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A Welfare Measurement of China's Rural Forestry Reform During the 1980s

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Summary. — Rural institutional innovation in China encompassed changes in land tenure arrangements and commodity pricing practices, and their effects hinged on how they were carried out. Properly implemented, the incentive structure could improve, forest production would increase, and thus producers and consumers would benefit. Otherwise, if the reform programs were inappropriately implemented, as reflected in market control and price distortions as well as policy uncertainty, then the incentive structure might improve only slightly. Chances for production increase could be diminished, making it hard for producers and consumers to benefit. In addition to quantifying these impacts using contrasting cases, this article also suggests some policy implications in a broader context.

Key words — Asia, China, rural reform, forestry growth, welfare effect, market control

1. INTRODUCTION

According to the well-known induced innovation theory proposed by Hayami and Ruttan (1985), China's rural reforms since 1978 can be viewed as a drive of institutional innovation. [1] Although there were numerous specific reform programs, the institutional innovation encompassed two fundamental components. One is the land tenure and production organizational changes brought on by replacing the collective system with the household responsibility system (HRS), and the other is the introduction of market mechanisms, which occurred through the gradual shift from compulsory delivery quotas and planned prices to market-based transactions of commodities (Lin, 1992; McMillan, Whalley, & Zhu, 1989). [2]

It was widely viewed that the old institutional regime before the reform era was so badly designed and practiced that its prevalent disincentive and mismanagement created severe constraints on resource allocation, production efficiency, and technical progress (Johnson, 1988; Rozelle, Albers, & Li, 1997). As a result, productivity increase and economic growth were jeopardized for over two decades, and people's living standards remained stagnant. Therefore, the institutional innovation was launched immediately following the end of the Cultural Revolution. [3]

Unlike the unprecedented high-rate growth in agriculture (Lin, 1992; Ministry of Agriculture, 1989; Wen, 1993), however, responses to the innovation in the rural forest sector have been mixed (Ross, 1988; Yin, 1994; Yong, 1992).

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In the north-central region, a major farming area including Henan, Shandong, and other adjacent provinces (hereafter, north), tremendous afforestation efforts were made since the late 1970s. Not only were plantations, orchards, and shelterbelts established, but also a great number of commercial trees were introduced into farm fields by means of various agroforestry practices. As a result, the average rate of forest and tree coverage over the land surface increased from less than 5% in 1977 to 11% in 1988 (Ministry of Forestry, 1992). This change in resource endowments has, in turn, eased the local timber and fuel shortages, and improved the environment for agriculture. In the south, however, a traditional timber-exporting region that covers roughly provinces south of the Yangtze River, while existing resources were being depleted, no significant improvement was made in planting new trees and managing young forest stands. Consequently, the total stocking volume declined from 1,931 to 1,710 million m^3 in 1987. Even though there was an improvement in forest conditions in the 1990s, it was largely driven by mass campaigns, international financing, and government loans and subsidies (Rozelle, Husain, & Zazueta, 2000; Yin, 1995). [4] The objective of this article is thus to quantify empirically the benefits and losses of the rural forestry reforms using these two contrasting regional cases.

Why did China's forest sector grow so differently? It was believed that the primary cause was the sharp regional variations in the implementation of the reform policies (e.g., Yin, 1994; Yong, 1992). While both regions experienced increases in the share of private tenure for forest land and both witnessed improving market incentives, authorities in the south were slow to liberalize, and quick to modify and even rescind some of the reform measures (Yin & Newman, 1997; Wang, Liu, & Xu, 1991). In consequence, a different policy environment was created that may well explain the southern region's poorer performance.

As the HRS swept through China's rural society, the idea of a similar program for forestry rapidly gained appeal. It found easy acceptance by provincial and local officials in the north, because forestry was a less important sector at that time. A household forest tenure system quickly followed. Trees on or near contracted farmlands were assigned to agricultural households and bare lands suitable for planting trees were also allocated to households. A few larger shelterbelts and commercial forest plantations that remained in collective ownership were also contracted to household management. Furthermore, authorities allowed farmers in this region to sell timber at market prices. Harvest permits were unnecessary, state procurement agencies were not existent, and taxes were low—rarely higher than 5% of sales revenues. Overall, these arrangements were well received by farmers, and they have prevailed (Zhong, Xian, & Li, 1991; Yong, 1987).

The experience of the south was very different. Doubts about the validity of the HRS for forestry arose. Initially, regional officials denied household rights to forestland on the presumption that family operations were too small to support longer-term forestry management activities. In general, only fragmented and less productive forests and woodlots were contracted to household management and, by the end of 1984, more than 70% of the forests in the region remained under collective control. Later, popular objections forced the authorities to adopt slowly certain compromised contract arrangements for collective forests in many areas. Beginning in 1986, contracted timberlands and private woodlots, which had been allocated to individual households earlier, were merged and the contractual terms were modified in the favor of households (Yin, 1994).

