Market Reform and Incentives in Vietnamese Agriculture

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Abstract

This paper analyzes the dramatic increases in rice output and productivity in Vietnam due largely to market reform, inducing farmers to work harder and use land more efficiently. The reform process is captured through changes in effort variables and total factor productivity (TFP) for Vietnam as a whole as well as the north and south regions of the country taken separately. The results show that the more extensive is market reform the larger the increase in TFP and the share of TFP growth due to incentive effects, suggesting that more competitive markets and secure property rights matter greatly.

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1. Introduction

Since the beginning of its 'doi moi' market reform process in 1981, Vietnam has achieved remarkable success in increasing the output of rice and other food products. From being a large importer of these products through the early 1980's, Vietnam has now become the second largest exporter of rice in the world, with the total output of all agricultural products more than doubling during the main period of reform from 1981 to 1994.[1] Even more notable is the fact that these gains have been achieved with a relatively modest growth of most inputs and with little or no technological change, suggesting an impressive rate of growth of total factor productivity in agriculture due largely to reform measures.

The market reform process in Vietnamese agriculture over this period has been pervasive, including a significant liberalization of internal and external trade, greater autonomy for farmers in decision making and fundamental institutional change including the reform of the property rights regime. It is the contention of

[1] The output of rice itself increased from 12,415 in 1981 to 23,528 thousand tons in 1994.

this paper that such far-reaching changes have considerably enhanced incentives for farmers to work hard and to use land more efficiently. A simple model is used to estimate the importance of these incentive effects in explaining the large increases in rice output and productivity which were observed from 1981-94.

As a whole the results are striking. Total factor productivity (TFP), which was declining at a rate of 2.8 per cent per annum in the north prior to the reforms, increased by almost 2 per cent per annum in the initial reform stage (1981-87) and by more than 3 per cent per annum in the later stage of reforms (1988-94). In the south, with a more recent memory of market institutions, the results were more immediate: TFP, growing at 2.4 per cent per annum prior to the reforms, grew at 5.3 per cent per annum for the initial years of reform, tapering off to a rate of 2.3 per cent per annum in the later years. In both the north and south growth due to the incentive component of TFP accelerated as reform proceeded, accounting for roughly 20 per cent of cumulative TFP growth in the early years of reform (relative to the communal regime, or prior to 'doi moi') and rising to about 60 per cent in the later years. Thus, the more extensive the degree of market reform the larger the effects on rice output and productivity, suggesting that incentives, more competitive markets and secure property rights matter greatly.

The paper is organized as follows. Section 2 provides a brief overview of the market reform process in Vietnam. Section 3 presents the basic model which will be used to explain the effects of market reform on agricultural output and productivity. The model captures market reform measures through policy induced changes in TFP and a decomposition of TFP into productivity changes due to enhanced incentive effects from those due to other 'unexplained' factors.[2] In Section 4 the parameters of the underlying production function are estimated using cross-sectional data and resulting measures of TFP with market reform are derived, which are then used in Section 5 to estimate the contribution of incentive effects to productivity growth over the reform period. The focus is on the years 1981 to 1994 for two reasons. First, this is the most comprehensive data set available that covers the period of the two main market reform measures that were introduced in Vietnam in the past twenty years.[3] Second, given the relatively closed nature of the society and the lack of resources necessary to purchase such things as new hybrid seeds for rice, it is generally understood that there was little or no technological change over this period save for a few experimental farms. Incentive effects on TFP are thus more reasonably accounted for by changes in market reform parameters. Section 6 concludes, appendix A indicates all data sources and the various methods used to construct specific variables in the data set and appendix B collects technical details.

[2] Che, Kompas and Vousden (2001) extend static model to the case of an intertemporal economy where incentive effects result in induced capital formation and larger transitional growth rates and steady state values for rice output.

[3] Given that the second and more extensive market reforms introduced in 1988-94 have continued since, rice output in Vietnam has continued to increase dramatically to 31,394 thousand tons in 1999, or 33 per cent more rice output than in 1994 (GSO, 2001).

2. Background

With roughly 80 per cent of the population living in rural areas in 1994 (GSO, 1995c), the agricultural sector in Vietnam, accounting for 50 per cent of material or non-service output and at least 30 per cent of Gross Domestic Product (GDP), provided employment for 72 per cent of the total labour force (GSO, 1995). Cultivated agriculture was predominant, at 74 per cent of gross agricultural output (GSO, 1995), especially rice production which constituted about 90 per cent of the output of food grains.[4]

There are two main rice growing regions in Vietnam, designated in this paper as being in the 'north' and 'south' of the country. The north includes the provinces of the North Mountain and Midlands, the Red River Delta and the North Central Coast. Of these, the Red River Delta is the principal agricultural region which roughly surrounds Hanoi. The south includes the Central Highlands and areas east of the South and Cuu Long (Mekong) River Delta.

The relevant transitional periods that correspond to the available data can be divided into the communal system (1975–80), used as a base comparison throughout, and two principal market reform periods designated by: (a) output contracts (1981–87) and (b) trade liberalization (1988–94). The overall process is characterized by a move from public ownership and central planning to a form of private property and more competitive markets, with enhanced incentives to produce more and more efficiently.

