

# Accounting for Agricultural Decline with Economic Growth in Taiwan<sup>1</sup>©

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**Abstract.** In this paper we propose an empirical model to decompose the evolution of the agricultural GDP share of Taiwan into three components: price changes, factor endowment changes and technological change. The full sample period is 1967 to 1997. The data were first tested to assess whether the time series are nonstationary and cointegrated. After confirming their nonstationarity and cointegrated relationship, we then employ an error correction model (ECM) in the empirical estimation to capture the dynamic as well as long-run equilibrium relationship among those economic variables. The results suggest that relative prices have a positive influence on the share of agriculture in GDP in both the long-run and the short-run. An increase in capital per unit of labor, on the other hand, is associated with a smaller agricultural share. This result is consistent with the Rybczynski Theorem. Technical change has been biased in favor of this sector. The strong negative impact of the change in factor endowments seems to dominate any possible positive effect of relative prices and technical change. This result makes a strong case for a Heckscher-Ohlin type model as a basis of understanding the development of the Taiwanese economy.

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## **I. Introduction**

Economic growth is usually accompanied by a relative decline of the agricultural sector. Although the total product of agriculture may still increase, its relative contribution to GDP is likely to decrease. One reason for this phenomenon is the slower rise in the demand for food according to Engel's Law. But Engel's Law does not explain why this structural change occurs not only in a closed economy, but also in an open economy with a comparative advantage in agriculture. In 1952 agricultural and processed agricultural products accounted for 92 percent of the value of exported goods in Taiwan. At that time, the agricultural sector's share in GDP was 32.2 percent. In 1997 the export share of agricultural and processed agricultural products was 2.1 percent, and the agricultural share in GDP was 2.7 percent.

From a neoclassical perspective, these changes may be explained by changes in preferences, factor endowments and technology. Preference changes will result in relative price level changes. For a small open economy, the change in the price ratio reflects relative world price variation for the traded goods. Technological progress will induce an outward shift of the production frontier. Bias in technological change will produce different growth rates in each sector and this can be a source of changes in comparative advantage. On the other hand, when technology and prices are constant, changes in relative factor endowments may also be the source of a change in comparative advantage. While changes in preferences, factor endowments and technology are the basis of comparative advantage, they also have significant influence on a country's industrial composition. It might be argued that policy can also play an important role in the evolution of economic structure. However the influence of a policy can be captured by the changes in relative prices, factor endowments and technology.

Though there are a lot of studies<sup>1</sup> concerning Taiwanese productivity growth there are

only a few studies of Taiwan's changing economic structure. Some<sup>2</sup> of these focus on the manufacturing sector while others<sup>3</sup> focus on the agricultural sector but are of a historical nature. In this paper we propose an empirical model to decompose the evolution of the agricultural share of GDP into three components: price changes, factor endowment changes and technological change. We use an aggregate restricted GDP function based on the theoretical models discussed by Dixit and Norman<sup>4</sup> and estimated by several authors, including Kohli<sup>5</sup>, Diewert and Morrison<sup>6</sup>, Lau<sup>7</sup>, Martin and Warr<sup>8</sup> and Harrigan<sup>9</sup>.

In the following section the theoretical model is formulated and discussed and the stochastic model is presented. The third section briefly discusses the approaches for data construction and the data series used. The estimates of the parameters are then presented and discussed, followed by some concluding comments.

## **II. Theory and Model**

We assume a small open economy with competitive market clearing producing two outputs with three inputs. Production is joint as outputs compete for the use of fixed factor endowments. Since the estimation of the model is based on time series data, consideration of the nature of technical progress is possible. We assume that the aggregate technology satisfies constant returns to scale, free disposability and non-increasing marginal rates of substitution and transformation. Even if individual firms have decreasing returns, the assumption of constant returns can still be applied at the economy wide level because changes in output can be achieved by changing the numbers of firms. Under profit maximization, the competitive equilibrium can be characterized as the solution to the problem of maximizing revenues subject to the technology, the endowment of domestic resources and a vector of positive output prices at each

point in time. Let  $T(t)$  be the production possibilities set at time  $t$ . We can then present the technology as the following *GDP* function<sup>10</sup>:

$$(1) \quad \pi(\mathbf{p}_t, \mathbf{x}_t, t) = \max_{\mathbf{y}_t} \{ \mathbf{p}'_t \mathbf{y}_t : (\mathbf{y}_t, \mathbf{x}_t) \in T(t) \}$$

$$\mathbf{p}, \mathbf{y} \geq 0, \mathbf{x} \geq \beta,$$

where  $\mathbf{y}$  is the vector of final goods, i.e. agricultural products ( $A$ ) and nonagricultural products ( $N$ ),  $\mathbf{p}$  is the vector of final goods prices ( $P_a$  and  $P_n$ ),  $\mathbf{x}$  is a vector of factor endowments that include labor ( $L$ ), capital ( $K$ ) and resources ( $R$ ),  $T(t)$  is a convex production set and  $t$  is a time trend used as a proxy for technical change. The *GDP* function is linearly homogenous and convex in output prices and is nondecreasing in both the prices and quantities of outputs.

