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# Changing Factor Income Shares in Agri-Food Industries

**Srinivasa Konduru and Bruce Bjornson**

A concern in the political economy is how national income is shared between labor and capital. This study evaluates long-term changes in factor income shares in three agri-food industries, their attribution to the level of factor usage or to factor compensation rates, and relation to changes in capital intensity and factor productivity. We find long-term stability in the profit and labor shares of farm income, decline in the profit share of agricultural services industry income, and increase in the profit share of food manufacturing income due to fewer productivity improvements being passed on to wage increases.

*Key Words:* agriculture, factor shares, food, GDP, national income

**JEL Classifications:** D33, E25, L66

A concern in the political economy is how national income is shared between labor and capital. These two production factors capture over three-fourths of gross domestic product (GDP) in the form of labor compensation and profits, with the remainder accruing to government and miscellany, and to rents in the case of residential and other real estate. Labor compensation is fundamental to personal income and political leaders often promise "good paying jobs" as they seek public support. Compensation attracts workers and creates incentives for public investments in education and human capital development. Profits are incentive for capital investment and job creation that is central to government policies seeking to promote economic growth.

Income growth depends on investment and productivity growth. This study evaluates whether labor and capital factor income shares have changed in terms of their two constituent components, factor usage or factor compensation rates. It analyzes (1) whether any changes in compensation rates are predicted by and follow from changes in factor productivity, and (2) whether changes in factor usage are predicted by changes in capital intensity that evolve with substitution between capital and labor. Analyses for the aggregate economy are used as a benchmark and compared with those for the three major agri-food industries defined by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA): (1) food and kindred products manufacturing, (2) farm production, and (3) agricultural services (though small, the agricultural services industry is a growing share of the agri-food sector, consistent with the possibility that advancing technology and specialization cause ever-larger farms to rely more on outside services).

Drawing on new BEA data on GDP and fixed assets by industry, this research describes the long-term trends in labor usage and how they are related to capital intensity, and how increases in labor productivity are passed on to increases in labor compensation. Although the trends are not necessarily predic-

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tive and may not be indefinitely sustainable, persistent long-term trends will inform us about continuing prospects in the absence of structural change. If an industry has a long-term trend of increasing labor productivity and passing on a high proportion of the improvement to wage increases, then this wage pass-through could bode well for encouraging development of this industry in localities with comparative advantage. Such development would depend on attracting and sufficiently rewarding complementary fixed-asset investment and usage. Hence, the study also looks at how capital intensity is related to fixed-assets usage and profit returns as a proportion of fixed assets. Regression analyses are used to assess how factor usage is affected by capital intensity, and how factor compensation is affected by productivity for the three agri-food industries and the aggregate economy benchmark.

Understanding the nature of these trends can ultimately inform the policy process on whether to attract and support industries. There has long been a debate on whether to promote food manufacturing at various levels. For example, at the national level, it has been argued that the United States should focus more on assisting the exports of value-added consumer food products and less on assisting exports of agricultural commodities. The basis of the argument is that the value-added products create more jobs and income that are otherwise sent overseas with the export of farm commodities. It has been similarly argued that some states should promote more value-added food manufacturing to create jobs and increase state income. Local and more rural communities have often looked to food manufacturing as a regional development strategy. This study seeks to show if capital investment has changed productivity and whether productivity improvements have transferred into wage increases, relative to the economy over the long term. The United States has a long history of supporting farm commodity production and export. A pertinent question addressed by this study is, to what degree has capital investment improved farm productivity and how has this transferred into improved factor income relative to the economy?

The next section of the paper gives background and related previous research. Then the research model is presented along with the data and variable construction, followed by a *Results* section. The paper finishes with a *Summary* and *Conclusion* sections.

## Prior Research

Overall U.S. productivity growth after WWII slowed after 1973 from approximately 2¾% to 1½%. The reasons are not clear but this slowdown represents a possible structural change for factor income shares that is tested in this study. There is also speculation that growth may have picked up again in the 1990s because of benefits from technological innovation (e.g., *Economist,* 2002c,d; Wessel). Although this growth spurt is too recent to test for long-term structural change, this study offers a 50-year perspective on income shares to assess the potential. Increasing productivity and profits in the economic boom of the 1990s sparked optimism about long-term higher growth rates for profits. A National Bureau of Economic Research study of BEA data through 1996 concluded that GDP growth and corporate profits as a share of GDP had risen, but were within historical norms (Poterba). While there has been a positive relation between productivity and profits since WWII, there has been recent debate that this may have faltered in the 1990s and that productivity improvements may instead have been captured more by wage increases (e.g., *Economist,* 2002b; Mandel).

In the agri-food sector, food manufacturers have long been scrutinized for their capacity to appropriate extranormal profits by limiting price competition through brand names or oligopolistic market structure. Although food manufacturing is a slow-growth industry, it has also been credited with productivity improvements over the years (e.g., see Morris). By contrast, farm income has steadily declined as a share of agri-food sector income. Farm labor compensation rates have also lagged for decades and new farm jobs today are filled mostly by low-skill immigrants (Martin).

Industry competitive conditions and profitability have been studied (e.g., Barkema, Drabenstott, and Novack; Schmalensee), but the link between industry productive activity and distribution of income between capital and labor has not been widely studied. Gustafson found that a long-standing trend in the farm sector has been the substitution of capital inputs for labor, and that capital productivity increased from 1940 to 1984, but that further capital substitution may not benefit agricultural producers. Emerson showed that remarkable transformation in agricultural labor markets had taken place during 1955–1985, which reduced the number of farm workers. He ascribed this transformation to the combined forces of technology, nonfarm labor policy, and the rising value of human time. Monke, Boehlje, and Pederson studied total farm returns in comparison with other types of investments. They concluded that returns from current income and capital gains for farm investment match or exceed that on many nonfarm investments (in contrast, this study examines real economic activity and not capital gains). Another line of research utilized plant-level data and found a positive relationship between wages and worker use of various new technologies (Doms, Dunne, and Troske; Dunne and Schmitz). However, Bartel and Sicherman found that the positive correlation between the wages and the technological change is significantly weakened when controlling for unobserved heterogeneity among individual workers.

