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Incentives and static and dynamic gains from market reform: rice production in Vietnam†

Tuong Nhu Che, Tom Kompas and Neil Vousden*

This article develops a dynamic model to account for the enhanced incentive effects that result from market reform through a move toward private property rights and competitive markets. Reform is captured through an emerging profits function which depends on effective prices and incentives to work harder. Static and dynamic output gains from reform are derived through increases in total factor productivity and induced capital accumulation. The model is applied to rice production in Vietnam over the period 1976–94. The more extensive is market reform, the larger the effects found on rice output, the capital stock and transitional growth rates, suggesting that incentives and more competitive markets matter greatly.

1. Introduction

In the past two decades, a number of transitional economies have experienced impressive increases in output through the process of trade liberalisation. This article develops a dynamic model in which these gains are largely explained by the enhanced incentive effects that result from institutional change and market reform, in the form of a move toward private property rights and competitive markets. The model is applied to the case of rice production in Vietnam as a striking example of the effects of market reform. In a fairly short period of time, Vietnam has gone from being a large importer of rice and other foodstuffs, at near subsistence levels of

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* Tuong Nhu Che, Australian Bureau of Agricultural and Resource Economics, Canberra. Tom Kompas, Australian Bureau of Agricultural and Resource Economics and National Centre for Development Studies, Australian National University, Canberra. Until his death in December 2000, Neil Vousden was at the National Centre for Development Studies and Department of Economics, Faculty of Economics and Commerce, Australian National University, Canberra.

consumption, to now the second largest exporter of rice in the world, all with virtually no discernible technological change throughout the reform process.

The model has several important features. To capture the effect of enhanced incentives through time, and following the static representations contained in McMillan *et al.* (1989) and Che *et al.* (2000), an effort variable is introduced and an associated measure of the effective contribution of labour to output in terms of efficiency units is defined. The effort variable is 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. In simple terms, the argument is that market reform results in incentives to work harder and to work more efficiently.

The process of market reform itself is captured through the effects of changes in policy and market parameters on average per unit profits. There are two things to consider here. First, in transitional economies the share of output that accrues to the state authority varies under different institutional settings, from communal systems to share-contracting schemes and finally to private competitive markets with taxes on retained earnings. Prices received by farmers for their product also vary considerably across these regimes. To capture such changes this article estimates an effective output price (the farmer's share of output multiplied by the actual output price) over time. With market reform it is asserted that both actual and effective prices increase, and this is certainly true in the case of Vietnam. With the reform process, in other words, output is directed over time toward markets where prices are higher and the share of output apportioned to the state government for centrally directed distribution falls.

Second, in transitional economies factor and product prices generally increase at different rates with market reform. In the article this process is characterised through a weighted-cost share parameter which measures the ratio of average factor to product prices under various institutional arrangements. As is true for most transitional economies, and again this is the case for Vietnam, the value of this share-cost parameter falls with reform. Changes in factor prices lag behind the increases in product prices and the result implies that average per unit profits rise over time. This, combined with a rising effective price of output, generates the emerging profits function developed in the article.

The static representation is then extended to the intertemporal economy.[1] The article develops a dynamic model of a market reform economy in which

[1] A static version of the model is developed for Vietnam in Che *et al.* (2000).

the representative farmer chooses effort levels at each point in time to maximise an intertemporal utility function that depends on consumption and effort. The resulting solution characterises the investment process, where effort levels and both the path and steady-state value of capital depend on the extent of market reform. In contrast to standard Ramsey growth models, the value of the rate of return to capital here depends on average per unit profits, and different market reform regimes result in different values of the capital stock and output per capita even if the equilibrium value of the rate of return is unchanged.

Following Baldwin (1992), measures of static and dynamic output gains from reform are also derived. Increases in average per unit profits result in more effort and increased values of total factor productivity as a measure of static gains. With increased effort, the marginal product of capital also increases and higher rates of return thus imply induced capital accumulation as a dynamic gain from market reform. Unlike Baldwin (1992), however, each measure now depends on parameter values for a work–disutility coefficient on effort and the inverse of a constant intertemporal elasticity of substitution. This turns out to be important and provides a justification for including the effort variable in the first place. The relative success of any new market reform regime, in terms of its effects on growth paths and steady-state values, now depends on the relative willingness to work harder in response to enhanced incentives and the degree to which farmers are willing to postpone consumption in response to higher rates of return. With reform, lower values of the work–disutility coefficient and the inverse of the constant intertemporal elasticity of substitution imply larger increases in total factor productivity and greater steady-state values for output and rates of growth along a transitional path.

The outline of the article is as follows. First, the dynamic emerging profits model is set out, then, the technology and the emerging profits function are defined. Next, the intertemporal problem for the farmer is solved. The model is in traditional neoclassical form in the sense that the rate of growth of labour is taken to be exogenous. Including the effort variable provides the desired endogeneity of growth paths and steady states in any case.[2] The next section derives equilibrium growth paths and steady-state values and both the static and intertemporal form of an 'institutional' production function, used to capture institutional change and market reform, is obtained. Unlike standard models, the value of total factor productivity is shown to depend on average per unit profits and the work–disutility coefficient. Static and

[2] The definition of capital is narrowly defined with the presumption that there are no significant 'spillovers' in agricultural production for transitional economies. Although human capital accumulation may also be important in practice, it is omitted from the model if for no other reason than data limitations.

dynamic gains from market reform are derived and a comparison between the model and standard Ramsey growth models is drawn. A further comparison with a model without the effort variable underscores the importance of incorporating effort into the model.

Then the model is applied to the case of rice production in Vietnam over the period 1976–94. The various transitional periods of market reform are described and the data sources and relevant estimations are set out. The article provides two empirical measures of the impact of market reform. A linear approximation around steady-state values is used to find the implied rates of growth in rice output from one stage of market reform to the next. Convergence times depend on the extent of market reform as does the steady-state value of capital, rice output and transitional growth in each stage.[3] The more extensive is the degree of reform, the larger are the effects, suggesting that incentives and competitive markets matter greatly. The results are confirmed in terms of the precise measures of the static and dynamic output gains from market reform drawn from actual data. Finally, a conclusion is drawn.

2. An emerging profits model

2.1 Technology and profits

Following McMillan *et al.* (1989), let ε represent the level of effort of a typical farmer, so that, for N workers εN is the effective contribution of labour to output measured in 'efficiency units'. As mentioned, the value of ε 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. Assume a 'technical' constant returns to scale production function:

$$Q = \alpha_0(\varepsilon N)^{\alpha_1} L^{\alpha_2} E^{\alpha_3} K^{\alpha_4} \tag{1}$$

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

$$q = \frac{Q}{N} = \alpha_0 \varepsilon^{\alpha_1} l^{\alpha_2} e^{\alpha_3} k^{\alpha_4} \tag{2}$$

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

In principle, farmers work in different institutional settings that vary from a communal system to various forms of share-contracting and private competitive markets. To represent this let $\beta \in [0, 1]$ be the fraction of additional revenue that

[3] From the individual farmer's point of view, the lengthy and gradual adjustment to a new steady-state value of the capital stock is assured by the absence of well-developed capital markets as typical in transitional economies.

the farmer is allowed to keep and let $\beta pq + d$ be a measure of income for price p, which also varies by institutional setting. The value d is a constant that represents payments received under a communal system, often regardless of effort, so that when β equals zero all production (less d) is transferred to the state government. Various share-contracting schemes thus imply that β is a positive fraction and when markets are perfectly private and competitive β equals one. In the latter case, the farmer retains all income and d is clearly zero so that, in this sense, β is an index that measures both the incentive to work and the fraction of the value of the marginal product that would be paid to the farmer.[4] An essential property of the reforms considered in this article is that both β and effective output prices βp increase with market reform.

