Liberalisation, Incentives and Vietnamese Agricultural Growth

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Abstract
This paper uses a dynamic model to analyse the effects of liberalisation on the long-run output and transitional growth of the Vietnamese rice sector during the period of reform from 1981 to the present. In particular, the paper attempts to allow for the incentive effects which can result if liberalisation induces individuals to work harder and use land more efficiently. Each new stage of liberalisation is shown to result in a higher steady-state level of physical capital and rice output. It is shown that, even with an assumed zero rate of growth in the 'Solow residual' component of total factor productivity, liberalisation may increase the long-run production of rice output by an order of two times its initial value. The analysis also predicts a significantly higher transitional growth rate of rice output for the more pervasive second stage of liberalisation than that for the first stage, suggesting that incentives and open markets matter greatly.

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This paper uses a dynamic model to analyse the effects of liberalisation on the long-run output and transitional growth of the Vietnamese rice sector during the period of reform from 1981 to the present. In particular, the paper attempts to allow for the incentive effects which can result if liberalisation induces individuals to work harder and use land more efficiently. Each new stage of liberalisation is shown to result in a higher steady-state level of physical capital and rice output. It is shown that, even with an assumed zero rate of growth in the ‘Solow residual’ component of total factor productivity, liberalisation may increase the long-run production of rice output by an order of two times its initial value. The analysis also predicts a significantly higher transitional growth rate of rice output for the more pervasive second stage of liberalisation than that for the first stage, suggesting that incentives and open markets matter greatly.
In the last two decades significant economic reforms have taken place in what were once purely socialist economies which are now moving towards a system of fully functioning competitive markets. This process has usually been accompanied and facilitated by changes in economic and legal institutions, in particular, changes in property rights that allow for some degree of private ownership and control. In most cases, the results of such liberalisations have been striking. One of the most recent and impressive reform success stories is that of Vietnamese agriculture. From being a large importer of rice and other foodstuffs in the 1980’s, Vietnam has now become the third largest exporter of rice in the world, all without a significant increase in capital or labour inputs and with virtually no technological change.

Liberalisation in Vietnamese agriculture has proceeded in several stages, from early partial attempts to de-collectivise the sector in the early 1980’s through to more complete liberalisation of the domestic market and international trade in the late 1980’s. Each stage of reform has been important and, indeed, vital to the stages which followed. However, the relative contributions of the different stages in the reform process is still poorly understood. In recent work, Che (1997) and Che and Vousden (1998) calculate the changes in total factor productivity which have accompanied each stage of liberalisation and determine what percentage of these changes is accounted for by so-called “incentive effects” --- reform-induced improvements in labour efficiency and land management practices driven by increases in effort by the farmer. Using a similar approach to McMillan, Whalley and Zhu (1989), it is estimated that the proportion of total factor productivity growth resulting from this sort of incentive effect is very high, ranging from 48 per cent to 77 per cent in the later stages of reform.
These models are static in nature, analysing the observed effects of policy changes on outputs and inputs and simulating the incentive effects for each year. In particular, physical capital accumulation is treated as exogenous, rather than as the outcome of an intertemporal optimising decision by economic agents. The aim of the present paper is to incorporate the capital accumulation decision into the earlier framework and thus provide a basis for estimating and predicting the long-run implications of each stage of reform. To this end, we employ a dynamic optimising model of the representative farmer’s behaviour over time. This enables us to generate a growth path for capital and output which converges to a steady state. Applying this model to the Vietnamese rice market, we find that the predicted transitional growth rates are significantly higher for the later stages of reform than for the initial stages. In addition, the incentive effects feed back onto the dynamic adjustment process, an increase in farmer effort driving up the marginal product of capital, stimulating capital accumulation and generating further growth. For this reason, the model with incentive effects yields longer convergence times and a larger steady state than the model without such effects.

The paper consists of four sections. Section 1 summarises the main features of the Vietnamese rice market and details the stages of liberalisation. Section 2 presents and solves a simple dynamic optimising model to determine the representative farmer’s choice of inputs (and hence output) over time. In section 3, this model is used to estimate the long-run effects of the different stages of liberalisation on the rice industry in Vietnam. Section 4 offers a summary of the main results and some concluding remarks.
1. **Background:**

Rice is the most significant industry in Vietnamese agriculture. In fact, it absolutely dominates agricultural and foodstuff production, and its role has become even more important during the process of economic reform. With reform, the proportion of rice in foodstuff production has increased from 80.8 per cent (in 1980) to 97.6 per cent (in 1996), and from 79.4 per cent (in 1980) to 85 per cent (in 1996) in terms of output (unhusked rice equivalent) and sown area respectively (GSO, various years). Rice production also absorbs the greatest percentage of the labour force in rural areas, where about 70 per cent of workers in the Vietnamese economy live and, on average, contributes 67 per cent of household income (World Bank, 1995).

In addition, rice production is a crucial source of nutrition for the population. In Vietnam, starch-products make up 90 per cent of daily nourishment and, of that, rice supplies 83.1 per cent of calorie intake in the rural regions and 77.6 per cent in the urban areas (Ministry of Agriculture and Food Processing Industry, MAFI, 1987 quoted by the State Department of Price, SDP, 1995).\(^1\) Moreover, rice exports are an important source of export revenue, accounting for (approximately) 30 per cent of total export revenue (GSO, 1996; and Ministry of Trade (MIT), 1992 and 1995).

As a result of economic reforms there has been a significant increase in rice production in Vietnam. From being a large importer of rice and other foodstuffs in the 1980’s, Vietnam has now become the third largest exporter of rice in the world. In fact, output in the agricultural sector as whole literally doubled from 1981 to 1993 (General Statistics Office of Vietnam, GSO, various years).\(^2\)

\(^1\) Although, it is argued that in Asia, rice is becoming an inferior good (Ito, Peterson and Grant, 1989).

\(^2\) In China the comparable figure for the period 1978 to 1984 is 61 percent (Lin, 1991).
The process of transition of Vietnamese agriculture from a centrally controlled sector can be divided into three main stages, the communal stage (1975-80), the period of output contracts and a tightly controlled domestic market (1981-87) and the final stage involving the gradual freeing up of domestic and international trade in agricultural products. These are now discussed in turn.

1.1: *The communal regime (1975-80)*:

In the initial communal stage, virtually all production was located in compulsory agricultural collectives\(^3\) with all activities of farmers (including choice of input quantities) chosen by the State. After submitting to the State a specified quantity of rice, most of the remaining rice had to be sold to the State at the state price which was generally very low, possibly 20-30 per cent of the black market price. Farm households maintained a subsistence living from the 5 per cent of their land which they were permitted to use for vegetable production and breeding of pigs and chickens, however there were strong restrictions on the sale of even this produce\(^4\).