Over long periods income shares to labor and capital have been somewhat stable in developed nation economies (Gollin). However, the same is not true of individual industries as markets reallocate rewards and resources to industries that evolve to create more economic value. Through economic cycles, underlying trends in technology and tastes and preferences drive change in how factors of production are allocated across industries and share income.

## Model

Economic theory leads us to expect that increases in capital intensity would result in substitution that would reduce labor usage. Increases in labor productivity should result in increased wages, and under stable competitive market conditions, we might expect that increases in labor productivity would result in similarly proportional increases in labor compensation. Regression analyses for the aggregate economy and for each of the three agri-food industries are used to assess whether factor usage and return components of factor income shares follow from capital intensity and factor productivity, respectively.

To better analyze the fundamental long-term trends, the model incorporates macroeconomic business cycle variables to control for alternating intervals of economic growth and recession. The objective is to control for cyclical impacts to more clearly see fundamental long-term trends. For example, labor compensation share of GDP tends to temporarily rise during recessions as downturns have proportionately greater effect on residual profit claims. The regression analyses use four macroeconomic variables that have been established as precursors of alternating intervals of growth and recession [*Macro*].

The four regression equations here are:

$$(1)\quad \ln[FTE/GDP]_{it} = \alpha_i + \ln[FA/FTE]_{i,t-1}\beta_i + [Macro]_{t-1}\delta_i + \varepsilon_{it}$$

$$(2)\quad \ln[COMP/FTE]_{it} = \alpha_i + \ln[GDP/FTE]_{i,t-1}\beta_i + [Macro]_{t-1}\delta_i + \varepsilon_{it}$$

$$(3)\quad \ln[FA/GDP]_{it} = \alpha_i + \ln[FA/FTE]_{i,t-1}\beta_i + [Macro]_{t-1}\delta_i + \varepsilon_{it}$$

$$(4)\quad \ln[PROFIT/FA]_{it} = \alpha_i + \ln[GDP/FA]_{i,t-1}\beta_i + [Macro]_{t-1}\delta_i + \varepsilon_{it},$$

where Equations (1) and (3) respectively regress the labor factor usage variable [*FTE/GDP*] and fixed-asset usage variable [*FA/GDP*] on their respective lagged capital intensity variable [FA/FTE] to estimate how factor usage relates to capital intensity; [*Mac-*

*ro*] represents four macroeconomic state variables used to control for the effects of business cycles in all equations; Equation (2) regresses labor factor compensation [*COMP/FTE*] on a lagged labor productivity [*GDP/FTE*] (to estimate the proportion of industry income per employee passed on to employee compensation); and Equation (4) regresses fixed-asset return [*PROFIT/FA*] on industry income return to fixed assets [*GDP/FA*] (to estimate the proportion of industry income per dollar of fixed assets passed on to profit returns). Discussion of the data and construction of the factor and macroeconomic variables follow.

### *BEA Factor Variables*

Income and factor measures are constructed from BEA National Income and Product Accounts data on GDP and stocks of fixed assets by industry. These measures are derived from income tax returns and are not as aggressive as generally accepted accounting principles; it includes stock option expenses and adjustments to capital consumption (depreciation), and inventory costs (*Economist* 2002a; Poterba). Construction of data for GDP and fixed assets by industry are detailed in Herman, and Lum, Moyer, and Yuskavage.

Factor shares of GDP for each industry, *i*, and the whole economy are constructed for labor compensation (*COMP*) and business profits (*PROFIT*) for each year, *t*, as $[COMP/GDP]_{it}$ and $[PROFIT/GDP]_{it}$, respectively, where: *COMP* ≡ compensation of employees, including (1) salaries accrual and (2) supplements to wages and salaries (nonwage benefits); and *PROFIT* ≡ firm earnings before interest and taxes, including corporate and proprietor profits calculated as the sum of (1) corporate profits and proprietors' income before taxes, (2) corporate and noncorporate net interest (interest is a share of the return to total business capital investment, irrespective of capital structure of debt and equity), (3) corporate and proprietors' inventory valuation adjustments (usually a negative adjustment to negate income effects of inventory price inflation), and (4) corporate and noncorporate capital consumption allowance (usually a positive adjustment to negate overstatement of tax-reported accelerated depreciation expense) (Evans et al.).

Each factor will command a larger share of GDP if (1) more of the factor is used per dollar of industry GDP, or (2) it earns a higher rate of compensation or return. To assess this breakdown, corresponding BEA factor measures for labor and fixed-asset investment are (1) *FTE* ≡ full-time equivalent number of employees and (2) *FA* ≡ net stock of private fixed assets (current cost), which includes equipment and structures other than consumer durable goods (Herman). Fixed assets exclude short-term net working capital and thus understate total capital investment, so this study focuses on fixed-asset investment as a proxy for capital commitment.

Each factor's income share can be expressed as the product of its rate of compensation per unit factor and factor usage per dollar of GDP: $[COMP/GDP]_{it} \equiv [COMP/FTE]_{it} \times [FTE/GDP]_{it}$, and $[PROFIT/GDP]_{it} \equiv [PROFIT/FA]_{it} \times [FA/GDP]_{it}$, where *FA* represent beginning-of-year amounts to reflect productive assets in place for the production of that year's income. *COMP* and *GDP* are deflated with the BEA's GDP price deflator (1996 = 100.00) in the labor variables, [*COMP/FTE*] and [*FTE/GDP*], whereas current cost amounts are used in the other variables with ratios of dollar amounts.