Meanwhile, the central government attempted to lift control over southern timber markets in 1985 and it did so in a drastic manner. Although farmers were not yet convinced that the policy would last, local authorities became concerned about the possibility of a forest liquidation induced by the policy shift and the stagnation of resource management. In 1986, they reversed the policy by returning timber markets to the control of state procurement companies and restored tough regulations on harvest volumes. Farmers had to apply for cutting and hauling permits for those trees that remained under their contracts. Farmers could sell only to the state procurement companies and only at prices that were approximately half of the market prices. Subsequently, local governments began reconsolidating contracted timberlands. They also raised forest taxes and fees on farmers in order to fund the government's planned reforestation activities (State Forestry Administration, 2001).

After reviewing these contrasting experiences, Yin and Newman (1997) formally estimated a supply-response model for the two regions. Their evidence showed that in the north, timber harvest and acreage rose by

184.0% and 115.9% from 1978 to 1989, respectively. Of the 94.8% stocking volume increase, 48.3% was due to the institutional innovation (26.5% from price changes and 21.8% from tenure changes), which implies an annual inventory growth of 3.5%. On the other hand, timber harvest and forest acreage increased 10.4% and 8.3% in the south during the same period, while timber inventory actually decreased by 9.6%. Changes in timber prices were able to offset the inventory decline by 13.2%, with changes in land tenure having had little impact. Together, reform policies only contributed to an annual rate of 0.1% inventory growth. Using an expanded dataset and a slightly different estimation strategy, Zhang, Uusivuori, and Kuuluvainen (2000) confirmed these major findings.

With knowledge of the contribution of the institutional innovation to resource expansion, it is then conceivable to assess the total and distributional welfare impacts of the forestry reforms if we can derive the timber supply elasticity of forest inventory. This is because timber supply is partially a function of forest inventory. If we know the supply elasticity of forest inventory in addition to the inventory changes resulting from the institutional innovation, then we can obtain the stumpage supply shifts; if we know the stumpage supply shifts, then we can further estimate the welfare impacts of the forestry reform. This is the exercise we will perform in this paper. To that end, we will adopt the estimated inventory changes induced by the institutional innovation from Yin and Newman (1997) and the estimated stumpage demand and supply systems from Yin (1995). We think that this effort to address one of the basic questions regarding China's forestry reform—who has benefited by how much—is both important and necessary. It will provide us with an ultimate economic rather than simply a physical measure as to how successful the forestry reforms have been. Further, this measurement can provide some interesting lessons and policy implications to not only China but also potentially to other developing countries for improved resource management.

Moreover, while Zhang *et al*. (2000) and Yin and Newman (1997) emphasized that a critical problem in the south was the existence of market control and heavy taxation, they could not look into its welfare effects. Undoubtedly, these practices have led to large sums of benefits being transferred to government agencies. Table 1 reports different timber prices in the two regions. Therefore, we are also interested in identifying effects of welfare transfers and deadweight losses from government market control and price distortions. We hope that this will shed additional light on the relationship between the incentive structure and farmer's response.

In the following sections, we present the analytical methods and market model estimation first, then we report our empirical results for

Table 1. *A comparison of timber prices (yuan/m³) in different regions of rural China*[a]

Year	North[b]		South			
	Fuyang	Suxian	Fuzhou		Yichun	
	Market price	Market price	Procurement price	Retail price	Procurement price	Retail price
1976			30.2	68.5	24.4	67.0
1977			28.3	66.1	23.0	66.5
1978			25.0	66.6	25.3	67.7
1979	139.2	122.0	38.1	70.1	35.3	73.4
1980	168.5	152.0	46.3	83.3	50.5	87.8
1981	205.8	184.0	45.8	97.1	61.1	97.6
1982	249.5	222.0	56.5	104.3	63.9	108.1
1983	262.2	255.1	48.8	105.4	55.0	109.7
1984	264.9	297.0	55.3	108.9	57.9	116.3
1985	310.8	368.9	83.9	174.5	99.5	165.9
1986	351.5	377.3	93.0	207.5	117.9	226.2
1987	436.0	457.2	126.0	289.8	177.4	346.3
1988	630.1	667.8	171.4	444.1	173.1	502.1
1989	741.7	787.0	169.3	436.7	189.9	473.2
1990	639.0	698.0	170.4	350.3	164.8	386.4

[a] Data were collected from local timber companies. Prices are average across species and grades.
[b] "North" represents the north-central farm region, and "south" is the southern timber production region.

the welfare benefits and/or losses from increased stumpage supply and imposed market distortions. Finally, we discuss our study's implications.