Costs depend on an vector of input prices $\mathbf{w}$ and the total cost function, as usual, is defined as:

$$C = c_0 W(\mathbf{w})q \tag{3}$$

where c_0 is a constant that depends on the share parameters for inputs in equation (1) and $W(\mathbf{w})$ defines the weighted share of input prices. The profit function is thus:

$$\pi = \beta pq - c_0 W(\mathbf{w})q \tag{4}$$

ignoring the communal payment d. As mentioned, in transitional economies, factor and product prices generally increase at different rates with market reform. To capture this, define $m = W(\mathbf{w})/\beta p$ as a weighted-cost share parameter or the ratio of average factor to effective product prices. The profit function now becomes:

$$\pi = \beta p[q(1 - c_0 m)] \tag{5}$$

for

$$\tau \equiv \beta p(1 - c_0 m) \tag{6}$$

a measure of average per unit profits. If factor or input prices lag behind effective output prices with market reform, increases in effective output prices βp will imply that average per unit profits τ increase and $\pi > 0$ along a transitional path. Equation (5) thus represents an emerging profits function.

2.2 Capital accumulation and intertemporal optimization

The representative farmer allocates profits at time t between current consumption $c(t)$ and investment $I(t)$ in capital goods, so that:

[4] This simple representation of the incentive scheme can be thought of as a reduced form of a more complex system of equations that define a reward structure. See MacRae (1977) and Sicular (1988).

$$I(t) = \tau\alpha_0 \varepsilon^{\alpha_1} l^{\alpha_2} e^{\alpha_3} k^{\alpha_4} - c(t) \tag{7}$$

using equations (2) and (5) and the definition of average per unit profits. Capital per unit of labour k evolves according to:

$$\dot{k} = I(t) - (\mu + n)k = \tau\alpha_0 \varepsilon^{\alpha_1} l^{\alpha_2} e^{\alpha_3} k^{\alpha_4} - (\mu + n)k - c(t) \tag{8}$$

for n an exogenous rate of growth of the labour force and μ the rate of depreciation. Note that the measure of output per capita depends on the degree of market reform, or average per unit profits τ and hence effective product prices βp. In a standard Ramsey (aggregate) growth model, $\tau\alpha_0 \varepsilon^{\alpha_1} l^{\alpha_2} e^{\alpha_3} k^{\alpha_4}$ would simply be given by q or output per capita, independent of any market reform.

Assume that farmers receive utility $u(c, \varepsilon)$ from consumption but dislike effort and represent the intertemporal value function by:

$$U(c(t), \varepsilon(t)) = \int_0^\infty \left[\frac{c(t)^{1-\sigma}}{1-\sigma} - \frac{\varepsilon(t)^z}{z\delta} \right] e^{-\rho t} dt \tag{9}$$

for σ the inverse of the constant intertemporal elasticity of substitution, ρ the constant subjective rate of time preference and parameter $\delta > 0$. The value $z > 0$ is a work–disutility coefficient implying that the marginal disutility of effort increases with effort. The value δ is chosen to guarantee that, roughly speaking, the concavity of $u(c)$ offsets the convexity of $u(\varepsilon)$ so that $U(c(t), \varepsilon(t))$ is jointly concave.

The representative farmer chooses consumption and effort levels $\varepsilon(t)$ at each point in time to maximise equation (9) subject to equation (8) and an initial condition $k(0) = k_0$. Effective output prices βp are parametric to the farmer. First-order necessary conditions are:

$$c(t)^{-\sigma} = \psi(t) \tag{10}$$

$$\varepsilon(t)^{z-\alpha_1} = \psi(t)\tau\alpha_0 l^{\alpha_2} e^{\alpha_3} \delta\alpha_1 k(t)^{\alpha_4} \tag{11}$$

$$\dot{\psi}(t) = -\psi\tau\alpha_0\alpha_4 \varepsilon^{\alpha_1} l^{\alpha_2} e^{\alpha_3} k^{\alpha_4 - 1} + \psi(\mu + n + \rho) \tag{12}$$

$$\dot{k}(t) = \tau\alpha_0 \varepsilon^{\alpha_1} l^{\alpha_2} e^{\alpha_3} k^{\alpha_4} - (\mu + n)k - c(t) \tag{13}$$

for $\psi(t)$ the co-state variable or 'shadow price' of capital. As usual, equation (10) 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 from an extra unit of capital today. Equation (11) simply requires that the marginal product of effort equals the marginal disutility of effort. Most importantly, from equations (11) and (13), market reform or increases in average per unit profits τ imply both more effort and larger transitional growth rates.

2.3 Equilibrium growth paths and steady states

Differentiating equation (10) with respect to time and substituting from equation (12) gives:

$$\frac{\dot{c}}{c} = \frac{1}{\sigma}\left[\tau\alpha_0\alpha_4\varepsilon^{\alpha_1}l^{\alpha_2}e^{\alpha_3}k^{\alpha_4-1} - (\mu + n + \rho)\right] \tag{14}$$

or the proportional rate of growth of consumption. Using equations (11)–(13) obtains explicit equations for the motions of c and k, or:

$$\dot{c} = \frac{1}{\sigma}\left[c(t)^{-\sigma\alpha_1/v+1}(\tau\alpha_0 l^{\alpha_2}e^{\alpha_3})^{z/v}(\delta\alpha_1)^{\alpha_1/v}\alpha_4 k(t)^{z\alpha_4/v-1}\right] - \frac{c(t)}{\sigma}(\mu + n + \rho) \tag{15}$$

and

$$\dot{k}(t) = c(t)^{-\sigma\alpha_1/v}(\tau\alpha_0 l^{\alpha_2}e^{\alpha_3})^{z/v}(\delta\alpha_1)^{\alpha_1/v}k(t)^{z\alpha_4/v} - (\mu + n)k - c(t) \tag{16}$$

for $v \equiv (z - \alpha_1)$, for convenience. The first term in brackets on the right-hand side of equation (14) is a market reform 'augmented value' of the marginal product of capital, stating that consumption increases over time only when the real return to capital per farmer (i.e., the reform augmented marginal product of capital net of depreciation and population growth) exceeds the rate of time preference.