A practical difficulty with factor income shares is that the definition of capital and labor shares is somewhat arbitrary because proprietor income is an inseparable composite of returns both to proprietor capital and proprietor labor (Poterba). If proprietor income were classified as labor compensation, then it would overstate compensation and understate business profits. In this research proprietors' income is included in profits and so overstates profits and understates compensation by the amount of returns to proprietor labor. There are three reasons to include proprietor income in profits rather than wages for this research. First, although returns to the proprietor's labor can be considered analogous to a wage, the risk profile of this compensation is more consistent with that of business investment. The

**Table 1.** Regression of Real per Capita GDP Growth on Predetermined Macroeconomic State Variables

| Dependent Variable | Predetermined Lagged Macroeconomic State Variables Parameter Estimates | | | | | |
|---|---|---|---|---|---|---|
| Economic Growth | TERM | DEF | MKT | GPR/cap | α | $R^2$ |
| GPR/cap | 0.004 | −0.018 | 0.087 | 0.039 | 0.029 | 0.35 |
| | (0.102) | (0.043) | (0.000) | (0.795) | (0.017) | |

Notes: *p*-values are in parentheses under corresponding parameter estimates. GDP is gross domestic product; TERM is term premium; DEF is default risk premium; MKT is stock market portfolio; GPR/cap is per capita real GDP.

proprietor's "wage" compensation depends upon the proprietor's risky fixed-asset investments and in principle is not "paid" until the proprietor has satisfied other creditors and claimants; thus, the "wage" component is a risky residual return that depends on the success of the proprietor's business, analogous to profits. Second, many farming industry firms are proprietorships and so it is crucial to include them in this study of industry profits. Third, including proprietor income as return to capital is consistent with BEA private fixed-asset measures that include proprietor capital investments, and with employee measures (FTE) that exclude proprietor labor.

*Macroeconomic Business Cycle Control Variables, [Macro]*

*$TERM_{t-1}$, the term premium* at the beginning of the year $t$ (lagged value from $t - 1$), is the annual yield on long-term (10-year) U.S. government treasury bonds in excess of the U.S. T-bill rate observed at the beginning of the period $t$. The term premium is the risk premium that compensates the investor for the risk of shifts in interest rates, including the impacts of inflation. *TERM* tends to be low around business peaks and high around troughs (Fama and French) (Federal Reserve Board data).

*$DEF_{t-1}$, the default risk premium,* represents the annual yield on a low-grade corporate bond portfolio (Moody's Baa bond grade) less the yield on high-grade corporate bonds with a lower default risk (Moody's Aaa bond grade) available at the beginning of period $t$. *DEF* tends to be high during business contractions (Fama and French), and is a negative predictor of economic growth (Chen) (Federal Reserve Board data).

*$MKT_{t-1}$, stock market portfolio return,* are returns (dividend plus capital gain as a proportion of beginning capital value) to the Standard and Poor's 500 portfolio of common stocks and is a positive predictor of economic growth (Fama) (Standard and Poor's data).

*$GPR/cap_{t-1}$* represents the change in per capita real gross product from the previous year. Lagged economic growth variables have historically been weak predictors of economic activity, but is included for possible other growth effects on factor shares (BEA data).

Table 1 shows the results of regressing growth in real per capita GDP (*$GPR/cap_t$*) on the four lagged macroeconomic predictor variables. As has been established in the literature, *$TERM_{t-1}$* and *$MKT_{t-1}$* are significant positive predictors of economic growth, *$DEF_{t-1}$* is a significant negative predictor, and *$GPR/cap_{t-1}$* is an insignificant positive predictor (TERM significance at 10% level here).

## Factor Regression Results

Regressions are corrected for second-order autocorrelation. Owing to the slowdown in economic growth after 1973, the sample was split into 1951–1973 and 1974–2001 intervals and each equation tested for structural change. Chow tests reject stationarity in favor of structural change for Equation (2) for the aggregate economy and all three agribusiness industries, and for Equation (4) for the farming industry. The corresponding changes for these five regressions are addressed in the analyses that follow.

*Aggregate Economy*

Regression results for the whole economy are in Table 2. Results for Equation (1) show that labor usage is largely explained by capital intensity as a percent increase results in almost 0.9% lower labor usage. That is, greater capital investment largely explains lower labor usage resulting from substitution of capital for labor (or explains greater labor productivity as the inverse of labor usage). In contrast, Equation (3) results show that capital intensity does not so closely explain fixed-asset usage. Greater investment per employee does not lead to significantly greater fixed-asset usage per dollar of GDP in the economy.

Results for Equation (2) show that increases in output per worker lead to proportionate wage rate increases in the aggregate economy. As *GDP/FTE* rises each percent it results in slightly more than a full percent rise in *COMP/FTE* (estimate slightly greater than one: $\beta = 1.057$). However, Chow tests reject stationarity over the whole 51-year period and re-estimates show that the proportion of productivity improvement passed on to wage advances has decreased slightly ($\beta_2 = 1.15$ over 1951–1973; $\beta_2 = 0.96$ over 1974–2001). Overall, increases in the economy's labor productivity are largely being passed on proportionately to labor as wage increases. Equation (4) results show that a percentage increase in GDP output per dollar of fixed-asset investment results in about a 0.6% increase in profit per dollar of fixed-asset investment. This is statistically significant but is not the full one-to-one correspondence as with labor productivity and wages. This is partly because the profit component of industry income is a noisy residual return. A residual return is more subject to idiosyncratic variation and business cycle influences than total industry GDP, and this is reflected in macroeconomic state variable coefficient estimates in Table 2: The term premium and stock market portfolio return are significant positive predictors, and the default premium is a significant negative predictor of profit rates, just as they are for economic growth in Table 1.

These four dependent variables from Equations (1–4) and the factor shares (*COMP/GDP* and *PROFIT/GDP*) for the aggregate economy are charted in Figure 1 in natural log form so that each factor usage rate and return rate sum to the log of its income share. Also, constant growth rates have linear graphical representation. Dollar amounts are scaled in millions divided by the deflator (equal to 100 in 1996), and *FTE*s are in thousands. Several observations emerge. Labor usage, *FTE/GDP*, has declined steadily, reflecting increasing real labor productivity (i.e., productivity is inverse, *GDP/FTE*). Consistent with the slowdown of post-WWII productivity growth, the slope of FTE/GDP is a bit less steep after 1973 (this juncture marked by dashed lines in Figures 1–4). In contrast to labor usage, fixed-asset usage, *FA/GDP*, does not have a clear trend. Unlike labor usage, which is a ratio of physical workers to dollars, *FA/GDP* is the ratio of two dollar amounts that would not be expected to decline indefinitely in a competitive economy. Market competition would preclude the indefinite climb of both GDP incomes relative to supporting fixed-asset investments, as the price of fixed-asset capital goods would also rise. Fixed-asset usage, *FA/GDP*, appears to rise during recessions when GDP would fall more than fixed investments (e.g., 1973–1974, 1980–1982, 1990–1991). Overall, though, *FA/GDP* in 2001 (2.10, untransformed) was not that different from 1951 (1.98).

