In Search of a Better Understanding of Sectoral Transformation: Theory and Measurement

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Many economists have stressed that improvement in agricultural productivity primarily determines the rate of sectoral transformation. But a comparative look at the cross country experiences suggest that the rise in nonagricultural productivity should also be an important factor in the process of sectoral transformation. This paper provides a theoretical model to explain sectoral transformation and attempts to assess the relative importance of each view by measuring the contribution of productivity increases in both sectors to the rate of sectoral transformation. First,preference parameters are fitted using the income and price elasticities of demand for the agricultural goods, and then the rates of sectoral transformation with respect to agricultural productivity, nonagricultural productivity, and a third factor, the capital stock increase, are calibrated based on the formula derived from the model. Finally, the rate of sectoral transformation is decomposed into those three basic factors. Preliminary empirical results show that more than 30% of the rate of sectoral transformation can be explained by the nonagricultural productivity increase, which is at least as important as that of the agricultural sector even in the closed economy.(*JEL* Classification: O10, O18)

I. Introduction

The rise in the share of the nonagricultural sector in output and

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employment, and the corresponding decline of the agricultural sector are among the best known regularities of economic growth. Industrialization, urbanization, and the sectoral transformation are commonly used terms to describe this aspect of development. While there have been some theoretical analyses, there has been relatively little effort to explain why sectoral transformation, while universally increasing, varies so greatly among countries in the rates at which it occurs.

To deal adequately with this phenomenon, a clearer understanding is needed of why sectoral transformation takes place and what determines its rate. In this paper, I seek to explain sectoral transformation in terms of demand and productivity in a general equilibrium setup with nonhomothetic preferences. The break from the common assumption of homothetic preferences allows the income elasticity of demand for the agricultural goods to be less than unitary.

For many years, economists have emphasized the role of agricultural productivity increase in the process of sectoral transformation. Nurkse (1953), Rostow(1960), and Todaro(1989), to name a few, are among those who have stressed improving agricultural productivity as an essential part of successful development strategy. According to this traditional view, the rise in agricultural productivity releases labor and capital for the nonagricultural sector since more agricultural output is now being produced with fewer inputs, leading to more rural to urban transformation.

But a comparative look at the cross country experiences suggests that the nonagricultural productivity should be an important factor in the sectoral transformation. An increase in efficiency lowers the price and, given the high price and income elasticities of demand for the nonagricultural goods, more sectoral transformation is to be expected.

To assess the relative importance of each view, this paper measures the contribution of productivity increases in both sectors to the rate of sectoral transformation. This requires the study of the interplay of demand and supply, especially price and income elasticities. The preliminary empirical results, using the formula on the rate of sectoral transformation derived from the model, show that an increase in nonagricultural productivity can explain more than 30% of the rate of sectoral transformation. The magnitude is at least as large as that of the agricultural productivity increase and would be expected to be more so in an open economy. This finding calls for a reevaluation of the traditional wisdom, which emphasizes the role of the agricultural sector in the sectoral transformation.

Based on a two sector economy model with nonhomothetic preferences, this paper first explains the nature of the underlying changes in demand and supply that determine sectoral transformation and derives the general formula on the rate of sectoral transformation. Then using the income and price elasticities of demand for agricultural goods, both the preference parameters and the multipliers of sectoral transformation with respect to agricultural productivity, nonagricultural productivity increase, and capital accumulation are fitted. Finally, the decomposition of the rate of sectoral transformation into three basic factors and their relative contributions are presented.

The analysis is conducted as follows: Section II describes typical patterns and determinants of sectoral transformation. Section III briefly reviews the traditional view in its extreme version. Section IV develops a general theory of structural transformation. Section V provides the preliminary results measuring the relative contribution of those three factors to the rate of sectoral transformation. Concluding remarks are contained in Section VI.