As a result of these controls, there was no incentive for farmers to use natural resources efficiently. The output of agriculture as well as food grain production fell markedly in the period 1977-80 causing Vietnam to import a large amount of foodstuffs, mainly from the Soviet Union.

3.2: *The period of output contracts (1981-87)*:

In response to a range of economic crises in 1979-80, the Vietnamese government moved to de-collectivise agriculture. The output contracts system was introduced whereby the land was allocated to peasants so that they could organise the weeding and harvesting, with

\(^{3}\) Although there were some differences in structure and functioning of the collectives between the North and the South; see Che (1997).
the remaining operations still to be carried out by the cooperative. A quota for produce delivery was fixed or based on the average yield of a plot of land in the previous three years. This change thus conferred limited decision-making power on the farmer. Moreover, although the State still nominally controlled all commercial activities at the state price, the farmer now had some control over the output and distribution of his product, so that black markets inevitably emerged. The main features of this stage were: (a) a tentative first move towards giving the farmers private property rights; (b) the existence of parallel markets, one at the state price, the other at the black-market price; and (c) the farmer now had some (albeit limited) responsibility for decision making.

1.3: Gradual freeing up of markets (1988 to the present)

In response to a range of economic problems, particularly severe food shortages, in 1987-88, the government liberalised the output contracts system so that households were allocated conditionally private land use (allocated to a household for 10 to 15 years) and were able to barter outputs for inputs etc. The cooperative still controlled land and water resources so that, if a farmer wanted land, he had no choice but to stay within the cooperative. However, the farm household now owned its draft animals, farm tools and other collective assets on its land and (after paying a tax) had the right to retain its income from production, although, until 1989 it was not permitted to sell its produce outside the local district. The cooperative largely opted out of the management of production although it retained the power to determine the type of product to be produced.

In June 1990, the government cancelled the dual price system (one state price and one market price) for most goods and the exchange rate. There were no longer any

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4 See Che (1997).
restrictions on trade in rice or any other agricultural goods. Inputs and outputs were now freely traded in decentralised markets. In addition, in 1989 the state monopoly on foreign trade began to be relaxed and most import quotas were replaced by tariffs. Exchange rate reform had also been strengthened by changing from a multiple to a unified exchange rate, with liberalisation of controls on foreign exchange (Annual Reports by State Bank of Vietnam).

In July, the 1993 Land Law (Congress of Vietnam, 1993) reinforced land use rights (over the 1988 Land Law) by extending tenure over agricultural land to 20 years and introducing provisions for the selling, leasing, exchanging, mortgage, and the inheritance of land. However, in principle, ownership rights still belonged to the State (World Bank, 1995).

Thus, this most recent stage of reform is characterised by: (a) a freeing up of domestic agricultural markets; (b) an opening up to international trade in agricultural products; (c) individual farmer responsibility for decision making; and (d) a significant move towards a system of private property rights. Although the liberalisation has clearly proceeded in many stages (and on many dimensions), for analytical purposes it is convenient to think of it as occurring in two stages, the introduction of output contracts stage and the freeing up of internal and external trade stage as discussed here. In the following section we present a simple framework developed in Che (1997) to formally distinguish the respective stages so that their properties may be modeled and estimated.
2. **A Simple Dynamic Model:**

This section uses a simple growth model to analyse the effects of successive stages of liberalisation on the steady-state level of output and transitional dynamics in Vietnam’s agricultural sector. The methodology is an extension of that used to analyse the static effects of reform in Che and Vousden (1998).

We model growth in the agricultural sector by considering the intertemporal optimization problem solved by a representative farmer. Suppose the farmer produces an output \( Q \) using land \((L)\), labour \((N)\), material inputs such as fertiliser, pesticides and seeds \((K_1)\) and farm machinery \((K_2)\). Suppose also that the farmer can choose the effort with which he or she works. If \( N \) represents the total number of workers and \( \varepsilon_1 \) is the effort of a typical farmer, the contribution of labour to output measured in efficiency units is \( \varepsilon_1 N \). The measure \( \varepsilon_1 \) may be interpreted broadly to include everything that determines the quality of the farmer’s labour, including the farmer’s willingness to literally exert more effort and the effects of removing external constraints on the kinds of tasks the farmer may undertake.

In the communal system the farmer did not have any choice of the types of crops to plant or the way in which the work was performed or the farm managed. However, after liberalisation, farmers were allocated conditional property rights to land, and they were also granted the freedom to choose which products to grow. The individual farmer then had the right to manage production and determine necessary input requirements. To capture the effect of reform on the farmer’s incentive to choose the most efficient manner to exploit a given area of land, we include another “effort” variable \( \varepsilon_2 \) to capture the effects of liberalisation on the productivity of a given sown area of land via increased effort in
managing the land, (eg., increasing the number of different crops sown in a fixed area over a year) and generally better land-use planning to increase the yield on a given amount of land. Then, if $L$ represents total sown area, the total contribution of land to output measured in efficiency units is $\epsilon_2 L$.

The empirical literature on aggregate agricultural production functions for twenty-two less developed countries (Hayami and Ruttan, 1985), and China (Tang, 1980), indicates that a typical aggregate production function is adequately captured by a Cobb-Douglas form, with constant returns to scale. Thus, in the present case, the production function is given by

$$Q = \alpha_0 (\varepsilon_1 N)^{\alpha_1} (\varepsilon_2 L)^{\alpha_2} (K_1)^{\alpha_3} (K_2)^{\alpha_4}$$

where $0 < \alpha_1, \alpha_2, \alpha_3, \alpha_4 < 1$ and $\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 = 1$, or, in per capita terms

$$q = \frac{Q}{N} = \alpha_0 \varepsilon_1^{\alpha_1} \varepsilon_2^{\alpha_2} l^{\alpha_3} k_1^{\alpha_4} k_2^{\alpha_4}$$

where $l$, $k_1$ and $k_2$ are respectively land, materials and capital per worker. To keep the exposition simple, we shall assume that each farm has one unit of labour (the “farmer”) so that $q$ in equation (1a) represents output per (representative) farmer.

The farmer’s profits from production at any point of time are influenced by government policies that affect both his cost and his revenue. We deal with these in turn.

