22% of all observations between 1980 and 1989 for which output quota is not missing, and *zero input quota* accounts for 49% of all observations for which input quota is not missing. These statistics suggest that at any given time more firms were required to sell their output at plan prices than were given inputs at plan prices. Furthermore, as Table 3 shows, the proportion of output sold at plan prices is always higher than the proportion of input bought at plan prices for each year in the sample. These findings, based on microeconomic data from a diverse set of state-owned enterprises, confirm the aggregate evidence of in-plan resource diversion in Section 2. Corruption, therefore, did not appear to be an isolated phenomenon confined to only a few commodities.

C. Base wage

To be consistent with the theory, wage should be defined as one that is exogenous to the firm and the official. In this paper, wage is measured as base wage per worker — total base wage payment divided by the total average number of employees in the enterprise in the year. The base wage rate for each wage grade is determined by the Chinese central government

[21] Since market prices in 1989 — the last year in the sample — were presumably less distortionary than either plan prices or market prices in earlier years, all quantity variables are measured in 1989 market prices to make them comparable both over time and across enterprises.

and apply to all employees of state-owned enterprises.[22] The wage grade for each employee is in turn determined, according to rules set by the central government, based the employee's technical skill, education, and seniority. This definition excludes bonuses that are often tied to the firm's financial performance.

4.2 Corruption Proceeds

If there were no diversion of in-plan resources, the market values of output and input quotas should be roughly the same: on average the procurement of in-plan resources should equal the distribution of in-plan resources. But this is not what we see in the data. In the first two columns in Table 4, I report the average market value (in 1989 market output prices) of output quota taken from sample enterprises and the average market value of input quota (in 1989 market input prices) given to sample enterprises.[23] The average market value of output quota exceeded the average market value of input quota in each year between 1980 and 1989. On average more resources were procured into the plan track than distributed through the plan track. Some of the in-plan resources must have been diverted to the market track. The gap in the market values between output and input quotas in a given firm represents a direct measure of corruption proceeds collected from the firm. Column 3 reports the average of corruption proceeds per firm for each year in the sample. Between 1980 and 1989, the average corruption proceeds per firm more than doubled.

Dividing the average corruption proceeds per firm by total sales per firm gives the sales-weighted average corruption proceeds as a proportion of total sales. Column 4 in Table 4 shows that sales-weighted average corruption proceeds grew from 22% of total sales in 1980 to as much as 45% in 1989. The t-ratios of the estimates, reported in parentheses,[24] indicate that the sales-weighted averages of corruption proceeds are quite precisely estimated.

[Table 4 about here.]

[22] The government maintained some small regional differences in the base wage rate. State employees in major cities or in remote (*hardship*) regions were given a slightly higher base wage rate for a given wage grade.

[23] Because of price control, the "market prices" before 1985 would underestimate the market values of in-plan goods. Using the 1989 market prices should eliminate the downward biases.

[24] Robust standard errors of the estimates, with correction for heteroskedasticity and autocorrelation (Andrews, 1991), are obtained by regressing R/GIO on year dummies. To estimate sales-weighted averages, each observation in the regression is weighted by total sales.

If the sample is representative of China's state-owned industry,[25] then using the estimated corruption proceeds, one can impute the size of corruption proceeds relative to GNP using the following formulae,

$$\begin{aligned} R/\text{GNP} = {} & \text{Sales-weighted average of } (R/\text{Sales}) \times \\ & \text{State-owned firms' share of industrial output} \times \\ & \text{Industrial sector's share of GNP} \end{aligned} \tag{25}$$

Aggregate times series data on state-owned firms' share of the aggregate industrial output and the industrial sector's share of Gross National Product are from State Statistical Bureau (1991). The results are presented in Column 5 in Table 4.

On average, corruption proceeds accounted for 9% of GNP in the 1980s. As expected, corruption was a bit more serious in the late 1980s than in earlier years.[26] Considering that in 1989 government revenue accounted for only 16.2% of the GNP (State Statistical Bureau, 1991), estimates in Table 4 imply that corruption in China in the 1980s was a serious economic and political matter. If the government were to sell in-plan resources at market prices itself, it could boost its revenue on average by an amount equal to 9% of GNP. The implied loss in government revenue due to corruption is thus staggering.

It is interesting and perhaps surprising to some observers that the estimated corruption proceeds are not much lower in as early as 1980 than in 1989, the year when students marched on to Tiananmen Square to demand democracy and an end to corruption. In 1989, the popular perception of official corruption was probably the highest in the history

[25] As discussed, the sample covers almost all two-digit industries. The number of firms in each industry covered in the sample correlates well with the total number of firms in each industry in China (Li, 1994). Looking at some important performance measures, say, labor productivity, the sample statistics also match well national aggregates. The sample average of labor productivity (output per person) between 1980 and 1989 is 14,600 yuan/person (in 1980 constant prices) while the aggregate counterpart is 14,690 yuan/person (source: the author's estimation and State Statistical Bureau (1991)). The weighted average of growth rate of output in the sample is also very similar to the national average.

[26] My estimates of corruption proceeds from diverting in-plan resources are smaller than the estimates reported in the Chinese media. But this is expected. The estimates summarized by Huang and Li (1991) are *potential* proceeds from diversion embodied in in-plan resources. They provide upper bounds on corruption proceeds since some of the in-plan resources were actually allocated at plan prices to final customers. With available data on in-plan deliveries of inputs to state-owned enterprises, I am able to estimate *actual* corruption proceeds. Using my data, the potential proceeds from corruption between 1980 and 1989 amount to 18% of GNP, near the high end of existing estimates.

of the People Republic.[27] In the writings of some Chinese economists (see for example the references in Yang and Li, 1993), corruption is the by-product of the dual-track system. The implicit presumption is that official diversion didn't exist before the introduction of the dual-track system. My estimates, using firm-level data, reveal that this presumption does not match reality. Results from econometric analyses below will further confirm that corruption was present in as early as 1980. This bags the question: Why was public perception of corruption low in the earlier years of reform, and why did it rise so quickly in the late 1980s?