In broad terms, under the communal system virtually all of rice production was located in compulsory agricultural collectives, with all farm activities, including the choice of inputs, designated by state-planning authorities. After harvest, a portion of output was extracted by the central government. The remainder was required by law to be sold in state markets at low state prices (roughly 20–30% of the estimated market price). Small private plots were allowed but only for the household consumption of subsidiary agricultural goods, and since individual effort was hard to accurately determine the distribution of rice within the commune was based on egalitarian criteria. As a apparent result of these controls the output of rice fell markedly and especially so over the period 1977–80, forcing Vietnam to import large amounts of rice to meet domestic demand.

The period of output contracts corresponds to a move to de-collectivize agriculture. Plots of land were allocated to prior members of the commune and farmers were allowed to organize production activities privately, in what effectively was a tentative first move towards private property rights. Although, for the most part, rice was still required to be sold in state markets at low state prices, private domestic markets (for some portion of output sold, roughly 20%) inevitably emerged and were condoned by state authorities. In fact, the period is

[4]Little has changed since 1994. At present, 80 per cent of the population still lives in rural areas and rice production accounts for roughly 92 per cent of the output of food grains (GSO, 2001).

generally characterized by a 'dual price' system (a low state price and a competitive market price), albeit with strict controls to prevent arbitrage opportunities between markets.

The period of trade liberalization finally allowed for effective private property rights over both land (initially 10–15 year leases) and capital equipment. Production decisions were de-centralized, all farm income (after tax) was retained by the farmer and in 1990 the central government abolished the dual price system. Rice could now be sold on competitive domestic markets with an incentive structure that rewarded individual effort. In 1993 tenure arrangements over land were extended (to 20 year leases), provisions for the exchanging of leases and the sale of land were introduced and farmers (through voluntary cooperatives) could now sell rice freely in international markets.

Table 1 gives a useful overview of the performance of the Vietnamese rice sector over this period in terms of the fitted annual rates of growth of output and inputs for the period as a whole and for each of the three stages considered above. For the communal period (1976-80), the north experienced a contraction in rice output of almost 4 per cent per annum, while output in the south grew at 3.4 per cent per annum, leading to almost no change for the country as a whole during this period. In contrast, in the first stage of reforms (1980-87), output grew by almost 6 per cent per annum in the south and 3 per cent per annum in the north (4.6 per cent for the country as a whole). In the second, trade liberalization stage of reform, output growth accelerated to 6.5 per cent annum in the south and 5.4 per cent per annum in the north 6.1 per cent for the country as a whole. In short, output growth was higher in the second stage of reforms in both the north and the south, although the growth rates in the south were higher than those in the north for the whole period 1976-94. This differential performance was particularly marked in the investment response of the two regions: in the latter stage of reforms, capital increased by 14.5 per cent per annum in the south compared with only 6.8 per cent per annum in the north. Apart from this accelerated capital growth in the period 1988-94, there was relatively little growth in measured factor inputs. Indeed, labour and land inputs into rice production were virtually unchanged over the full period 1980-94 with the sown area of land contracting slightly in each stage of reform. This suggests the presence of significant growth in total factor productivity. In the following section, a simple model is developed to measure TFP growth in the Vietnamese rice sector and to estimate the contribution of incentive effects to that growth.

3. Model

3.1. The technical production function

The model of the effects of market reform on agricultural output is based on the approach used by McMillan, Whalley and Zhu (1989) to analyze Chinese

agriculture. Let ε_n represent the level of effort of a typical farmer so that for N workers $\varepsilon_n N$ is the effective contribution of labour to output measured in 'efficiency units'. As mentioned, the value of ε_n can be broadly interpreted to include everything that determines the quality of the farmer's labour as well as the willingness to literally exert more effort due to the enhanced incentives that accompany market reform and the removal of externally imposed restrictions on the kinds of tasks a farmer may undertake.

With security over land tenure and the freedom to manage farm production, the typical farmer may be expected to manage land-use in a way which increases the productivity of a given area. To capture this effect let L represent total sown area and let ε_l capture the effort associated with exploiting and managing the land. Optimal land use may involve effort directed towards increasing the number of different crops sown in a given area or simply the planning involved in increasing the yield on a given amount of land. The total input of land measured in efficiency units is given by $\varepsilon_l L$.

Assume a 'technical' constant returns to scale production function[5]

$$Q = \alpha_0(\varepsilon_n N)^{\alpha_1}(\varepsilon_l L)^{\alpha_2} M^{\alpha_3} K^{\alpha_4} \tag{3.1}$$

where Q, L, M, and K represent output, land, material inputs (e.g., fertilizer and seeds) and physical capital or, in per capita terms,

$$q = \frac{Q}{N} = \alpha_0 \varepsilon_n^{\alpha_1} \varepsilon_l^{\alpha_2} l^{\alpha_2} m^{\alpha_3} k^{\alpha_4} \tag{3.2}$$

where q, l, m, k are output, land, material inputs, and capital per farmer.