The compensation rate or "wage rate" for labor, *COMP/FTE*, shows a steady increase from $18,450 in 1951 to $43,010 in 2001 (deflated to 1996 dollars) that approximately mirrors labor usage, including shallower slope and slower increase in wage rates after 1973, the period of lower labor productivity growth. These symmetric effects result in relatively steady labor compensation as a share of GDP (COMP/GDP).

Analogously, the rate of return to fixed assets (*PROFIT/FA*) roughly mirrors fixed-asset usage (*FA/GDP*), although it is necessarily more volatile because profits are a residual return after all input cost claims have been met.

**Table 2.** Regressions of Factor Usage and Compensation Variables on Lagged Capital Intensity, Factor Productivity Variables, and Predetermined Macroeconomic Control Variables (1951–2001)

| | | Aggregate Economy | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Economy Factor Variables | | | Macroeconomic State Variables | | | | | |
| Eq. No. | Dependent Factor Variables | FA/FTE | GDP/FTE | GDP/FA | TERM | DEF | MKT | CPR/cap | α | $R^2$ |
| (1) | FTE/GDP | −0.917 | — | — | −0.003 | 0.038 | 0.043 | −0.062 | −0.009 | 0.98 |
| | | (0.000) | | | (0.356) | (0.022) | (0.169) | (0.768) | (0.885) | |
| (2)* | COMP/FTE | — | 1.057 | — | 0.001 | 0.006 | −0.014 | −0.373 | −0.507 | 0.99 |
| | | | (0.000) | | (0.357) | (0.305) | (0.285) | (0.000) | (0.000) | |
| (3) | FA/GDP | 0.031 | — | — | −0.000 | 0.080 | −0.066 | 0.012 | −0.090 | 0.91 |
| | | (0.680) | | | (0.945) | (0.000) | (0.007) | (0.942) | (0.132) | |
| (4) | PROFIT/FA | — | — | 0.584 | 0.010 | −0.081 | 0.183 | 0.182 | −1.159 | 0.84 |
| | | | | (0.000) | (0.022) | (0.000) | (0.000) | (0.508) | (0.000) | |

Notes: $p$-values in parentheses are under corresponding parameter estimates. GDP is gross domestic product; FA is net stock of private fixed assets; FTE is full-time equivalent number of employees; COMP is compensation of employees; PROFIT is corporate and proprietor profits before interest and taxes; Macroeconomic State Variables are as defined in Table 1.

* Chow tests reject stationarity from 1951–1973 to 1974–2001. Regressions of these intervals are reported in Table 4.

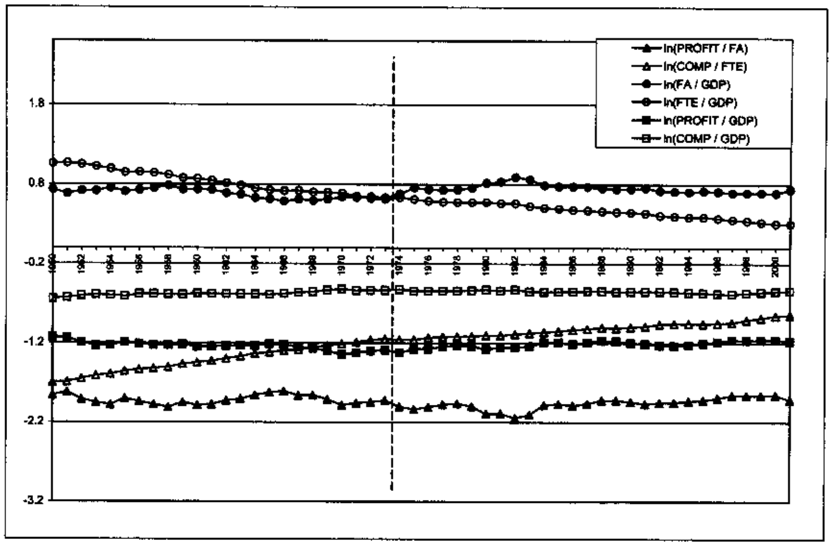


**Figure 1.** Aggregate Economy Labor and Capital Income Shares. Ln is natural log; GDP: Gross Domestic Product; FA: Net Stock of Private Fixed Assets; FTE: Full Time Equivalent Number of Employees; COMP: Compensation of Employees; PROFIT: Corporate and Proprietor Profits before Interest and Tax Dollar Amounts in Millions and Deflated by GDP Deflator (= 100 in 1996); FTEs in Thousands

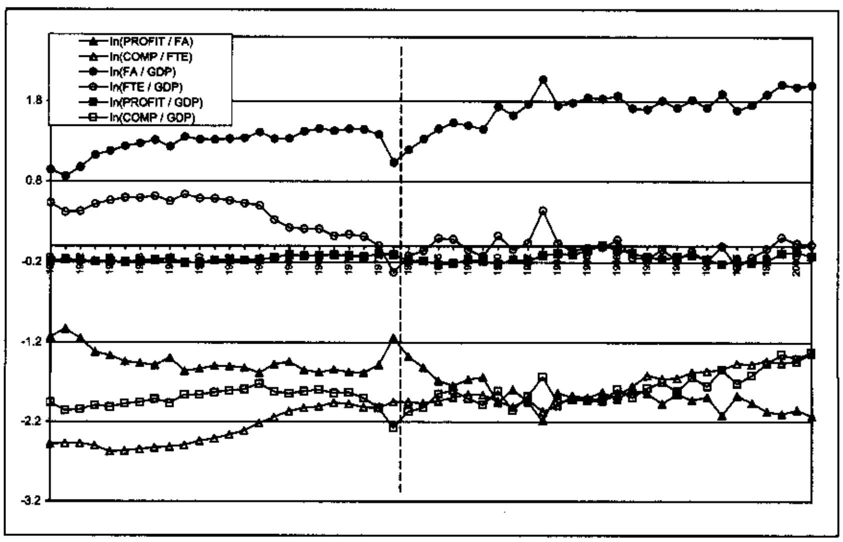


**Figure 2.** Farm Labor and Capital Income Shares. Ln is natural log; GDP: Gross Domestic Product; FA: Net Stock of Private Fixed Assets; FTE: Full Time Equivalent Number of Employees; COMP: Compensation of Employees; PROFIT: Corporate and Proprietor Profits before Interest and Tax Dollar Amounts in Millions and Deflated by GDP Deflator (= 100 in 1996); FTEs in Thousands