Part of the answer may be that the nature of corruption had changed in the 1980s. First, the economic reform in the 1980s had significantly decentralized the economy, giving many lower-level officials the rights to make allocation decisions and hence the opportunity to divert in-plan resources. The decentralization may have "democratized" corruption, allowing top-level as well as low-level officials to participate in "official diversion." This conjecture is supported by the data. In the last column of Table 4, I report estimates of *unweighted* or simple arithmetic average of corruption proceeds as a proportion of sales and the corresponding t-ratios. The unweighted averages are smaller than the sales-weighted averages in all years and are considerably smaller in the early 1980s. This suggests that the diversion of in-plan resources in earlier years is more concentrated in larger enterprises that are supervised by higher-level officials. The narrowing of the gap between the two averages towards the end of 1980's is indicative of the spread in corruption to lower-level officials who controlled smaller firms. Secondly, the introduction of the market track helped monetize corruption and may have significantly reduced the transaction costs of official diversion. Under tight price control, corrupt officials would have to rely on costly barter exchanges to trade diverted goods.[28] By reducing the transaction costs of corruption, the dual-track system may have increased the pervasiveness of corruption in China. By helping monetize corruption, the dual-track system also heightened public awareness of corruption since under the Chinese law corruption must involve monetary payoffs. The increased pervasiveness of corruption could have helped boosting public perception of corruption to levels unseen in

[27] Some of the workers who joined the demonstration in 1989 were nostalgic for the pre-reform days when the government was perceived as "clean" (see for example, *Wall Street Journal*, May 19, 1989, "People's Republic: Chinese Communism Faces a Crossroads as the Masses Speak").

[28] Before the emergence of product markets, corrupt officials would have received in-kind payments and favors, such as desirable jobs for their children. Such official indiscretion was pervasive in the pre-reform China.

the history of the People's Republic.

4.3 Econometric methods

Structural relations that determine firm n's (log) market price in year t, $\ln P_{nt}$, output quota, Q_{nt}, and input quota, X_{nt}, as implied by first order conditions (3), (7) and (8), can be expressed in the following linear specification,

$$\ln P_{nt} = \alpha_Q Q_{nt} + \alpha_W \ln W_{nt} + \alpha_M \ln M_{nt} + \epsilon'_{nt} \tag{26}$$

$$Q_{nt} = \beta_p \ln p_{nt} + \beta_W \ln W_{nt} + \beta_M \ln M_{nt} + \beta_m \ln m_{nt} + \xi'_{nt} \tag{27}$$

$$X_{nt} = \gamma_p \ln p_{nt} + \gamma_W \ln W_{nt} + \gamma_M \ln M_{nt} + \gamma_m \ln m_{nt} + \eta'_{nt} \tag{28}$$

where $\ln W_{nt}$ is the log of firm n's base wage rate in year t, $\ln M_{nt}$ is the log of market price of input, $\ln p_{nt}$ and $\log m_{nt}$ are the log plan prices of output and input, and ϵ'_{nt}, ξ'_{nt} and η'_{nt} are random errors (not necessarily of mean zero).

This system of three equations consist of three endogenous variables ($\ln P_{nt}$, Q_{nt} and X_{nt}). The remaining four variables ($\ln W_{nt}$, $\ln M_{nt}$, $\ln p_{nt}$, and $\ln m_{nt}$) are typically beyond the control of either the firm or the official. As discussed, the base wage rate and plan prices are set and adjusted by the central government. The market price of input is typically set by imperfectly competitive producers. Among many buyers, an individual buyer usually has little influence over the market price of input. The plan prices, the base wage rate and the market price of input can thus be considered exogenous. The exclusion of $\ln p_{nt}$ and $\ln m_{nt}$ from (26) implies that the system is identified.

But as they stands, equations (26)–(28) are not estimable because of the following data limitations. First, only *price indexes* are observed. That is only $P^i_{nt} \equiv P_{nt}/P_{n,80}$, $p^i_{nt} \equiv p_{nt}/p_{n,80}$, $M^i_{nt} \equiv M_{nt}/M_{n,80}$, and $m^i_{nt} \equiv m_{nt}/m_{n,80}$, where 1980 is the base year, are observed. Second, the observed output and input quotas are censored, since a significant number of firms reported that they had zero output or input quotas. The theory implies that the official would set zero quotas if it is unprofitable to set positive quotas. In other words, the observed output and input quotas are simply $Q_{nt} = \max\{Q^*_{nt}, 0\}$ and $X_{nt} = \max\{X^*_{nt}, 0\}$, where Q^*_{nt} and X^*_{nt} are the latent output and input quotas. Finally, two unobserved variables, the base wage rate W^*_{nt} and market input price M^*_{nt} that firm n's input supplier faces, are omitted from (28). Below, I address the econometric issues imposed

by the data limitations for each of the three equations.

Consider first the output quota equation (27). Using observed price indexes and observed output quota Q_{nt}, the equation can be rewritten as

$$Q_{nt} = \max\{\beta_p \ln p^i_{nt} + \beta_W \ln W_{nt} + \beta_M \ln M^i_{nt} + \beta_m \ln m^i_{nt} + \mu^q_n + \nu^q_t + \xi_{nt}, 0\} \qquad (29)$$

where $\beta_p \ln p_{n,80} + \beta_M \ln M_{n,80} + \beta_m \ln m_{n,80}$ has been absorbed into μ^q_n, which accounts for the enterprise-specific effects in (29), ν^q_t measures the time-specific effects, and ξ_{nt} the idiosyncratic error. In addition to absorbing the enterprise-specific base-year prices, μ^q_n also captures unobserved enterprise-specific factors that may affect Q_{nt}. Such factors include, for example, product characteristics, enterprise-official relationship and changes in the dual-track system that is specific to the enterprise. The time-specific effects, ν^q_t, capture the effects of unobserved macroeconomic factors that influence Q_{nt} uniformly for all firms. Examples of these factors include inflation, nationwide anti-corruption campaigns and the general trend in the development of the dual-track system. Taking into account the fact that some observations of Q_{nt} are censored at zero, equation (29) specifies a fixed-effects Tobit model where the fixed effects enter nonlinearly.