3.2. The farmer's profit function

In principle, farmers may work in different institutional settings that vary from a communal system to various forms of share-contracting and private competitive markets. Let farm income received be given by

$$y = \beta p(q - d) \tag{3.3}$$

where p is the price of the agricultural good at which output is sold and d is a constant term that can be considered as the fixed rent or lump-sum tax the farmer has to deliver to the state for the right to use the property. Outside if pure communal arrangements, the value β is the fraction of the additional revenue generated that the farmer is allowed to keep, so that β can be considered as a share-cropping contract between the landlord (the State) and the farmer. For

[5] This is consistent with the empirical literature on agricultural production functions for twenty-two developing countries (Hayami and Ruttan, 1985) and China (Tang, 1980). The specification is confirmed on cross-sectional data for Vietnam in section 4.1.

our purposes, the value βp also represents an average goods price including three components defined as

$$\beta p = (\beta_s p_s + \beta_m p_m + \beta_w p_w) \tag{3.4}$$

where p_s, p_m and p_w are the state price, the market-clearing price and the export price respectively and β_s, β_m and β_w are the fractions or shares of agricultural output, that sum to one, allocated or delivered to the state, the domestic market or sold internationally. Different regimes imply different values for βp. Under the communal system, the farmer was required to sell the entire agricultural output to the State at a low state controlled price, implying that $\beta_s = 1$. In the output-contracts stage of reform, domestic markets existed but were still tightly controlled, with the farmer still required to sell the major share of output to the State at the low compulsory price, with the remainder to be sold on the domestic market at a higher domestic market price. No trade in international markets was allowed and arbitrage between state and domestic markets was rigorously enforced. With the period of trade liberalization, the state market was effectively abolished, controls were largely removed from the domestic market and international trade was permitted. Rice output was allocated between domestic and world markets at higher prices, with the differential between domestic market prices and the world export price p_w becoming increasingly smaller.[6]

Assume the farmer chooses inputs in order to minimize costs. With constant returns to scale, the total cost (TC) function is given by

$$TC = c_0 \prod_i w_i^{\alpha_i} Q \tag{3.5}$$

where α_i are the share parameters in the technical production function, c_0 is a constant and w_i are input prices indexed across labour, land, material inputs and capital. Define $W(\mathbf{w}) \equiv \prod_i w_i^{\alpha_i}$ as the average (real) factor price, so that the cost of production per farmer (C) can be given as

$$C = c_0 W(\mathbf{w}) q. \tag{3.6}$$

During the process of market reform, factor markets in Vietnamese agriculture changed considerably in terms of both their structure and their speed of development. In the earlier stages, some types of inputs were 'free' (such as the labour of the farmer), or unpaid, receiving only implicit or in-kind payments. With market result such payments became explicit and it is necessary to take into account any resultant increases in input costs. In addition, in Vietnam, as is the case in many transitional economies, factor and product prices generally increase at different rates with market reform. To capture these effects, define $\omega \equiv W(\mathbf{w})/\beta p$ as a

[6] Since Vietnam is a natural exporter of agricultural goods, its export price will exceed its domestic market price under autarky with free internal trade, which in turn will exceed its domestic price under tightly regulated domestic markets. All prices are higher than the state-controlled price.

weighted-cost share parameter or the ratio of observed average factor to product prices. The farmer's profit function (π) thus becomes

$$\pi = \beta p(q-d) - c_0 W(\mathbf{w})q = \beta p\left[q(1-c_0\omega) - d\right] \tag{3.7}$$

using equations (3.3) and (3.6) and the definition of ω.

3.3. Optimal behavior and the institutional production function

Following McMillan, Whalley and Zhu (1989), assume the farmer receives utility from income but dislikes the effort of hard work and of planning for more efficient use of land, so that

$$U(\pi, \varepsilon_n, \varepsilon_l) = \pi - \frac{\varepsilon_n^z}{z\delta} - \frac{\varepsilon_l^z}{z\delta} \tag{3.8}$$

where $\delta > 0$ and $z > 1$ are constants, so that marginal disutility of effort increases with effort. The effort-disutility coefficient z is analogous to the coefficient of risk aversion and δ is chosen to guarantee that the utility function is jointly concave. It is assumed that z is that same across effort variables for labour and land, although this clearly could be generalized. Substituting from equations (3.2) and (3.7) gives

$$U(\pi, \varepsilon_1, \varepsilon_2) = \beta p\left[\alpha_0 \varepsilon_n^{\alpha_1}\varepsilon_l^{\alpha_2} l^{\alpha_2} m^{\alpha_3} k^{\alpha_4}(1-c_0\omega) - d\right] - \frac{\varepsilon_n^z}{z\delta} - \frac{\varepsilon_l^z}{z\delta}. \tag{3.9}$$

Consider the farmer's optimal choice of effort levels. Maximizing (3.9) with respect to ε_n and ε_l implies that optimal values for labour and land effort must satisfy

$$\varepsilon_n^* = \left(\delta\beta p(1-c_0\omega)\alpha_0 l^{\alpha_2} m^{\alpha_3} k^{\alpha_4} \alpha_1^{(z-\alpha_2)/z} \alpha_2^{\alpha_2/z}\right)^{1/\nu} \tag{3.10}$$

and

$$\varepsilon_l^* = \left(\delta\beta p(1-c_0\omega)\alpha_0 l^{\alpha_2} m^{\alpha_3} k^{\alpha_4} \alpha_1^{(z-\alpha_1)/z} \alpha_2^{\alpha_1/z}\right)^{1/\nu} \tag{3.11}$$

for $\nu = (z - \alpha_1 - \alpha_2)$. Finally, substituting equations (3.10) and (3.11) into the per capita technical production function, or (3.2), and multiplying both sides by N, gives the following 'institutional' production function

$$Q = AN^{\gamma_1} L^{\gamma_2} M^{\gamma_3} K^{\gamma_4} \tag{3.12}$$

where the total factor productivity coefficient A is given by

$$A = \alpha_0^{z/\nu}\delta\beta p(1-c_0\omega)^{(\alpha_1+\alpha_2)/\nu}\alpha_1^{\alpha_1/\nu}\alpha_2^{\alpha_2/\nu} \tag{3.13}$$

and share parameters are

$$\gamma_1 = (z\alpha_1 - \alpha_1 - \alpha_2)/\nu \qquad \gamma_2 = z\alpha_2/\nu \qquad \gamma_3 = z\alpha_3/\nu \tag{3.14}$$

and

$$\gamma_4 = z\alpha_4/\nu \tag{3.15}$$

for labour, land, material inputs and capital respectively.