Setting $\dot{c} = \dot{k} = 0$ and solving gives:

$$c^* = k^*\left(\frac{\rho + (1 - \alpha_4)(\mu + n)}{\alpha_4}\right) \tag{17}$$

$$k^* = \left(\frac{\tau\alpha_0 l^{\alpha_2}e^{\alpha_3}\alpha_4^{1+\sigma\alpha_1/v}}{(\mu + n + \rho)[(1 - \alpha_4)(\mu + n) + \rho]^{\sigma\alpha_1/v}}\right)^{1/(1-z\alpha_4/v+\sigma\alpha_1/v)} \tag{18}$$

for the steady-state value of per-capita consumption c^* and capital per farmer k^*. In steady state $\dot{\psi} = 0$, so the optimal value of effort is:

$$\varepsilon^* = (\tau\alpha_0 l^{\alpha_2}e^{\alpha_3}\delta\alpha_1 k(t)^{\alpha_4})^{1/(z-\alpha_1)} \tag{19}$$

for ψ normalised to one in equation (11).[5] Multiplying by N and substituting this value of ε^* into the 'technical' production function, equation (1), and solving yields:

[5] The normalisation is appropriate only in the sense that the measure of static and dynamic output gains from market reform (to follow) is derived by writing equation (20) in logarithmic form, with a variation in average per unit profits τ. All constant terms, including $\psi = c^{-\sigma}$, drop out. The linear approximation proceeds directly in terms of equations (15) and (16), without the normalisation, and accordingly redefines (20) as an optimal intertemporal production function. See equation (43). Equations (19)–(21) are also solutions to a static problem for an optimal value of ε^* obtained from maximising a utility function $u(\pi, \varepsilon)$. See McMillan *et al.* (1989).

$$Q = AN^{\gamma_1}L^{\gamma_2}E^{\gamma_3}K^{\gamma_4} \tag{20}$$

for $\gamma_1 = (z\alpha_1 - \alpha_1)/v$, $\gamma_2 = z\alpha_2/v$, $\gamma_3 = z\alpha_3/v$ and $\gamma_4 = z\alpha_4/v$, where:

$$A(\tau) = \alpha_0(\tau\alpha_0\delta\alpha_1)^{\alpha_1/(z-\alpha_1)} \tag{21}$$

for again $v \equiv (z - \alpha_1)$. Equation (20) is the exact counterpart to the static 'institutional' production function contained in McMillan *et al.* (1989), and clearly depends on institutional setting. Note as well that both total factor productivity $A(\tau)$ and effort ε now depend on the extent of market reform or average per unit profits τ.

2.4 Static and dynamic gains from market reform

Following Baldwin (1992), focus on paths and steady-state comparisons in terms of the effects of a change in average per unit profits in the above model. There are two things to consider. An increase in τ affects the level of total factor productivity $A(\tau)$ as a static output gain from market reform, but it also affects the value of the steady state capital–labour ratio k^* in equation (18), with an induced capital accumulation effect along a transitional path. A higher value for k^* implies a larger value for output per capita and thus a dynamic output gain from market reform.

To see this, consider first the simple Baldwin (1992) case. Let output per capita be represented by $q = f(k, \tau)$, so that in steady state $c^* = f(k^*, \tau)$ for a given level of market reform and $r(k^*, \tau) = \rho + \mu + n$, for r the rate of return to capital as a function of k and τ. A change in average per unit profits τ has two effects, given by:

$$\frac{dq/q}{d\tau/\tau} = \left(\frac{\partial f/q}{\partial k/k}\right)\left(-\frac{\partial r/r}{\partial \tau/\tau}\Big/\frac{\partial r/r}{\partial k/k}\right) + \frac{\partial f/q}{\partial \tau/\tau}. \tag{22}$$

As Baldwin (1992, p. 164) argues, the second term in equation (22) captures the usual static output gain, while the first term reflects the induced capital accumulation effect. If market reform (or an increase in τ) induces capital accumulation through a higher value of the rate of return r, the static output effect is enhanced.

The relevant decomposition is especially clear for the simple expression $Q = \beta K^{\alpha+\theta}$. Differentiating in log-form with respect to τ implies that:

$$\hat{Q} = \hat{\beta} + \frac{\alpha + \theta}{1 - \alpha - \theta}\hat{\beta} \tag{23}$$

as in Baldwin (1992, p. 168), where the circumflex indicates a percentage change. The static output effect is given by $\hat{\beta}$ and the dynamic output effect as a result of induced capital accumulation is a multiple of this term.

In terms of the emerging profits model above, using equation (15), the market reform 'augmented value' for the rate of return along a transitional path is:

$$r(k, \tau) = c(t)^{-\sigma\alpha_1/v+1}(\tau\alpha_0 l^{\alpha_2} e^{\alpha_3})^{z/v}(\delta\alpha_1)^{\alpha_1/v}\alpha_4 k(t)^{z\alpha_4/v-1} \tag{24}$$

as a function of both k and τ. The variation $\partial r/\partial k$ is less than zero if $\gamma_4 = z\alpha_4/v = z\alpha_4/(z-\alpha_1)$ is less than one and $\partial r/\partial\tau$ is greater than zero if $(z-\alpha_1)$ is positive. If so, market reform induces capital accumulation through an increase in average per unit profits τ. To form a decomposition between static and dynamic effects, write equation (18), or the steady-state value of the capital–labour ratio, in non-per capita form and as a function of τ so that:

$$K^* = B(\tau)^{1/(1-z\alpha_4/v+\sigma\alpha_1/v)} \tag{25}$$

where the term $B(\tau)$ now captures all of the constants in equation (18). Static efficiency requires that equation (20) holds at each point along an optimal path. Substituting from equation (25) implies that:

$$Q = A(\tau)N^{\gamma_1}L^{\gamma_2}E^{\gamma_3}[B(\tau)^{1/(1-z\alpha_4/v+\sigma\alpha_1/v)}]^{\gamma_4} \tag{26}$$

for $A(\tau)$ a function of average per unit profits, given by equation (21). Finally, differentiating in log-form with respect to τ obtains:

$$\hat{Q} = \left(\frac{\alpha_1}{z-\alpha_1}\right)\hat{\tau} + \left(\frac{\gamma_4}{1-\gamma_4+\frac{\sigma\alpha_1}{z-\alpha_1}}\right)\hat{\tau}. \tag{27}$$

The first term on the right-hand side of equation (27) measures static output gains. Recall that α_1 is the share parameter on effective labour units or εN. If $(z-\alpha_1) > 0$, proportional increases in τ, or larger average per-unit profits, result in more effort and an increase in output through an increase in measured total factor productivity $A(\tau)$. The second term in equation (27) captures dynamic output gains from market reform.[6] If effort increases with average per unit profits τ, as it must from equations (11) or (19), for γ_4 a positive fraction and $(z-\alpha_1) > 0$, the marginal product of capital will also be larger. The second term on the right-hand side of equation (27) in fact now requires (with parameter restrictions) that the rate of return to capital $r(k, \tau)$ rises with average per unit profits τ. Market reform thus induces capital accumulation and affects both the transitional growth path, see equation (16), and the steady-state value of the capital–labour ratio given by equation (18).

[6] In per capita form, this term is exactly $\gamma_4(\dot{k}/k)$ or the contribution of increases in the capital–labour ratio to increases in output per capita.