For empirical purposes a translog function is used to represent *GDP*. Without the time subscript, the *GDP* function is:

$$\begin{aligned} \ln \pi = & \alpha_0 + \sum_i \alpha_i \ln p_i + 1/2 \sum_i \sum_h \alpha_{ih} \ln p_i \ln p_h + \sum_j \beta_j \ln x_j + 1/2 \sum_j \sum_k \beta_{jk} \ln x_j \ln x_k \\ & + \sum_i \sum_j \gamma_{ij} \ln p_i \ln x_j + \sum_i \gamma_{it} \ln p_i t + \sum_j \gamma_{jt} \ln x_j t + \phi_t t + 1/2 \phi_{tt} t^2 \end{aligned} \quad (2)$$

$$i \in \{A, N\}, j \in \{L, K, R\}$$

where  $p_i$  represents output prices;  $x_j$  represents quantities of factor endowments, and  $t$  is the time trend. Symmetry and linear homogeneity in  $\mathbf{x}$  (constant returns to scale) and in  $\mathbf{p}$  are imposed using the following restrictions:

$$\begin{aligned} \sum_i \alpha_i = 1; \quad \sum_j \beta_j = 1; \quad \alpha_{ih} = \alpha_{hi}; \quad \beta_{jk} = \beta_{kj}; \quad \gamma_{ij} = \gamma_{ji}; \quad \alpha_{ih} = 0; \quad \beta_{jk} = 0; \quad \gamma_{ij} = 0; \quad \gamma_{it} = 0; \quad \gamma_{jt} = 0 \end{aligned} \quad (3)$$

According to Hotelling's Lemma, the vector of net output supplies  $y_i(\mathbf{p}, \mathbf{x})$  is given by the gradient of  $\pi(\mathbf{p}_t, \mathbf{x}_t, t)$  with respect to  $\mathbf{p}$ :

$$y_i(\mathbf{p}_t, \mathbf{x}_t, t) = M\pi(\mathbf{p}_t, \mathbf{x}_t, t) / Mp_i \quad (4)$$

Under the Translog form, it is convenient to represent the output supply in terms of share:

$$S_i = \alpha_i + \sum_h \alpha_{ih} \ln p_h + \sum_j \gamma_{ij} \ln x_j + \gamma_{it} t \quad (5)$$

$i, h \in \{A, N\}; j \in \{L, K, R\};$

where  $S_i = p_i y_i / \pi$  is the GDP share of output  $i$ .

The homogeneity conditions are imposed directly on the agricultural share using the price of labor and the quantity of natural resources as numeraire:

$$S_a = \alpha_0 + \alpha_1 \ln(p_a / p_n) + \gamma_1 \ln(K / L) + \gamma_2 \ln(R / L) + \gamma_3 t \quad (6)$$

This equation is used later to understand how changes in output prices, factor endowments and technical change account for the decline in the GDP share of the agricultural sector in Taiwan.

### III. Data

To estimate equation (6) we need data on agricultural share, output prices and factor endowments. The agricultural price we use is the GDP deflator of the agricultural sector. The nonagricultural price is a weighted average of different sectors' GDP deflators with weights given by their contributions to overall GDP. The factors we consider in this model are capital ( $K$ ), labor ( $L$ ) and land (or natural resources  $R$ ). The capital stock series was constructed using a perpetual inventory method with an annual depreciation rate of 5 percent:

$$K_t = (1 - d) K_{t-1} + I_t \quad (7)$$

where  $K$  is capital stock by the end of each year,  $d$  is the depreciation rate,  $I$  is investment. A level of physical capital stock is estimated for 1966 following Harberger's method<sup>11</sup> of estimation for the capital stock at the steady state. First, we assume a steady-state relation

$$I^* = (g + d) K^* \quad (8)$$

the initial capital stock can be retrieved by

$$K^*=I^*/(g+d) \tag{9}$$

where  $I^*$  is the steady state level of investment,  $g$  is the rate of growth of real investment (and capital),  $d$  is the rate of depreciation and  $K^*$  is the steady-state capital stock. Second, we estimate the growth rate  $g$  by

$$\ln I = \tau_0 + \tau_1 t \tag{10}$$

where  $t$  is the time trend and the coefficient of  $t$  is the growth rate of real investment,  $g$ . Employing a 5 percent depreciation rate we can obtain the initial capital stock in the first period of the sample from the steady-state relation. Then by adding investment during the previous period and deducting depreciation we can rebuild the capital stock series.

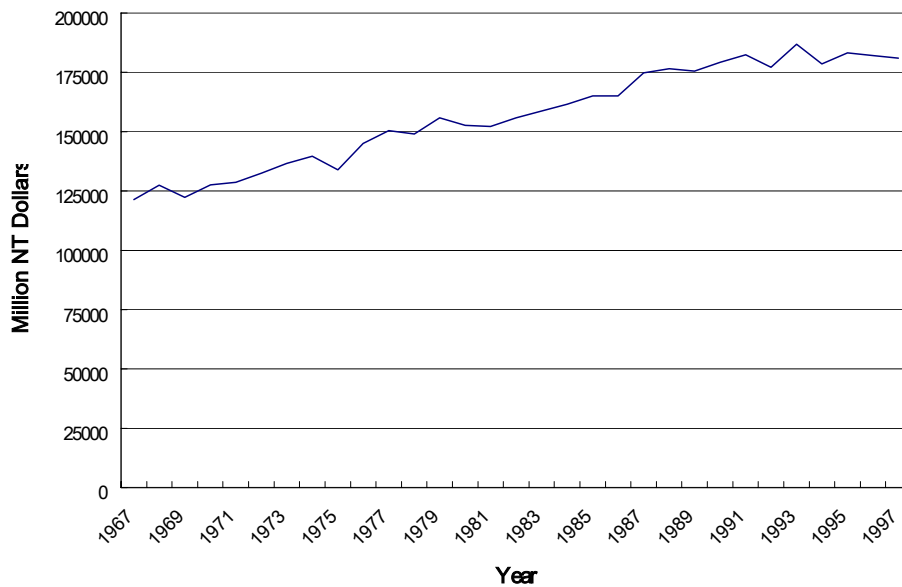
As to the labor endowments, Darby<sup>12</sup> suggests that labor stock data should be adjusted to embody human capital. We therefore included the average number of years of schooling for the working age population as a proxy for human capital. Land in use in Taiwan has not shown a significant change in the last 30 years. The most obvious change is the transformation from the use of land for agriculture to nonagricultural activities, but such changes have been small. However, due to the growth of the adjusted labor force, the ratio of  $R$  to  $L$  has declined. The time series data are shown in Appendix Table A-1.