2. METHODS

Alternative ways exist for calculating the welfare triangle areas arising from supply shifts. Ideally, given all the parameter estimates, we can first solve the demand and supply equations simultaneously to derive the equilibrium prices and quantities before and after the shifts of stumpage supply, and then determine the exact welfare measures (Varian, 1992). But this approach requires demand and supply schedules to be estimated with considerable precision; otherwise, the results might be obscured. Another way is to approximate linearly the welfare measures based on the price elasticities of demand and supply, and the amount of a supply shift due to inventory changes. Although it may not be exact, this approach is simpler and the derived results can be maintained within a meaningful range. Therefore, we choose this linear approximation method in our analysis.

The specific method for calculating the welfare benefits from supply shifts was originally derived by Hertford and Schmitz (1977). It was then introduced into the forest sector by Bengston and Gregerson (1986) and Newman (1990) in evaluating the effects of technical changes in forest products industry and forest management. In addition to linear demand and supply functions, a parallel shift in the supply curve is adopted in these works. The formulas for calculating the changes in consumer benefits (CB), producer benefits (PB), and total benefits (TB) are:

$$\mathrm{CB} = (\kappa P_1 Q_1/(\eta+\epsilon))[1 - 0.5(\kappa\eta/(\eta+\epsilon))] \tag{1}$$

$$\mathrm{PB} = \kappa P_1 Q_1(1 - (1/(\eta+\epsilon))[1 - 0.5\kappa(2\eta+\epsilon)/(\eta+\epsilon)]) \tag{2}$$

$$\mathrm{TB} = \mathrm{CB} + \mathrm{PB} = \kappa P_1 Q_1[1 + 0.5(\kappa/(\eta+\epsilon))] \tag{3}$$

Referring to Figure 1, κ is defined as the percentage increase in production attributable to the shift induced by the institutional innovation (the horizontal distance between the two supply curves divided by final production, that is, $\kappa = (s_1 - s_0)/Q_1$). Because our analysis is *ex post* in nature, P_1 is the stumpage price after the supply shift occurred or the observed market price; and η and ε are the absolute values of price elasticities of timber demand and supply. With demand held constant, TB represents the gains in social welfare from expanding the entire market by shifting out supply from s_0S_0 to s_1S_1 (the area s_0ABs_1); CB represents the increased benefit that stumpage buyers receive by being

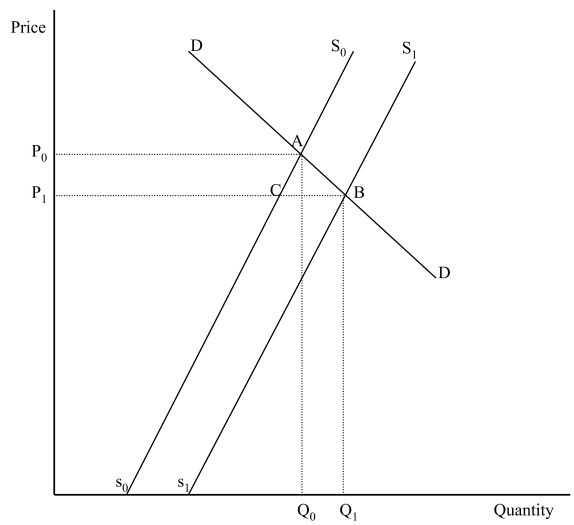

Figure 1. *Welfare effects from supply shift.*

able to purchase a greater quantity of timber at a lower price (i.e., the difference between what buyers would be willing to pay for stumpage and what they actually pay, P_0ABP_1); and PB represents the gains in profit and rent to producers and other fixed factors of production from selling more stumpage (s_0CBs_1) minus the lost profit and rent due to selling at a lower price (P_0ACP_1).

The above equations contain several important *ceteris paribus* results: (a) if the sum of the demand and supply elasticities ($\eta + \varepsilon$) is less than 1, PB is negative as the price reduction is greater than the quantity increase; (b) the smaller the price elasticity, η, the larger is CB; conversely (c) the larger η, the larger is PB; and finally (d) the effects of the elasticity magnitudes themselves on TB are very small, given normal values of κ, η, and ε. Namely, the initial size of the market and the expected κ value will largely determine the size of TB.

The premise of our evaluation with the above formulas is the following three assumptions with regard to how productivity change occurs and how it affects the stumpage market (Newman, 1990). The first assumption is that the shifts that occurred in the supply function are exogenous, which seems reasonable given the fact that supply shifts came from institutional changes. The second assumption is that the changes in the level of standing timber can serve as an adequate instrument for the analysis of productivity-enhancing policies. That is, although the policy impacts can be reflected in both acreage augmentation and management intensification, the ultimate indicator of productivity improvement is reflected in the increased forest inventory. The last assumption is that annual welfare gains can be measured as individual one-year shifts in the supply function.

Under these assumptions, we assess the annual welfare gains/losses for the two regions during 1985–90.