2.1: Revenue:

On the revenue side, the farmer will be affected by any explicit or implicit taxes charged by the state, by state regulation of the price he can receive for his product and by any fixed charges collected by the state for the use of the land. In order to capture the effects of different policies in different stages of liberalisation, we write net revenue as

$$R = \beta p (q - d)$$
where $p$ is the price of the agricultural good at which output is sold, $d$ is the fixed rent or lump-sum tax (in units of the agricultural good) that the farmer pays the state for the right to use the property and $\beta$ is the fraction of additional revenue which the state allows the farmer to keep. In effect, $\beta$ represents the division of income under a share-cropping contract between the landlord (the state) and the farmer. The product $\beta p$ is actually a vector product representing an average goods price which includes three components, one for each stage in the liberalisation process. It is given by

$$\beta p = (\beta_0 p_s + \beta_1 p_M + \beta_2 p_W)$$

where $\sum_{i=0}^{2} \beta_i = 1$, $p_s$, $p_M$, $p_W$ are the state price, the market-clearing price and the export price respectively, and $\beta_0$, $\beta_1$ and $\beta_2$ are the fractions or shares of agricultural output allocated or delivered to the state, the domestic market, or sold internationally.

These variables will take on different values in each stage of liberalisation. Under the communal system, prior to any liberalisation, the farmer is required to sell all his output at the low, state-controlled price $p_S$. Thus, in this case,

$$\beta_0^c = 1; \beta_1^c = 0; \beta_2^c = 0.$$  \hspace{1cm} (4)

For some time after the de-collectivisation of property rights and the granting of free management in production, the domestic market remained tightly controlled with the farmer still required to sell most of his output to the State at the low compulsory price, but free to sell a small fraction $\beta_1^D$ to the domestic market at the market price. In this first phase of reform, the values of $\beta$ are

$$1 > \beta_0^D > 0; 1 > \beta_1^D > 0; \beta_2^D = 0; \beta_0^D + \beta_1^D = 1.$$  \hspace{1cm} (5)
In the next stage, where the farmer is free to sell all of his output on the domestic market at the market price and there are no domestic price controls (although free international trade is still not permitted), the values of $\beta$ are
\[ \beta^M_0 = 0; \beta^M_1 = 1; \beta^M_2 = 0. \] 

(6)

In the final stage, where the government opens up the economy to free international trade under a realistic exchange rate, the share parameter values are
\[ \beta^W_0 = 0; 1 > \beta^W_1 > 0; 1 > \beta^W_2 > 0; \beta^W_1 + \beta^W_2 = 1. \]

(7)

Thus, as the reform process proceeds, the share of output going to the state will decline, the share going to the domestic market initially increasing and subsequently decreasing as some of the output is exported. This process will gradually redirect output towards markets where the price is higher. Since Vietnam is currently a natural exporter of agricultural goods, its export price will exceed its domestic market price under autarky which will, in turn, exceed its domestic market price under tightly regulated domestic markets, and this, in turn, is higher than the state price, i.e.,
\[ p_S < p_D < p_M < p_W. \]

(8)

In short, the relative values of the coefficients $\beta_0$, $\beta_1$ and $\beta_2$ reflect the transition of the sector from entirely communal to a free domestic market to free international trade. Although equation (3) does not reflect all the complexities of the various payment systems, it does capture the main features of how the values of $p$ and $\beta$ vary during the reform process. In particular, it is clear from the above that at each stage of the transition, the value of $\beta p$ will be higher than at the previous stage, so that the reform process will affect revenue by a steady increase in the average effective price faced by the farmer. The estimated cumulative growth of $\beta p$ over the period 1976-1994 is given in Table 2 at the
end of the paper and illustrated in Figure 1 for Vietnam as a whole, the North and the South respectively.

**Cumulative Growth of βp**

![Cumulative Growth of βp](image)

**Figure 1**

2.2: *Cost:*

Liberalisation also affects the farmer’s costs by deregulating some input markets and removing factor subsidies. To capture this, we first note that, given the Cobb-Douglas production function (1), total cost is given by

\[ TC = C_0 \prod_{i=1}^{4} w_i^{a_i} Q \]  

(9)

where \( C_0 \) is constant and \( w_i \) (\( i=1,4 \)) represents the factor prices for labour, land, material inputs, and capital respectively. Defining

\[ W(w_i) = \prod_{i=1}^{4} w_i^{a_i} \]  

(10)

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5 Source, Che (1997).
as the average (real) factor price, the cost of production ($C$) for a representative farmer depends on the quantity produced and the average factor price

$$C = C_0 W(w_i)q.$$  \hspace{1cm} (11)

If we define $m = \frac{W(w_i)}{p}$, then $C$ may be written as

$$C = C_0 m p q$$  \hspace{1cm} (12)

where $m$ is a ratio of the average input price to the average output price. It captures the relative effects of reform on these prices at different stages of liberalisation. The estimated cumulative growth of $(1-C_0 m)$ is given in Table 2 and is illustrated for Vietnam as a whole in Figure 2.\(^6\) It is clear from Figure 2 that $m$ has been generally rising for most of the period, suggesting that goods markets have adjusted ahead of factor markets.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{cumulative_growth.png}
\caption{Cumulative Growth of (1-$C_0 m$)}
\end{figure}

\(^6\) Source, Che (1997).
2.3: **Profits:**

The farmer’s profits are now given by

\[ \Pi = \beta_p (1 - C_0m) - d \]  \hspace{1cm} (13)

2.4: **Capital Accumulation:**

The representative farmer’s profits at time \( t \) are allocated between current consumption at time \( t \) and investment \((I(t))\) in machinery to supply future consumption:

\[ \beta_p (1 - C_0m)q(t) - d = c(t) + I(t) \]  \hspace{1cm} (14)

Thus, if \( \mu \) is the exogenous rate of depreciation of farm capital and \( n \) is the exogenous rate of growth of the farm workforce, capital per farm changes over time according to

\[ k_2(t) = I(t) - (\mu + n)k_2(t) \]  \hspace{1cm} (15)

2.5: **The Farmer’s Optimisation Problem:**

We assume that the present value of the typical farmer’s lifetime stream of utility is given by

\[ U = \int_0^\infty \left[ \frac{c(t)^{1-\sigma}}{1-\sigma} - \frac{\varepsilon_1(t)^z}{z^\delta} - \frac{\varepsilon_2(t)^z}{z^\delta} \right] e^{-\rho u} dt \]  \hspace{1cm} (16)

where \( \sigma \in (0,1) \cup (1,\infty) \) is the inverse of the constant intertemporal elasticity of substitution, \( \delta > 0 \) and \( z > 1 \) are constants and \( \rho \) is the farmer’s constant subjective rate of time preference.\(^8\). Because we wish to use data on rates of change of land (sown area) and material inputs in our empirical analysis, we assume that \( l \) and \( k_1 \) are given exogenously. The farmer’s production function may then be written as

\[ q = B\varepsilon_1^{\alpha_1} \varepsilon_2^{\alpha_2} k_2^{\alpha_4} \]  \hspace{1cm} (1b)