For such a specification, the traditional Tobit estimator that maximizes a likelihood function over all parameters, including the fixed effects, are consistent and asymptotically normal only if both the number of firms and the number of years approach infinity (Heckman and MaCurdy, 1980). This estimator may exhibit significant small-sample biases if applied to our data since the number of available observations per firm is limited to ten. However, the model can be estimated consistently using Honoré's (1992) semi-parametric method for fixed-effects Tobit models. The method exploits a symmetry in the distribution of the latent variables. If the true parameter values were known, then trimming could introduce the same symmetry in the distribution of the observed variables. The symmetry suggests orthogonality conditions which must hold at the true parameter values. Each orthogonality condition in effect compares two observations per individual (firm). These orthogonality conditions are used to construct objective functions. Honore's estimators are then defined as the parameter values that minimize the objective functions. Honoré (1992) shows that the estimators are consistent and asymptotically normal if the included regressors are exogenous, and if, conditional on the fixed effects and included regressors, the idiosyncratic errors, ξ_{nt}

and ξ_{ns} for all $t \neq s$, are independent, identically and continuously distributed.[29] Honore's semi-parametric method is more robust than the traditional Tobit, for it does not require a parametric distribution for the idiosyncratic errors, or homoskedasticity across firms.

Similarly for the input quota equation, we can rewrite (28) as

$$X_{nt} = \max\{\gamma_p \ln p^i_{nt} + \gamma_W \ln W_{nt} + \gamma_M \ln M^i_{nt} + \gamma_m \ln m^i_{nt} + \mu^x_n + \nu^x_t + \eta_{nt}, 0\} \tag{30}$$

where μ^x_n and ν^x_t are the enterprise-specific and time-specific effects, and η_{nt} is the idiosyncratic error. As a fixed-effects Tobit model, equation (30) can be estimated using Honoré's (1992) method. But the estimates may be affected by omitted variables biases. Conditional on the fixed effects, the error term η_{nt} may contain idiosyncratic components of $\ln M^*_{nt}$ and $\ln W^*_{nt}$. But because of uncoordinated market forces and random sampling of enterprises, it is possible, conditional on the fixed effects, that the idiosyncratic component of $\ln M^*_{nt}$ is not correlated with the included regressors. The same logic may not apply to $\ln W^*_{nt}$. Since changes in the base wage rate are coordinated by the central government, it is possible that even after controlling for the fixed effects the idiosyncratic component of $\ln W^*_{nt}$ is positively correlated with $\ln W_{nt}$. Since $\ln W_{nt}$ is predicted to have no impact on X_{nt} while $\ln W^*_{nt}$ is predicted to raise X_{nt} under imperfect competition (see (18)), the coefficient on $\ln W_{nt}$ is likely to be biased upward. Without additional data, the omitted variables biases cannot be easily corrected.

For both the output and input quota equations, the discussed econometric method is also applicable to the case where the output market is perfectly competitive. As implied by (19) and (20), the only modification to (29) and (30) needed in this case is to add $\ln P^i_{nt}$ as a regressor in both equations.

Turn now to the pricing equation (26) under the null hypothesis of imperfect competition. I apply a first-order, year-on-year difference on both side. Doing so yields,

$$\Delta \ln P^i_{nt} = \alpha_Q \Delta Q_{nt} + \alpha_W \Delta \ln W_{nt} + \alpha_M \Delta \ln M^i_{nt} + \nu^p_t + \epsilon_{nt} \tag{31}$$

where Δ is the first difference operator such that $\Delta \ln P^i_{nt} = \ln P^i_{nt} - \ln P^i_{n,t-1}$. By differenc-

[29] As Honoré (1992, p. 543) commented, the assumption that ξ_{nt} and ξ_{ns} "are independent is less restrictive than it may seem. The fixed effects can capture some dependence between the error terms. For example, [the assumption is] satisfied if the error terms are joint normal, with equal variance but arbitrary positive correlation. Dependent normals with positive correlation can be written as a (normal) fixed effect plus independent normals—the dependence can be captured by the fixed effect."

ing, we have eliminated from (31) firm-specific fixed effects, including firm-specific base-year log prices. Note the use of the observed, actual output quota, Q_{nt}, in the specification. This is appropriate since each firm actually faces the observed output quota. It would be wrong to use the latent quota, Q^*_{nt}, as firms were never given negative output quotas.

The observed output quota Q_{nt} is endogenous, and likely correlated with the idiosyncratic error ϵ_{nt}. For example, if the official expects an upward shift in the market demand for the firm's output that will increase ϵ_{nt}, he would have an incentive to raise Q_{nt}, resulting in a positive correlation between Q_{nt} and ϵ_{nt} (Byrd, 1992). To estimate (31) consistently, I use Generalized Method of Moments (GMM, Hansen (1982)). The instruments I use are, $\Delta \ln p^i_{nt}$, $\Delta \ln m^i_{nt}$, $\Delta \ln M^i_{nt}$, and $\Delta \ln W_{nt}$, a constant, and year dummies. These variables should be correlated with the regressors in (31) (see (29)) but not correlated with the idiosyncratic error ϵ_{nt}. The GMM estimates should therefore be consistent and asymptotically normal.

4.4 Empirical results

Panel A of Table 5 reports four sets of estimates for the parameters of the output quota equation (29) using fixed-effects Tobit. The time-specific effects, estimated by including year dummies in the regression, are not reported in the table. In the first three columns, two sets of estimates are presented from model specifications that assume imperfectly competitive markets. Column 1 reports estimates obtained under the hypothesis that the parameters are time invariant. This hypothesis is relaxed for estimates in Columns 2 and 3 to allow parameters to differ before and after the price liberalization in January 1985. For comparison, Columns 4 to 6 report the same two sets of estimates from specifications that assume perfectly competitive markets, where an additional regressor, "log market output price," is included in the regression. Panel B of Table 5 reports the same four sets of estimates for the input quota equation (30).

[Table 5 about here.]