The institutional production function captures the farmer's response to institutional arrangements and government policies, through changes in effective prices βp and the average ratio of input to product prices ω. It is equation (3.12) rather than (3.1) that would be estimated using observable input and output data. In this equation total factor productivity and the optimal choice of effort depend both on the price level p, effective product prices βp and the ratio of average input to effective output prices ω, variables which clearly differ from one stage of market reform to the next.

4. Empirical Results

4.1. Estimation of the institutional rice production function

Estimates of equation (3.12) are based on 1993 data, the only year in which complete cross-section data is available for 53 provinces and cities in Vietnam. (See the appendix for data sources and descriptions.) It follows that the input share parameters γ_i in the institutional production function are assumed to be constant throughout the process of market reform. Although this is a concern, it is an assumption that is in accord with the prevailing view. As mentioned, given the closed nature of the Vietnamese society and the lack of resources necessary to purchase such things as new hybrid seeds for rice, it is generally understood that there was little technological change throughout the reform period (1981–94) and nothing close to the 'green revolution' that characterizes other transitional economies, save for a few experimental farms in Vietnam. Water use and irrigation methods also remained relatively unchanged, and even so to this day. Very little change in the values of each γ_i are thus expected from 1981-94. In addition, the calculated values (see section 5) of the share coefficients α_i in the technical production function, which directly correspond to the estimates of each γ_i, are roughly the same as the estimates for agricultural production obtained by Tang (1980) for China and for twenty-two other developing countries provided by Hayami and Ruttan (1985).

OLS results are summarized in table 2. Share coefficients for each γ or labour, land, material inputs and capital are 0.18, 0.42, 0.44 and 0.14 respectively. A Wald-test indicates that the hypothesis of constant returns to scale could not be rejected at the 10 per cent level of significance. The relatively high coefficient on material inputs is fully consistent with the results of research by the United Nations Development Program and the Food and Agriculture Organization (FAO) showing that expenditure on chemical fertilizer in particular is the major cost component faced by farmers, at roughly 65 per cent of total variable cost (Nguyen Khiem, 1991). In Vietnam, fertilizer is the largest component of material inputs by far. Diagnostic tests show no evidence of heteroscedasticity and Jacque-Bera, RESET and CUSUM tests indicate no error in the distribution of residuals or the specification. Although the coefficient on labour does not test

as significant, variable deletion tests indicate that it cannot be removed from the overall regression.

4.2. Total factor productivity with market reform

This section uses the market reform augmented share parameters from the above estimates of the institutional production function to derive estimates of total factor growth calculated as a Solow residual for each of the years 1981-94. This is done using the data for output and inputs summarized in table 3 for Vietnam as a whole and the north and south of Vietnam respectively for the years 1976-94. The annual growth rate for total factor productivity (A) is calculated in the usual 'growth accounting' manner as the difference between the growth of output and the growth of each input weighted by share parameters. The resulting estimates of the year-by-year growth rates for A are then used to calculate an index for TFP using the average of the years 1976-80 in the communal period as the base. These figures are summarized in table 4. Average fitted annual growth rates are also given for the communal regime (1976-80) and for each of the two main reform stages.

The results are revealing. Under the communal regime, TFP growth was low for the country as a whole (0.68 per cent per annum) and was significantly negative for the north (a fall of 2.84 per cent per annum). On the other hand, even under the communal regime, the south managed an annual rate of TFP growth of 2.43 per cent per annum. In addition, TFP in the south responded much more rapidly than the north to the earlier reforms, achieving an annual growth rate of TFP in the years 1981-87 of over 5 per cent per annum. In contrast, the north achieved TFP growth of less than 2 per cent per annum in this period. Interestingly, the south's annual rate of TFP growth tapered off in the second stage of reform, whereas that of the north increased to over 3 per cent per annum.

This seems to suggest that in the south, where the push for trade liberalization was more determined and the experience of market institutions was more recent, farmers were able to adapt and seize opportunities much more quickly when the first reforms arrived. Thus, much of the TFP growth in the South was achieved early, whereas it was not until the later market liberalization stage that the North was able to achieve a reasonable level of TFP growth. This is not to suggest that growth slowed down in the South during the second stage of reform, just that the main gains in TFP were achieved early. In fact, as shown in table 1, the latter stage of reform in the South was marked by a dramatic rise in capital growth (from 3.36 per cent per annum in 1981-87 to 14.5 per cent per annum in 1987-94) and a slight rise in annual rates of growth of rice output.

It is usual in studies of this kind to attempt to explain the sources of TFP growth. However, in the case of Vietnam this is difficult. In particular, there are no reliable figures for human capital, a potentially large factor in productivity improvement. However, we are able to directly estimate the incentive compo-

nent of TFP and its relative contribution to growth since the beginning of the reform process. While this may be a poor substitute for direct observation of human capital accumulation and learning by doing, it does provide us with an estimable measure of productivity change that can be directly related to policy changes through the 'institutional' parameters βp and $(1 - c_0\omega)$. Accordingly, we now consider the relative importance of these incentive effects in Vietnamese agricultural TFP growth.