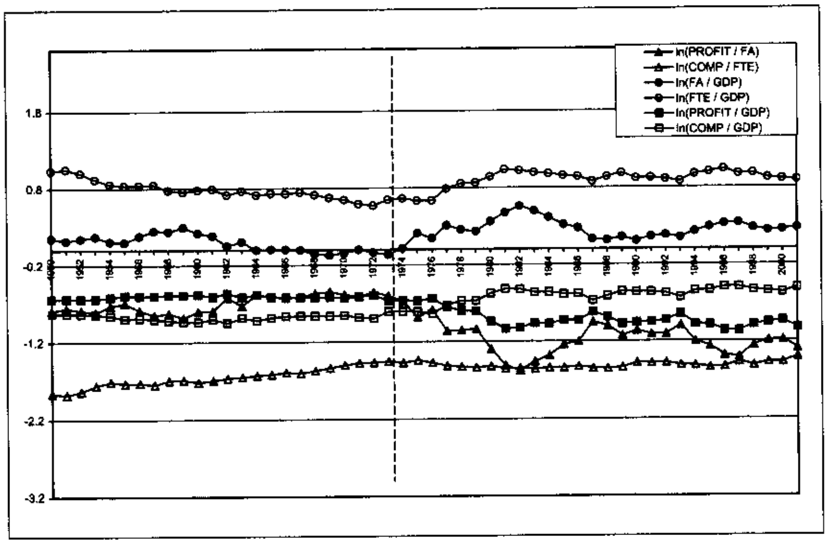


**Figure 3.** Agricultural Services Labor and Captial Income Shares. Ln is natural log; GDP: Gross Domestic Product; FA: Net Stock of Private Fixed Assets; FTE: Full Time Equivalent Number of Employees; COMP: Compensation of Employees; PROFIT: Corporate and Proprietor Profits before Interest and Tax Dollar Amounts in Millions and Deflated by GDP Deflator (= 100 in 1996); FTEs in Thousands

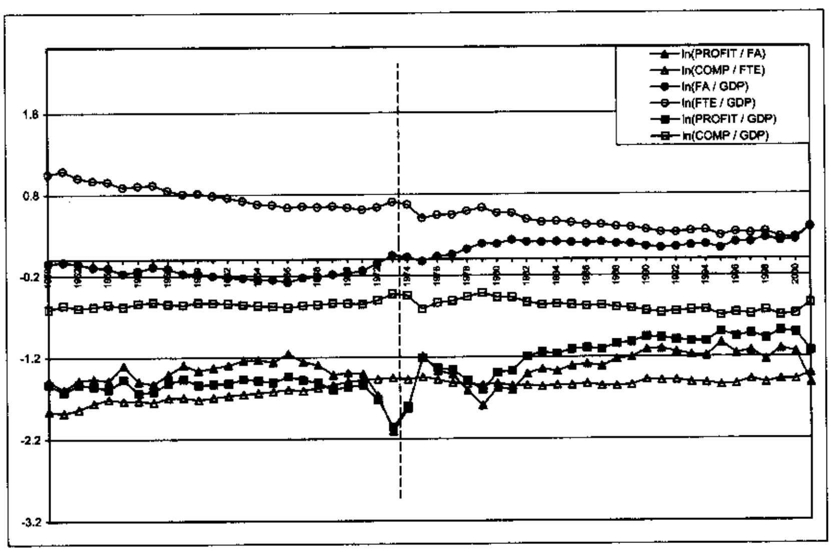


**Figure 4.** Food and Kindred Products Labor and Capital Income Shares. Ln is natural log; GDP: Gross Domestic Product; FA: Net Stock of Private Fixed Assets; FTE: Full Time Equivalent Number of Employees; COMP: Compensation of Employees; PROFIT: Corporate and Proprietor Profits before Interest and Tax Dollar Amounts in Millions and Deflated by GDP Deflator (= 100 in 1996); FTEs in Thousands

Input costs are contracted and predictable, whereas the residual ownership profit claim depends more closely on uncertain outcomes. The profit share of national income (*PROFIT/GDP*) is consistently and significantly less than the labor compensation share (e.g., 31% and 58% in 2001, respectively).

*Farming Industry*

In the farming industry, increases in capital intensity have reduced nonproprietor farm labor usage proportionately half as much [$\beta_i$ = −0.490, Equation (1), Table 3A]. This relation is significant but less than the impact for the aggregate economy, probably reflecting the increasing difficulty for the farm industry to add economic value to inputs (and perhaps diminishing marginal labor productivity gains in the most capital-intensive industry). Labor productivity increases that do result lead to only about three-fourths proportionate wage increases (Equation 2), also significant but less than the fully proportionate increase for the general economy shown in Table 2. Chow tests reject Equation (2) stationarity in favor of structural change. Regression results for these two periods in Table 4 (panel B) show that the *GDP/FTE* coefficient declined from a significant estimate of eight-tenths in 1951–1973 to an insignificant two-tenths in 1974–2001. Thus, in the last 28 years through 2001, farm labor productivity (*GDP/FTE*) improvements are not passed on significantly as increases in wages (*COMP/FTE*).