\(^7\) A dot over a variable denotes a derivative with respect to time.

where \( B \equiv \alpha_0 \beta^{\alpha_2} k_1^{\alpha_3} \). It is also convenient to use (14) to rewrite the capital accumulation equation as

\[
\dot{k}_2 = \left(1 - C_{0,m} B \epsilon_1^{a_1} \epsilon_2^{a_2} k_2^{a_3} - d\right) - c - (\mu + n) k_2. \tag{15a}
\]

The farmer then chooses his consumption, investment and “effort” levels \( \epsilon_1 \) and \( \epsilon_2 \) at each point of time to maximise (16) subject to (1a), and (15). This yields solutions for the sector’s transitional dynamics and long-run steady-state levels of capital and output as in a standard neoclassical growth model\(^9\).

The neoclassical paradigm is appropriate for this model because farming is a perfectly competitive industry which is not characterised by increasing returns to scale or significant spillovers as embodied in the ‘new growth theory’ of Lucas (1988), Romer (1990), Grossman and Helpman (1991) and Barro and Sala-i-Martin (1995). These models generate positive long-run growth of per capita output without requiring ongoing exogenous technical progress, whereas the present model yields convergence to a steady-state level of per capita output.

Although the present model makes the standard neoclassical assumption of an exogenous growth rate of labour in the sector, it allows for some endogeneity of labour and land by including endogenous incentive effects via the “effort” variables \( \epsilon_1 \) and \( \epsilon_2 \). Although human capital accumulation may also be important in practice, it is omitted from the model because of data limitations\(^10\). Nevertheless, the analysis manages to capture most of the relevant effects of liberalisation on dynamic paths and the steady-state levels of consumption, output, the capital stock, and worker effort and efficiency.

\(^9\) See. Solow (1956), Swan (1956), Cass (1965) and Mankiw, Romer and Weil (1992)

\(^{10}\) More correctly, it is now included (with a number of other unspecified things) in the ‘Solow residual’.
Letting $\psi$ denote the farmer’s shadow price of capital\footnote{This equals the increase in the value of the objective function (16) resulting from a small increment in the farmer’s stock of physical capital.} the solution of the model satisfies the following equations

\begin{align*}
\frac{\partial c(t)}{\partial t} &= \psi(t) \quad (17) \\
\frac{\partial \epsilon_1(t)}{\partial t} &= \psi(t) B_1 \delta \alpha \epsilon_2(t) \kappa_2(t) \quad (18) \\
\frac{\partial \epsilon_2(t)}{\partial t} &= \psi(t) B_1 \delta \alpha \epsilon_1(t) \kappa_2(t) \quad (19)
\end{align*}

where $B_1 \equiv \beta P (1 - \delta_m) B$. Equation (11) states that output will be allocated to investment up to the point where the loss of current utility from a unit of current consumption foregone equals the increase in utility over all future periods resulting from an extra unit of capital now. Equations (18) and (19) are simply rearrangements of the conditions that the marginal product of each sort of effort equals its marginal disutility.

Taking the ratio of equations (19) to (18) yields the following simple relationship between $\epsilon_2(t)$ and $\epsilon_1(t)$

$$\epsilon_2(t) = \epsilon_1(t) \left( \frac{\alpha_2}{\alpha_1} \right)^{1/\delta} \quad (20)$$

as in the static model in Che and Vousden (1998). The rate of growth of consumption is given by

$$\hat{c} = \frac{1}{\sigma} \left[ B_1 \alpha \epsilon_1(t) \kappa_2(t) \kappa_2^{-1} - (\mu + n + \rho) \right] \quad (21)$$

The last term in brackets on the right-hand side of (21) is the marginal product of capital in reproducing itself. Thus (21) states that consumption increases over time if and only if the real return to capital per farmer (the marginal product of capital net of depreciation and
population growth) exceeds the farmer’s rate of time preference $\rho$. Finally, we note the transversality condition

$$\lim_{t \to \infty} \varphi(t)k_2(t) = 0. \quad (22)$$

### 2.6: The Equilibrium Growth Path:

From (18) and (20) we obtain the following solutions for $\varepsilon_1$ and $\varepsilon_2$ at time $t$

$$\varepsilon_1(t) = \left[ \psi(t) \delta B_1 (\alpha_2) \frac{\alpha}{\zeta} (\alpha_2) \right] \frac{1}{\zeta^{a_1-a_2}} (23)$$

$$\varepsilon_2(t) = \left[ \psi(t) \delta B_1 (\alpha_2) \frac{\alpha}{\zeta} (\alpha_2) \right] \frac{1}{\zeta^{a_1-a_2}} (24)$$

Substituting these solutions for $\varepsilon_1$ and $\varepsilon_2$ into (15a) and (21) yields a system of differential equations in $k_2$ and $c$, defining the movement of these variables over time. It is straightforward to show that these variables each converge to a steady-state level (where $\dot{c} = \dot{k}_2 = 0$), as in the neoclassical growth model, rather than growing indefinitely as in endogenous growth models. This result is a consequence of the absence of increasing returns and spillovers from the model.

The steady-state values of consumption and physical capital per farmer are denoted by $c^*$ and $k_2^*$. Setting $\dot{c} = 0$ and $\dot{k}_2 = 0$ in (21) and (15a) respectively, it is straightforward to show that

$$c^* = k_2^* \left[ \frac{\rho + (1 - \alpha_e)(\mu + n)}{\alpha_e} \right] - p\beta d. \quad (25)$$

For convenience and in order to simplify the solution, we set $d$ equal to zero in what follows. This gives us the following solution for the steady-state capital stock
\[
k_2^* = \left\{ \frac{B_2 \alpha_4}{(\mu + n + \rho)((1 - \alpha_4)\alpha_1 - \alpha_2)} \left[ \frac{1}{(1 - \gamma_4)} \right] \left( \frac{1}{\alpha_1 - \alpha_2} \right) \right\}
\]

where \( B_2 = \delta^{-\alpha_1 - \alpha_2} B_1^{-\alpha_1 - \alpha_2} \alpha_4^{-\alpha_1 - \alpha_2} \alpha_2^{-\alpha_1 - \alpha_2} \) and \( \gamma_4 = \frac{\alpha_4}{z - \alpha_1 - \alpha_2} \).