The data used in this paper are annual series drawn primarily from the Taiwan Statistical Data Book<sup>13</sup>, Quarterly National Economic Trends Taiwan Area, the Republic of China<sup>14</sup> and Monthly Bulletin of Earnings and Productivity Statistics, the Republic of China<sup>15</sup>.

The full sample period is 1967 to 1997. The real GDP in the agricultural sector is presented in figure 1, and the share of agriculture in GDP is presented in Figure 2. The two diagrams show that even though there is substantial growth in the value of agriculture output for the last 30 years, the share of agriculture in GDP has declined. The price of agricultural output in relation to nonagricultural output is plotted in Figure 3. No substantial trend in the relative prices is evident. There does not appear to be much relation between relative agricultural prices

and the share of agriculture in GDP although the increase in relative price between 1973 and 1975 does seem to correspond to a brief increase in agriculture's share of GDP. The capital-labor ratio computed as described above is depicted in Figure 4. This series shows a smooth

Figure 1. GDP in the Agriculture Sector in Taiwan, 1967-1997 ( 1991 prices)



increase in the 1970s and 1980s. After 1989, the rate of capital over labor increases more rapidly because the rate of investment increased and per unit of labor. The declining ratio of land to labor is shown in Figure 5.

**Figure 2. Agricultural Share in Taiwanese GDP, 1967-1997**

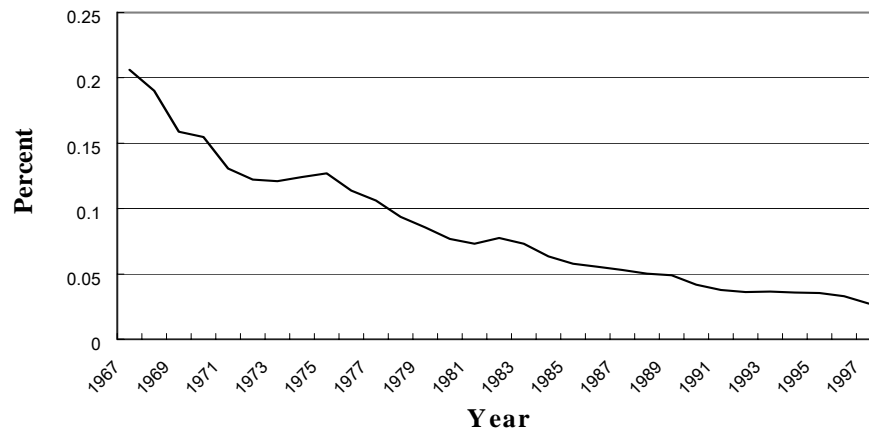


Figure 3. Index of Relative Prices of the Agricultural and Nonagricultural Outputs