Increasing farm capital intensity has resulted in significantly higher fixed-asset usage [almost proportionately one-half greater, $\beta_i$ = 0.485; Equation (3)]. Unlike the aggregate economy, this increasingly capital-intensive industry has increasing fixed-asset investments supporting each dollar of GDP income. Conversely, total industry income to fixed assets (*GDP/FA*) is decreasing, and Equation (4) results show that the decreases are three-fourths passed on as reduced profit return to fixed assets (*PROFIT/FA*) (significant $\beta_i$ = 0.776). The Chow test indicates structural change and re-estimates for 1951–1973 and 1974–2001 that show that corresponding coefficients on *GDP/FA* are both significantly positive, but less in 1974–2001 (Table 4B). Although labor compensation and profit shares of farming industry income have been relatively stable, wage rates and returns to fixed assets have fallen behind the economy. Industry strains have caused profits, wages, and industry income to not keep pace with increasing investment.

Figure 2 shows factor usage, returns, and income shares for the farming industry, analogous to Figure 1 for the aggregate economy. The farm industry shows labor usage (*FTE/GDP*) to have become more efficient up until about 1973 when it leveled off. Fixed-asset usage (*FA/GDP*) has a continual upward trend resulting from rising capital intensity over the whole sample interval, rising well above the average for the economy. Farm profits have not risen commensurately as return to fixed asset investment (*PROFIT/FA*) has fallen (while industry profits are noisier than for the diversified general economy, the drop is apparent in Figure 2). Wage rates (*COMP/FTE*) have risen more slowly and remain well below that of the general economy (e.g., $26,390 versus $43,010 for the whole economy in 2001 in 1996 dollars). Compensation represents a smaller share of GDP than profits in the capital-intensive farm industry, distinct from the general economy.

*Agricultural Services Industry*

Agricultural services are inputs to the farming industry and have also been subject to the strains of U.S. agriculture. Agricultural services is a labor-intensive industry and capital intensity has not had a significant impact on labor usage (Equation [1]; Table 3B). Labor productivity, which has not had a long-term improvement trend, has not had a significant relation to wages over the whole interval, contrary to the general economy [Equation (2)]. Yet, as with farming, Chow test rejects stationarity of Equation (2) and re-estimates reveal that *GDP/FTE* has a significantly positive effect on *COMP/FTE* in 1951–1973, but becomes insignificant in 1974–2001 (Table 4C). Labor productivity *decreases* in 1974–2001

**Table 3.** Regressions of Industry Factor Variables on Lagged Industry Variables and Macroeconomic State Variables (1951–2001)

| Eq. No. | Dependent Factor Variables | Industry Factor Variables: FA/FTE | GDP/FTE | GDP/FA | Macroeconomic State Variables: TERM | DEF | MKT | GPR/cap | α | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | A. Farms | | | | | |
| (1) | FTE/GDP | −0.490 | — | — | 0.015 | 0.077 | −0.026 | −1.411 | 0.782 | 0.84 |
| | | (0.000) | | | (0.264) | (0.217) | (0.840) | (0.117) | (0.000) | |
| (2)* | COMP/FTE | — | 0.761 | — | 0.016 | −0.071 | 0.089 | 0.653 | −1.821 | 0.87 |
| | | | (0.000) | | (0.322) | (0.318) | (0.546) | (0.513) | (0.000) | |
| (3) | FA/GDP | 0.485 | — | — | 0.016 | 0.047 | −0.045 | −0.944 | 0.831 | 0.87 |
| | | (0.000) | | | (0.212) | (0.421) | (0.704) | (0.249) | (0.000) | |
| (4)* | PROFIT/FA | — | — | 0.776 | 0.005 | −0.065 | 0.054 | 1.17 | −0.481 | 0.78 |
| | | | | (0.000) | (0.756) | (0.245) | (0.733) | (0.259) | (0.000) | |
| | | | | | B. Agricultural Services | | | | | |
| (1) | FTE/GDP | −0.136 | — | — | −0.007 | 0.012 | 0.010 | 0.548 | 0.752 | 0.83 |
| | | (0.331) | | | (0.330) | (0.691) | (0.863) | (0.177) | (0.000) | |
| (2)* | COMP/FTE | — | 0.156 | — | 0.001 | 0.023 | −0.041 | −0.247 | −1.460 | 0.86 |
| | | | (0.177) | | (0.793) | (0.311) | (0.334) | (0.383) | (0.000) | |
| (3) | FA/GDP | 0.298 | — | — | −0.009 | 0.075 | −0.103 | −0.035 | 0.325 | 0.80 |
| | | (0.084) | | | (0.308) | (0.057) | (0.162) | (0.945) | (0.023) | |
| (4) | PROFIT/FA | — | — | 0.911 | 0.026 | −0.085 | 0.168 | −0.248 | −0.749 | 0.86 |
| | | | | (0.000) | (0.052) | (0.185) | (0.169) | (0.778) | (0.000) | |
| | | | | | C. Food and Kindred Products | | | | | |
| (1) | FTE/GDP | −0.524 | — | — | −0.010 | −0.009 | 0.071 | 0.560 | 0.309 | 0.96 |
| | | (0.000) | | | (0.095) | (0.709) | (0.147) | (0.089) | (0.000) | |
| (2)* | COMP/FTE | — | 0.793 | — | 0.000 | 0.044 | −0.010 | −0.119 | −0.709 | 0.97 |
| | | | (0.000) | | (0.932) | (0.013) | (0.015) | (0.636) | (0.000) | |
| (3) | FA/GDP | 0.462 | — | — | −0.012 | 0.008 | 0.031 | 0.495 | 0.278 | 0.95 |
| | | (0.000) | | | (0.026) | (0.728) | (0.459) | (0.073) | (0.000) | |
| (4) | PROFIT/FA | — | — | −0.173 | 0.032 | −0.032 | −0.205 | −2.054 | −1.301 | 0.55 |
| | | | | (0.458) | (0.090) | (0.667) | (0.198) | (0.041) | (0.000) | |

Notes: $p$-values in parentheses are under corresponding parameter estimates. See definitions of industry factor variables under analogous economy factor variables in Table 2.
* Chow tests reject stationarity from 1951–1973 to 1974–2001. Regressions of these intervals are reported in Table 4.