5. The Contribution of Incentive Effects

In this section the institutional production function estimated in section 4.1 is used to decompose TFP (A), given equation (3.13), into two components; the first attributable to incentive effects as captured in the effort variables, or

$$A_1 = [\beta p(1 - c_0\omega)]^{(\alpha_1+\alpha_2)/\nu} \tag{5.1}$$

and the second

$$A_0 = \left(\delta^{\alpha_1+\alpha_2}\alpha_0^z\alpha_1^{\alpha_1}\alpha_2^{\alpha_2}\right)^{1/\nu} \tag{5.2}$$

an 'unexplained residual' reflecting the influence of a host of other factors, where $A_1 \cdot A_0 = A$ and (again) $\nu = (z - \alpha_1 - \alpha_2)$. While z, δ, α_1 and α_2 are all known (or can be calculated) and are assumed to be time invariant, α_0 will change over time. With the available data set, its time path cannot be estimated and thus we cannot directly estimate the time path of A_0. However, the time path of A has already been estimated as a Solow residual (section 4.2) and we have time series data for the 'institutional variables' βp and $c_0\omega$ (table 5) so that a time path for the incentive component of TFP or A_1 can be estimated. Appendix B calculates the value of z (with sensitivity results noted below) and the share coefficients in the technical production function, which are $\alpha_1 = 0.4$ for labour, $\alpha_2 = 0.3$ for land, $\alpha_3 = 0.3$ for material inputs and $\alpha_4 = 0.1$ for capital.[7] The value of c_0 in equation (3.6) is 1.4 and the exponential term in equation (5.1) is thus 0.3. Data sources and the method for constructing the time series for the average rice price βp and ω are given in the appendix.

Using all information, the resulting series for A_1 is given in table 5 (the communal period, 1976-80 = 100). Table 5 also replicates the index of TFP or A given in table 4 and calculates the proportion of cumulative TFP growth relative to the communal regime (1976-80) accounted for by the incentive component. This proportion changes considerably from year to year, however it is clear from table 5 that, on average, the incentive component of growth is a larger proportion

[7] Given the relative importance of fertilizer in rice production, the share parameters for Vietnam do not differ much from the estimates for agricultural production obtained by Tang (1980) for China (0.50 for labour, 0.25 for land, 0.15 for material inputs and 0.10 for capital) and for twenty-two other developing countries (respectively, 0.53, 0.10, 0.16 and 0.21) reported by Hayami and Ruttan (1985). The difference in the estimates for labour in Vietnam may be explained by the use of labour work days rather than (the unavailable) work hours.

of overall TFP growth in the second stage of reform (trade liberalization, 1988-94) than in the earlier stage (the output-contracts stage, 1981-87). This higher relative contribution of the incentive effect to overall TFP growth in the later years of reform is observed for Vietnam as a whole and for the north and the south respectively (table 5).[8] It is also notable that the annual rate of increase of A_1 is uniformly higher for the second stage of reform than the first (increasing from 1.35 per cent per annum to 3.14 per cent per annum for the country as a whole).

The relationship between the incentive component of TFP and total TFP is illustrated for Vietnam as a whole in figure 1, which graphs the time paths of the indices of A (TFP) and A_1(the incentive component). The diagram is not intended to show any absolute relationship between A and A_1 because both indices are set equal to 100 in the initial period (the communal regime). Rather, the graph illustrates the cumulative growth of the incentive component relative to the cumulative growth of TFP. The bold vertical line in the middle of figure 1 marks the switch from the output-contracts to the trade liberalization regime in 1987. The transition to a more extensive market reform regime is thus seen to result in a rapid increase in both TFP and the incentive component of TFP. Moreover, after 1987, cumulative growth due to the incentive effect rises steadily from just over one-third of cumulative TFP growth in 1987 to three-fifths of cumulative TFP growth in 1994.

6. Conclusion

This paper has focused on the effects of the reforms which have occurred in Vietnamese agricultural markets since 1980. A simple model is used to consider optimizing behavior by farmers based on an 'institutional' production function, which reflects not only the usual technical relationship between inputs and outputs, but also effort responses to the institutional and market arrangements within which farmers work. Assuming farmers choose their effort levels optimally, it is possible to estimate these 'incentive effects' at each stage of reform and compare them with the overall change in total factor productivity. Results show that this incentive component represents a higher proportion of post-1980 total factor productivity growth for the later trade liberalization stage of reform than for the earlier, more limited output-contracts stage. We also observe an earlier response of productivity to reform in the south than in the north, conceivably because of the more recent experience of market institutions in the south. The overall results confirm that the more extensive is market reform the larger the increase in TFP and the

[8] Sensitivity results on the effort disutility coefficient z imply small variations in the growth rate of A_1. For $z = 2.8$, the resulting growth rate in Vietnam as a whole is 1.65 in the period of output contracts and 4.47 with trade liberalization. The comparable figures for the north and south are 2.07, 1.39 and 3.68, 5.12 respectively. For $z = 3.2$, the resulting growth rate in Vietnam as a whole is 1.36 in the period of output contracts and 3.84 with trade liberalization. For the north and south are the values are 1.70, 1.14 and 3.15, 4.40 respectively.

share of TFP growth due to incentive effects, suggesting that more competitive markets and secure property rights matter greatly.

Appendix A: Data sources and methods

Original data sources are mainly drawn from the General Statistics Office of Vietnam (GSO) and related project investigations, studies and reports by Vietnamese organizations, such as the State Planning Committee (SPC), the Ministry of Agriculture and Food Processing Industry (MAFI), the Ministry of Water Resources (MWR), the State Department of Price (SDP), and international organizations including the World Bank (WB) and the Food and Agriculture Organization (FAO).