Since the estimates of price elasticities used in calculating welfare measures are themselves random variables, we also derive the confidence intervals for these measures. Considering potential data and estimation problems associated with demand and supply functions, we feel that this is a useful step. Assuming that estimated elasticities are normally distributed, a $(1 - \alpha)$ confidence interval is obtained by ranking the vector of calculated welfare values and dropping the $\alpha/2$ values from each tail of the ranked vector from 3,000 drawings. As the welfare measures are nonlinear functions of elasticity estimates, the computed confidence intervals may not be symmetric.

To assess welfare transfer and deadweight losses due to government market control and price distortions, the approach proposed by Just, Hutch, and Schmitz (1982) is used. Corresponding to Figure 2, total welfare transferred to the government (TL), deadweight loss (DL), consumer loss (CL), and producer loss (PL) are computed with the following formulas:

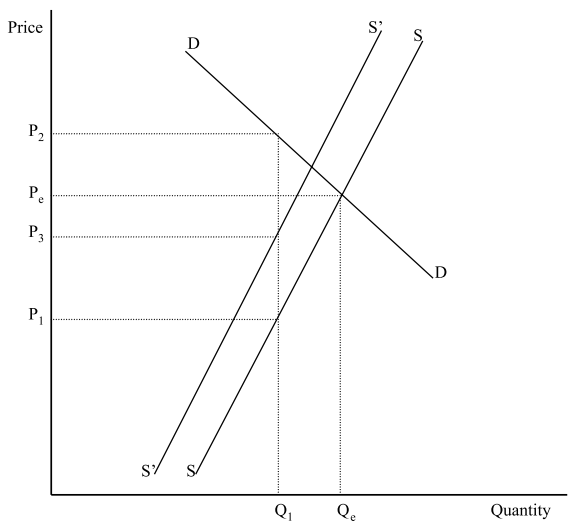

Figure 2. *Welfare effects from price distortion.*

$$TL = Q_1(P_2 - P_1) \quad (4)$$

$$DL = 0.5(Q_e - Q_1)(P_2 - P_3) \quad (5)$$

$$CL = Q_1(P_2 - P_e) + 0.5(Q_e - Q_1)(P_2 - P_e) \quad (6)$$

$$PL = Q_1(P_e - P_1) + 0.5(Q_e - Q_1)(P_e - P_3) \quad (7)$$

where Q_1 is the quantity supplied; P_1 the procurement price received by farmers; and P_2 is the market price received by timber companies. The quantity is defined as the annual sum of the cross-sections of our sample, while price is the annual average of the cross-sections. In addition, P_3 represents the procurement price multiplied by a factor of 1 or 1.5 under different assumptions regarding the deadweight loss calculation, and P_e and Q_e are market equilibrium price and quantity.

It is noteworthy that if we simply use government procurement prices to compute the price gaps, the deadweight losses might be overestimated because procurement and sales expenditures incurred by state timber companies are a portion of the overall supply costs. As such, they should be deducted from the sales prices in estimating the welfare losses. In our calculation, the timber sales prices are subtracted by two different procurement prices in order to get a possible range of distortions, one being the original procurement prices as the upper bound for welfare losses (Scenario I), and the other being the procurement prices multiplied by a factor of 1.15 as the lower bound for welfare losses (Scenario II). The 15% addition to the original procurement prices is an approximation to procurement and sales costs incurred by state timber companies. [5]

In addition, since state procurement companies sell timber to other regions, the demand elasticity in the south cannot be used for the calculation. What comes to our mind is that the one in the north may serve as a proxy. This idea is plausible because the north well reflects the relationship between quantities demanded and prices offered in those markets where the southern timber is consumed. In fact, the north was one of the major markets for the southern timber before the late 1980s.

Further, notice that consumer benefits, as defined here, are associated with the Marshallian demand curve. Therefore, consumer benefits are an exact measure of welfare change only in the case where the utility function is quasi-linear (Varian, 1992). Nonetheless, consumer benefits may still be a reasonable approximation in our case. As Hertford and Schmitz (1977) argued, because the bias is probably not substantial and, for a normal good, consumer benefit is bounded by the compensating variation and equivalent variation. In addition, when trade is involved, the above formulas for calculating welfare benefits from shifts in stumpage supply need to be modified. As