**Table 4.** Structural Change: Regressions of 1951–1973 and 1974–2001 Time Periods for Equations that Chow Tests Reject Stationarity from Tables 2 and 3

| Eq. No. | Dependent Factor Variables | Time Period | Industry Factor Variables | | | Macroeconomic State Variables | | | | α | $R^2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FA/FTE | GDP/FTE | GDP/FA | TERM | DEF | MKT | GPR/cap | | |
| | | | | | A. Aggregate Economy | | | | | | |
| (2) | COMP/FTE | 1951–1973 | — | 1.152 | — | −0.001 | 0.014 | −0.027 | −0.492 | −0.423 | 0.99 |
| | | | | (0.000) | | (0.798) | (0.283) | (0.296) | (0.001) | (0.000) | |
| | | 1974–2001 | — | 0.961 | — | 0.001 | 0.004 | 0.000 | −0.255 | −0.557 | 0.99 |
| | | | | (0.000) | | (0.498) | (0.487) | 0.992) | (0.021) | (0.000) | |
| | | | | | B. Farms | | | | | | |
| (2) | COMP/FTE | 1951–1973 | — | 0.814 | — | 0.013 | −0.007 | 0.028 | 0.793 | −1.982 | 0.93 |
| | | | | (0.000) | | (0.545) | (0.935) | (0.848) | (0.321) | (0.000) | |
| | | 1974–2001 | — | 0.185 | — | 0.006 | −0.238 | 0.139 | −0.865 | −1.473 | 0.72 |
| | | | | (0.336) | | (0.763) | (0.011) | (0.480) | (0.598) | (0.000) | |
| (4) | PROFIT/FA | 1951–1973 | — | — | 0.709 | 0.014 | 0.245 | 0.388 | 3.225 | −0.834 | 0.76 |
| | | | | | (0.001) | (0.631) | (0.006) | (0.110) | (0.004) | (0.001) | |
| | | 1974–2001 | — | — | 0.563 | 0.003 | −0.009 | −0.163 | 1.103 | −0.920 | 0.56 |
| | | | | | (0.000) | (0.849) | (0.887) | (0.480) | (0.490) | (0.001) | |
| | | | | | C. Agricultural Services | | | | | | |
| (2) | COMP/FTE | 1951–1973 | — | 0.796 | — | −0.013 | 0.031 | −0.056 | −0.606 | −1.019 | 0.92 |
| | | | | (0.000) | | (0.347) | (0.483) | (0.460) | (0.162) | (0.000) | |
| | | 1974–2001 | — | 0.076 | — | −0.005 | −0.023 | −0.038 | −0.491 | −1.394 | 0.42 |
| | | | | (0.348) | | (0.289) | (0.294) | (0.470) | (0.252) | (0.000) | |
| | | | | | D. Food and Kindred Products | | | | | | |
| (2) | COMP/FTE | 1951–1973 | — | 0.915 | — | 0.015 | 0.025 | −0.064 | −0.276 | −0.612 | 0.98 |
| | | | | (0.000) | | (0.033) | (0.246) | (0.247) | (0.310) | (0.000) | |
| | | 1974–2001 | — | 0.380 | — | −0.001 | 0.019 | −0.029 | 0.307 | −0.863 | 0.92 |
| | | | | (0.000) | | (0.657) | (0.125) | (0.266) | (0.125) | (0.000) | |

Notes: $p$-values in parentheses are under corresponding parameter estimates. See variables definitions in Table 2.

while wage rates still hold relatively steady. Total industry income to fixed assets (*GDP/FA*) has also declined, but each percent decline has resulted in an estimated 0.9% decline in profit return to fixed assets (*PROFIT/FA*) [Equation (4)]. In sum, decreased productivity has affected agricultural services profits the most, while wages have held steady and relative GDP factor shares are shifting from capital to labor (see Figure 3).

Figure 3 shows factor usage, returns, and income shares for agricultural services. Labor usage decreased until 1973 and then rose and leveled off. Services are less capital intensive and normally show less productivity growth than manufacturing or extractive industries. Wage rates rose until 1973, then leveled off below wage levels for the economy (e.g., $24,540 versus $43,010 for the economy in 2001 in 1996 dollars). Fixed-asset usage rose after 1973, and returns to fixed assets fell sufficiently so that profits as a share of agricultural services GDP decreased and fell below the labor compensation share.

### *Food and Kindred Products Industry*

Food and kindred products (food products) is largely a consumer goods industry where much income accrues to marketing-intensive, brand-name product businesses. Increases in capital intensity have resulted in significant but only half-proportionate efficiency improvements in labor usage ($\beta_i = -0.524$; Equation [1]; Table 3C). Reductions in food product labor usage have paralleled those in the economy. Yet, food product industry capital intensity has increased more than in the general economy and so has not resulted in proportionately as much labor usage reduction.

From Equation (2), a percent increase in labor productivity is estimated to result in only about an 0.8% increase in the wage rate (Table 3C). This is statistically significant, but less than the full proportionate one-to-one relationship in the general economy from Table 2. Further, Chow tests reject stationarity and reestimates reveal that the coefficient declined from approximately nine-tenths in 1951–1973 to four-tenths in 1974–2001 (Table 4D). Thus, fewer labor productivity improvements were being passed on as wage increases after 1973, and fewer are passed on than in the general economy.

Capital intensity and resulting fixed-asset usage are increasing in this industry, contrasting the flat trend in the general economy. Even though *GDP/FA* is declining, results from Equation (4) show that it is insignificantly *negatively* associated with returns to fixed assets (*PROFIT/FA*), which have held up within historic norms. Thus, even though each dollar of fixed-asset investment is generating less GDP income, the profit generated from each dollar of fixed-asset investment is holding up, unlike the decline in farming and agricultural services. This represents a relatively more favorable position for capital with respect to labor in the food and kindred products industry, in addition to this industry being healthier on the whole than farming or agricultural services.