3. Comparisons to standard Ramsey models

Before considering the case of Vietnam, it is useful to draw some comparisons between the model above and standard Ramsey models. Recall first that the optimal motion for consumption in a typical growth model (without technological progress) is:

$$\frac{\dot{c}}{c} = \frac{1}{\sigma}[f'(k) - (\mu + n + \rho)] \tag{28}$$

and in steady state the condition:

$$r(k^*) = (\mu + n + \rho) \tag{29}$$

determines, with regularity, a unique value of the capital–labour ratio k^*, for given constants $(\mu + n + \rho)$. This is not the case for the model above and most importantly so. With equations (15) and (24), the steady-state rate of return is now:

$$r(k, \tau) = (\mu + n + \rho) \tag{30}$$

as a function of both the capital–labour ratio k and average per unit profits τ. As described above, increases in average per unit profits result in an increase in rate of return and thus induced capital accumulation. With increases in the capital–labour ratio, the rate of return again falls along a transitional path and since $(\mu + n + \rho)$ is constant, the rate of return r must eventually reach the same steady-state value. However, the value of the capital–labour ratio will now be larger in steady state. In fact, this is the point. Different market reform regimes result in different values of the steady state capital–labour ratio k^* and thus different values for output and consumption per capita.[7] Such a connection cannot be obtained in equation (29) since k^* is uniquely determined, independent of market reform parameters.

Next, to highlight the importance of effort ε, consider a comparison between the model above and a comparable system with the effects of market reform (or changes in τ), but without the effort variable. To see this, maximise equation (9) with $\varepsilon = 0$, subject to:

$$\dot{k} = \tau\alpha_0 l^{\alpha_2} e^{\alpha_3} k^{\alpha_4} - (\mu + n)k - c(t) \tag{31}$$

and initial conditions. The optimal motion for consumption is:

$$\frac{\dot{c}}{c} = \frac{1}{\sigma}\left[\tau\alpha_0\alpha_4 l^{\alpha_2} e^{\alpha_3} k^{\alpha_4 - 1} - (\mu + n + \rho)\right] \tag{32}$$

and the steady-state value of capital is now simply:

[7] It is easy to show that $\partial r/\partial k < 0$ and $\partial q/\partial k > 0$ are both necessary for the motions given by equations (15) and (16) to saddlepoint stable. This is confirmed by the sign of the determinant value of the coefficient matrix given by equation (A1) in the appendix.

$$k^* = \left(\frac{\tau\alpha_0 l^{\alpha_2} e^{\alpha_3}\alpha_4}{\mu + n + \rho}\right)^{1/(1-\alpha_4)} \tag{33}$$

where (recall) α_4 is the share parameter for k. It is clear from equation (32) that the market reform 'augmented value' of the marginal product of capital (the first term in brackets), or $r(k, \tau)$, is still a function of the capital–labour ratio and average per unit profits τ. But compare equations (18) and (33). By examining the coefficients in the exponential terms, and noting that $\gamma_4 = z\alpha_4/(z - \alpha_1)$, it is easy to see that:

$$\frac{1}{1 - \gamma_4 + \frac{\sigma\alpha_1}{z-\alpha_1}} < \frac{1}{1 - \alpha_4} \tag{34}$$

whenever $\sigma > \alpha_4$. The opposite of course holds for $\sigma < \alpha_4$. A similar restriction applies for transitional paths. Using equations (18) and (33) in logarithmic form, and differentiating with respect to τ, gives relative proportional rates of growth $\dot{k}/k$ such that:

$$\frac{z}{z - \alpha_1}\left(\frac{1}{1 - \gamma_4 + \frac{\sigma\alpha_1}{z-\alpha_1}}\right)\hat{\tau} > \frac{1}{1 - \alpha_4}\hat{\tau} \tag{35}$$

for $\sigma < 1$.[8] In other words, for $1 > \sigma > \alpha_4$, the model with an effort variable, compared to one without, results in a lower steady-state value for capital and faster transitional paths. But all of this is exactly what one would expect and want. The use of ε incorporates an extra and important degree of endogeneity in the model, so that paths and steady states depend on the size (indirectly) of the effort–disutility coefficient z, or the relative willingness to work harder in response to enhanced incentives and the degree to which farmers are willing to postpone consumption in response to higher rates of return, or the value of the inverse of the constant intertemporal elasticity of substitution σ. In terms of the dynamics, the relative effects of z and σ cannot be captured in the model without an effort variable, or in Baldwin's (1992) measure of dynamic gains from market reform, equation (23).[9]

[8] Multiplying both sides of equation (35) by α_4 gives dynamic gains from market reform. Multiplying $1/(1 - \alpha_4)$ by α_4 is also exactly the second term on the right-hand side of equation (23) for $\alpha + \theta = \alpha_4$, as in Baldwin (1992).

[9] In any event, it is clear from equation (27) that for any non-negative value of the inverse of the intertemporal elasticity of substitution σ there will be substantial dynamic gains from market reform, including the case in which $\sigma > \alpha_4$, and this is the effect that is emphasised throughout the article. Simulations on the linear approximation (details are available from the authors on request) for values of σ from 0.1 to 10, show (as expected) that the length of time of convergence to a steady state increases with σ but, most importantly, the effects of different values of σ are relatively insignificant to the resulting rate of growth in rice output along a transitional path. This is confirmed by the sensitivity results for the work–disutility coefficient z on the measure of the dynamic output gains effect.

The same point applies to the measure of the static gains from market reform. Recall that this measure is given by $\hat{\tau}\alpha_1/(z - \alpha_1)$. Including an effort variable in the model thus implies that both the measures of static gains from reform and total factor productivity $A(\tau)$, given by equation (21), depend on z or the work–disutility coefficient for effort. Not only is this crucial for the empirical results to follow, since changes in average per unit profits τ or market reform can now be nicely represented by changes in total factor productivity, in an otherwise traditional manner, but including an effort variable (once again) also captures an important parameter effect. An increase in the work–disutility coefficient z implies that work is more 'disagreeable' and as such is partly a measure of the curvature of the utility function, see equation (9). For any given proportional increase in average per unit profits $\hat{\tau}$, higher values of z thus result in both lower values of measured $A(\tau)$ and static gains from market reform. An increase in τ clearly results in more effort, but the impact of any new market reform regime, in terms of increases in output, also clearly depends on the relative willingness to work. None of this can be shown in the model without an effort variable.[10]

4. Market reform and rice production in Vietnam

4.1 Transitional periods

The model above is now applied to the case of rice production (by far, the most significant agricultural industry) in Vietnam. The relevant market reform or transitional periods that correspond to the available data can be divided into: (a) the communal system (1975–80); (b) output contracts (1981–87); and (c) trade liberalisation (1988–94). The overall process is characterised 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 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 per cent of the estimated market price). Small private plots were allowed but only for the household consumption of subsidiary agricultural goods, other than

[10] Compare Baldwin's (1992) measure or the first term on the right-hand side of equation (23). Numerical estimates show that the measure of static gains is in fact quite sensitive to changes in the work–disutility coefficient z.

Table 1 Rice production in Vietnam, annual growth rates (%)

Period	Output	Labour	Land	Material inputs	Capital	TFP
1976–80	0.4	0.4	−0.8	−1.1	2.2	0.6
1981–87	4.6	0.2	−1.3	2.9	2.5	3.8
1988–94	6.1	1.3	−0.5	5.6	10.6	3.6

rice, and since individual effort was hard to accurately determine, the distribution of rice within the commune was based on egalitarian criteria. As an 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 decollectivise agriculture. Plots of land were allocated to prior members of the commune and farmers were allowed to organise 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 per cent) inevitably emerged and were condoned by state authorities. In fact, the period is generally characterised 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 liberalisation finally allowed for effective private property rights over both land (initially 10–15 year leases) and capital equipment. Production decisions were further decentralised, 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.