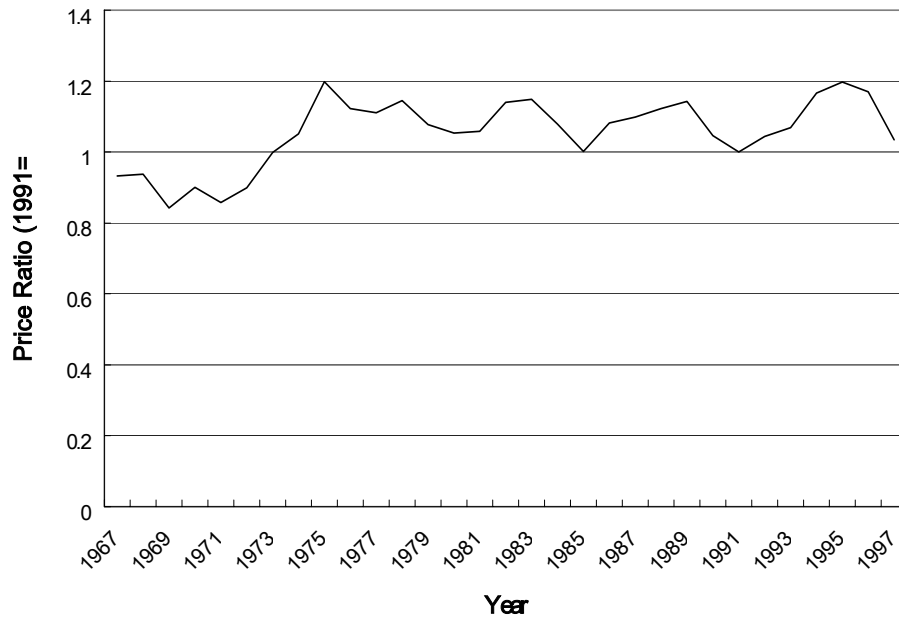


Figure 4. The Capital-Labor Ratio in Taiwan, 1967-1997

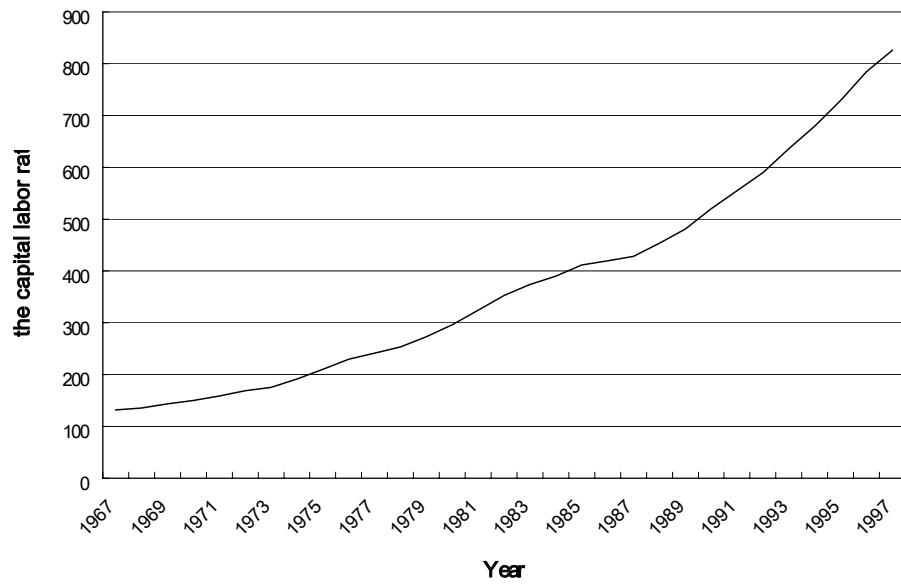
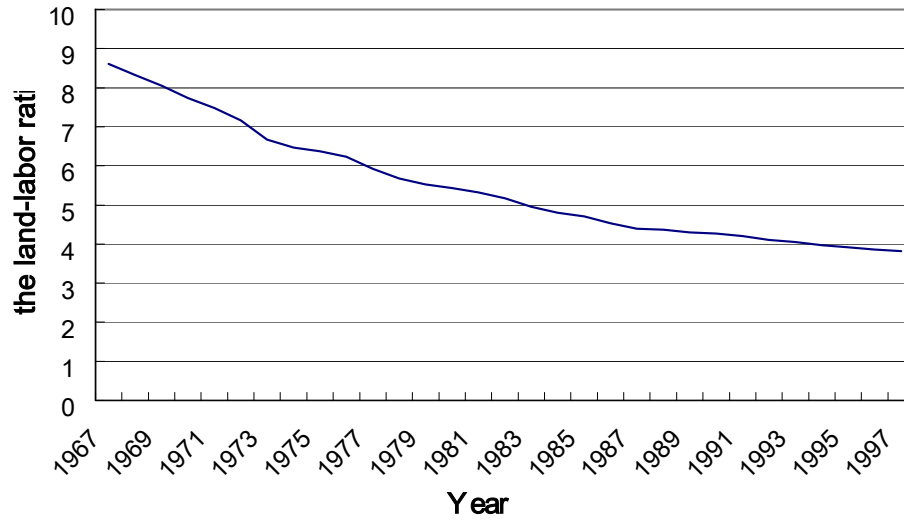


Figure 5. The Land-Labor Ratio in Taiwan, 1967-1997



#### IV. Empirical Results

The data were first tested to assess whether the variables are nonstationary. Regressions involving independent nonstationary variables tend to generate spurious results. The standard method for detecting nonstationary behavior in a time series is to test if there is a unit root. A variable that has a unit root but whose first differences are stationary is referred to as being integrated of order one and is denoted as I(1). We can difference the variables prior to estimation to get consistent estimates of the model coefficients when the variables are not cointegrated. However, if variables are cointegrated, revealing a long-run relation between ‘integrated’ economic variables, the relationship can be represented with an error-correction model (ECM).

We add an error term to Equation (6) to represent the long-run relation between the agricultural share, prices, factor endowments and technology,  $a_0, a_1, a_2, a_3, a_4$  are parameters to be estimated in the empirical model.

$$S_a = a_0 + a_1 \ln(p_a / p_n) + a_2 \ln(K / L) + a_3 \ln(R/L) + a_4 t + u_t \quad (11)$$

The ECM equation in first differences is

$$\in S_a = a_4 + a_1 \in \ln(p_a / p_n) + a_2 \in \ln(K / L) + a_3 \in \ln(R/L) + (u_t - u_{t-1}) \quad (12)$$

where  $\in$  is the first-difference operator.

If  $u_t$  is serially correlated

$$u_t = \rho u_{t-1} + \gamma_t, \quad (13)$$

whith  $\gamma_t$  distributed with zero mean and finite variance, (12) can be rewritten as

$$\in S_a = a_4 + a_1 \in \ln(p_a / p_n) + a_2 \in \ln(K / L) + a_3 \in \ln(R/L) + \lambda u_{t-1} + \gamma_t \quad (14)$$

where  $\lambda = (\rho - 1)$ . If  $\rho = 1$  then  $u_t$  is nonstationary and  $\lambda$  is zero. In this case the first-differences

specification in (12) does not include the term  $(u_t - u_{t-1})$  and can be consistently estimated by OLS. However the estimated coefficients do not carry the same interpretation as the coefficients in equation (11) since equation (12) will be a dynamic specification measuring the short-run effects of changes but not levels. When  $\rho$  is smaller than unity so that  $u_t$  is stationary then  $\lambda$  will be different from zero and the error correction term should be included in the dynamic ECM specification of (12). Estimating the specification in first differences without the error correction term will not provide consistent estimates, as changes in the agricultural share will be affected by deviations from the steady state.

A number of tests for stationarity are available such as the Dickey-Fuller test<sup>16</sup> and the Phillips-Perron test<sup>17</sup>. Table 1 presents the results of the standard Dickey-Fuller (DF) and the augmented Dickey-Fuller (ADF) tests as well as the cointegration test. These tests and all econometric analysis were undertaken using SHAZAM. Results suggest that the relative price ratio and the resources per worker variables do not have unit roots. While we cannot reject the unit root hypothesis for the capital per worker and agricultural share variables. The cointegration test performed on residuals indicates rejection of the hypothesis of nonstationarity, confirming a long-run relationship between the variables of interest.