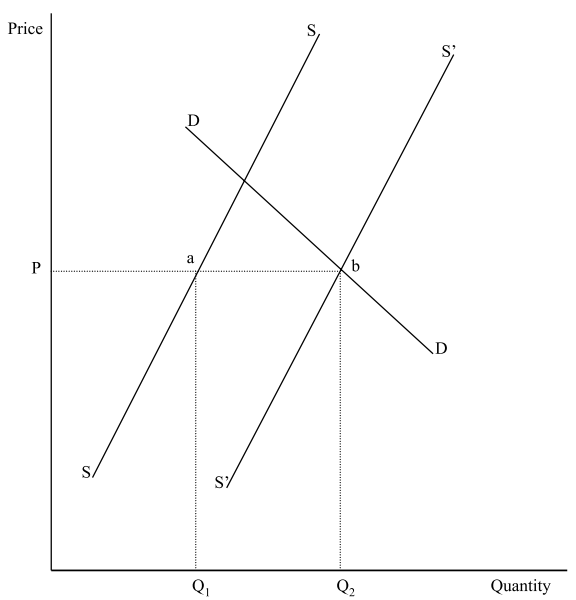

Figure 3. *Welfare effects from supply shift—an imported good.*

shown in Figure 3, if the supply shifts from SS to S′S′ and the "small country" assumption is used, there is no gain to consumers, but producers gain the area SabS′. The result is a smaller surplus, *ceteris paribus*, attributable to the institutional innovation than would have been the case had commodity not been traded at a constant "world" price. Because more than a half of the timber produced in the south was exported, it is natural to incorporate this factor into our analysis. On the other hand, since the late 1980s, over 95% of the timber consumed in the north has been produced within the region. Therefore, we will ignore the effect of imports and treat it as a "closed" economy. As such, the total welfare benefits in the north may be biased upwards, while those in the south may be biased downwards.

3. DATA

The stumpage supply and demand functions used in our welfare analysis come from Yin (1995). To facilitate understanding, we discuss the underlying data and estimation of these functions in this section. To model the regional stumpage markets, a set of panel (time-series and cross-sectional) data were collected for each of them from the local statistics bureaus and forestry divisions. The data set for the south covered 11 years (1979–89) and included six neighboring prefectures (Yichun, Ji-an, Fuzhou, and Gangzhou in Jianxi Province, and Nanping and Sanming in Fujie Province). The data set for the north contained 44 annual observations in four prefectures (Fuyang and Suxian in Anhui Province, and Kaifeng and Zhoukou in Henan Province), covering 1980–90.

The supply model was specified as a function of timber price, agricultural price (index), and standing inventory. Likewise, the demand model was specified as a function of timber price, agricultural price, per capita income, and population. Price and income variables were deflated by the price index for rural industrial products to obtain real values. To remove heteroskedasticity, the observations of timber production, consumption, inventory, and population were normalized by the 1980 population of every sample prefecture. The empirical model was estimated by the one-way fixed effects procedure (Greene, 1993). Because of the government market control in the south, the stumpage prices were exogenously determined, implying little interaction between demand and supply. Hence, demand and supply were not estimated simultaneously, and the north was treated similarly. Moreover, given the different market settings between the two regions, the stumpage market systems were estimated separately. Regression results are presented in Table 2.

It can be seen that, in the north, the supply elasticity of stumpage price is 0.80. Given the substantial price increase during the period of concern, this indicates that roundwood supply was fairly responsive. In contrast, an elasticity of 0.14 in the south implies that supply was unresponsive to price. As to the relationship between agricultural goods and stumpage, we found that they could be substitutes or complements, however, the cross-price effects in both cases were insignificant. The supply elasticity of inventory was significant in each case. In the north, a 10% increase in inventory

Table 2. *Estimated results of regional stumpage markets in China*[a]

Variable	North[b]		South[b]	
	Supply	Demand	Demand	Supply
Intercept	−12.54 (−7.37)**	−2.77 (−6.92)**	−1.02 (−6.43)**	−0.04 (−0.1 7)
Timber price	0.80 (3.25)**	−0.45 (−0.86)	0.14 (1.79)*	−0.04 (−0.27)
Agricultural price	0.26 (0.60)	−1.58 (−1.65)*	−0.04 (−0.18)	−0.60 (−1.44)
Inventory	1.23 (2.63)**		0.59 (7.48)**	
Income		1.44 (2.58)**		0.43 (1.94)*
Population		4.18 (4.04)**		0.44 (3.06)**
df	37	36	56	55
R^2	0.87	0.68	0.97	0.48

*Significant at the 0.05 probability level.

**Significant at the 0.025 probability level.

[a] These results were originally estimated in Yin (1995). Values in parenthesis are *t* statistics of two-tail test.

[b] North represents the north-central farm region, and south is the southern timber production region.

brought about a 12.3% increase in supply. This elastic result was not inconsistent with our expectation in the region in which both timber harvest and inventory rose tremendously, with the former growing even faster. In the south, however, a 10% increase in inventory contributed to roughly a 6% increase in timber supply. This suggests that the timber harvest rate was achieved at the expense of shrinking inventory volume. Further, it should be stated that the actual harvested volume was larger than that reflected in the governmental statistics. Without adequate incentive, farmers literally used more wood for fuel, housing, and other noncommercial purposes.