As a whole, the effects of market reform on rice production are striking, with the more pervasive the degree of liberalisation, the higher the rate of growth of rice output. Table 1 shows this clearly.[11] Although rice output has increased steadily over the periods of market reform, the growth rate of rice output is significantly higher in the second stage of reform, or the period of trade liberalisation. Labour inputs have increased slowly over time and sown

[11] For data sources and estimations see pp. 560–3 and the notes to table 5.

areas of land have actually decreased. Material inputs (such as fertiliser), although clearly important, have grown more slowly than output in each period, while investment has increased dramatically from 1988 to 1994, apparently accounting for a good part of the high rates of growth in output during the trade liberalisation period. Indeed, not only does this period roughly correspond to the extension of private property rights over capital goods, which undoubtedly is a contributory factor, but the increase in the rate of growth of capital is also fully consistent with an induced capital accumulation effect that goes with the enhanced incentives to produce rice with market reform. The last column of table 1 shows the annual growth rates for total factor productivity (TFP), calculated in the usual way as Solow residuals. In all stages TFP exhibits positive growth, but note this measure (given $A(\tau)$ in equation (21) above) will partly depend on the extent of market reform or average per unit profits τ. Part of the exercise to follow involves a further decomposition of TFP to account for the static and dynamic gains that result from a change in τ.

4.2 Data sources and estimations

Data for rice output and inputs are drawn from 53 provinces in Vietnam and partly based on original data sets constructed by the GSO (1995), the SPC (1995), the MAFI (1995), the SDP (1995), the World Bank (1994, 1995), SRF (1994) and the SDAFF. All results for the 53 provinces are reported in extensive tabular form in Che (1997) and form the basis of the first five columns (by year) of table 4. Since table 4 is expressed in terms of growth indexes for all variables, table 5 lists the actual data for aggregate rice output and inputs in Vietnam from 1976–94. Following Tang (1980) and Sicular (1988), the total value of material inputs is obtained by a measure of the nutritional content of all fertiliser (organic and chemical), insecticide and seeds used in rice production. Labour is measured by working days and is obtained by multiplying the average (per person) working day per hectare in agriculture by the cultivated rice area, divided by 300 days (or the standard labour unit in one year). Capital inputs are represented in terms of tractor-equivalents, with a conversion rate based on known observations between a bullock-day and a tractor-hour at 15 horsepower.

As above, the value of effective output prices βp depends on institutional arrangements and is represented here as a vector across all rice producers, or:

$$\beta p = (\beta_0 p_S + \beta_1 p_M + \beta_2 p_w) \tag{36}$$

where the sum over $\beta_i \in [0, 1]$ must equal one. In the communal system, $\beta_0 = 1$ and all output was sold to the state at a low and controlled state price

Table 2 Growth indexes for inputs, effective output prices and average per unit profits (τ)

	Growth index value for		
Year	$(1 - C_0 m)$	βp	τ
1976–80	100.0	100.0	100.0
1981	100.0	113.9	113.9
1982	100.0	118.3	118.3
1983	100.0	122.0	122.0
1984	100.0	125.6	125.6
1985	107.1	121.4	130.1
1986	107.1	127.4	136.5
1987	108.9	130.7	142.4
1988	108.9	158.6	172.8
1989	114.3	177.3	202.6
1990	116.1	194.3	225.5
1991	123.2	232.7	286.7
1992	125.0	212.1	265.1
1993	123.2	213.1	262.6
1994	121.4	253.8	308.2

Source: Computed from the data set constructed by Che (1997).

p_S. During the period of output contracts, the domestic market remained tightly regulated (with most of farm output still required to be sold to the state government at p_S), with approximate share values of $\beta_0 = 0.8$ and $\beta_1 = 0.2$, and a new (albeit restricted) domestic market price p_M. With the period of trade liberalisation, the state market was abolished, most controls were 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 export price p_w becoming increasingly smaller.[12] As the reform process proceeds, in other words, the share of output to the state falls to zero, the share going to the domestic market initially increases and then starts to fall as output is exported. As a whole, the process directs output toward markets where price is higher and the value of effective output prices βp over time reflects this fact (see table 2).

The actual measure of prices p used to construct table 2 is the real value of the average price for rice in Vietnam in terms of a constant value of the

[12] Since Vietnam is currently 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.

US dollar.[13] The value of $m = W(\mathbf{w})/\beta p$, or the ratio of average input to effective output prices, is constructed by measuring the real value (in US dollars) of input prices in terms of rice units. The resulting values of $(1 - c_0 m)$, from equation (5), are reported in the first column of table 2. With βp and $(1 - c_0 m)$, values of τ, or average per unit profits, given by equation (6), can be calculated. The results are listed in the final column of table 2. The emerging profits story holds. The value of τ generally rises with the most substantial gains occurring during the period from 1988–91, or the first four years of the period of trade liberalisation.

The input share parameters γ_i from the 'institutional' production, equation (20), are estimated on cross-sectional data over farms in the 53 provinces of Vietnam for the year 1993, with estimated values $\gamma_1 = 0.2$, $\gamma_2 = 0.4$, $\gamma_3 = 0.4$, and $\gamma_4 = 0.1$.[14] Following McMillan *et al.* (1989), the effort–disutility coefficient z can be calculated directly from equation (21), by noting that the ratio of the proportional rates of change of $A(\tau)$ to τ is simply $\alpha_1/(z - \alpha_1)$. On the basis of proportional changes $\hat{A}$ and $\hat{\tau}$ on trials over successive pairs of dates, and solving simultaneously, the measure of z ranges between 2.8 and 3.2, with $z = 3$ the most common. Finally, given the technical relationship (see above) that exists between the 'technical' production function, equation (1), and the 'institutional' production function, equation (20), the values of each share parameter α_i, again solving simultaneously, are $\alpha_1 = 0.3$, $\alpha_2 = 0.35$, $\alpha_3 = 0.35$, and $\alpha_4 = 0.1$.[15] The term

[13] Accordingly, the relevant deflator for βp is the ratio Dong/\$US, which is in line with the high correlation between the Vietnamese inflation rate and the value of Dong/\$US reported by the World Bank (1994, pp. 67–8). The use of the US dollar standard (commonly employed by the Vietnamese people themselves) is due to domestic price instability and (especially) the often unreliable 'official' estimates of the rate of inflation by government agencies. For much of the period in question the Vietnamese authorities still regarded inflation as a 'capitalist phenomenon', and its measurement generated little interest and was often poorly constructed.

[14] See Che (1997) and Che *et al.* (2000) for further details. The share parameters sum to slightly more than one, but a Wald-test indicates that the hypothesis of constant returns to scale cannot be rejected at the 5 per cent level. The assumption of constant returns to scale in equation (20) is also consistent with the prevailing empirical literature on aggregate agricultural production functions. For example, see Hayami and Ruttan (1985) for comparable estimates for 22 developing countries and Tang (1980) for China. Given the limited number of years in the data set, time-series estimates of each γ are unreliable. As such, it is assumed that these values are constant throughout the process of market reform, a fact that basically corresponds to common observation. 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 this period (1976–94) and nothing close to the 'green revolution' that characterises other transitional economies, save for a few experimental farms in Vietnam. Water use and irrigation methods also remained relatively unchanged.