Equation (11) was first estimated with OLS. The results are presented in Table 2 part A. Since the agricultural share and the relative capital labor ratio are I(1) and there exists a cointegration relationship between these variables the OLS estimates are inefficient. The error correction model will be a more appropriate specification. We formulate a more general model by introducing the lagged changes of each variable into equation (14) as indicated by Akaike's Information Criterion:

$$\begin{aligned} \ln S_a = & b_0 + \sum b_{1s} \ln S_{a,t-s-1} + \sum b_{2s} \ln(p_a/p_n)_{t-s} + \sum b_{3s} \ln(K/L)_{t-s} + \sum b_{4s} \ln(R/L)_{t-s} \\ & + \lambda u_{t-1} + \gamma_t \end{aligned} \quad (15)$$

Table 1. Results for the Stationarity and Cointegration Tests

Variables	D-F Test	ADF Test	Number of Lags for ADF
Sa	-1.37	-2.52	4
In(Pa/Pn)	-3.68**	-4.35**	1
In(K/L)	-0.77	-1.05	1
In(R/L)	-4.67*	-4.88**	2
Residual	-3.84**		

1. ‘\*\*’ indicates significance at the 5 percent level. The 5 percent critical value for DF and ADF test is -3.0, 10 percent critical value is -2.63. When there is a smaller number than the critical value we reject the hypothesis of unit root.

2. Number of lags for ADF test is decided by the AIC criterion.

Short-run and long-run parameters are estimated jointly by replacing  $u_{t-1}$  in Equation (15) with Equation (11):

$$\begin{aligned} \in S_a = & b_0 + \Sigma b_{1s} \in S_{a\ t-s-1} + \Sigma b_{2s} \in \ln(p_a / p_n)_{t-s} + \Sigma b_{3s} \in \ln(K / L)_{t-s} + \Sigma b_{4s} \in \ln(R/L)_{t-s} \\ & + \lambda ( S_{a\ t-1} - a_0 - a_1 \ln(p_a / p_n)_{t-1} - a_2 \ln(K / L)_{t-1} - a_3 \ln(R/L)_{t-1} - a_4 t_{t-1} ) + \gamma_t \end{aligned} \quad (16)$$

or equivalently as:

$$\begin{aligned} \in S_a = & c_0 + \Sigma b_{1s} \in S_{a\ t-s-1} \Sigma b_{2s} \in \ln(p_a / p_n)_{t-s} + \Sigma b_{3s} \in \ln(K / L)_{t-s} + \Sigma b_{4s} \in \ln(R/L)_{t-s} \\ & + c_1 S_{a\ t-1} + c_2 \ln(p_a / p_n)_{t-1} + c_3 \ln(K / L)_{t-1} + c_4 \ln(R/L)_{t-3} + c_5 t_{t-1} + \gamma_t \end{aligned} \quad (17)$$

where  $c_0 = b_0 - a_0 \lambda$

$$c_1 = \lambda$$

$$c_2 = -a_1 \lambda$$

$$c_3 = -a_2 \lambda$$

$$c_4 = -a_3 \lambda$$

$$c_5 = -a_4 \lambda \quad (18)$$

and from which we can recover the long-run parameters of (11):

$$a_1 = -c_2 / \lambda$$

$$a_2 = -c_3 / \lambda$$

$$a_3 = -c_4 / \lambda$$

$$a_4 = -c_5 / \lambda$$

$$a_0 = (b_0 - c_0) / \lambda \quad (19)$$

One feature of estimating (17) that is of interest in this study is the possibility of identifying not only the steady state equilibrium relationship represented by the vector of  $a$ 's but also of obtaining information about the path of the variables towards that long-run equilibrium which is captured by the vector of  $b$ 's and  $c$ 's. Results are presented in Table 2, B and C.

From the dynamic and the long-run parameters in B and C (Table 2), we see that both

equations have positive gradients with respect to the contemporaneous price ratio. This indicates that when the relative price of agricultural products increases so does the share of the sector, doing so at an increasing rate. The negative signs for the coefficient of  $\ln(K/L)$  indicate that the capital-labor ratio contributes negatively to agriculture's share in GDP as well as to its change. This is consistent with the Rybczynski theorem, which hypothesizes that an increase in the endowment of one factor will increase the output of the commodity intensive in that factor and will reduce the output of other commodities. Since agriculture is relatively labor intensive, the rapid accumulation of capital will cause a relative decline of the agricultural sector's share. As to the influence of land per unit of labor, the positive sign indicates that the declining land-labor ratio may be responsible for some of the decrease of the agricultural share. The coefficient of the time trend shows that technical change has been biased in favor of agriculture.

As to the short-run adjustments only first-differences of  $\ln(P_a/P_n)$  and of two lagged agriculture shares are significant at the 5 percent level and make a positive contribution to the change in agricultural share. This implies that the greater the change in relative prices, the more the agricultural share adjusts. The significant coefficients for lagged shares indicate that dynamic adjustments are important in the production process. An alternative interpretation would highlight the importance of expectations.