The price elasticity of demand for stumpage in the south was insignificant. In the north, it was −0.45, indicating inelastic demand. As to the cross-price elasticity, both were insignificant once again. Income was positively associated with roundwood demand. This association was significant in each case, but it was more so in the north, suggesting that, as income improved, farmers spent more on wood consumption (Yin, 1995). Of course, the boom of housing constructions might reflect the fact that there was a substantial pent-up demand due to the absence of any sizable housing investment in the pre-reform years. Thus, it appears plausible for roundwood demand to have a large income elasticity but a small price elasticity. Similar to the supply side, a possible explanation for the low income and price elasticities of demand in the south is that, as a traditional timber production region, forest resources were relatively abundant. But due to the long-time government control and market distortions, people did not benefit much from their favorable resource endowments. As such, their consumption and production patterns were generally insensitive to either price or income changes. Similarly, population effects in the two regions differ substantially. The demand response in the north was, although great in magnitude, insignificant, while in the south it was small but significant. It seems that under a relatively favorable market setting, the effect of income tended to be more reflected in quantities demanded and therefore to dominate the population effect.

To put these results in perspective, notice that the price elasticities of demand and supply in the southern market were so small that they sum to less than one. Since price decrease would overwhelm quantity increase in this case, it implies that if stumpage supply shifted outward, then producers could become losers. To consumers, as long as the shifts in stumpage supply only resulted in increases in exports, they were neither losers nor winners. In the north, however, the sum of price elasticities of demand and supply was greater than one. This means that both producers and consumers were winners if stumpage supply shifted outward, although inelastic demand and supply made the former group better off than the latter. Given that all the relevant elasticities in the north were greater (in absolute value) than those in the south, it is expected that a same rate of inventory change resulting from the institutional innovation would have a larger welfare impact in the north.

4. RESULTS

First, we consider the welfare benefits from shifts in stumpage supply. Tables 3 and 4 summarize the calculated results. In the northern four prefectures, the total welfare benefits rose from 13.6 million yuans in 1985 to 31.64 million yuans in 1990. Moreover, over 75% of the total benefits were captured by consumers, with the remaining less than one-forth accrued to producers. In contrast, producers in the six southern prefectures suffered minor losses (1.3–3.6 million yuans annually) from outward

Table 3. *Assessment of the welfare benefits from shifts in stumpage supplies, North*[a]

Year	LB	CB	UB	LB	PB	UB	TB
1985	7.17	10.64	20.52	−6.83	2.99	6.39	13.63
1986	9.30	13.80	26.62	−8.65	3.88	8.29	17.68
1987	11.02	16.35	31.53	−10.26	4.61	9.82	20.96
1988	13.52	20.06	38.69	−12.58	5.64	14.04	25.70
1989	15.66	23.24	44.82	−14.58	6.54	13.95	29.78
1990	16.64	24.69	47.63	−15.49	6.95	14.83	31.64

[a] Values, in million yuans, are calculated without deflation. CB, PB, and TB are consumer benefits, producer benefits, and total benefits, and LB and UB represent the lower bound and upper bound of 90% confidence intervals. The northern market is made up four prefectures—Kaifeng and Zhoukou in Henan, and Fuyang and Suxian in Anhui.

Table 4. *Assessment of the welfare benefits from shifts in stumpage supplies, South*[a]

Year	CB	LB	PB	UB	TB
1985	0.00	−5.04	−1.25	−0.52	−1.25
1986	0.00	−7.39	−1.84	−0.76	−1.84
1987	0.00	−9.94	−2.47	−1.02	−2.47
1988	0.00	−11.43	−2.84	−1.18	−2.84
1989	0.00	−14.21	−3.53	−1.46	−3.53
1990	0.00	−14.12	−3.57	−1.45	−3.57

[a] Values, in million yuans, are calculated without deflation. CB, PB, and TB are consumer benefits, producer benefits, and total benefits, and LB and UB represent the lower bound and upper bound of 90% confidence intervals. The southern market consists of six prefectures—Yichun, Ji-an, Fuzhou, and Ganzhou in Jiangxi, and Sanming and Nanping in Fujian.

supply shifts due to the reform's offsetting effect on inventory decline. These results are consistent with our prediction and also supported by the computed confidence intervals, which give a higher consumer benefit but a lower producer benefit.

The direct reason for producer losses in the south is, as discussed before, the extreme price inelasticity of both supply and demand. But what caused the extreme inelasticity of supply and demand was at least partly that the prices facing producers and consumers within the region were distorted to such an extent that their behavior became less sensitive to changes in price levels. Table 5 presents the imputed results of welfare transfers, deadweight losses, consumer losses, and producer losses due to government control over the market and the imposition of taxes and levies. In 1984, the last year before the central government removed compulsory timber delivery quotas and planned pricing, government revenues via price control and taxation were 224.6 million yuans. This was equivalent to 54.8 yuan/m^3, whereas the average procurement price was just 58.5 yuan/m^3. In 1988, when timber prices reached peak levels, government revenues soared to 785.7 million yuans, or 261.2 yuan/m^3. In contrast, the average timber procurement price in that year was 174.8 yuan/m^3. Then, in 1990, the total government revenues declined to 435.5 million yuans as timber prices dropped and production was cut back due to a housing sector slow-down. Still, that was 157.6 yuan/m^3, while the procurement price was 177.3 yuan/m^3. It can be seen that the portion of timber sales revenues captured by government organizations was over a half of sales prices in most years.