Inspection of the signs of the estimated coefficients in the first three columns of Table 5 reveals that all variables operate more or less as predicted. Focus first on the estimates in Panel A. "Log plan output price" increases corrupt officials' marginal cost of diversion. It should reduce the amount of output quota that the official procures and diverts. The

estimated negative coefficients on this variable in Table 5 empirically confirm the presence of the Shleifer-Vishny effect of the official price on corruption. "Log market input price" and "log base wage rate" both increase the marginal cost of production that the firm faces. In an imperfectly competitive market, they raise the market price of output for any given output quota. If the resulting upward shift in the market price increases the marginal revenue in diverting output quota, it would raise the procurement and the diversion of output quota. It is therefore not surprising to find that the estimated coefficients on both variables are positive and statistically significant. There is a negative but (statistically) insignificant effect of the plan price of input on output quota. This is consistent with model predictions derived under the assumption that the diversion cost function is separable, suggesting that there may indeed be few economies of scope in quota diversion.

Turn next to the estimates of (30) in Panel B under the hypothesis of imperfect competition. As discussed, the estimates may be affected by omitted variables biases. In particular, estimates of the coefficient on "log base wage rate," which are predicted to have no effect on X, may be biased upward. Table 5 shows that the bias appears to be concentrated in the second half of the 1980s. However, the estimate based on the whole sample (Column 1) shows little evidence of a upward bias. The results suggest that the omitted variables biases are not strong enough to alter the qualitative results. With this in mind, we now examine estimates of the remaining parameters.

As discussed, "log plan input price" is expected to have ambiguous effect on X because the Shleifer-Vishny effect is offset by the effect of m on the availability of in-plan input (X^s). Estimates of the coefficient on "log plan input price" are small and statistically insignificant, suggesting that the two offsetting effects may be roughly equal in strength. "Log market input price" raises the marginal revenue of input diversion, therefore should reduce X. Estimates of the coefficient on this variable are indeed negative and statistically significant. There is a positive but (statistically) insignificant effect of the plan price of output on X. This is again consistent with the model prediction derived under the assumption that the diversion cost function is separable, offering additional support for the hypothesis that there are few economies of scope in quota diversion.

In contrast, inspection of the signs of the estimated coefficients in the last three columns of Table 5 reveals that most of the variables do not operate as hypothesized under the assumption of perfect competition. Theoretically, an increase in $\ln P^i_{nt}$ raises the marginal revenue of diversion. Holding everything else constant, this should increase Q. Estimates

of the coefficient on $\ln P_{nt}^i$ in Panel A, however, are negative and statistically insignificant at the 5% level. Estimates of the remaining parameters are qualitatively similar to those in Columns 1-3, even though in theory they should differ substantially. For example, under perfect competition, both $\ln M_{nt}^i$ and $\ln W_{nt}$ should have negligible impact on Q_{nt}. The estimates in Table 5 show that both variables have significantly positive impact on Q_{nt}. The inconsistencies between theory and empirics under the assumption of perfect competition but not under the assumption of imperfect competition provides strong evidence against the hypothesis of perfect competition. They suggest that "log market output price" should be treated as an endogenous variable as implied by imperfect competition. In the discussion below, we maintain the hypothesis that product markets are imperfectly competitive.

To what extent did the effects of corruption on resource allocation change as a result the full implementation of the dual-track system that liberalized market prices in 1985? Answer to this question is of interest since estimates of corruption proceeds in Table 4 show that diversion of in-plan resources was already quite serious even in the early 1980s. A comparison of estimates before and after the liberalization in Columns 2 and 3 in Panel A shows that there is no qualitative change in how the output quota responds to changes in the included variables. This result reveals strikingly that even before the full implementation of the dual-track system, the allocation of in-plan resources is consistent with the hypothesis of corruption. The econometric analysis thus confirms the findings summarized in Table 4 that official diversion was not new and may well have existed before the economic reform. The findings here offer direct evidence of official corruption under planning. This paper thus provides strong evidence for Shleifer and Vishny's (1992) theory of shortage in Soviet-type economies.

But there are quantitative differences in the size of the estimated coefficients. The estimated Shleifer-Vishny effect is stronger before price liberalization: a one percentage point increase in the plan price would reduce the output quota by 73,000 yuan between 1980 and 1984 and by 56,600 yuan between 1985 and 1989. The estimated effects of $\ln M_{nt}^i$ and $\ln W_{nt}$ on Q_{nt} are stronger after the liberalization: a one percentage point increase in the market input price (the wage rate) would increase output quota by 37,400 yuan (11,500 yuan) between 1980 and 1984 and by 42,000 yuan (65,500 yuan) between 1985 and 1989. However, Wald tests, conducted separately for each parameter pair, rejected at 5% significant level only the hypothesis that the parameter on "log base wage rate" is identical before and after the liberalization. The decrease in the estimated Shleifer-Vishny effect

after the liberalization is not statistically significant.

The increase in the response of output quota to changes in the base wage rate, and less statistically significantly in the market price of input, is probably due to increased product market competition as a result of the price liberalization and the concurrent reduction in entry barriers into industries once monopolized by state-owned enterprises. Evidence of increased competition is provided by Li (1997) who finds that the estimated markup ratio (or the Lerner index) of state-owned enterprises declined significantly between 1980 and 1989. As increased competition squeezes tighter a firm's profit margin, an increase in the marginal cost of production will likely be passed through more fully to the customers in the form of increased output price. Holding everything else constant, an increase in the wage rate or in the market price of input in a more competitive environment would likely cause a higher upward shift in the equilibrium market price of output. This in turn would induce a higher rise in output quota.

Diversion of in-plan resources is also expected to intensify product market competition. As discussed in Section 3, by selling in-plan goods at market prices, the corrupt official competes against the producer in the market. As a result, the output quota imposed on the enterprise should have a negative effect on the equilibrium market price. To test this and other implications summarized in equations (4)–(6), I estimate (31) using the GMM procedure discussed earlier. Table 6 reports the regression results. For comparison, I also report an OLS regression in Table 6.

[Table 6 about here.]

Inspection of the signs of the GMM estimates in Table 6 reveals that all variables operate as predicted. The estimated coefficients on ΔQ_{nt} are all negative, suggesting that quota diversion did exert competitive pressures on imperfectly competitive producers. For any given output quota, an increase in either the market price of input or in the base wage rate raises the marginal cost of production and therefore should prompt the enterprise to raise its market price. As predicted, the estimates of the coefficients on $\ln M_{nt}^i$ and $\ln W_{nt}$ are all positive.