Table 2. The econometric results of alternative specifications

A. The OLS regression of agriculture share

$$S_{a,t} = -0.5466 + 0.0734 \ln(p_a/p_n)_t + 0.0343 \ln(K/L)_t + 0.031 \ln(R/L)_t + 0.0025 t + u_t$$

(-2.474)\*\* (3.301)\*\* (0.817) (8.861)\*\* (0.947)

$R^2 = 0.9781$ , adjusted  $R^2 = 0.9747$ ,

D-W = 0.5365

Weak exogeneity test:

$\ln(p_a/p_n)$  (-0.7223)

$\ln(K/L)$  (-0.0023)

$\ln(R/L)$  (0.0802)

B. The ECM of change of agriculture share

$$\epsilon S_{a,t} = -0.0928 + 0.5814 \epsilon S_{a,t-1} + 0.29011 \epsilon S_{a,t-2} + 0.1858 \epsilon S_{a,t-3} + 0.0518 \epsilon \ln(p_a/p_n)_t - 0.0449 \epsilon \ln(p_a/p_n)_{t-1}$$

(-1.07) (2.859)\*\* (2.025)\*\* (1.155) (3.744)\*\* (-1.833)\*

$$- 0.0321 \epsilon \ln(p_a/p_n)_{t-2} - 0.0235 \epsilon \ln(p_a/p_n)_{t-3} - 0.0175 \epsilon \ln(K/L)_t + 0.0304 \epsilon \ln(K/L)_{t-1}$$

(-1.599) (-1.375) (-0.6940) (1.071)

$$- 0.00715 \epsilon \ln(K/L)_{t-2} - 0.0231 \epsilon \ln(K/L)_{t-3} + 0.21196 \epsilon \ln(R/L)_t - 0.1271 \epsilon \ln(R/L)_{t-1}$$

(-0.236) (-0.7795) (2.139)\*\* (-1.796)

$$- 0.00631 \epsilon \ln(R/L)_{t-2} + 0.051 \epsilon \ln(R/L)_{t-3} - 1.4012 S_{a,t-1} + 0.1017 \ln(p_a/p_n)_{t-1} - 0.0466 \ln(K/L)_{t-1}$$

(-0.0805) (0.6897) (-5.783)\*\* (2.83)\*\* (-2.285)\*\*

$$+ 0.3091 \ln(R/L)_{t-1} + 0.0057 t_{t-1} + \gamma_t$$

(4.317)\*\* (2.936)\*\*

$R^2 = 0.999$ , adjusted  $R^2 = 0.997$ ,

Weak exogeneity test:

♠  $\ln(p_a/p_n)$  (1.017)

♠  $\ln(K/L)$  (0.0654)

♠  $\ln(R/L)$  (0.0861)

C. The long run relationship derived from the ECM

$$S_{a,t} = -0.0694 + 0.0726 \ln(p_a/p_n)_t - 0.03324 \ln(K/L)_t + 0.2206 \ln(R/L)_t + 0.004 t + u_t$$

(4.17)\*\* (-2.71)\*\* (11.12)\*\* (4.19)\*\*

$\epsilon_{aa} = 0.0623$ ,  $\epsilon_{nn} = 0.0049$ ,  $\tau_{an} = \tau_{na} = -0.0672$

1: The number inside the parenthesis is the t ratio, and the t statistic is 2.228 at a 95 percent confidence level and 1.812 at a 90 percent confidence level. The 5 percent critical value of t statistic is 2.228, 10 percent critical value is 1.812.

2. A “\*\*\*” indicates significance at the 5 percent level, “\*\*” indicates significance at the 10 percent level.

3. The t ratios for the coefficients of long-run relationship were retrieved underlying the nonlinear approach.

4.  $\epsilon_{aa}$  and  $\epsilon_{nn}$  are supply elasticities of agriculture and nonagriculture output at the mean.  $\tau_{an}$  and  $\tau_{na}$  are transformation elasticities between agriculture and nonagriculture outputs.

We use the long-run parameters from part C in Table 2 to calculate output supplies and

transformation elasticities. Even though the elasticities at the mean, shown in Table 2, have the expected sign, in 10 out of 31 observations the curvature condition is violated indicating lack of global convexity of the translog GDP function. The supply elasticity of nonagricultural products at the mean is smaller than that of agricultural products. The transformation elasticity between the two sectors is negative indicating substitutability.

If the regressors of a model are asymptotically correlated with the contemporaneous disturbance of the model the coefficient estimated by OLS may be inconsistent.<sup>18</sup> Though tests of the exogeneity of regressors do not reject endogeneity, it can be shown that this does not cause inconsistent estimated coefficients. The coefficients are tested for simultaneous equation bias. A weak exogeneity test<sup>19</sup> (Ericsson, 1992) is used to examine this potential problem for both the OLS model and the ECM model. T-tests for the significance of the lagged residual from equation (11) as an explanation of  $\ln(P_a/P_n)$ ,  $\ln(K/L)$  and  $\ln(R/L)$  in the OLS estimation and for the lagged residual in equation (17) as an explanation of  $\blacktriangleleft \ln(P_a/P_n)$ ,  $\blacktriangleleft \ln(K/L)$ ,  $\blacktriangleleft \ln(R/L)$  in the ECM model are used. The tests indicate an absence of simultaneous equation bias, confirming the validity of the single equation model used in this paper.

Decomposition of the change of the agricultural share into short-run variations and long-run factors is illustrated in Figures 6 and 7. Figure 6 shows the separate effects of each factor and Figure 7 shows the accumulated effects from each factor. Our estimates indicate that the long-run effect, which is the sum of the influences from the relative agricultural price, factor endowments and technical change in the last time period, accounts for most of the agricultural share dynamics. The changes in these variables have a small negative effect on the change in agriculture's share. These results indicate that the speed of adjustment of  $S_a$  to a new steady state will depend crucially on the level of the variables at the initial steady state, more than on how the specific dynamic paths of these variables evolve.

The different sources that affect the adjustment of the agricultural share from Part B and Part C in Table 2 were summarized in five categories: share of agriculture in GDP, relative prices, land-labor ratio, capital-labor ratio and technical change. Their contribution to the short-run adjustment or long-run state of the agricultural share is shown in Figures 8 and 9, respectively. The land-labor ratio makes positive but declining contributions to the short-run change of the agricultural share as well as the long-run agricultural share in GDP. This shows

that with a declining land-labor ratio the positive contribution from land has been restricted. It is clear from these figures that the primary negative effect is the capital-labor ratio, which dominates relative prices and pro-agricultural technical change in explaining the decline of the sector in GDP, whether in the steady-state or the dynamic adjustment.