Given the form of the production function (1), a constant subjective rate of time preference \((\rho)\), the depreciation rate for physical capital \((\mu)\), and the growth rate of the labour force \((n)\), the steady-state values of physical capital and consumption depend only on the value of \(B_2\) and hence on \(\beta \rho (1 - C_0 m)\). By calculating \(\beta \rho (1 - C_0 m)\) for each stage of the liberalisation process, we can then estimate the steady-state value of \(c\) and \(k^*_2\) at each stage. As a theoretical proposition, it is difficult to generalise about the direction of movement of \(\beta \rho (1 - C_0 m)\) over time. On the one hand, as we have already argued, \(\beta \rho\) will increase from one stage of liberalisation to the next. On the other hand, it is possible that this will be at least partly offset by increases in \(m\), if deregulation of factor markets puts upward pressure on input prices. Ultimately, the direction of change of \(\beta \rho (1 - C_0 m)\) is an empirical issue. Figures 1 and 2 show that, for the case of Vietnamese agriculture, both \(\beta \rho\) and \((1 - C_0 m)\) are increasing throughout most of the period in question and it is straightforward to check that \(\beta \rho (1 - C_0 m)\) is increasing from one stage of liberalisation to the next. As already noted, this seems consistent with the view that the effects of reform on factor markets lags behind the effects on goods markets so that any increases in \(m\) are more than outweighed by increases in \(\beta \rho\). The broad conclusions of this analysis are straightforward. It is clear that each stage of liberalisation results in both enhanced path effects and larger steady-state values of consumption and physical capital. This predicts a pattern of growth, shown in Figure 3 in which each new liberalisation sets the sector off on
a new path of (temporarily) higher transitional growth. If a given stage of liberalisation were to persist indefinitely, the sector would ultimately converge to a new permanently higher steady-state level of $k_2$ at $E_1$. However the first stage of liberalisation, the output contracts regime, is interrupted before it reaches the steady state by the implementation of the second stage of reforms beginning in 1987. The broken curve from 1987 to year $t(I)$ illustrates the predicted path of $k_2$ for the output contracts regime if that regime were to persist until the steady state. Similarly, the bold curve from 1987-1994 illustrates the predicted path of $k_2$ for the second stage up to 1994, the last year considered. If that stage of reform were to persist indefinitely, $k_2$ would follow the broken path to $E_2$.

Figure 3
Figure 4

Figure 3 illustrates the path of the sector’s capital stock as predicted by the model. Figure 4 illustrates the actual growth path of $k_2$ over the period 1980-94 which appears to be broadly in line with the predictions of the model.

3. **Empirical Estimation:**

In this section, we derive empirical estimates for the steady-state levels of the capital stock and output in each stage of liberalisation as well as calculating the approximate time taken for the sector to converge to the steady state. This will, in turn, enable us to estimate implied annual growth rates for each stage of the liberalisation if that stage had continued indefinitely. We begin with the steady state values for capital and output. Throughout, the data used and the estimated parameters for the production function (1) and the utility function (16) as well as the policy parameters in $\beta p(1-C_o m)$ are taken from Che (1997).

3.1: **Steady State Capital Stocks:**

To facilitate estimation of steady-state capital and output, we first note that, from (26), the value of the capital-labour ratio at liberalisation stage $j$ is a simple multiple of the capital-
labour ratio under the communal system, the multiple depending on the policy parameters as follows

\[ k_j^j = k_2^C \frac{\left( 1 - C_j^m j \right) \left( 1 - C_j^m j \right)}{\left( 1 - C_j^m j \right) \left( 1 - C_j^m j \right)} \frac{1}{1 - \gamma_4 \frac{\alpha_1 + \alpha_2}{\alpha_1 - \alpha_2}}, \]  

(27)

where \( k_j^j \) (\( k_2^C \)) is the steady-state level of the capital-labour ratio in stage \( j \) (in the communal stage) and \( j \) (\( C \)) sub/superscripts denote stage \( j \) (the communal stage). In estimating these capital labour ratios, the value taken for \( \beta p(1-C_j m) \) in stage \( j \) is the last observed value in that stage. For example, for the stage of a partially liberalised domestic market which extended from 1980-1987, the value of \( \beta p(1-C_j m) \) in 1987 is taken. It is implicitly assumed that, if that stage were to continue indefinitely without further reforms, \( \beta p(1-C_j m) \) would not change much between 1987 and the steady-state. In addition, the capital-labour ratio for the communal period, \( k_2^C \), is estimated as the arithmetic average of the observed level for the years 1976-1980. These estimates of \( k_j^j \) are then used to calculate the steady-state values of the capital stock \( K_j^j \) at each stage of liberalisation. The resulting estimates for the steady state value of the capital stock are given in Table 1.

Table 1

Steady-State Capital Stocks at Different Stages of Liberalisation

(ten thousand horsepower)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Vietnam</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communal system</td>
<td>245.5</td>
<td>146.6</td>
<td>99.1</td>
</tr>
<tr>
<td>Tightly Controlled Domestic Market</td>
<td>363.2</td>
<td>216.7</td>
<td>146.7</td>
</tr>
<tr>
<td>Free Domestic and International Trade</td>
<td>844.0</td>
<td>503.6</td>
<td>340.9</td>
</tr>
</tbody>
</table>
3.2: Speed of Convergence to Steady State:

Although convergence to a long-run steady state theoretically takes an infinite time, it is possible to calculate the time taken by a dynamic system to reach a close vicinity or neighbourhood of the steady-state. This section uses this approach to obtain approximate estimates of convergence times which are subsequently used to derive estimates for steady-state output.

Here the standard approach of a log-linear approximation around steady-state values is used to generate numerical solutions of the approximate nonlinear system (see, for example, Barro and Sala-i- Martin (1995, p.59-92). The relevant system of simultaneous differential equations in consumption (c) and capital (k₂) is given by equations (15a) and (21) with ε₁ and ε₂ replaced by (23) and (24). The resulting solution for the time path of the physical capital stock is given by (details available from authors on request)

\[ K_2(t) = a_i e^{-0.25t} + 0.97 K_2^* \]  

where \( K_2^* \) is the steady-state level of the capital stock. Thus the speed of convergence of capital is calculated as -0.25 for any stage of trade liberalisation. It is straightforward to show from the production function that the speed of convergence of output is also -0.25.