$(z - \alpha_1)$ is thus positive. The value of the inverse of the constant intertemporal elasticity of substitution σ is set at 0.5, the rate of depreciation μ is .015, and the subjective rate of time preference ρ is 0.01.[16]

4.3 Empirical results

Based on the econometric estimates of the share parameters in the 'institutional' production function, the derived share parameters in the 'technical' production function, the measure of inputs, rice output, average per unit profits and the calculated value of the work-disutility coefficient z, the model above is now used to account for actual data. Of particular interest is the induced capital accumulation effect and the values of the static and dynamic gains from market reform.

A linear approximation

Begin by setting aside, for the moment, the measure of static and dynamic gains given by equation (27). The idea is to obtain a value for the changes in the capital stock and rice output given market reform, or a change in average per unit profits τ, and to find an implied annual rate of growth in rice output between steady states. To facilitate the estimation note first, from equation (18), and the discussion above, that the steady-state value of the capital–labour ratio from one stage of market reform j to the next is a simple multiple, depending on τ and parameter values, of the value of k in the communal system, or:

[15] The value of c_0 in equation (3) is accordingly $1.13\alpha_0$.

[16] The precise value of the inverse of the constant intertemporal elasticity of substitution σ for the case of Vietnam is an open empirical issue and worth further study. For developed economies the estimates of σ vary considerably and often depend on prior estimates (and beliefs) regarding how broad the definition of capital should be. For example, compare Barro and Sala-i-Martin (1995), Hall (1988) and Summers (1982). A relatively low value of σ implies that the representative farmer is more willing to postpone consumption in response to higher rates of return and this seems to accord with the experience of Vietnam. Even though the economy is still relatively poor (but growing), estimates of savings rates are very high. A value for $\sigma < 1$ implies that the growth rate along a transitional path (see equation 35) is larger for the model with an effort variable than without and this too seems a reasonable characterisation of Vietnam given the large increases in the capital stock, especially during the period of trade liberalisation (see table 1). In addition, the restriction that $\sigma < \alpha_4$ implies that the ratio of c/k will rise over time, a fact consistent with aggregate data (available from the authors on request) for Vietnam. In any case, in the empirical results to follow, the effect of variations in σ on the rate of growth of rice output and the dynamic gains to market reform are relatively small. As noted above, as long as σ is non-negative dynamic gains from market reform will still be substantial.

Table 3 Growth rates, years of convergence and steady-state values for capital (K) and rice output (Q)

Periods	Capital (10,000 horsepower equivalent)	Years	Rice output ('000 tons)	Growth rate
Communal system	245.5		15102.6	
Output contracts	338.3	24	18741.5	1.3
Trade liberalisation	674.4	33	47417.9	2.5

$$k^j = k^C\left(\frac{\tau_j}{\tau_c}\right)^{1/(1-z\alpha_4/v+\sigma\alpha_1/v)} \tag{37}$$

where k^C is the measure of the capital–labour ratio in the communal system, as an arithmetic average of the observed values for the years 1976–80. The value of average per unit profits τ is taken as the last observed value of per unit profits in each stage or, for example, its observed value in 1987 for the period of output contracts. It is implicitly assumed that if a given stage of market reform were to continue, without interruption or further market reform, that τ would remain roughly unchanged until a steady state is reached. The resulting estimates for steady-state values of the capital stock are given in the first column of table 3.[17]

The next step is to calculate the length of time required to reach a close vicinity of the steady state, for a calculated value of the speed of convergence. This is done in the usual way by taking a log-linear approximation to the equations of motion, (15) and (16), around steady-state values in order to generate numerical solutions of the approximate non-linear system.[18] The resulting time path for capital is given by:

$$K(t) = ae^{-0.11t} + K^* \tag{38}$$

where K^* is the steady-state value of the capital stock for a given size of the labour force and a is a constant.

However, the value of K^* also depends on the parameter τ which varies across different periods of market reform, so it is necessary to derive the time path of capital and the convergence time for each stage of reform separately. For the period of output contracts, the value of a in equation (38), setting $t = 0$, is $K(0) - K^*_{oc} = -92.8$, for $K(0)$ the value of the capital stock for the communal system (see table 3) and K^*_{oc} its value under output

[17] The ratio of τ_j/τ_c is approximately 1.43 from the communal system to output contracts and 3.07 from the communal system to the period of trade liberalisation. See table 2. The value of the capital stock for the communal system in table 3 is the actual value, averaged over the years 1976 to 1980.

[18] See the Appendix for technical details.

contracts. The comparable expression for the period of trade liberalisation is $\tilde{K}(0) - K_{tl}^{*} = -336.1$, where $\tilde{K}(0)$ is now the value of the capital stock in the last year of output contracts (1987), just prior to the shift in regimes, and K_{tl}^{*} is the capital stock in the period of trade liberalisation. The relevant reform time paths are thus:

$$K_{oc}(t) = -92.8e^{-0.11t} + 338.3 \tag{39}$$

and

$$K_{tl}(t) = -336.1^{-0.11t} + 674.4 \tag{40}$$

with an estimated time of convergence (to at least 99 per cent of the steady-state value) of 24 years for output contracts and 33 years for the period of trade liberalisation, as reported in the second column of table 3.

The final step in the argument is to find the predicted values of rice output in each stage of market reform, as if that stage continued to a steady-state value. From this, implied annual rates of growth in rice output can be obtained. Using all parameter values, observed variables, and the values of the capital stock in table 3, equation (20) can be approximated for the level of rice output, assuming growth rates in all inputs and TFP from one steady-state to the next. Since, in general, the concern is with level effects and the resulting growth path, equation (21) now becomes:

$$A(\tau) = \alpha_0(\tau\alpha_0\delta\alpha_1)^{\alpha_1/v}\left(\frac{\rho + (1-\alpha_4)(\mu + n)}{\alpha_4}\right)^{-\sigma} \tag{41}$$

using equations (10) and (17), and equation (20) is thus appropriately redefined as an optimal intertemporal production function.

For the period of output contracts (1981–87), the available data ends in 1987 but the length of time to convergence is estimated to be 24 years. To keep things simple, assume that the rate of growth in labour and material inputs after 1987 is simply the average (actual) growth rate of both variables over the period 1981–87 (see table 1), or 0.2 and 2.9 per cent. The rate of growth of land is set equal to zero, which roughly conforms to the data throughout.[19] The growth rate of total factor productivity $A(\tau)$, however, is more complicated since it depends directly on the effects of market reform or average per unit profits τ. To make a clear point, focus on the case where the assumed rate of growth of $A(\tau)$ is zero after 1987. If so, the remaining measure of the change in rice output in terms of a change in the capital component is due simply to induced capital accumulation from a change in τ. In other words, with observed values in 1987 and a zero rate of growth in $A(\tau)$ for subsequent years, the resulting growth path due to an increase in τ,

[19] In 1993 the Vietnamese government in fact introduced a regulation banning the conversion of rice land to other uses.

given by equation (16), results only in dynamic gains from market reform, or the second term on the right-hand side of equation (27).[20]

Given the observed values of rice output, capital, labour, material inputs (see table 4) and total factor productivity in 1987, using equation (41), the assumed values for rates of growth over the remaining 17 years for all variables and the predicted value of the steady-state capital stock for the period of output contracts (see table 3), equation (20) gives a estimated value of rice output of 18,741.5 thousand tons. The implied annual rate of growth (as a fitted value of the exponential growth rate) from the observed value of rice output in 1987 to its estimated steady-state value (in year 2004) is 1.3 per cent per annum. All results are reported in table 3.