The data used for estimation of the institutional rice production function, equation (3.12), is cross-sectional for 53 provinces and cities in 1993 and is obtained from the National Investigation of Rural Regions (SDAFF, GSO, 1995b). A rice equivalent for output is chosen rather than rice output alone since in the same rice fields farmers usually overlap production with other short-term cereal crops, such as sweet potatoes and maize. Time series data for rice output is from SDAFF (1991) and MAFI (1991) for the period 1976-90, from SDAFF (1995a) for 1990-93 and from GSO (1995) for 1994.

Labor is measured as person-days and is obtained by multiplying average person-days per hectare in agriculture (SRF, various issues) by the rice cultivated area (SDAFF (1991, 1994, 1995b), MAFI (1991), GSO (1995)) divided by 300 days or one standard labour unit in one year). The data for rice as sown area is drawn from the National Investigation of Rural Regions in Vietnam, reported by the GSO (1994).

The land input is measured as the sown area of rice, obtained from SDAFF (1991, 1995a), MAFI (1991) and GSO (1995). Capital inputs are obtained as a weighted sum of draught animals (SDAFF (1992, 1995a), MAFI (1991) and GSO (1995)) and tractors (SDAFF, various years). The conversion from the number of draught animals to tractor capacity is based on (Blomqvist, 1986:142) and assumes that a bullock-day (a pair of bullock working 8 hours) is approximately the same as a tractor-hour at 15 to 25 horsepower. Total capital input for rice production is then derived as the total capital input for cultivation multiplied by the proportional share of rice cultivated area to the total cultivated area of agriculture.

Material inputs include the nutrition content of all fertilizers (organic and chemical), insecticides and seeds (Tang, 1980, Sicular, 1985). The conversion factor used to aggregate organic and chemical fertilizers is similar to that used by Tang (1980:61). Because green manure data is not available, organic fertilizer data is obtained by aggregating estimates of night soil (based on rural population data) and large animal manure (buffaloes, cattle and pigs) from SDAFF (1992, 1995a), MAFI (1991) and GSO (1995). Population-adjusted night-soil equals the rural population (GSO, 1995) multiplied by a rural utilization rate (0.9). The standard number of large animals equals the sum of buffaloes, cattle and pigs (GSO, 1994) for which the weighted ratios are 1, 1 and 0.33 respectively.

The time series for chemical fertilizers is calculated from the average amounts

of chemical fertilizer used per hectare (SDAFF, 1996) multiplied by cultivated area in each year. The series data for insecticides and seeds are calculated from the average use of insecticide and seeds per hectare (SDAFF, 1996) multiplied by rice area for each year. The derived data are consistent with a study done by the World Bank (1994). A figure for total material inputs is obtained by aggregating fertilizer, insecticide and seeds using the weights in Sicular (1985)

The value of β, equation (3.4), in the output contracts stage of reform is set at a market share of 0.8, 0.2 and zero for the state, domestic and international market. This is average data computed from the GSO (various years) in which the market share is 0.88, 0.12 (in 1985), 0.82, 0.18 (in 1986) and 0.82, 0.18 (in 1987) for state and domestic markets for grains. Research by the State Planning Committee also used the rate 0.8, 0.2 to adjust the multiple prices for grain at this time. In the stage of trade liberalization, the share of output sold to the state was clearly zero, with the share between domestic and international markets obtained from average GSO data from 1988-94.

Time series data for nominal rice prices for 1976-94 was obtained from the State Department of Price (SDP). These prices are multiplied by the appropriate values of β as in equation (3.4) to obtain an average nominal rice price. To convert this to an average real price, it would normally be usual to deflate by the consumer price index. However, in the case of Vietnam, such price indices are highly volatile and unreliable due largely to poor and erratic construction methods (see Che (1997:190-203)). Under the circumstances, a more reliable measure of the underlying rate of inflation is the Dong/U.S. dollar exchange rate which is used here as the deflator for βp. This is in line with the high correlation between the Vietnamese inflation rate and the ratio Dong/$US noted by the World Bank (1994:67-68) and is a measure commonly used by the Vietnamese (especially so during periods of high inflation). Following the practice of the State Department of Rice (SDP), the nominal rice price in Nam Dinh and Can Tho is taken to represent the rice price in the north and south respectively.

Input prices in equation (3.6), used to construct the weighted-cost share parameter ω, are measured in rice units or, for example, how many tons of rice farmers have to pay to get one ton of urea, to employ one thousand labour work-days, or to rent one hectare of land. Details are contained in Che (1997). Many official data sources for input expenditures are already measured in terms of rice units as a matter of practice. The time-series data for the relative price of urea to rice are drawn from the Central Price Committee (CPC), as reported in Nguyen Hien (1991) and Nguyen Khiem (1995).

Appendix B: Calculation of the effort-disutility coefficient and share parameters in the technical production function

Given the relationship that exists between the share parameters in the technical and institutional production function, equations (3.14) and (3.15), it is straightforward to calculate the estimated values of α_i from the values of γ_i and the work-disutility coefficient z. Following McMillan, Whalley and Zhu (1989:793), the effort disutility coefficient, although unobservable, can be derived directly from equation (3.13) with a knowledge of βp. To simplify, calculate z from the approximate growth rate of A in two contiguous years during the communal system and within a given reform period, where the average weighted-cost share parameter ω and β are the same. The years 1978-79 and 1982-83 roughly correspond. Using values for βp from table 5, and given the estimated value of the proportional growth in total factor productivity from section 4.2 , z can be shown to range from 2.8 to 3.2. The approximate values of the share parameters in the technical production function (solving simultaneously) are thus $\alpha_1 = 0.4$ $\alpha_2 = 0.3$, $\alpha_3 = 0.3$ and $\alpha_4 = 0.1$ for labour, land, material inputs and capital respectively.