But there are visible differences in the magnitudes of GMM estimates under different model specifications. Column 1 (GMM1) report GMM estimates using the full sample under the assumption that coefficients in (31) are time invariant. Conceptually, this regression is problematic. The main reason is that prices were liberalized in January 1985, so the

"market" prices before 1985 are not true market prices. As discussed in Section 2, "market" or rathar "negotiated" prices were still under tight price control to keep them close to their corresponding plan prices. As a result, changes in plan prices would influence changes in "market" prices before 1985. It is thus unlikely that the plan price of output is uncorrelated with the idiosyncratic error term ϵ_{nt}, making $\ln p^i_{nt}$ an invalid instrument over the time period between 1980 and 1984. The estimates under this specification are likely biased. Indeed as shown in Panel B of Table 6, this specification is rejected by Hansen's (1982) test of over-identifying restrictions at 5% significance level.

In Columns 2 and 3 (GMM2), I report GMM estimates of (31) in a specification that allows parameters to vary before and after the price liberalization. The estimates before and after 1985 are substantially different. A Wald test of parameter stability rejects the null hypothesis that the parameters are time invariant at 1% significance level.[30] This is now intuitive. The estimates for the period between 1980 and 1984 are likely biased since the plan price p^i_{nt} is unlikely to be a valid instrument before price liberalization. Perhaps because estimates of the parameters for the post-liberalization period are unbiased, this specification (GMM2) is not rejected by Hansen's test of over-identifying restrictions which has a p-value equal to 0.20.

Given the problem with pre-1985 "market" prices, I rerun the regression using a subsample that contains observations between 1985 and 1989. The regression results are reported in Column 4 (GMM3). Deleting pre-1985 observations changes the parameter estimates only slightly when compared to the post-liberalization estimates in Column 3. But it raises the p-value of Hansen's test (to 0.35).

A comparison of the GMM estimates with the OLS estimates in Columns 6 and 7 reveals that there are substantial differences between the two estimates. For one, GMM estimates of the effect of output quota on the market price of output are much stronger than OLS estimates. Conceptually, an increase in the demand for the output, if anticipated by the official, would induce the official to raise the output quota. One therefore expects that changes in output quota be positively correlated with the idiosyncratic error ϵ_{nt}. The positive correlation would tend to bias the OLS estimate of the coefficient on ΔQ_{nt} upward (or downward in absolute value). This offers a plausible explanation for noted differences bewteen OLS and GMM estimates of the coefficient on ΔQ_{nt}.

[30]The test statistics, distributed χ^2 with 4 degrees of freedom under the null, is 31.35, while the 1% critical value is only 13.3.

The GMM estimates offer additional evidence in support of the hypothesis of imperfect competition. Under perfect competition, the market price of output should equal the marginal cost of production. This has two implications. First, an increase in the output quota that a firm faces should not affect production on the margin, even though it will affect the firm's profitability since imposing an output quota is equivalent to imposing a lump sum tax. This implication is contradicted by empirical evidence. The GMM estimates of the coefficient on ΔQ_{nt} is negative and statistically significantly different from zero. The second implication of marginal cost pricing is that any percentage change in the marginal cost of production should translate into an equal percentage change in the market price of output. The estimated elasticities of the market price of output with respect to the input price and the base wage rate are 0.151 and 0.220, implying that a one percentage point increase in both input price and in wage rate would increase output price by 0.371%. The estimated elasticities appear too small to support the implied complete pass-through of the marginal cost to the market price of output. But under imperfect competition, an increase in the marginal cost need not be translated into an equal increase in the market price of output. Table 3 shows that during the sample period, market prices of material inputs rose much faster than market prices of output, suggesting that on average some of the increases in input prices were "absorbed" by state-owned enterprises through reduced profits and improved productivity (Li, 1997).

In sum, the empirical analysis has shown that the allocation of in-plan resources between 1980–89 in China exhibits strong empirical patterns, and that these patterns strongly support the joint hypothesis of official corruption and imperfectly competitive product markets. The analysis has also shown that there is little qualitative change in the patterns of in-plan resource allocation before and after the full implementation of the dual-track system in 1985. This finding suggests that the diversion of in-plan resources was a not a new phenomenon, rather it thrived even before the formal introduction of the dual-track system.

4.5 Discussion

While this paper offers strong evidence for the Shleifer-Vishny effect of corruption on resource allocation, it is useful to point out a subtle but important difference in the industrial organization of corruption in China from that analyzed in Shleifer and Vishny (1993). In Shleifer and Vishny (1993), each corrupt official is a monopolist providing government-

owned goods and services for private gain. There exists no other channel by which one could obtain the goods or services. In this case, one way to reduce corruption is to introduce competition by allowing more than one official to provide identical services. Under the dual-track system, however, the corrupt official competes against the producer of the good that he diverts.

Conceptually, the corruption under the Chinese dual-track system would be identical to that in Shleifer and Vishny (1993) if the corrupt official and the firm collude perfectly so that the interests of the official and the firm are perfectly aligned. The firm-official combination in this case would set aside just enough output, say d, for sale on the market to satisfy any bureaucratic requirement. But it would produce and procure, at the margin, output at the plan price p and then divert a portion of the procured output the market. The production would not be determined by equating the marginal revenue to the marginal cost of production, rather it would be determined by equating the marginal revenue to the plan price plus the marginal cost of diversion. Just as in Shleifer and Vishny (1993), the cost of production would be immaterial to the allocation of in-plan resources as long as it is borne by the government. As a result, changes in the market price of input and in the wage rate should have negligible effects on Q_{nt}. The predictions are inconsistent with the estimated positive coefficients on $\ln M^i_{nt}$ and $\ln W_{nt}$ in Panel A of Table 5. The results provide evidence supporting Byrd's (1992) finding in a case study that there are sufficient conflicts of interest between the official and the firm.

While the evidence suggests that the dual-track system introduced competition against corrupt officials, the competition here is different from the type discussed in Shleifer and Vishny (1993). In Shleifer and Vishny (1993) competition comes from other corrupt officials offering identical services, so it could force the equilibrium market price to converge to the plan price and eliminate corruption all together. Under the Chinese dual-track system, the firm faces the quota imposed by the official, so its output or pricing decisions are dependent on the actions of the official. We therefore expect that the competition between the firm and the official be less intensive than the competition between officials offering identical services. The competition identified here is not expected to have much restraint on corruption.