In fact, \( K_2^* \) also depends on parameters such as \( \beta p \) which vary across the different stages of liberalisation. It is therefore necessary to derive the time path of physical capital and the convergence time separately for each stage of reform. These calculations are performed below for each of the two liberalisation stages.

---

12 For simplification we use the derived result for the whole of Vietnam as applying to both the north and the south, i.e., we assume that it takes the same timescale for Vietnam, the north and south to reach the vicinity of the steady state.
3.2.1: Output contracts with tightly controlled markets

The value of \( a_1 \) in (28) can be computed by setting \( t = 0 \) in that equation. The resulting value is given as

\[
a_1 = K_2(0) - 0.97K_2^* = -106.8
\]  

(29)

where \( K_2^* \) is 363.2 ten thousands horsepower, the steady-state level for this stage and \( K_2(0) \) equals 245.5 ten thousands horsepower, the steady-state level of \( K_2 \) for the previous (communal) stage (Table 1).

Substituting the values of \( a_1 \) and \( K_2^* \) into (28), the time path for physical capital in this stage of reform is

\[
K_2(t) = (-106.8)e^{-0.25t} + 352.3.
\]  

(30)

Based on (30), it can be computed that the time taken by the system to reach a neighbourhood of the steady state is about 22 years.

3.2.2: Freeing up of domestic and international trade:

Similarly, in this second stage of reform, it may be shown that the time path for physical capital is given by

\[
K_2(t) = (-526.6)e^{-0.25t} + 818.7.
\]  

(31)

In this case, \( K_2^* \) is the steady state for stage 2 (844.0) while \( K_2(0) \) is the level of \( K_2 \) in 1987, the last year in stage 1. From (31) it can be calculated that the time required for the system to reach a neighbourhood of the steady state in this stage is about 33 years.

3.3: Steady-State Output:

We now consider the steady-state level of rice output. It is possible to derive this
from the production function (1) with $e_1$ and $e_2$ replaced by (23) and (24), yielding an “institutional” or “indirect” production function of the form

$$Q^S = A(N^S)^{\gamma_1} (L^S)^{\gamma_2} (K_1^S)^{\gamma_3} (K_2^S)^{\gamma_4}$$  \hspace{1cm} (32)

where $Q^S$, $L^S$, $K_1^S$ and $K_2^S$ are the steady-state values of labour, land, current input and physical capital respectively. This function was estimated from cross-section data in Che (1997), yielding the following parameter values: $\gamma_1 = 0.2$, $\gamma_2 = 0.4$, $\gamma_3 = 0.4$ and $\gamma_4 = 0.1$ (see Che, 1997, pp.101-115). It is assumed that these “share parameters” do not change over time. The time path of the total factor productivity parameter $A$ was derived in Che (1997) by the usual “Solow-residual” method of subtracting the weighted rates of growth of the factor inputs from the rate of growth of output. $A$ is also equal to

$$A = (\alpha_q)^{-\rho/(1-C_0 m)} \left[ \delta \beta p (1-C_0 m) \right]^{\alpha_1} \left[ \delta \beta p \right]^{\alpha_2} \left[ \alpha_3 \right]^{\alpha_4} \left[ \rho + (1-\alpha_4)(\mu + n) \right]^{-\sigma}$$  \hspace{1cm} (33)

Thus, as in the static model in Che (1997), total factor productivity depends on the component $\delta \beta p (1-C_0 m)$, which as discussed reflects the changes in market structure and the prices of goods and factors in the different stages of liberalisation. We now use equations (32) and (33) to estimate the steady-state level of rice output in the different liberalisation regimes.

3.3.1: Output contracts with tightly controlled domestic market:

As we have seen, the convergence time for this stage is about 22 years. Thus if the system started in 1980, and this liberalisation regime were unchanged, it would converge to a neighbourhood of the steady state in the year 2002. In reality, this liberalisation stage

\[\text{For each stage of liberalisation, the neighbourhood of the steady-state being considered includes all points which are at least 90 per cent of the distance from the initial point to the steady state.}\]
finished in 1987, the seventh year in the path. The steady-state value of the parameters in equation (32) can thus be approximated by applying their annual growth rates to their 1987 value for the 15 years to 2002. This yields the following equation for the approximate steady-state level of rice output under this regime.

\[
Q = A^{1987} (1 + g_A)^{15} (N^{1987})^{(1)\gamma} (1 + g_N)^{15\gamma} (L^{1987})^{(1)\gamma} (1 + g_L)^{15\gamma} (K_i^{1987})^{(1)\gamma} (1 + g_{K_i})^{15\gamma} (K^{1987})^{(1)\gamma} \left( \frac{K^{1987}}{K_2^{1987}} \right)^{(1)\gamma},
\]

(34)

where \( g_A, g_N, g_L \) and \( g_{K_i} \) are the respective annual growth rates of total factor productivity, labour, land and material inputs from 1987 to 2002.

Based on the institutional production function in equation (32) for the year 1987, (34) can be rewritten as

\[
Q'_t = Q^{1987}(1 + g_A)^{15} (1 + g_N)^{15\gamma} (1 + g_L)^{15\gamma} (1 + g_{K_i})^{15\gamma} \left[ \frac{K^{1987}}{K_2^{1987}} \right]^{(1)\gamma},
\]

(35)

where the annual growth rates for labour and material inputs for the period 1988-2002 are simply assumed to equal their average values for the period 1976-94, approximately 0.6 and 3.1 per cent respectively (see Che (1997) pp.116-132 for the whole of Vietnam). Given that there is not much change in the actual land area for rice production, we also make the simplifying assumption that \( g_L \) is equal to zero.\(^\text{14}\)

Finally, consider the growth rate of total factor productivity (\( g_A \)). This is complicated because it depends directly on the growth effects of liberalisation (see equation (33)). Suppose the market structure and price level in the goods and factor markets, as represented by \( \delta Bp(1 - C_{om}) \), changes significantly (as suggested by the available data for the period of 1981 to 1987) in the earliest years of a particular liberalisation regime and
then becomes constant after five or seven years of this regime. On this supposition, the
growth rate of $\delta p(1 - C_0m)$ may be assumed to equal zero for 1988-2002. If the annual
growth rate of $A$ in 1981-87 is about 3.8 per cent (see Che (1997), pp.116-132 for the
whole of Vietnam), then the annual growth rate of total factor productivity must be less than
3.8 per cent for 1988-2002 if $\delta p(1 - C_0m)$ is constant over this time. Because of the
difficulty of estimating the rate of growth of $A$ over the later years of the period, we
consider three alternative possibilities (reflecting varying degrees of optimism) for $g_A$.