A similar procedure is adopted for the period of trade liberalisation (1988–94). The length of time for convergence is now 33 years and the assumed average annual growth rates for labour and material inputs after 1994 are 1.3 and 5.6 per cent. Current levels of rice output, all inputs and total factor productivity in 1994 are taken as the base. The predicted steady-state value for capital is drawn from table 3 and the rate of growth of $A(\tau)$ is again assumed to be zero after 1994. Using equation (20), as above, the estimated value of rice output (in year 2023) is 47,417.9 thousand tons and the implied rate of growth is 2.5 per cent per annum.

The results are clear. As table 3 shows, if a given period of market reform were allowed to persist indefinitely to its new steady-state value, the predicted effect on the level of rice output and its rate of growth is substantial, even with an assumed zero rate of growth in TFP in each period of reform.[21] Moreover, the more extensive is the degree of market reform, the larger the effects. The predicted value of rice output under the trade liberalisation regime is more than 2.5 times larger than that of output contracts and more

[20] An alternative procedure is to assume that the growth rate in $A(\tau)$ over the years from 1987 onward is just its average rate of growth for observed values from 1981–87, or 3.8 per cent. Equation (41) would thus need to be applied directly over this period and the final implied rates of growth in rice output would of course be much larger. In any case, setting the growth rate of $A(\tau)$ equal to zero for periods after 1987 not only isolates the induced capital accumulation effect, which is the idea, but it also broadly conforms to observed data. Table 2 shows that most of the impact of market reform, in terms of changes in τ, occurs in the first four or five years of a new market reform regime. If so, using an observed value of $A(\tau)$ in 1987 (or 1994 for the trade liberalisation period), and a zero growth rate thereafter, already captures the bulk of the static gains from market reform in this period. In addition, setting the growth rate of $A(\tau)$ equal to zero after 1987 (or 1994) is, of course, also consistent with the manner in which predicted steady-state values of the capital stock are determined for the period of output contracts and trade liberalisation, as given in table 3.

[21] The actual growth rates for rice output over the much shorter but observed time intervals (and presumably points further away from steady-state values), or the periods 1981–87 and 1988–94, were of course much larger. See table 1.

Table 4 Growth indexes for inputs, rice output and static and dynamic gains from market reform

	Growth index value for (= 100 in the period of the communal system, 1976–80)						
Year	Output	Labour	Land	Material inputs	Capital	Static gain from reform	Dynamic gain from reform
1976–80	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1981	112.4	104.0	97.2	100.2	114.5	101.5	101.4
1982	130.3	104.8	96.3	103.9	111.9	102.0	101.9
1983	133.5	103.6	95.3	110.1	111.3	102.4	102.3
1984	140.4	103.9	94.3	111.5	114.4	102.8	102.7
1985	143.7	104.9	92.3	114.3	117.2	104.4	104.2
1986	144.9	103.4	91.3	120.5	128.0	105.2	104.9
1987	136.7	102.8	91.1	118.6	119.0	106.0	105.7
1988	153.9	104.2	88.3	126.9	121.6	109.6	109.1
1989	172.0	105.9	88.3	130.4	121.8	113.0	112.3
1990	174.1	107.0	88.3	134.1	120.8	115.5	114.7
1991	177.7	107.7	88.1	139.6	142.9	122.8	121.5
1992	195.5	111.5	88.1	153.4	170.3	120.2	119.1
1993	206.8	110.4	86.8	160.5	209.7	119.9	118.9
1994	213.0	112.1	86.8	178.7	229.0	125.3	124.0
	Average annual growth rate (%)						
1981–87	4.6	0.2	−1.3	2.9	2.3	0.80	0.70
1988–94	6.1	1.3	−0.5	5.6	10.6	2.30	2.10

Note: The annual growth rate is measured as the fitted value of the exponential growth rate.

Table 5 Output and inputs for rice production in Vietnam, 1976–94

Year	Rice output ('000 tons)	Labour ('000 work days)	Land ('000 ha)	Material inputs ('000 tons equivalent)	Capital (10,000 horsepower equivalent)
1976	11827.2	764.1	4710.0	2137.6	236.7
1977	10597.1	764.2	4709.8	2129.6	243.8
1978	9789.9	782.1	4664.0	2186.7	237.9
1979	11362.9	786.0	4618.1	2127.7	245.2
1980	11647.4	768.6	4572.3	2026.4	263.7
1981	12415.2	803.8	4526.4	2126.3	281.2
1982	14390.2	810.1	4480.5	2203.5	274.7
1983	14743.3	800.5	4434.6	2336.0	273.2
1984	15505.6	803.4	4388.8	2365.8	280.8
1985	15874.8	810.8	4296.5	2425.4	287.7
1986	16002.9	798.9	4250.0	2556.9	314.2
1987	15102.6	794.3	4242.6	2517.2	292.1
1988	17000.0	805.5	4108.9	2693.2	298.6
1989	18996.3	818.9	4108.0	2766.3	299.1
1990	19225.2	827.4	4108.0	2844.4	296.5
1991	19621.9	832.5	4101.0	2962.6	350.7
1992	21590.3	862.1	4100.0	3254.3	418.1
1993	22836.6	853.1	4038.6	3404.4	514.8
1994	23528.3	866.7	4038.6	3790.4	562.2

Sources: General Statistics Office, Statistics Department of Agriculture, Forestry and Fishery, the General Department of Land Management of Vietnam, Ministry of Agriculture, Food Processing Industry, Statistics for Rice Farms, and the National Investigation of Rural Regions.

than 3 times larger than the actual value of rice output (averaged over 1976–80) in the communal system. Average annual growth rates over the implied path to a steady state almost double between the period of output contracts and trade liberalisation. In fact, the model predicts that (roughly) 18.7 million tons of rice will be produced in year 2004 under the output contracts regime, but that target, with the enhanced incentives given by the period of trade liberalisation, was actually surpassed in 1989 (see table 5).[22]

The measure of static and dynamic gains from market reform

Using equation (27), or

$$\hat{Q} = \left(\frac{\alpha_1}{z - \alpha_1}\right)\hat{\tau} + \left(\frac{\gamma_4}{1 - \gamma_4 + \frac{\sigma\alpha_1}{z-\alpha_1}}\right)\hat{\tau} \tag{42}$$

[22] In an earlier version of this article, Che *et al.* (1998), simulated results from the linear approximation were also decomposed between rice production in North and South Vietnam. As might be expected, given some initial reluctance to accept market reform in the north, the estimated growth rates vary, although not by a large amount. The growth rate in the south is roughly 0.5 per cent larger than the north in both reform periods.