II. Determinants of Sectoral Transformation

As shown in Table 1, the percentage of labor force employed in agriculture in all three groups of countries declined as per capita income increased. For example, in 1960 more than 83% of the labor force of low-income countries was employed in the agricultural sector, 55% in middle-income countries, and less than 18% was so employed in high-income countries. By 1980 these percentages had decreased to 72%, 43%, and 7% for low, middle, and high income countries, respectively. The output share of the agricultural sector also decreased with the level of per capita income: It fell from 54% to 34% for low-income countries, from 25% to 14% for middle-income countries, and from 10% to 7% between 1960 and 1980 for high income countries.

This sectoral transformation is often explained as a shift of demand away from the agricultural sector. If real income per capita increases, the demand for nonagricultural goods is likely to rise more than the demand for the agricultural goods. This effect occurs due to the low income elasticity of the demand for food. Hence, a rise in per capita real income will cause a shift in labor out of the agricultural sector and a change in the structure of total output. In this paper, nonhomothetic preferences are used to allow the income elasticity of demand for agricultural goods to be less than unitary.

TABLE 1

SHARES OF LABOR FORCE AND GDP IN AGRICULTURE

	Labor Force		GDP	
Countries	1960	1980	1960	1980
Low-income countries (38 countries)	83	72	52	34
Middle-income countries (52 countries)	55	43	25	14
High-income countries (18 countries)	18	7	10	3

Note: Data from the *World Development Report* (1980, 1987)

A second common theory of the sectoral transformation also considers the differences of technological progress or growth of factor productivity in the two sectors to be important. Traditional explanations of this type have long emphasized rapid technological progress in the agricultural sector which acts in conjunction with low income elasticities to release resources from agriculture and, therefore, leads to more rural to urban transformation. But the converse of this argument, consistent with casual empiricism, implies that the nonagricultural productivity increase should be as important a factor in the process of sectoral transformation as the agricultural productivity increase. While there have been some theories relating the productivity increases in the two sectors to the rate of sectoral transformation, little effort has been made to measure their relative importance. This paper attempts to fill this gap.

In addition, external effects from investment and innovation may play a role in the explanation of rural to urban transformation. As the economy develops, new knowledge is being created and adopted which may have positive external effects. A new process invented by a firm may positively affect the production possibilities of other firms because it is imitated by other firms.[1] The opportunity to imitate generates an external benefit. The elasticities of output with respect to this kind of external effect may vary from industry to industry, and likewise vary from agricultural sector to nonagricultural sector due to the different applicabilities of new knowledge. This paper also attempts to show how externalities affect sectoral transformation.

[1]See Shleifer (1989) for a discussion of recent work on these externalities.

III. A Review of the Traditional View in its Extreme Version

The traditional model in its extreme version emphasizes the role of agriculture in sectoral transformation and predicts that the rise in agricultural productivity leads to more rural to urban transformation while the rise in nonagricultural productivity leads to less rural to urban transformation. The former releases resources for the nonagricultural sector since more agriculture is now being produced with fewer inputs, and similarly, the latter releases the resource from the nonagricultural sector to the agricultural sector.[2] It is worth while to review this model briefly.

In order for this model to be valid, a crucial condition must be met that the ratio of the percentage increase in output per capita, $\hat{y}_i$, will be the ratio of their income elasticities of demand, η_i. That is $\hat{y}_n/\hat{y}_a = \eta_n/\eta_a$. This follows because the traditional model does not take into account price changes and only considers income effects. A casual reading of development textbooks suggests that differences in the income elasticities between the two sectors form the crux of sectoral transformation.

On the production side of this model, the percentage increase in output per capita is equal to the productivity growth, $\hat{A}_i$, plus the percentage change in the employment share, $\hat{l}_i$. These conditions are $\hat{y}_n = \hat{A}_n + \hat{l}_n$ for the nonagricultural sector and $\hat{y}_a = \hat{A}_a + \hat{l}_a$ for the agricultural sector. Using these three equations and noting that $\hat{l}_a = -(l_n/l_a)\hat{l}_n$ gives equation (1) below.