- In the first and most pessimistic scenario assume that $g_A$ equals zero for the period from
  1988-2002.\textsuperscript{15}

- In the second case, as an optimistic possibility, assume that the annual growth rate of
total factor productivity maintains the annual growth of rate 3.8 per cent as experienced
in 1981-87 until the steady state. In other words, let $g_A$ equal 3.8 per cent per year for
the period 1988-2002.

- In the third case, as a compromise possibility, let $g_A$ equal the arithmetic mean of the
  values in the two cases above, ie. 1.9 per cent per annum for 1988-2002.

Substituting into equation (35) the initial values of rice output in 1987 as 15102.6,
6075.2 and 9027.4 million tons of rice for Vietnam, the north and south respectively, and
the values $g_N = 0.6$, $g_L = 0$ and $g_{K1} = 3.1$, with the three alternative values for $g_A$ of 0, 3.8
per cent and 1.9 per cent, we obtain estimates of the steady-state level of rice output in

\textsuperscript{14} As another way of looking at this, suppose the regulation of the Vietnamese government banning
conversion of rice land to other purposes is enforced efficiently. Then the rate of change in the area of
land used for rice production can be ignored.

\textsuperscript{15} The main reservation about this approach is that it may be not be realistic to assume a zero growth
rate of the Solow residual. In other words, the actual figure for the Solow residual in 1981-87 (see Che,
1997, pp.116-132) may not allow us simply to ignore the growth rate of this component in the growth of
total factor productivity.
Vietnam, the north, and the south (at the point of fifty years after 1980). These are summarised in Table 3.

According to Table 3 and for all three values of $g_A$, this initial stage of liberalisation, although limited in scope, still yields a positive effect on the steady-state level of rice output. The difference in the value of steady-state rice output between this stage and the former communal system is 4.53, 19.25 and 11.0 million tons of rice respectively for the first, second and third value of $g_A$ (whole of Vietnam). The corresponding differences for the north are 1.82, 7.75 and 4.43 million tons of rice and, for the south, 2.70, 11.50 and 6.58 million tons of rice.

These results also allow us to compute the predicted annual growth rate of rice output if this initial liberalisation regime were to persist indefinitely. Since we know the initial value of rice output (as the arithmetic average of rice output for the years 1976-80), the steady-state value of rice output, and the approximate convergence time (all summarised in Table 4), the predicted annual growth rate of rice output is easily calculated and is summarised in Table 4.

3.3.2: Free domestic and international trade in rice:

In this case, we found that the convergence time is approximately 33 years. Thus if the system starts in 1988-89, it will converge to a ‘near’ steady-state value in 2023. 1994 is the fifth year in that process.

Here, we follow the same approach as that applied to the initial liberalisation stage in 3.3.1, but use values of variables in the fifth year (1994) as the base. The steady-state output for this second stage of the liberalisation process is then given by the following analogue of (35)
where, as before, the annual growth rates for labour and material inputs are approximately 0.6 and 3.1 per cent respectively. As before, we consider three possible values of $g_A$ for the period from 1995 to 2004. In the first case $g_A = 0$. In the second case the annual growth rate of total factor productivity of 3.6 per cent in 1988-94 (see Che (1997) pp.116-132 for the whole of Vietnam) is assumed to continue for 1995-2004. In the third or intermediate case, the growth rate of total factor productivity is the arithmetic average of these, 1.8 per cent. The value $g_L$ is again assumed to be zero.

The initial values of rice output in 1994 are 23528.3, 9100.0 and 14428.3 million tons of rice for the whole of Vietnam, the north, and south respectively (GSO, 1996). Substituting those values and $g_N = 0.6$, $g_L = 0$ and $g_{KL} = 3.1$ per cent into equation (36), for the three possible values of $g_A$, we obtain three alternative values for the steady-state level of rice output for Vietnam, the north and south. These are summarised in Table 3. For all three values of $g_A$, the second stage of liberalisation is found to cause a large increase in long-run rice output. Even in the most pessimistic case of a zero rate of growth of total factor productivity ($g_A = 0$), the increase in long-run rice output between the second round of liberalisation and the communal system is about 13.13, 4.84 and 8.29 million tons of rice and between the first and second stages of liberalisation is 8.60, 3.02 and 5.58 million tons of rice for Vietnam, the north, and the south respectively (see Table 3).

These figures can then be used to derive annual growth rates of rice output for the different values of $g_A$ (see Table 4). The most notable feature of these results is that, for any given assumed value of $g_A$, the implied annual growth rate of rice output in this second...
stage is much higher than that in the first stage of liberalisation. For example even in the
most pessimistic case with $g_A$ equal to zero, the growth rate of rice output in the second
stage is 2.0, 1.8 and 2.0 per cent per annum (for Vietnam, the north and the south
respectively) compared with 1.2, 1.2 and 1.2 per cent in the first stage. The difference in
projected growth rates between the two stages is much more pronounced under more
optimistic assumptions about the growth rate of total factor productivity.

4. Concluding Remarks:

This paper extends the static model of the effects of staged liberalisation in Vietnamese
agriculture by developing a dynamic optimising model to simulate the effects of each stage
of reform on the long-run level and the transitional growth rate of rice output. The model
differs from conventional growth predictions by incorporating incentive effects captured by
labour-enhancing and land-enhancing effort variables. The optimum effort levels are solved
for and substituted into the production function to yield an “institutional” production
function as in McMillan, Whalley and Zhu (1989). The results of the analysis predict
enhanced path and steady-state effects for each stage of liberalisation. Moreover, a direct
comparison between our model with incentive effects, and the corresponding growth model
without such effects, shows that incentive effects lead to higher steady-state values for
consumption and physical capital, particularly if the intertemporal elasticity of consumption
is less than the share parameter of physical capital in the production function (details
available from authors on request).

The empirical study of rice production in Vietnam shows a pattern of growth
broadly in keeping with that predicted by the theoretical model. Each new stage of
liberalisation results in a new and higher steady-state level of physical capital and rice output. It is shown that, even under the most pessimistic scenario for the ‘Solow residual’ component of total factor productivity, liberalisation may, by itself, increase the long-run production of rice output by an order of two times its initial value. It is also clear that the second, more pervasive, stage of liberalisation has a much larger effect on the average transitional growth rate of rice output than the first stage.