Figure 4 shows factor usage, returns, and income shares for the food and kindred products industry. It is a consumer nondurable goods manufacturing industry that shows more similarity to the general economy than the farm and agricultural services industries. Labor usage has fallen in a pattern very similar to the economy. Wage rates have risen similarly, but slowed a bit more after 1973 and now lag the general economy (e.g., $39,559 versus $43,010 for the economy in 2001 in 1996 dollars). Labor compensation as a share of industry income has declined. As shown in Figure 4, the (log of) labor usage, ln(*FTE/GDP*), declines more than the rise in wages ln(*COMP/FTE*) so that there is a net decrease in labor factor share ln(*COMP/GDP*) = ln(*COMP/FTE*) + ln(*FTE/GDP*). Fixed-asset usage has been below that of the general economy, but showed more increase in the post-1973 period. Return to fixed assets also increased as did the profit share of industry GDP.

## Summary Analysis and Conclusion

The U.S. economy shows a steady progression of investing, substituting capital for labor and increasing labor productivity. The rate of improvement slowed after 1973 but continues. Throughout the study period from 1951 to 2001, increases in labor productivity are proportionately passed on to wage increases with the rest accruing to government and miscellany, and the residual to profits. This does not address the degree of income equality or differentials in human capital across FTEs, but observes that, on average or in total, investment-induced increases in the productivity of human capital have been proportionately passed on to increased wage compensation of human capital. Income per dollar of fixed-asset capital and returns to fixed assets and its ultimate financial capital claimants vary within historic horizontal bands depending on business cycles and competitive conditions. The GDP income shares to labor and capital are relatively stable over time. The stable relationships and norms in the aggregate U.S. economy conceal shifts in factor usage and rewards in individual industries.

*Farming* is the most capital-intensive agri-food industry, and has the most fixed assets and least number of employees per dollar of GDP among the agri-food industries (and aggregate economy). Despite high productivity, industry income is too low relative to the required investment, and so wage rates are low. Labor productivity improvements leveled off after 1973, and farm labor is relatively low-skill so that farm wages are low with continuing adverse trends. After 1973, income generated per dollar of investment (*GDP/FA*) has steadily declined, and each percent decline has been passed on as 0.75% decline in return to fixed assets (*PROFIT/FA*). Farming is a relatively heavily subsidized industry, but profits keep declining relative to the necessary capital investments. In sum, labor compensation and profits have held relatively steady shares of total farm GDP, but the rewards to the requisite human and financial capital continue a long-term decline.

*Agricultural services* have not only grown as a share of the agri-food sector, but have grown as a share of national GDP. Yet, although it is a growth industry, it is a small industry growing within a shrinking agricultural economy by substituting for functions that used to be performed in the farming industry. As an intermediate input supplier to the farming industry it is, like farming, pressured by similar shrinking rewards. Sharply contrasting with farming, though, agricultural services is a labor-intensive industry. Labor productivity improved and was significantly related to wage increases in 1951–1973, but after 1973 productivity actually declined and became not significantly related to wages. This labor-intensive industry must maintain requisite employees with skills that correspond to agricultural technologies, and so maintain certain wage levels. Decreasing GDP per dollar of fixed-asset investment is substantially passed through to decreases in returns to fixed-asset investment (*PROFIT/FA*). Overall, profits are declining as a share of industry income (*PROFIT/GDP*). This long-term trend bodes poorly for future aggregate levels of investment in agricultural services that support farming.

*Food and kindred product* investments have improved labor productivity to an extent comparable to the general economy through 1973, after which improvements lagged behind. Also comparable to the general economy, labor productivity improvements were largely passed through to wage increases on a proportionate basis through 1973. After 1973, though, each percent of productivity improvement passed through to only a 0.4% increase in wages. After 1973 the industry generated less GDP income per dollar of fixed assets, but this deterioration did not pass through to profits, which did not drop relative to fixed-asset investments. Though the industry is healthy and wages near the average for the economy, there is a 3-decade adverse trend for wages relative to profits. Declines in factor productivity rates have largely been absorbed by wage rates, while the profit share of industry GDP has increased.

These are unsustainable trends in agriculture. In the capital-intensive farming industry, GDP is declining relative to the supporting fixed-asset investments. This decline is being passed on to lower returns to fixed-asset investments while low labor wages improve only modestly. In the labor-intensive agricultural services industry, labor productivity declined after 1973 and is at early-1950s levels. Wages stopped improving after 1973, and profit returns to fixed assets have declined. Rewards to investment have fallen even more as profits lost share of agricultural services GDP, shifting to more labor. The agricultural economy crisis continues steadily with deterioration worsening since 1973. Aggregated results mask many individual firms that prosper from firm-specific advantages even in business environments with poor industry fundamentals. Yet broad development strategies cannot depend on this. The evidence in this study corroborates views that rural development strategies must look beyond farming to other business investment.

One strategy that has been touted as an economic growth and job creation vehicle has been investment in value-added food manufacturing, which has a long history of productivity improvements and wage levels more comparable to the general economy. Increases in capital intensity significantly reduce labor usage, and food and kindred products industry employment growth is low (0.35% average annual growth from 1991–2001). Productivity improvements of 1% result in wage increases of only 0.38% since 1974. This is lower than subsuming nondurable goods manufacturing (0.63%). One of the pressures on the food and kindred industry is that industry income per dollar of fixed-asset investment has fallen. However, this pressure seems to fall more on wages, as profits per dollar of fixed-asset investment have not fallen. In fact, the profit share of industry income has risen over the years. The effects of decline in labor productivity growth rates have largely been absorbed by wage rates, while the profit share of industry GDP has increased. Jobs in this industry are of average pay level but are not benefiting further from productivity improvements very well. These trends are not encouraging for national strategy to boost value-added food manufacturing to increase high-wage jobs. However, wage levels in this industry may be attractive in agricultural production regions with comparative advantage or less opportunity cost of labor. The profits in this industry are holding up, which may make food manufacturing attractive to investors. The profit-generating aspect of this industry may be attractive to farmers to process their products into value-added foods through cooperative action and investment. Also, there can be opportunity for any firm with an innovation or competitive advantage to be successful, though this is aside from broad policy prescription. Generally, though, the value-added food product manufacturing industry is competitive and mature with modest growth prospects and trends that do not suggest a strong case for policies that tip more investment into food manufacturing.

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