confirms the results of the linear approximation, with the additional benefit that only observed data need be used (with the exception of the inverse of the constant intertemporal elasticity of substitution σ) and a clear decomposition between static and dynamic gains from market reform is obtained. Note first that for values of $\alpha_1 = 0.3$, $z = 3$, $\gamma_4 = 0.1$ and $\sigma = 0.5$, the first term in brackets is 0.111 and the second is 0.104. In other words, for a given proportional increase in average per unit profits $\hat{\tau}$, the dynamic gain from market reform is only slightly less than the static effect.[23] It is also clear that the static gain is much more sensitive to changes in z than is the dynamic gain, and for good reason. Recall that z is the work-disutility coefficient for effort. As discussed above, an increase in z implies that work is more 'disagreeable'. The measured value of TFP or $A(\tau)$ in equation (21) and thus static gains from reform will both be lower.[24] Variations in σ show that the dynamic effect varies, but to a small extent. For variations in z it virtually does not vary at all.[25]

The rest is simple. Recall that increases in τ, or higher average per unit profits, result in an increase in effort ε and total factor productivity $A(\tau)$. A higher value for effective units of labour εN increases the marginal product of capital or the rate of return $r(k, \tau)$ and thus induces capital accumulation. With equations (26) and (42), the growth in rice output (Q) is given by:

$$\hat{Q} = \gamma_1 \hat{N} + \gamma_2 \hat{L} + \gamma_3 \hat{E} + \left(\frac{\alpha_1}{z - \alpha_1}\right)\hat{\tau} + \left(\frac{\gamma_4}{1 - \gamma_4 + \frac{\sigma\alpha_1}{z - \alpha_1}}\right)\hat{\tau} + \hat{A}_0 \tag{43}$$

where again a circumflex represents a percentage change and A_0 is now the adjusted value of the Solow residual. In other words, the growth in rice output now depends on the growth of labour N, land L and material inputs E, adjusting each by a share parameter estimated from the 'institutional' production function, or the relevant γ, static and dynamic output gains from market reform and the growth in the Solow residual.

[23] This is consistent with the argument in Baldwin (1992), at least in terms of welfare effects, where it is claimed that dynamic effect should be some fraction of the static gain. In other words, in Baldwin (1992, p. 172), the static gain is seen as largely 'for free', whereas the dynamic gain is offset by the forgone consumption (and a consequent loss in welfare) necessary to accumulate capital. However, in the model above, any welfare measure of the static gain also depends on the 'pain' associated with the extra effort that goes with an increase in average per unit profits. In this sense, the issue is more complicated.

[24] Numerical results for values of z at 2.6, 2.8, 3.2, 3.4, 3.6 and 3.8 imply a multiplier for static gains of 0.130, 0.120, 0.103, 0.097, 0.091 and 0.086.

[25] Numerical results for values of σ of 0.2, 0.4, 0.6, 0.8, 1, 1.2 and 1.4, imply a multiplier for dynamic gains of 0.108, 0.105, 0.103, 0.101, 0.098, 0.096 and 0.094. Variations in z of from 2 to 6 imply only changes in the dynamic gains from trade from 0.101 to 0.108.

The growth in Q, N, L, and E is taken from observed values in table 4 and the value of the proportional increase in average per unit profits $\hat{\tau}$ is drawn from table 2. With parameter values, the measure of static and dynamic gains (along with all other measures) is reported in table 4. For the period of output contracts (1981–87), the values are 0.8 and 0.7 per cent (on average) per annum, and for the trade liberalisation period, 2.3 and 2.1 per cent (on average) per annum.[26] In particular, for the period of trade liberalisation, of the 6.1 per cent average annual growth rate from 1988 to 1994, 2.3 and 2.1 per cent are due to enhanced productivity effects and induced capital accumulation. Once again, the more extensive the degree of market reform is, the larger the effects in terms of the growth of rice output. The measures are roughly three times larger for the period of trade liberalisation compared to output contracts in each case. Market reform and the enhanced incentive effects that it generates result in considerable output growth.

5. Conclusion

This article has developed a dynamic model to account for the enhanced incentive effects that result from market reform. The effort variable figures prominently in the analysis. Market reform and thus higher average per unit profits generate more effort and, depending on the value of the work–disutility coefficient, increases in the measure of total factor productivity. In addition, increases in effort imply a higher value for the marginal product of capital and thus induced capital accumulation. Regardless of the exact value of the inverse of the constant intertemporal elasticity of substitution, dynamic gains from reform are seen to be substantial.

The model was then applied to the case of rice production for the transitional economy of Vietnam, over the period 1976–94. The particular focus centred on two market reform regimes, that of output contracts (1981–87) and the period of trade liberalisation (1988–94). Empirical results were based on estimates of all relevant parameters. Both the linear approximation, in terms of implied rates of growth from one stage of reform to the next, and the measures of static and dynamic gains show considerable increases in steady-state values of rice output, capital stocks and transitional rates of growth with reform. Moreover, the more extensive the degree of market reform, the larger the effects. All measures for the period of trade liberalisation are substantially higher than that of output contracts, suggesting that incentives and more competitive markets matter greatly.

[26] The values for the adjusted Solow residual or A_0 are now (as expected) lower, or 0.2 for output contracts and approximately zero for the period of trade liberalisation.

Nevertheless, none of the measures in this article suggest anything precise about welfare gains. Following Baldwin (1992), and given the significant capital market distortions that exist in a transitional economy like Vietnam, welfare gains are potentially quite large. Estimation of the magnitude of such effects would be a worthwhile extension of this article. However, an exact welfare measure will also have to account for the effects of increased levels of effort on disutility. To this end, a more precise estimate of the value of the inverse of the constant intertemporal elasticity of substitution, or an indirect inference of its value relative to the share parameter for capital, in terms of the time series properties of the ratio of consumption to the capital stock along a transitional path, would also be desirable.

Appendix

This appendix provides the numerical values of the log-linear approximation to equations (15) and (16). Given parameter values, the relevant system is given by:

$$\begin{bmatrix} \dot{k}(t) \\ \dot{c}(t) \end{bmatrix} = \begin{bmatrix} f_k^* & f_c^* \\ g_k^* & g_c^* \end{bmatrix} \begin{bmatrix} k(t) - k^* \\ c(t) - c^* \end{bmatrix} = \begin{bmatrix} 0.013 & -1.10 \\ -0.012 & -0.003 \end{bmatrix} \begin{bmatrix} k(t) - k^* \\ c(t) - c^* \end{bmatrix} \tag{A1}$$

where $f_{(\cdot)}^*$ and $g_{(\cdot)}^*$ represent first-order variations to equations (15) and (16). Using actual and predicted steady-state values of capital stocks in table 3 and noting that $c^*/k^* = 0.28$ from equation (17), gives the system (A1) in standard form as:

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \dot{k}(t) \\ \dot{c}(t) \end{bmatrix} + \begin{bmatrix} -0.013 & 1.10 \\ 0.012 & 0.003 \end{bmatrix} \begin{bmatrix} k(t) \\ c(t) \end{bmatrix} = \begin{bmatrix} 0.30k^* \\ 0.02k^* \end{bmatrix}. \tag{A2}$$

To obtain general solutions, adopt trial solutions of the form $k(t) = ae^{\lambda t}$ and $c(t) = be^{\lambda t}$ so that the underlying homogeneous system for equation (39) yields the characteristic equation $\lambda^2 - 0.01\lambda - 0.013 = 0$ and two roots, $\lambda_1 = -0.11$ and $\lambda_2 = 0.12$. Finally, transversality conditions (or ignoring the unstable root) give a resulting time path for capital of:

$$K(t) = ae^{-0.11t} + K^* \tag{A3}$$

or equation (38) in the text.

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