The rate of sectoral transformation, defined as the growth rate of the employment share of the nonagricultural sector, is written as:

$$\hat{l}_n = \frac{(\eta_n / \eta_a)\hat{A}_a - \hat{A}_n}{(\eta_n / \eta_a)(l_n / l_a) + 1} \tag{1}$$

where $\hat{l}_n$ is the rate of growth of the share of employment in the nonagricultural sector; $\hat{A}_i$ is the productivity growth in sector i; and η_i is the income elasticity of demand in sector i.

Note that the numerator is the sum of two components. One is agri-

[2]Tolley(1987) termed this model as traditional and pointed out that, with international specialization, nonagricultural productivity increases might positively affect the rate of sectoral transformation. This paper will show that rising nonagricultural productivity leads to more sectoral transformation rather than less even in the closed economy, consistent with casual empiricism.

cultural productivity, $\hat{A}_a$, weighted by the ratio of nonagricultural to agricultural income elasticities, η_n / η_a. This has a positive effect on sectoral transformation because agricultural productivity increase releases labor for nonagricultural production. The other is the negative of the nonagricultural productivity increase, $\hat{A}_n$. Here, a rise in nonagricultural productivity, with other things equal, leads to a decrease in nonagricultural employment because the demand for the nonagricultural goods now can be met by fewer labor inputs. The denominator is one plus the product of the ratio of income elasticities and the ratio of employment shares.

This equation asserts that a rise in nonagricultural productivity releases resources from the nonagricultural sector so as to produce more agricultural goods and, therefore, leads to less rural to urban transformation. This unrealistic prediction follows from the fact that it considers only income elasticities and does not take into account price effects. But one might think that if the nonagricultural sector became more efficient, we would substitute resources in its favor and increase its production, not decrease it. An increase in efficiency lowers the price and, with high price and income elasticities of demand for the nonagricultural goods, a production response is to be expected. Understanding sectoral transformation more fully requires us to study the interplay of demand and supply more deeply, as will be done in the following section.

IV. A More General Model of Sectoral Transformation

This section explains preferences and technology and derives the formula for the rate of sectoral transformation.

A. Income Elasticities of Demand

Preferences for the representative consumer are:

$$U(c_a, c_n) = \frac{c_a^{1-\gamma_a}}{1-\gamma_a} + \upsilon \frac{c_n^{1-\gamma_n}}{1-\gamma_n} \tag{2}$$

where c_a is the consumption of agricultural goods and c_n is the consumption of nonagricultural goods. This utility function is used here to allow differing income elasticities of demand. Income elasticities of both goods are equal to 1 if $\gamma_a = \gamma_n$. If $\gamma_a > \gamma_n$, income elasticity for the nonagricultural goods is greater than one, while that of agricultural goods is less than one.

The γ_i's can be usefully written in terms solely of the agricultural goods' price and income elasticities by noting that Marshallian demand equation's satisfy the following two conditions, i.e., a budget constraint and equating prices with marginal rate of substitution.

$$p_a c_a + p_n c_n = y \tag{3}$$

$$c_n = (\upsilon p)^{1/\gamma_n} c_a^{\gamma_a/\gamma_n}, \quad p = \frac{p_a}{p_n}. \tag{4}$$

First, let E_{ay} be the income elasticity $(= \partial \ln c_a / \partial \ln y = (\partial c_a / \partial y) \cdot (y / c_a)$. Substituting (4) into (3) and taking partial derivatives with respect to y yields:

$$p_a \frac{\partial c_a}{\partial y} + p_n \frac{\gamma_a}{\gamma_n} \frac{c_n}{c_a} \frac{\partial c_a}{\partial y} = 1.$$

Converting to elasticities:

$$\frac{p_a c_a}{y} \frac{\partial c_a}{\partial y} \frac{y}{c_a} + \frac{\gamma_a}{\gamma_n} \frac{p_n c_n}{y} \frac{\partial c_a}{\partial e} \frac{y}{c_a} = 1$$

which using the definition of E_{ay} and re-arranging, gives:

$$E_{ay} = \frac{\partial c_a}{\partial y} \frac{y}{c_a} = \frac{\gamma_n}{\gamma_n \pi_a + \gamma_a \pi_n} \tag{5}$$

where π_i is expenditure share on good i. Second, to derive the price elasticity, $E_{ap} = -\partial \ln c_a / \partial \ln p_a = -(\partial c_a / \partial p_a) \cdot (p_a / c_a)$, substitute (4) into (3) and take partial derivatives with respect to p_a.