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Table 1: Average annual growth rates of output and inputs (per cent/year) in Vietnamese rice production 1976-94

	Vietnam				The North				The South			
	1976-80	**1981-87**	**1988-94**	**1976-94**	**1976-80**	**1981-87**	**1988-94**	**1976-94**	**1976-80**	**1981-87**	**1988-94**	**1976-94**
Output	0.39	4.63	6.11	4.65	-3.87	2.93	5.40	3.33	3.43	5.93	6.55	5.62
Labor	0.40	0.20	1.27	0.61	-0.18	0.17	0.39	0.32	2.17	0.29	3.73	1.43
Land	-0.79	-1.30	-0.52	-.97	-0.26	-0.17	-.60	-0.30	-1.08	-1.97	-0.51	-1.35
Material Inputs	-1.07	2.92	5.59	3.07	-3.29	2.59	5.56	2.66	1.28	3.25	5.60	3.48
Capital	2.24	2.33	10.62	3.79	1.09	1.57	6.80	2.26	3.97	3.36	14.52	5.54

Table 2: Estimated Results and Diagnostic Tests
Dependent variable: Log of rice output (thousand tons) (y)

Estimated results				
Variables in log-form	Estimated coefficient	Standard error	T statistic	p-value
Labour	0.18	0.176	1.046	0.301
Land	0.42	0.153	2.799	0.007
Material inputs	0.44	0.243	1.812	0.076
Capital	0.14	0.696	2.035	0.047
Constant	1.11	0.434	2.552	0.014
R-Squared	0.91			
R-Squared Adjusted	0.90			
F statistic (4,48)	120.7			0.000
Standard error of estimation (σ)	0.26			
Jarque-Bera (normality)	2.28			0.318

Heteroskedasticity tests *(*e *residual of regression)*	χ^2 statistic	Degrees of freedom	p-value
• e^2 on $\hat{y}$	0.365	1	0.545
• e^2 on $\hat{y}$ squared	0.297	1	0.586
• e^2 on log ($\hat{y}$) squared	0.426	1	0.514
• Breusch-Pagan-Godfrey test			
Based on R^2	4.543	4	0.337
Based on SSR	2.735	4	0.603
• White Heteroskedasticity test	1.582	4	0.158
• Harvey test	1.023	4	0.906
• Glejser test	2.890	4	0.576

Ramsey reset specification tests	F statistic	p-value
Reset (2)	2.981	0.283
Reset (3)	2.319	0.224
Reset (4)	1.512	0.165

Table 3: Output and inputs for rice production for Vietnam as a whole, the north and the south separately, 1976-94

Year	Vietnam					The North					The South				
	Rice output *('000 tons)*	Labour *('000 work days)*	Land *('000 ha)*	Material inputs *('000 tons)*	Capital *(10,000 hp)*	Rice output *('000 tons)*	Labour *('000 work*	Land *('000 ha)*	Material inputs *('000 tons)*	Capital *(10,000 hp)*	Rice output *('000 tons)*	Labour *('000 work*	Land *('000 ha)*	Material inputs *('000 tons)*	Capital *(10,000 hp)*
1976	11827.2	764.1	4710.0	2137.6	236.7	5457.7	584.9	1672.0	1141.3	144.6	6364.0	179.2	3038.0	996.4	92.1
1977	10597.1	764.2	4709.8	2129.6	243.8	4645.9	571.0	1671.8	1098.5	146.0	5887.4	193.2	3038.0	1031.1	97.9
1978	9789.9	782.1	4664.0	2186.7	237.9	4749.6	595.3	1666.5	1104.9	143.3	5014.8	186.8	2997.5	1081.8	94.6
1979	11362.9	786.0	4618.1	2127.7	245.2	4878.7	598.7	1661.1	1065.4	144.9	6431.9	187.3	2957.0	1062.3	100.4
1980	11647.4	768.6	4572.3	2026.4	263.7	4371.4	566.0	1655.8	980.4	153.2	7207.5	202.6	2916.4	1046.0	110.5
1981	12415.2	803.8	4526.4	2126.3	281.2	5401.1	608.8	1650.6	1035.2	148.6	7014.1	195.0	2875.8	1091.2	132.5
1982	14390.2	810.1	4480.5	2203.5	274.7	6170.5	612.3	1645.3	1080.4	146.9	8219.6	197.8	2835.2	1123.1	127.8
1983	14743.3	800.5	4434.6	2336.0	273.2	6174.1	607.7	1640.0	1148.1	148.2	8569.2	192.8	2794.6	1187.9	124.9
1984	15505.6	803.4	4388.8	2365.8	280.8	6200.0	606.3	1634.8	1162.9	151.3	9305.6	197.1	2753.9	1202.9	129.6
1985	15874.8	810.8	4296.5	2425.4	287.7	6292.0	613.9	1629.6	1192.9	153.8	9582.3	196.9	2666.9	1232.5	133.8
1986	16002.9	798.9	4250.0	2556.9	314.2	6262.8	599.2	1651.3	1242.3	166.2	9740.1	199.7	2598.7	1314.6	148.0
1987	15102.6	794.3	4242.6	2517.2	292.1	6075.2	601.3	1638.6	1230.7	159.3	9027.4	193.0	2604.0	1286.5	132.8
1988	17000.0	805.5	4108.9	2693.2	298.6	6708.7	604.9	1633.4	1286.7	164.6	10291.3	200.6	2490.9	1406.5	134.0
1989	18996.3	818.9	4108.0	2766.3	299.1	7275.4	608.9	1628.1	1330.3	157.1	11720.9	210.0	2490.0	1436.0	142.0
1990	19225.2	827.4	4108.0	2844.4	296.5	6962.4	609.5	1618.0	1382.1	158.4	12262.7	218.0	2490.0	1462.3	138.1
1991	19621.9	832.5	4101.0	2962.6	350.7	6257.5	615.8	1618.0	1391.6	173.9	13364.4	216.7	2531.0	1571.0	176.8
1992	21590.3	862.1	4100.0	3254.3	418.1	7885.1	618.9	1570.0	1551.6	198.2	13705.2	243.1	2517.0	1702.7	219.9
1993	22836.6	853.1	4038.6	3404.4	514.8	8973.3	614.2	1583.0	1609.3	227.6	13863.3	238.9	2455.6	1795.1	287.2
1994	23528.3	866.7	4038.6	3790.4	562.2	9100.0	618.3	1583.0	1877.3	248.6	14428.3	248.5	2455.6	1913.1	313.6
Annual	4.7	0.6	-1.0	3.1	3.8	3.3	0.3	-0.3	2.7	2.3	5.6	1.4	-1.3	3.5	5.5