Clearly these effects are descriptive only. They suggest that the more wide-ranging the reform, the larger the transitional growth response. However, they do not, as they stand, tell us any thing about welfare gains – they have no immediate normative implications. It is possible that any welfare effects associated with the transition to the steady-state are already captured in standard triangle measures of welfare change which use long-run elasticities. On the other hand, as Baldwin (1992) has noted, if there are significant capital market distortions, additional “dynamic” gains from liberalisation may be estimated. Although Baldwin’s empirical analysis suggests that such dynamic gains are likely to be small in practice, his conclusions are based on data from selected European countries. In the case of Vietnam, capital market distortions are much larger than in Europe, so it possible that dynamic gains will be correspondingly larger. Estimation of the magnitude of such gains would be a worthwhile extension of the long-run analysis of the present paper.
Table 2

Estimates of \( \beta_p \) and \( (1-C_{om}) \)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cumulative growth of ( (1-C_{om}) )</th>
<th>Vietnam</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>1976-80</td>
<td>0.0</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>1981</td>
<td>0.0</td>
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<td>3.39</td>
<td>23.94</td>
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<td>1982</td>
<td>0.0</td>
<td>18.33</td>
<td>8.52</td>
<td>27.86</td>
</tr>
<tr>
<td>1983</td>
<td>0.0</td>
<td>22.04</td>
<td>17.34</td>
<td>27.27</td>
</tr>
<tr>
<td>1984</td>
<td>0.0</td>
<td>25.55</td>
<td>17.76</td>
<td>33.58</td>
</tr>
<tr>
<td>1985</td>
<td>15.7</td>
<td>21.35</td>
<td>20.57</td>
<td>23.94</td>
</tr>
<tr>
<td>1986</td>
<td>15.7</td>
<td>27.42</td>
<td>33.26</td>
<td>25.24</td>
</tr>
<tr>
<td>1987</td>
<td>18.1</td>
<td>30.72</td>
<td>31.29</td>
<td>32.2</td>
</tr>
<tr>
<td>1988</td>
<td>18.1</td>
<td>58.55</td>
<td>78.73</td>
<td>45.75</td>
</tr>
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<td>1989</td>
<td>23.0</td>
<td>77.33</td>
<td>77.86</td>
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<td>1990</td>
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<td>94.29</td>
<td>93.39</td>
<td>99.71</td>
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<td>1991</td>
<td>32.0</td>
<td>132.72</td>
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<td>151.72</td>
</tr>
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<td>1992</td>
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<td>112.1</td>
<td>103.89</td>
<td>122.77</td>
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<tr>
<td>1993</td>
<td>32.0</td>
<td>113.1</td>
<td>90.38</td>
<td>134.05</td>
</tr>
<tr>
<td>1994</td>
<td>30.2</td>
<td>153.79</td>
<td>153.65</td>
<td>158.66</td>
</tr>
</tbody>
</table>

Fitted Annual Growth Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Vietnam</th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981-87</td>
<td>2.8</td>
<td>3.1</td>
<td>4.2</td>
</tr>
<tr>
<td>1988-94</td>
<td>1.9</td>
<td>8.5</td>
<td>6.7</td>
</tr>
</tbody>
</table>
Table 3 The long-run level for rice output in the different stages of liberalisation (thousand tons)

<table>
<thead>
<tr>
<th>Stage of Liberalisation</th>
<th>Vietnam</th>
<th>The North</th>
<th>The South</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\sigma_A$</td>
<td>$\sigma_A$</td>
<td>$\sigma_A$</td>
</tr>
<tr>
<td></td>
<td>Case 1</td>
<td>Case 2</td>
<td>Case 3</td>
</tr>
<tr>
<td></td>
<td>zero</td>
<td>pre-existing</td>
<td>average</td>
</tr>
<tr>
<td>(0) Communal system</td>
<td>15102.6</td>
<td>15102.6</td>
<td>15102.6</td>
</tr>
<tr>
<td>(I) Output contracts</td>
<td>19633.4</td>
<td>34358.5</td>
<td>26112.4</td>
</tr>
<tr>
<td>(II) Opening up of</td>
<td>28234.0</td>
<td>76231.7</td>
<td>46303.7</td>
</tr>
<tr>
<td>markets</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The difference of the steady-state rice output

|                         | Vietnam | The North | The South |
|                         |         |           |           |
| Between stages (I) and (0) | 4530.8  | 19255.9   | 11009.8  |
| Between stages (II) and (I) | 8600.6  | 41873.2   | 20191.3  |
| Between stages (II) and (0) | 13131.4 | 61129.1   | 31201.1  |
Table 4 The predicted annual growth rate of rice output in the different stages of liberalisation (per cent)

<table>
<thead>
<tr>
<th>Stage of liberalisation</th>
<th>VIETNAM</th>
<th>The North</th>
<th>The South</th>
</tr>
</thead>
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<td>$g_A$</td>
<td>$g_A$</td>
<td>$g_A$</td>
</tr>
<tr>
<td></td>
<td>Case 1</td>
<td>Case 2</td>
<td>Case 3</td>
</tr>
<tr>
<td>(I) Output Contracts</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>-Initial level of rice</td>
<td>15102.6</td>
<td>15102.6</td>
<td>15102.6</td>
</tr>
<tr>
<td>output (thous tons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-The long-run level of</td>
<td>19633.4</td>
<td>34358.5</td>
<td>26112.4</td>
</tr>
<tr>
<td>rice output (thous tons)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Convergence time (years)</td>
<td>22</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>-Predicted annual</td>
<td>1.2</td>
<td>3.7</td>
<td>2.5</td>
</tr>
<tr>
<td>growth rate of rice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>output (per cent)</td>
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<td></td>
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<tr>
<td>(II) Opening up of</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>markets</td>
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<td></td>
<td></td>
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<tr>
<td>-Initial level of rice</td>
<td>15102.6</td>
<td>15102.6</td>
<td>15102.6</td>
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<tr>
<td>output (thous tons)</td>
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<td></td>
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<tr>
<td>-The long-run level of</td>
<td>28234.0</td>
<td>40092.3</td>
<td>33880.8</td>
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<td>rice output (thous tons)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>-Convergence time (years)</td>
<td>33</td>
<td>33</td>
<td>33</td>
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<tr>
<td>-Predicted annual</td>
<td>2.0</td>
<td>5.1</td>
<td>3.5</td>
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<tr>
<td>growth rate of rice</td>
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<tr>
<td>output (per cent)</td>
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