$$c_a + p_a \frac{\partial c_a}{\partial p_a} + \frac{1}{\gamma_n} \frac{p_n c_n}{p_a} + \frac{\gamma_a}{\gamma_n} \frac{p_n c_n}{c_a} \frac{\partial c_a}{\partial p_a} = 0.$$

Multiplying by p_a and dividing by y:

$$\pi_a - \pi_a E_{ap} + \frac{1}{\gamma_n} \pi_n - \frac{\gamma_a}{\gamma_n} \pi_n E_{ap} = 0$$

which upon re-arrangement gives:

$$E_{ap} = -\frac{\partial c_a}{\partial p_a} \frac{p_a}{c_a} = \frac{\gamma_n \pi_a + \pi_n}{\gamma_n \pi_a + \gamma_a \pi_n}. \tag{6}$$

Now, using equations (5) and (6) we can solve for γ_a and γ_n

$$\gamma_a = \frac{1 - E_{ay} \pi_a}{E_{ap} - E_{ay} \pi_a}, \quad \gamma_n = \frac{E_{ay} \pi_n}{E_{ap} - E_{ay} \pi_a} \tag{7}$$

where E_{ay}, E_{ap}, π_a, and π_n are the the income and price elasticities of demand for agricultural goods, and expenditure shares in the agricultural and nonagricultural sector, respectively.

It can be easily shown that if $E_{ay} < 1$ (implying $E_{ny} > 1$ because the expenditure weighted sum of the elasticities is equal to unity), then $\gamma_a > \gamma_n > 0$. This inequality will be assumed throughout the analysis. With these nonhomothetic preferences, the next section derives a formula for sectoral transformation.

B. A Theory of Sectoral Transformation with Nonhomothetic Preferences

Consider an economy with identical agents and two sectors – agriculture and nonagriculture. The production technology in each sector is:

$$\begin{aligned} y_a &= A_a l_a^{1-\alpha}(k_a)^{\alpha}\kappa^{\varepsilon_a} = A_a l_a^{1-\alpha}(\phi_a k)^{\alpha}\kappa^{\varepsilon_a} \\ y_n &= A_n l_n^{1-\beta}(k_n)^{\beta}\kappa^{\varepsilon_n} = A_n l_n^{1-\beta}(\phi_n k)^{\beta}\kappa^{\varepsilon_n} \end{aligned} \tag{8}$$

where l_i is the fraction of manhours; ϕ_i is the fraction of capital stock (k) devoted to the production of the good i (y_i); A_i is Hicks neutral technology in sector i; κ is the general knowledge stock assumed to grow in proportion to the capital stock and ε_i is the elasticity of output with respect to this general knowledge stock in sector i. A_i can be interpreted as a sector-specific technology and κ as an economy-wide general knowledge stock such as knowledge in chemistry, physics, and the like. The applicability of the general knowledge stock in each sector might differ but no assumption is made as to the relative magnitude of ε_n and ε_a.

Labor and capital is allocated to each sector to achieve full employment of resources:

$$l_a + l_n = 1, \qquad \phi_a + \phi_n = 1. \tag{9}$$

The first order conditions are summarized into the following three equations (10), (11), (12). Consumers equate the relative price to the marginal rate of substitution between agricultural and non-agricultural goods.

$$\frac{p_a}{p_n} = \frac{c_n^{\gamma_n}}{\upsilon c_a^{\gamma_a}} = \frac{[A_n l_n^{1-\beta}(\phi_n k)^{\beta}\kappa^{\varepsilon_n}]^{\gamma_n}}{\upsilon[A_a l_a^{1-\alpha}(\phi_a k)^{\alpha}\kappa^{\varepsilon_a}]^{\gamma_a}}. \tag{10}$$