5 Conclusion

Exploiting a unique data set containing detailed transaction and price data from a panel of 769 Chinese state-owned enterprises, this paper estimates corruption proceeds from official diversion and analyzes the effects of corruption on resource allocation. Estimates of corruption proceeds range from 8% of GNP in 1980 to 11% of GNP in 1988. Corruption was pervasive both before and after the full implementation of the dual-track system in 1985. More important, corruption is found to have significant impact on the allocation of both in-plan and outside-plan resources under the dual-track system in China in ways that are consistent with implications of an extended version of Shleifer and Vishny's (1993) model of corruption. The fixed-effects tobit regressions show that an increase in the plan output price — part of the marginal cost that the corrupt official faces — significantly lowers the procurement and diversion of output quota both before and after the implementation of the dual-track system.

The fixed-effects tobit regressions also provide evidence that the product markets in China in the 1980s were not perfectly competitive. Estimates of the effects on output and input quotas of the market output price, the market price of input and the wage rate are inconsistent with the joint hypothesis of corruption and perfect competition, but consistent with the joint hypothesis of corruption and imperfect competition. The evidence suggests that the market output price cannot be treated as an exogenous variable to the firm. Subsequent GMM regressions of the output pricing equation provides coroborating evidence in favor of the joint hypothesis of corruption and imperfect competition. In particular, it is found that an increase in the output quota imposed on the firm would help lower the market price of output (after controlling for the implied endogeneity). This finding provides evidence supporting the model of the dual-track system in Li (1999).

The findings suggest that it was not the dual-track system *per se* that bred corruption: Corruption had been pervasive before the full implementation of the dual-track system in 1985. The culprit is the continued reliance on the plan. By introducing the market track, the dual-track system represents a half-way move from the plan toward the market. Economic benefits of such a move have been studied in depth (see for example Byrd, 1991; Lau et al., 1997; Li, 1999; Lau et al., forthcoming). But, as the evidence in this paper shows, this reform strategy has a serious downside — corruption. The dual-track system allowed corruption to continue to exert an allocative role in the economy. This allocation is distorted since corrupt

officials would procure and divert more resources the larger the gaps between market and plan prices. Given the arbitrariness of the plan prices, some goods may be over-procured and hence over-produced while others under-produced. However, this misallocation might be partially mitigated by the limited competition between corrupt officials and the producers. In addition, the introduction of the market track helped monetize corruption and may have significantly reduced the transaction costs of official diversion. Under tight price control, corrupt officials would have to rely on costly barter exchanges to trade diverted goods. By reducing the transaction costs of corruption, the dual-track system may have increased the pervasiveness of corruption in China. By helping monetize corruption, the dual-track system also heightened public awareness of corruption.

Public outrage against corruption and the lack of official accountability erupted in 1989. Massive demonstrations were held in Tiananmen Square from April 18 until June 4 1989. The bloody crackdown that followed has turned out to be a watershed event for China. Although the post-crackdown government has yet to introduce democratic reforms, it did try to tighten the oversight over official behavior. After a short hiatus, economic reform resumed and planning was gradually phrased out in the industrial sector.[31] On January 1, 1994, China also ended the dual-track system for foreign exchanges by abandoning the official exchange rate and allowing the currency swap markets and later the inter-bank currency markets to determine the exchange rate for current account purposes.[32] By the mid-1990s, hardly any industrial goods were still allocated under the plan. However, the government continues to impose centralized control over the financial sector. It continues to impose stringent capital control to block the outflow of domestic savings, and it continues to repress deposit and loan interest rates, and to restrict the listing of firms on China's stock exchanges (Gordon and Li, 1999). As a result of these changes, corruption in China has gradually shifted from industrial production and distribution sectors of the economy to

[31] On September 1992, China freeed the prices of all but 111 production materials and delegated control over 22 of the others to localities. See "China Lifts Controls on Prices of 593 Items," Asian Wall Street Journal, September 2, 1992.

[32] The central bank continues to intervene in domestic currency markets and have so far managed to maintain a stable yuan/$ exchange rate. But under stringent capital control, the yuan remains a non-convertible currency on the capital account.

other sectors, most notably the financial sector.[33] By most accounts,[34] China remains one of the most corrupt countries in the world.

References

Andrews, D. W. K. (1991). Heteroskedasticity and autocorrelation consistent covariance matrix estimation, *Econometrica* **59**(3): 817–858.

Byrd, W. A. (1991). *The Market Mechanism and Economic Reforms in China*, M.E. Sharpe, New York.

Byrd, W. A. (1992). *Chinese Industrial Firms under Reform*, Oxford University Press, Oxford.

Gordon, R. H. and Li, W. (1999). Government as a discriminating monopolist in the financial market: The case of China. Duke University.

Hansen, L. P. (1982). Large sample properties of generalized method of moments estimators, *Econometrica* **50**: 1029–1054.

Heckman, J. J. and MaCurdy, T. E. (1980). A life cycle model of female labour supply, *Review of Economic Studies* **47**: 47–74.

Honoré, B. E. (1992). Trimmed LAD and least squares estimation of truncated and censored regression models with fixed effects, *Econometrica* **60**: 533–565.

Hu, H. (1989). 1988 nian woguo zhujing jiazhi de gushuang (estimation of the value of rents in China in 1988), *(Jingji Shehui Tizhi Bijia (Comparative Economic and Social Systems)* .

[33] One particular corruption scheme involves diverting bank loans given to a state-owned organization into private investment accounts on the stock market or into private real estate investments; see Huang (1996, p. 259–260). Corrupt officials keep the upsides of these investments, but leave the banks to pick up the downside risks. Although no reliable statistics are available, it is believed (Huang, 1996) that a good portion of China's non-performing bank assets is linked to official corruption.

[34] Transparency International's (1999) "poll of polls" corruption perception index gives China a score of 3.5 (out of a perfect score of 10). China was tied with Namibia and ranked lower than El Salvador and Belarus.

Huang, W. (1996). *Zhongguo de Yingxing Jingji (The Hidden Economy in China)*, Commercial Publishing House, Beijing.