In addition, under Scenario I about 70% of the government revenues came from the production side, with the remaining 30% or so contributed by consumers. The different assumptions regarding the prices facing farmers did not alter this estimation much. The share of producer losses went up by 5–8% under Scenario II, while that of consumer losses was reduced by 3–5%. The deadweight losses were very small, compared to the total welfare benefits transferred to government or producer and

Table 5. *Estimated welfare results of market control and distortions in the South*[a]

Year	TL	Scenario I			Scenario II		
		DL	CL	PL	DL	CL	PL
1984	224.56	8.04	69.50	163.10	5.23	55.06	174.73
1985	283.94	10.95	89.49	205.40	7.40	72.20	219.14
1986	289.61	9.74	88.47	210.87	6.22	69.13	226.69
1987	314.75	9.73	94.14	230.35	5.82	71.45	249.16
1988	785.71	40.27	268.85	557.14	30.47	229.77	586.42
1989	582.32	27.22	194.56	418.97	19.87	163.23	442.97
1990	435.48	17.76	139.46	313.77	12.30	113.84	333.93

[a] Values, in million yuans, are calculated without deflation. Scenarios I and II are results computed with the original procurement prices multiplied either by 1 or 1.15 to account for procurement and selling costs. DL, CL, PL, and TL are deadweight loss, consumer loss, producer loss, and total loss due to market control and distortions. The results represent six prefectures—Yichun, Ji-an, Fuzhou, and Ganzhou in Jiangxi, and Sanming and Nanping in Fujian.

consumer losses. Again, this was primarily due to the inelastic stumpage demand.

To sum up, the rural institutional innovation from the late 1970s brought about an annual forest inventory growth of 3.5% in the northern farm region, which in turn pushed up the stumpage supply considerably. As a result, both consumers and producers benefited from the reform, even though the former group gained more than the latter. In the traditional southern timber-producing region, the reform policies were implemented differently. One of the major differences was the imposition of market control and price distortions, through which about a half of farmers' timber revenues were captured by government agencies. Consequently, the production response was extremely weak, causing an annual increase of stocking volume by only 0.1% which, given the market structure, translated into a slight producer welfare reduction while consumers might not have become worse off. [6]

5. DISCUSSION

In this paper, we evaluated the impacts of the rural economic reform on forestry development using welfare measures. We found that the institutional innovation, featured by changes in land tenure arrangements and commodity transaction practices, could be an important step in increasing social welfare. Their impacts depended critically, however, on how they were implemented. Properly implemented, the production incentive structure could be improved, and therefore forest production would increase. As a result of production growth, greater welfare benefits could be captured by producers and consumers. The experience in the northern farm region provides a good example of this. If the reform policies were not appropriately implemented, as reflected in market control, price distortion, and policy uncertainty in the south, then the production incentive structure could improve little, and the chances for timber production increase would be diminished, making it hard for producers and consumers to benefit from expanded stumpage supply.

It should be pointed out that in the 1990s, land tenure arrangements in the south have evolved as local authorities and the private sector have gained experience. Notable advances include more attractive benefit-sharing schemes for households to provide greater incentives for afforestation and forest management, increased market liquidity, allowance of transferring young timber stands freely, introduction of auctions to allocate remaining community plots to households individually or collectively, and lengthening of management contracts (Zhang, 2001). These appear to be some steps in the right direction. Nonetheless, timber harvested by farmers in the south remains subject to allowable quota and cutting permits; similarly, timber shipped by farmers remains subject to transport permits and inspection by the government. Moreover, it is still true that farmers are mandated to sell their timber to government procurement agencies at prices lower than what these agencies get from the open markets when they resell the timber; and when farmers sell their timber, heavy taxes and fees are levied. Unfortunately, when the Forest Law was amended in 1998, even though the government acknowledged the private ownership of forest stands and trees grown on lands contracted from local communities, it failed to address these issues (State Forestry Administration, 1998). It has been claimed that the harvest regulations are imposed to prevent the depletion of existing resources that were contracted out for household management. But, the accompanying consequence of these restrictions has been the deprivation of incentive and thus interest for farmers to plant trees and manage forests.

Ironically, without extensive involvement by the private sector, the government has to resort to public investments and international sources to boost forestry. [7] As a matter of fact, public forest investments have been used as a major justification for regional and local authorities to collect more revenues from harvested timber through taxing and levying. But, the fact is that most of the forestry revenues have been incorporated into the general government budgets or funds for the forest administration, including the enforcement of the prevalent regulations mentioned above. According to some reports (Chen, Wang, & Chen, 1988; Yin & Xu, 1987), only a small portion (no more than 20% of the total revenues) has been actually reinvested in forestry. History has shown that the efficiency and effectiveness of the government forest investments are far from satisfactory. [8] In short, even though a certain amount of government intervention and support may be reasonable and necessary, it seems illusionary to attempt to substitute government efforts for private initiatives in a successful program of forestry development. The time has come for Chinese

policy makers to deal with the market access and taxation problems in its forest sector.