In equilibrium, wages and rate of returns are equalized across sectors, or $p_a MPL_a = p_n MPL_n$ which re-arranging gives:

$$\frac{p_a}{p_n} = \frac{A_n(1-\beta)l_n^{-\beta}(\phi_n k)^{\beta}\kappa^{\varepsilon_n}}{A_a(1-\alpha)l_a^{-\alpha}(\phi_a k)^{\alpha}\kappa^{\varepsilon_a}} \tag{11}$$

and similarly $p_a MPK_a = p_n MPK_n$:

$$\frac{p_a}{p_n} = \frac{A_n \beta l_n^{1-\beta}\phi_n^{\beta-1}k^{\beta}\kappa^{\varepsilon_n}}{A_a \alpha l_z^{-\alpha}\phi_a^{\alpha-1}k^{\alpha}\kappa^{\varepsilon_a}}. \tag{12}$$

Replace prices with quantities in equation (11) using equation (10), and noting that resources are fully employed, (9), and κ increases in proportion with capital stock where the proportionality is set to one for simplicity:

$$\begin{aligned} &v\frac{(1-l_n)^{\gamma_a(1-\alpha)}}{l_n^{\gamma_n(1-\beta)}}\frac{\phi_n^{\beta(1-\gamma_n)}}{(1-\phi_n)^{\alpha(1-\gamma_a)}}\frac{k^{(\beta+\varepsilon_n)(1-\gamma_n)}}{k^{(\alpha+\varepsilon_a)(1-\gamma_a)}} \\ &= \frac{A_a^{1-\gamma_a}}{A_n^{1-\gamma_n}}\frac{(1-\alpha)}{(1-\beta)}\frac{l_n^{\beta}}{(1-l_n)^{\alpha}}. \end{aligned} \tag{13}$$

The left hand side of equation (13) is decreasing with l_n, given ϕ_n, which implies that the marginal product of labor in the nonagricultural sector (relative to the agricultural sector) decreases due to the diminishing returns. The right hand side of equation (13) increases with l_n, which implies that relative price of agricultural goods is increasing as the production of the nonagricultural goods increases.

Replacing prices with quantities in equation (12), using equation (10), and noting that resources are fully employed, (9) gives.

$$\begin{aligned} &v\frac{(1-\phi_n)^{\alpha\gamma_a}}{\phi_n^{\beta\gamma_n}}\frac{l_n^{(1-\beta)(1-\gamma_n)}}{(1-l_n)^{(1-\alpha)(1-\gamma_a)}}\frac{k^{(\beta+\varepsilon_n)(1-\gamma_n)}}{k^{(\alpha+\varepsilon_a)(1-\gamma_a)}} \\ &= \frac{A_a^{1-\gamma_a}}{A_n^{1-\gamma_n}}\frac{\alpha}{\beta}\frac{\phi_n^{1-\beta}}{(1-\phi_n)^{1-\alpha}}. \end{aligned} \tag{14}$$

This provides the similar results that the left hand side of equation (14) is decreasing with ϕ_n, given l_n, which implies that marginal product of capital in the nonagricultural (relative to the agricultural sector) decreases. And, the right hand side of equation (14) increases with ϕ_n, which implies that relative price of agricultural goods is increasing as the production of nonagricultural goods increases.

Equations (13) and (14) are two equations with two unknowns, l_n, and ϕ_n, whose solution satisfies the following condition for l_n:

$$\frac{l_n^{\gamma_n}}{l_a^{\gamma_a}}[l_a+\zeta(1-l_a)]^{\beta(1-\gamma_n)-\alpha(1-\gamma_a)}=\Psi_a\frac{A_n^{1-\gamma_n}}{A_a^{1-\gamma_a}}k^{(\beta+\varepsilon_n)(1-\gamma_n)-(\alpha+\varepsilon_a)(1-\gamma_a)}$$

where $\Psi_a = [(1-\beta)/(1-\alpha)]\cdot\upsilon\zeta^{\beta(1-\rho)}$, and $\zeta = (\beta/\alpha)\cdot[(1-\alpha)/(1-\beta)]$. The condition for ϕ_n is similar. Only the employment share will be considered in this paper.