Huang, W. D. and Li, F. (1991). *Dangdai Zhongguo de Xiaofei Zhi Mi (Consumption Puzzles in Contemporary China)*, Commercial Publishing House, Beijing.

Johnson, S., Kaufmann, D., McMillan, J. and Woodruff, C. (1999). Why do firms hide? bribes and unofficial activity after communism. MIT manuscript.

Lau, L., Qian, Y. and Roland, G. (1997). Pareto–improving economic reforms through dual-track liberalization, *Economics Letters* **55**: 285–92.

Lau, L., Qian, Y. and Roland, G. (forthcoming). Reform without losers: An interpretation of china's dual-track approach to transition, *Journal of Political Economy* .

Li, W. (1994). *Essays on the Economics of Transition*, PhD thesis, University of Michigan.

Li, W. (1997). The impact of economic reform on the performance of Chinese state enterprises, 1980–1989, *Journal of Political Economy* **105**(5): 1080–1106.

Li, W. (1999). A tale of two reforms, *Rand Journal of Economics* **30**: 120–136.

Mauro, P. (1995). Corruption and growth, *Quarterly Journal of Economics* **110**: 681–712.

Naughton, B. (1995). *Growing Out of the Plan: China's Economic Reform 1978–1992*, Cambridge University Press, Cambridge, UK.

Shleifer, A. and Vishny, R. W. (1992). Pervasive shortages under socialism, *Rand Journal of Economics* **23**: 237–246.

Shleifer, A. and Vishny, R. W. (1993). Corruption, *Quarterly Journal of Economics* **108**: 599–617.

State Statistical Bureau (1989a). *China Statistical Yearbook*, China Statistical Publishing House, Beijing.

State Statistical Bureau (1989b). *China Statistical Yearbook of Industrial Economy*, China Statistical Publishing House, Beijing.

State Statistical Bureau (1991). *China Statistical Yearbook*, China Statistical Publishing House, Beijing.

Tirole, J. (1988). *The Theory of Industrial Organization*, MIT Press, Cambridge, MA.

Transparency International (1999). Corruption perception index. `http://www.transparency.de/`, Otto-Suhr-Allee 97/99, 10585 Berlin, Germany.

World Bank (1997). *World Development Report: The State in a Changing World*, Oxford University Press, New York.

Yang, S. and Li, J. (1993). *The Historical Role of the Dual-Track Pricing System (Jiage Shuangguizhi de Lishi Mingyun)*, Chinese Social Sciences Publishing House, Beijing.

Table 1: Average ex-factory plan and market prices of four industrial commodities, 1987–1989. Market prices exceeded plan prices by a large margin.

Commodity	Price	1987	1988	1989
Steel	Plan	859.80	964.80	1078.00
(yuan/ton)	Market	1432.60	1514.60	1870.80
	Market/Plan	1.67	1.57	1.74
Aluminum	Plan	4367.00	4922.00	5261.00
(yuan/ton)	Market	6093.00	8444.00	10430.00
	Market/Plan	1.40	1.72	1.98
Coal	Plan	35.89	39.54	42.25
(yuan/ton)	Market	80.00	110.00	153.40
	Market/Plan	2.23	2.78	3.63
Timber	Plan	150.00	158.15	160.62
(yuan/m^3)	Market	368.87	435.38	481.40
	Market/Plan	2.46	2.75	3.00

Source: Yang and Li (1993), p. 58–59.

Table 2: Comparing market sales and market purchases by state-owned enterprises, 1987.

	Proportion of output sold by producers at market prices	Proportion of input bought by firms at market prices
Steel	22%	55%
Cement	66%	85%
Non-ferrous metals	33%	N/A[1]
Aluminum	N/A[1]	48%
Chemical raw materials	36%	N/A[1]
Caustic soda	N/A[1]	52%

Source: Huang and Li (1991, p. 225).
[1] Not available.

Table 3: Dual-track system as seen from a diverse sample of state-owned enterprises.

	Output			*Material Inputs*		
Year	Market Price Inflation[a]	$\left(\frac{\text{Market } P}{\text{Plan } P} - 1\right) \times 100\%$[b]	Percent Sold at Plan P	Market Price Inflation[c]	$\left(\frac{\text{Market } P}{\text{Plan } P} - 1\right) \times 100\%$[d]	Percent Bought at Plan P
1981	0.6	3.3	69	1.3	22.3	60
1982	2.4	5.4	69	1.0	15.9	58
1983	2.2	4.4	69	2.0	30.8	56
1984	3.2	5.8	68	7.1	24.0	53
1985	7.3	15.5	66	5.2	29.8	46
1986	9.3	25.5	66	19.0	41.4	42
1987	4.6	17.1	65	11.9	63.4	38
1988	22.0	15.9	67	39.6	84.4	34
1989	21.2	39.3	65	18.7	117.1	32

Market prices between 1980 and 1984 were measured as the "negotiated" prices, which remained under price control until January 1985.

[a] Percentage change in market prices this year over the previous year, weighted by total sales measured in market prices.

[b] Weighted by total sales measured in plan prices.

[c] Percentage change in market prices this year over the previous year, weighted by total purchases of inputs measured in market prices.

[d] Weighted by total purchases of inputs measured in plan prices.

Table 4: Estimates of corruption proceeds using accounting data reported by state-owned enterprises.

Year	Output quota per firm[a]	Input quota per firm[a]	Corruption proceeds (R) per firm[b]	Sales-Weighted R/Sales (t-ratio)[c]	Imputed R/GNP[d]	Unweighted R/Sales (t-ratio)[c]
1980	33.6	18.6	15.0	22% (2.2)	8%	–2.5% (–0.3)
1981	32.2	16.0	16.1	26% (4.3)	8%	5.5% (1.0)
1982	30.4	16.8	13.6	29% (5.5)	9%	12% (2.0)
1983	32.0	21.5	10.5	23% (4.5)	7%	15% (3.3)
1984	33.9	20.4	13.4	27% (5.5)	8%	21% (5.1)
1985	36.2	20.6	15.6	29% (7.8)	8%	23% (6.6)
1986	37.7	17.4	20.2	36% (10.9)	9%	31% (12.8)
1987	45.6	17.1	28.5	47% (6.8)	11%	34% (10.0)
1988	45.2	14.1	31.0	47% (13.3)	11%	41% (20.3)
1989	44.2	14.1	30.1	45% (11.0)	10%	39% (16.0)
1980–89	37.2	17.7	19.6	35% (14.3)	9%	31% (19.2)

[a] Average output and input quotas per firm are measured in 1989 market prices (millions of yuan).