## **VI. Conclusion**

The results suggest that relative prices have a positive influence on the share of agriculture in GDP in both the long-run and the short-run. A decline in the relative price of agricultural products is associated with a decline in the share of agriculture in GDP, other things equal. An increase in capital per unit of labor, on the other hand, is associated with a smaller agricultural share. This result is consistent with the Rybczynski theorem, since agriculture is relatively labor intensive. Technical change has been biased in favor of the agricultural sector.

In summary, the strong negative impact of the change in factor endowments seems to dominate any possible positive effect of relative prices and technical change. This result makes a strong case for a Heckscher-Ohlin type model as a basis of understanding the development of the Taiwanese economy. It also indicates the importance of Taiwan's open economy trade policies as the growth of its capital stock would probably not have been as dramatic in the absence of such policies. The export-oriented policy implemented by the Taiwan government led to capital accumulation in industries with comparative advantages in the world market and fostered high economic growth over the last half century.

Figure 6. Short- and Long-run Effects Accounted for by the Change in Agriculture Share

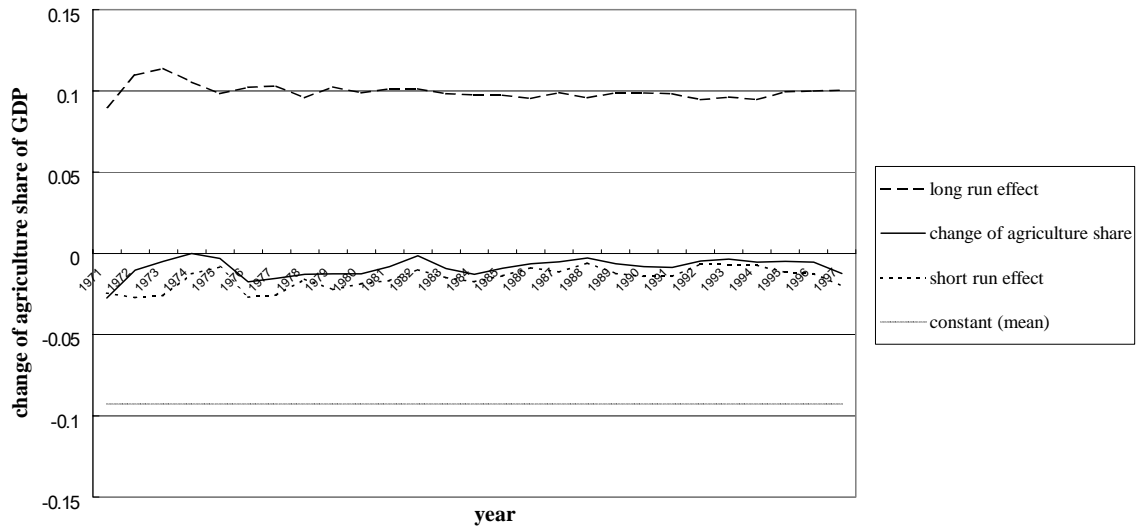
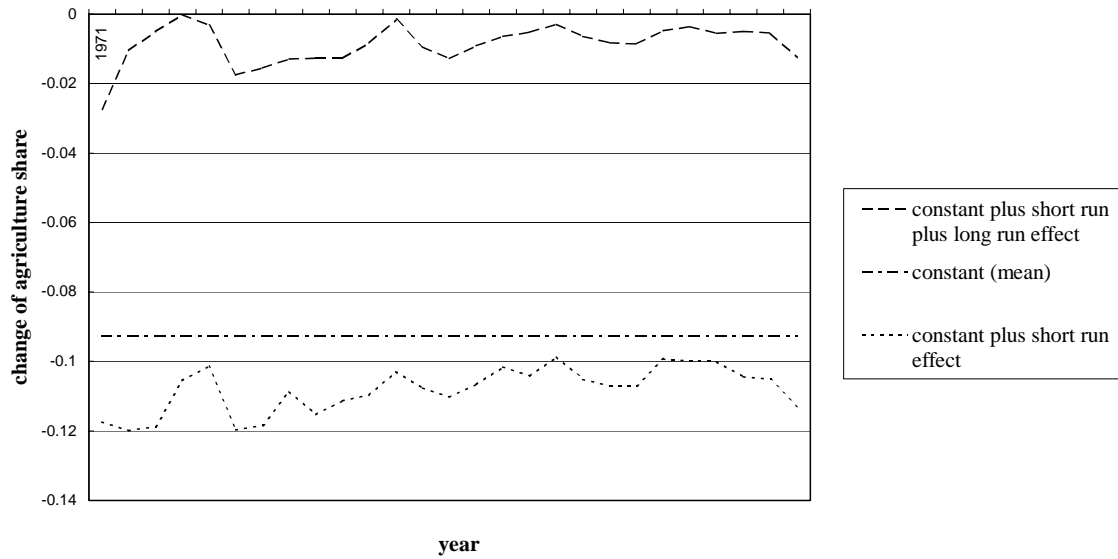


Figure 7. Decomposition of the Change in the Agricultural Share  
(accumulation effect)