Note that the bracket equals one if capital shares in the two sectors, α and β are the same, that is if ζ is one, which we will assume as an approximation. Then taking the log and the time derivative gives:

$$\hat{l}_n = m_n\hat{A}_n + m_a\hat{A}_a + m_k\hat{k} \tag{15}$$

where
$$m_n = \frac{1-\gamma_n}{\gamma_n+\frac{l_n}{l_a}\gamma_a},\quad m_a = -\frac{1-\gamma_a}{\gamma_n+\frac{l_n}{l_a}\gamma_a},$$
$$m_k = \frac{(\beta+\varepsilon_n)(1-\gamma_n)-(\alpha+\varepsilon_a)(1-\gamma_a)}{\gamma_n+\frac{l_n}{l_a}\gamma_a}.$$

m_i's are the rates of sectoral transformation with respect to nonagricultural productivity increase, agriculture productivity change, and the increase of the capital stock, respectively and $\hat{x}$ denotes the rate of change of x.

C. The Rate of Sectoral Transformation in a More General Model

The solution of the model for $\hat{l}_n$, given by equation (15), indicates the basic factors which generate the sectoral transformation. The first is nonagricultural productivity, $\hat{A}_n$. The second is agricultural productivity, $\hat{A}_a$. The third is the rate of growth of per capita capital stock, $\hat{k}$.

The denominator of the multipliers of sectoral transformation—γ_n plus the product of the employment ratio and γ_a—arises from the interaction of demand and supply. The numerator of the rate of sectoral transformation with respect to nonagricultural productivity is one minus the preference parameter for nonagricultural goods, γ_n. Likewise the numerator of the rate of sectoral transformation with respect to agricultural productivity is (negative) one minus the preference parameter for agricultural goods, γ_a. The rate of sectoral transformation with respect to the capital increase is a function of demand and supply parameters of both goods, as one might expect.

If $\gamma_a > 1$ and $\gamma_n > 1$, then the rate of sectoral transformation with respect to agricultural productivity, m_a, is positive and the rate of sec-

TABLE 2

PREFERENCE PARAMETERS AND THE SECTORAL TRANSFORMATION

$\gamma_a > 1$	$\gamma_n > 1$	$\Rightarrow$	$m_a > 0$	$m_n < 0$
$0 < \gamma_a < 1$	$0 < \gamma_n < 1$	$\Rightarrow$	$m_a \quad 0$	$m_n > 0$
$\gamma_a > 1$	$0 < \gamma_n < 1$	$\Rightarrow$	$m_a > 0$	$m_n > 0$

Note: γ_a is the preference parameter for the agricultural consumption, and γ_n is the preference parameter for the nonagricultural consumption. Positive m_i means that an increase in the i th factor increases the rural to urban sectoral transformation.

toral transformation with respect to nonagricultural productivity, m_n, is negative. This corresponds to the traditional model in its extreme version.[3] But if $0 < \gamma_a < 1$, and $0 < \gamma_n < 1$, the rate of sectoral transformation with respect to agriculture productivity, m_a, is negative and the rate of sectoral transformation with respect to nonagricultural productivity, m_n, is positive, opposite to the traditional model. This also corresponds to the open economy prediction of Matsuyama (1990) and Kim (1991a). Meanwhile if $\gamma_a > 1$ and $0 < \gamma_n < 1$, the rates of sectoral transformation with respect to the both types of productivity are positive. These results are summarized in Table 2.

These different results depend on the dissimilarity of demand structure for agricultural and nonagricultural goods, namely income and price elasticities of the demand for the both types of goods. With plausible parameter value, the last case in which the rate of sectoral transformation is positive with respect to both agricultural and nonagricultural productivity increases, seems to be closest to reality. For example, preference parameters are $\gamma_a = 1.87$ and $\gamma_n = 0.38$, assuming $E_{ap} = 0.6$, $E_{ay} = 0.3$, $\pi_a = 0.4$ and $l_a = 0.25$ in equation (7).