Source: *See Che (1997:179-89);* ***Note:*** *Average annual growth rate is measured as the fitted value of the exponential growth rate*

Table 4: Index of Total Factor Productivity (1976-80 =100) for Vietnam as a whole, the North and the South

	Vietnam	The North	The South
1976-80	100	100	100
1981	110.79	112.12	109.44
1982	127.66	126.71	127.82
1983	129.53	124.73	133.04
1984	135.77	124.76	143.35
1985	138.41	125.13	147.94
1986	137.21	122.22	146.73
1987	131.42	119.65	139.80
1988	145.99	130.03	156.12
1989	161.20	140.20	173.72
1990	161.42	132.72	179.28
1991	159.60	117.30	185.51
1992	166.14	143.34	174.68
1993	171.10	159.25	171.12
1994	168.07	151.75	171.08
% growth rate 1976-80	0.68	-2.84	2.43
% growth rate 1981-87	3.97	1.98	5.28
%growth rate 1988-94	3.14	3.17	2.32

Table 5: Components of TFP Growth in Rice Production for Vietnam as a whole, the North and the South

Year	$1 - C_0\,\omega$	Vietnam				The North				The South			
		Average price βp (US$/ton)	Index of A	Index of A_1	Proportion of TFP growth due to incentive effects (%)	Average price βp (US$/ton)	Index of A	Index of A_1	Proportion of TFP growth due to incentive effects (%)	Average price βp (US$/ton	Index of A	Index of A_1	Proption. of TFP growth due to incentive effects (%)
1976-80	0.56	77.74	100	100		84.63	100	100		72.04	100	100	
1981	0.56	88.51	110.79	104.02	37.29	87.5	112.12	101.02	8.41	89.29	109.44	106.74	71.45
1982	0.56	91.99	127.66	105.25	18.98	91.84	126.71	102.52	9.42	92.11	127.82	107.76	27.89
1983	0.56	94.87	129.53	106.24	21.13	99.3	124.73	104.98	20.14	91.68	133.04	107.61	23.02
1984	0.56	97.6	135.77	107.16	20.02	99.66	124.76	105.10	20.58	96.23	143.35	109.20	21.23
1985	0.6	94.34	138.41	108.31	21.63	102.04	125.13	108.10	32.22	89.29	147.94	109.01	18.79
1986	0.6	99.05	137.21	109.92	26.67	112.78	122.22	111.44	51.46	90.23	146.73	109.35	20.02
1987	0.61	101.62	131.42	111.34	36.10	111.11	119.65	111.49	58.47	95.24	139.80	111.73	29.46
1988	0.61	123.26	145.99	118.07	39.29	151.26	130.03	122.45	74.76	105	156.12	115.09	26.89
1989	0.64	137.86	161.20	123.95	39.14	150.52	140.20	124.07	59.87	130	173.72	124.61	33.39
1990	0.65	151.04	161.42	128.05	45.66	163.67	132.72	127.87	85.17	143.87	179.28	129.12	36.73
1991	0.69	180.91	159.60	137.74	63.33	180	117.30	134.03	100.00	181.34	185.51	141.07	48.03
1992	0.7	164.89	166.14	134.50	52.17	172.55	143.34	132.90	75.91	160.48	174.68	136.52	48.91
1993	0.69	165.67	171.10	134.11	47.97	161.12	159.25	129.59	49.94	168.61	171.12	137.99	53.41
1994	0.68	197.29	168.07	140.80	59.93	214.66	151.75	140.77	78.79	186.34	171.08	141.61	58.55
% annual growth 1981-87			3.97	1.35			1.98	1.70			5.28	1.13	
% annual growth 1988-94			3.14	3.14			3.17	2.62			2.32	3.55	

Source: Tables DA.10, DA.12 in Che (1997).

Figure 1: Indices of Total Factor Productivity in Vietnamese Rice Production (1976-80=100)