[b] Corruption proceeds = market value of output quota − market value of input quota.

[c] The number in parentheses are t-ratios. Robust standard errors for the estimates are estimated by regressing R/GIO on year dummies with correction for hetroskedasticity and autocorrelation.

[d] Corruption proceeds as a proportion of GNP is computed using (25). Data source: state-owned enterprises' contribution to national gross value of industrial output, State Statistical Bureau (1991), p. 396; industrial sector's contribution to GNP, State Statistical Bureau (1991), p. 31.

Table 5: Estimation of the output quota equation (29) (Panel A) and input quota equation (30) (Panel B) using Honoré's semi-parametric fixed-effects Tobit. The dependent variables, Q_{nt} and X_{nt}, are measured in 1989 market prices. For specifications under perfectly competitive output market, an additional regressor, "log market output price" is added. The time-specific effects, estimated by including year dummies in the regression, are not reported below. Estimation and hypothesis testing are done using Pantob, a library of GAUSS routines provided by Bo Honoré. The estimator uses the absolute value loss function. The numbers reported in parentheses are t-ratios (asymptotically normal statistics).

A. Output quota equation (29), Q_{nt} (10 millions of yuan)

	Imperfectly competitive mkts			*Perfectly competitive mkts*		
	1980–89	*1980–84*	*1985–89*	*1980–89*	*1980–84*	*1985–89*
Log market output price, $\ln P^i_{nt}$				-0.157	-0.319	-0.107
				(-1.227)	(-1.539)	(-0.887)
Log plan output price, $\ln p^i_{nt}$	-0.534	-0.730	-0.566	-0.421	-0.430	-0.472
	(-4.821)	(-6.968)	(-5.087)	(-3.248)	(-2.327)	(-4.080)
Log market input price, $\ln M^i_{nt}$	0.419	0.374	0.420	0.489	0.515	0.444
	(3.676)	(3.103)	(3.740)	(4.321)	(4.113)	(3.822)
Log plan input price, $\ln m^i_{nt}$	-0.175	-0.053	-0.157	-0.199	-0.147	-0.125
	(-1.686)	(-0.466)	(-1.376)	(-1.944)	(-1.336)	(-1.153)
Log base wage rate, $\ln W_{nt}$	0.395	0.115	0.655	0.396	-0.091	0.610
	(4.986)	(1.390)	(4.702)	(5.021)	(-0.869)	(4.594)
Observations [% censored]	7086 [22%]	7086 [22%]		7086 [22%]	7086 [22%]	

B. Input quota equation (30), X_{nt} (10 millions of yuan)

	Imperfectly competitive mkts			*Perfectly competitive mkts*		
	1980–89	*1980–84*	*1985–89*	*1980–89*	*1980–84*	*1985–89*
Log market output price, $\ln P^i_{nt}$				0.131	-0.099	0.077
				(2.032)	(-0.661)	(1.141)
Log plan output price, $\ln p^i_{nt}$	0.055	0.096	0.019	-0.062	0.225	-0.022
	(1.127)	(1.685)	(0.373)	(-1.073)	(1.585)	(-0.343)
Log market input price, $\ln M^i_{nt}$	-0.219	-0.170	-0.260	-0.225	-0.158	-0.224
	(-2.822)	(-2.778)	(-3.191)	(-2.725)	(-2.246)	(-2.418)
Log plan input price, $\ln m^i_{nt}$	-0.027	-0.026	0.013	-0.014	-0.060	-0.024
	(-0.369)	(-0.412)	(0.187)	(-0.165)	(-0.682)	(-0.261)
Log base wage rate, $\ln W_{nt}$	0.026	-0.082	0.163	0.037	-0.059	0.212
	(0.602)	(-1.436)	(2.402)	(0.825)	(-1.110)	(3.245)
Observations [% censored]	4434 [49%]	4434 [49%]		4434 [49%]	4434 [49%]	

Table 6: GMM and OLS estimation of the output pricing equation (31). The dependent variable is the year-on-year change in the log of market output price index, $\Delta \ln P^i_{nt}$. Not reported here are time-specific effects, which are estimated by including year dummies each regressions. Instrumental variables for GMM estimation are a constant, year dummies, and four exogenous variables ($\Delta \ln M^i_{nt}$, $\Delta \ln W_{nt}$, $\Delta \ln p^i_{nt}$, and $\Delta \ln m^i_{nt}$). There is one over-identifying restriction in specifications GMM1 and GMM3. In specification GMM2, the number of parameters increases by 3, while the number of instruments increases by 4, giving a total of 2 over-identifying restrictions.

A. Estimation	*GMM1*	*GMM2*		*GMM3*	*OLS*	
	1981–89	*1981–84*	*1985-89*	*1985–89*	*1981–84*	*1985-89*
Year-on-year change in						
Output quota ΔQ_{nt}	-0.105	-0.028	-0.290	-0.289	-0.003	-0.001
	(-1.109)	(-0.344)	(-4.822)	(-4.872)	(-6.767)	(-1.660)
Log market input price $\Delta \ln M^i_{nt}$	0.387	0.538	0.150	0.151	0.509	0.117
	(2.940)	(2.707)	(1.770)	(1.756)	(28.336)	(6.803)
Log base wage rate $\Delta \ln W_{nt}$	0.106	0.013	0.215	0.220	0.038	0.074
	(1.159)	(0.146)	(2.361)	(2.411)	(1.857)	(4.551)
Intercept	-0.022	-0.019		0.118	-0.011	
	(-0.979)	(-1.070)		(3.774)	(-1.622)	
Year dummies	Yes	Yes		Yes	Yes	
Number of observations	6439	6439		3655	6439	
B. Testing over-identifying restrictions						
Hansen's statitics, χ^2(DF)	4.27	3.19		0.80		
Degress of freedom (DF)	1	2		1		
p-value	0.04	0.20		0.37		