The general formula given in equation (15) provides a basis for measuring the relative contribution of the three basic factors of the model to the rate of sectoral transformation. First using the income and price

[3]More precisely, the traditional model in its extreme version corresponds to the case where $\gamma_a \to \infty$ and $\gamma_n \to \infty$. To see this, write $m_n = [-1 + (1/\gamma_n)]/[1 + (l_n/l_a)(\gamma_a/\gamma_n)]$ and $m_a = [(\gamma_a/\gamma_n) - (1/\gamma_n)]/[1 + (l_n/l_a)(\gamma_a/\gamma_n)]$. Noting that the ratio of income elasticities of demand for nonagricultural goods to agricultural goods, E_{ny}/E_{ay}, is equal to γ_a/γ_n from equation (6) and using $\gamma_a \to \infty$ and $\gamma_n \to \infty$, we have $m_n = -1/[1 + (l_n/l_a)(\eta_n/\eta_a)]$ and $m_a = (\eta_a/\eta_n)/[1 + (l_n/l_a)(\eta_n/\eta_a)]$. This is the same expression as equation (1), where η_n/η_a is the ratio of income elasticities (E_{ny}/E_{ay}).

elasticities of demand for agricultural goods, preference parameters, γ_a and γ_n, can be fitted and then multipliers of sectoral transformation with respect to nonagricultural productivity increase, m_n, agricultural productivity increase, m_a, and the capital stock increase, m_k, can be calibrated. The decomposition results from several countries will be presented in the next section with more explanations of the procedures.

V. Decomposition of the Rate of Sectoral Transformation

Equation (15), which is restated below, provides a basis for decomposing the rate of sectoral transformation into three basic factors—agricultural productivity increase, nonagricultural productivity increase, and the capital stock growth.

$$\hat{l}_n = m_n \hat{A}_n + m_a \hat{A}_a + m_k \hat{k}$$

where

$$m_n = \frac{1-\gamma_n}{\gamma_n + \frac{l_n}{l_a}\gamma_a}, \quad m_a = -\frac{1-\gamma_a}{\gamma_n + \frac{l_n}{l_a}\gamma_a},$$

$$m_k = \frac{(\beta+\varepsilon_n)(1-\gamma_n)-(\alpha+\varepsilon_a)(1-\gamma_a)}{\gamma_n + \frac{l_n}{l_a}\gamma_a}.$$

The data for $\hat{l}_n$, $\hat{A}_n$, $\hat{A}_a$ come from Tolley (1987). Since comparable capital data is nonexistent per capita GNP growth rates from the *World Bank Development Report* are substituted for the rates of change of capital stock. These are shown in Table 3 for 6 countries—South Korea, Columbia, Panama, Mexico, Chile, and Morocco.[4]

To calculate the values of the rates of sectoral transformation, m_i, the parameter values of γ_a and γ_n must be fitted, which I have shown can be accomplished using income and price elasticities of demand for agricultural goods. Systematic measures of these elasticities that are comparable among countries are not available, but the general orders of magnitude can be obtained. The income elasticity of demand for the agricultural goods and the price elasticity of demand for the agricultural goods are assumed to be 0.3 and 0.6, respectively. With these elas-

[4]The country selection is arbitrary and a fuller analysis of cross country comparisons will be done in subsequent papers.

TABLE 3
THE RATES OF SECTORAL TRANSFORMATION AND PRODUCTIVITY INCREASES[a]

Countries	l_n	A_a	A_n	k
South Korea	0.034	0.047	0.064	0.067
Columbia	0.019	0.026	0.034	0.024
Panama	0.014	0.026	0.034	0.024
Mexico	0.013	0.018	0.029	0.026
Chile	0.009	0.016	0.027	-0.002
Morocco	0.017	0.013	0.021	0.019

[a]Data from Tolley (1987) and *World Bank Report* (1988):1960-1980.

ticities, equation (7) gives the values of $\gamma_a = 1.87$ and $\gamma_n = 0.37$. The m_i's can now be estimated using the equations above.