**Figure 8 Price, Resource and Technology Effects Accounted for by the Change in Agricultural Share (short-run)**

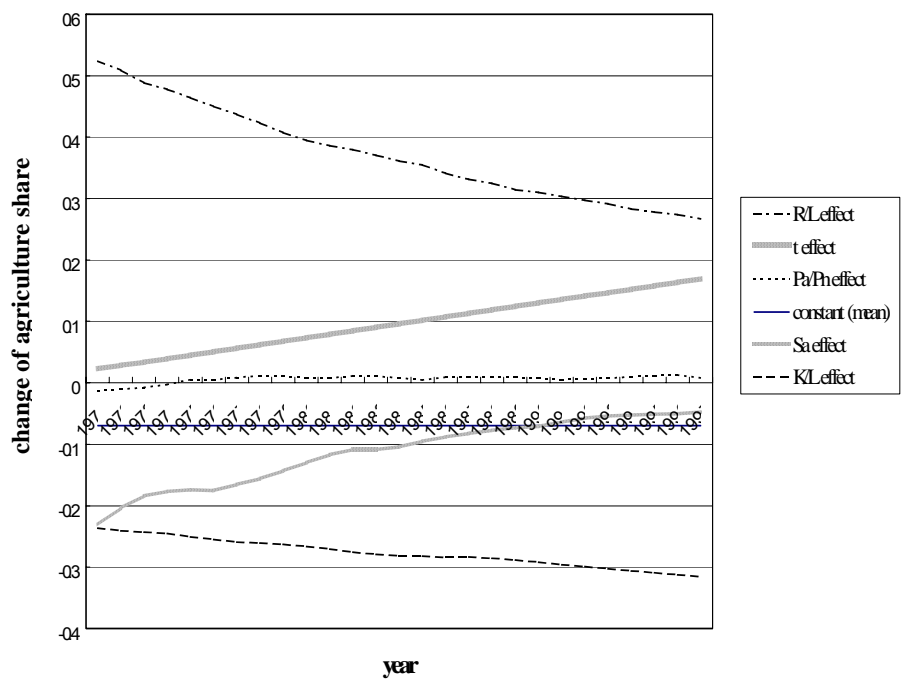
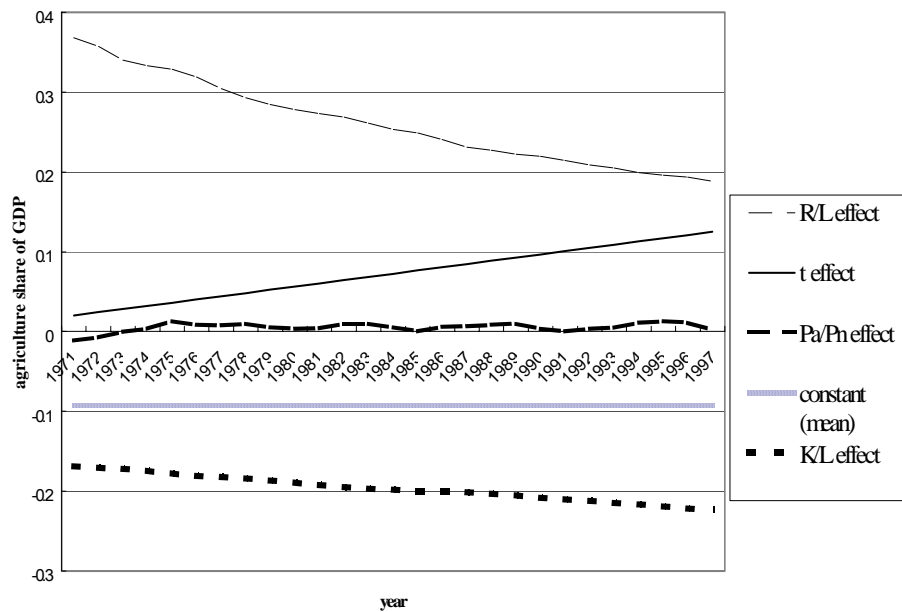


Figure 9. Price, Resources and Technology Effects Accounted for by the Change in Agricultural Share (long-run)



**Table A-1 The Data Set**

YEAR	Ag. product (at 1991 price) Million NT Dollars	Ag. Share in GDP %	Ag. Price / Non Ag. Price %	Capital/Labor %	Land/Labor %
1967	121442	0.2061	0.9320	131.65	6.2409
1968	127433	0.1902	0.9376	135.16	5.9486
1969	122370	0.1589	0.8421	143.67	5.7865
1970	127598	0.1547	0.9009	150.00	5.5183
1971	128672	0.1307	0.8572	158.77	5.3093
1972	132534	0.1221	0.8997	168.86	5.0515
1973	136657	0.1210	0.9990	175.72	4.6683
1974	139656	0.1242	1.0517	191.23	4.5240
1975	133944	0.1270	1.1986	210.33	4.4291
1976	145007	0.1138	1.1224	229.64	4.2494
1977	150509	0.1060	1.1110	241.05	3.9788
1978	148941	0.0938	1.1447	253.97	3.7705
1979	155851	0.0855	1.0770	273.05	3.6325
1980	152729	0.0768	1.0530	296.41	3.5277
1981	152149	0.0730	1.0578	324.94	3.4462
1982	155881	0.0774	1.1405	353.22	3.3763
1983	158659	0.0730	1.1483	374.10	3.2631
1984	161507	0.0633	1.0779	389.66	3.1499
1985	165090	0.0578	1.0013	411.35	3.0936
1986	165020	0.0555	1.0825	419.40	2.9735
1987	174687	0.0531	1.0990	428.47	2.8521
1988	176514	0.0504	1.1219	453.31	2.7999
1989	175550	0.0490	1.1426	481.52	2.7395
1990	179200	0.0418	1.0468	520.59	2.7085
1991	182356	0.0379	1.0000	554.89	2.6451
1992	177115	0.0360	1.0445	589.75	2.5762
1993	186747	0.0366	1.0689	635.94	2.5314
1994	178581	0.0357	1.1658	679.75	2.4690
1995	183189	0.0355	1.1970	729.74	2.4302
1996	182060	0.0329	1.1700	784.76	2.4063
1997	180984	0.0273	1.0348	826.41	2.3500

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## Notes

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