In addition, China's experience is of broader significance. First, it indicates that developing countries, such as Indonesia and the Philippines, should exercise caution in their pursuit of devolving resource management from the state to communities. While we do not doubt the need for transition, it must be recognized that any political instability or policy uncertainty could cause the resource base to shrink. On the other hand, when environmental and development organizations argue for more restrictions on forest markets in developing countries, they should understand that even if these restrictions can alleviate pressures put on resources in the near future, they may become obstacles to long-term growth, as manifested in southern China. That outcome could eventually run against the interest and desire of the very environmental and development agencies. Of course, the question is not whether to build institutions for markets, but rather, how to do so (World Bank, 2002).

It is worth stressing that the above conclusions and remarks are derived on the basis of our observations of farmers' responses to the changed institutional settings in a relatively short period of time. To that effect, certain restrictive assumptions were made. Although we are confident in our results, they may differ from the longer-term impacts of the rural reforms. Therefore, care should be taken in interpreting them. If more data can be gathered in the future, it will be worthwhile to repeat and extend the current study. In addition, while a changing resource base has important non-timber production and environmental implications, our analysis did not consider these benefits and costs.

Finally, China has initiated a few major environmental protection and biodiversity conservation programs in the last three years (State Forestry Administration, 2001). While the Natural Forest Protection Program calls for phasing out logging operations and strengthening resource management in all natural forests, including those in the southern collective forest region, the Land Conservation Program is aimed at a withdrawal of farming on slope uplands along the upper reach of the Yangtze River and the upper and middle reaches of the Yellow River and returning these lands back to grasslands and forests. These programs are projected to cost over $10 billion each in the next 10 years, largely based on government investments and subsidies as well as mass campaigns. On the other hand, proper institutional structures, including property rights definition, contractual design and enforcement, and market-based incentives, have largely been ignored. One may wonder whether, without appropriate institutional arrangements, the history of China's failed afforestation and resource management will repeat in these new programs. Compared to the high attention received by these new national programs, one may also wonder why few efforts have so far been directed to addressing the institutional impediments to forestry growth in the south, which has great potentials for not only timber production but also ecological services.

NOTES

1. Hayami and Ruttan (1985, pp. 94, 95) pointed out that "Institutions are the rules of a society or of organizations that facilitate coordination among people by helping them form expectations which each person can reasonably hold in dealing with others ... In the area of economic relations they (institutions) have a crucial role in establishing expectations about the rights to use resources in economic activities and about the partitioning of the income stream resulting from economic activities." The authors further noted that property rights and markets are among the basic economic institutions.

2. We do not claim that all that happened to the Chinese rural society from 1978 were institutional changes, but we believe that our generalization is supportable. This is not only because the major reform programs are of an institutional nature, but also because the effects of any other important policy shifts during the period were somehow contingent on or induced by changes in institutional arrangements (Lin, 1988).

3. China's recent institutional changes and their social and economic impacts have been an active area of research. For some excellent reviews, syntheses, and outlooks, the readers can refer to Perkins (1994), Naughton (1995), Huang (1996), and World Bank (1997). Since our primary objective is to quantify the welfare effects of the institutional reforms in the forest sector, however, it goes beyond the scope of this article to take an extended account of the literature or to

discuss what has happened in other sectors of the economy.

4. Historically, China's forest resource management fell into two major categories—national forests in the northeast and southwest, which were and still are owned by the state and managed by state-run forest bureaus; and collective forests elsewhere owned and managed by rural communities. Thus, rural forests refer to the latter. Moreover, it is the rural forestry development that has been directly affected by the rural reform. That is why we are interested in measuring the benefits and losses in the rural forest induced by the rural reform here.

5. It should be stated that the procurement and sales costs of the state-run companies are excessive, and part of them should be accounted in operating profits of the state companies. The reason for this practice is that otherwise they must hand more of their profits over to the government treasury (Yin, 1994; Yin & Xu, 1987).

6. Consumers in other regions might have been hurt because of reduction in their imports, but we ignore this broader linkage in our analysis.

7. Particularly, plantation forests in the south have expanded significantly with support from the World Bank (Rozelle *et al*., 2000).

8. For example, it was reported that in Anhui province, of the total government forestry investment of 64.6 million yuans during 1981–85, the northern part (a plains farm area) and the southern part (a long-time timber-producing area) received 13.4% and 57.8%, respectively. But new forested acreage accomplished by the northern part and the southern part was 20.0% and 48.7% of the provincial total, even if various agroforestry regimes, such as shelterbelts and intercropping that are a feature of the northern part, are excluded from the calculation (Zhong *et al*., 1991).

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