Table 4 present the values of the rates of sectoral transformation, m_i's, and the decomposition results.[5] The last three columns show the contribution of agricultural productivity increases, nonagricultural productivity increases, and the capital stock increase to the overall rate of sectoral transformation during the periods of 1960-80. As the table demonstrates, the productivity increases in the nonagricultural sector contribute the greatest proportion to the rate of sectoral transformation.

Note that this result is based on the closed economy model. With the increase of international specialization, a rise in the agricultural productivity increase may lead to more specialization in this sector due to comparative advantage and a country's enhanced competitive position. This would imply that an increase in agricultural productivity will retard the sectoral transformation (see Matsuyama 1990; Kim 1991a). In this open economy case, the role of nonagricultural sector is expected to be more important than in the closed economy case in the process of sectoral transformation and the traditional wisdom, which emphasizes the role of agricultural sector, must be reconsidered.

[5]Various values of income and price elasticities were used, and the final decomposition results, which are shown in Table 4, stayed about the same. And this calculation also assumed $\alpha = \beta = 0.3$ and $\varepsilon_a = \varepsilon_n = 0{,}1$. Theses values may be different across countries and m_k may change accordingly. For a more complete study, additional effort should be given to estimating these parameters.

TABLE 4
CONTRIBUTION OF THREE FACTORS TO THE RATE OF SECTORAL TRANSFORMATION

Countries	m_a	m_n	m_k	$\frac{m_a\hat{A}_a}{\hat{l}_a}$	$\frac{m_n\hat{A}_n}{\hat{l}_n}$	$\frac{m_k\hat{k}}{\hat{l}_n}$
South Korea	0.234	0.167	0.161	32.3%	31.4%	31.7%
Columbia	0.217	0.155	0.149	29.7%	32.6%	21.9%
Panama	0.200	0.142	0.137	37.1%	34.5%	23.5%
Mexico	0.244	0.174	0.167	33.8%	38.8%	33.4%
Chile	0.091	0.065	0.063	16.1%	19.5%	-1.4%
Morocco	0.339	0.241	0.232	25.9%	29.8%	25.9%

Note: 1. m_a is the rate of sectoral transformation with respect to $\hat{A}_a$.
2. m_n is the rate of sectoral transformation with respect to $\hat{A}_n$.
3. m_k is the rate of sectoral transformation with respect to $\hat{k}$.

VI. Concluding Remarks

This paper provides a theoretical model to explain the nature of the underlying changes in demand and supply that determine sectoral transformation and measures the relative contribution of the basic factors to the rate of sectoral transformation. The model presented in this paper incorporates the dissimilarities in demand structures, productivity changes, and external effects between the two sectors. Then, preference parameters are fitted, the multipliers of sectoral transformation are calibrated, and the rate of sectoral transformation is decomposed. Nonhomothetic preferences used in this paper allow the income elasticity of demand for the agricultural good to be less than unitary, which many economists think important in the explanation of sectoral transformation. Since little consensus has been made about the relationship and their relative contribution between the productivity changes in the two sectors and the rate of sectoral transformation, this paper also attempts to fill this gap and shows that the contribution of the nonagricultural sector to the rate of sectoral transformation is at least as large as that of the agricultural sector and in an open economy can be expected to be greater.

In addition, this paper provides a formula for the rate of sectoral transformation and indicates three basic factors which generate sectoral transformation. The first is nonagricultural productivity, the second is agricultural productivity, and the third factor into which sectoral transformation is decomposed is the rate of growth of per capita capital stock. The contribution of each of these factors to the rate of sectoral transformation is estimated. As important as the general framework is the usefulness of the formula of this paper as a basis for decomposing the rate of sectoral transformation into three basic factors and quantifying the experiences of individual countries. A fuller empirical analysis is being done in subsequent papers.

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