One of the Things We Know that Ain't So: Is U.S. Labor's Share Relatively Stable?*

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Abstract

Robert Solow (1958) argued that, from 1929–1954, U.S. aggregate labor's share was not stable relative to what we would expect given individual industry labor's shares. I confirm and extend this result using data from 1958–1996 that includes 35 industries (roughly 2-digit SIC level) and spans the entire U.S. economy. Changes in industry shares in total value-added contribute negligibly to aggregate labor's share volatility. Industry labor's shares comovement actually *adds to* aggregate labor's share volatility. These findings highlight economists' imprecise understanding of one of the stylized facts of economic growth. If the great macroeconomic ratio is meaningful, it must be interpreted in terms of long-run, offsetting shifts in "services" industries versus "goods" industries, both in terms of their labor's shares and shares in total value-added.

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[*F*]*or one internally consistent definition of "relatively stable," the wage share in the United States for the period 1929-1954 (or perhaps longer) has not been relatively stable.*

Robert Solow (1958, p. 618)

"The shares of labor and physical capital in national income are nearly constant." This is how Barro and Sala-i-Martin (1995, p. 5), in their popular text on economic growth, expressed one of the well-known stylized facts of economic growth, most closely associated with the pioneering work of Nicholas Kaldor (1961). The relative stability of labor's share constitutes one of the great macroeconomic ratios – something that all economists know, despite the fact that Robert Solow showed it ain't so.[1]

At least, it ain't so given one "internally consistent definition" of "relatively stable". Specifically, Solow argued that U.S. aggregate labor's share is not stable *relative to the behavior of industry labor's shares*. In this paper I re-present Solow's argument and demonstrate that it has held true into recent times. Then I will argue that for the great macroeconomic ratio to be meaningful it must be interpreted in terms of long-run, offsetting shifts in "services" industries versus "goods" industries, both in terms of their respective labor's shares and shares in total value-added.

[1] While this paper was originally motivated by Robert Solow's 1958 paper, "A Skeptical Note on the Constancy of Relative Shares," it plays on title of a 1997 paper by the same author: "It Ain't the Things You Don't Know that Hurt You, It's the Things You Know that Ain't So."

Figure 1 demonstrates that, from 1958–1996, labor's share remained somewhere between 65 and 70 percent.[2] Such was also roughly the case when Kaldor wrote in the earlier twentieth century. So what do I mean by "Robert Solow showed it ain't so"?

The approximately two thirds labor's share is considered a great *macro*economic ratio. However, **Table 1**, using data on 35 industries spanning the entire U.S. economy, illustrates that labor's shares vary across industries from less than 30 percent to well over 80 percent. Furthermore, industries with shares outside the 65 to 70 percent range are not negligible in terms of shares of total value-added. So there is nothing special at the industry level about the two thirds number.

Table 2 reports standard deviations for industry labor's shares from 1958–1996, as well as the standard deviation of aggregate labor's share. Each and every industry standard deviation is larger than the aggregate standard deviation. One is tempted to declare that the aggregate share has been surprisingly stable. However, as Solow (1958, p. 621) noted, the intuition rests on an interpretation of stability *relative to that which we expect given changes in industry shares*. Consider the following benchmark: k industries, each with an equal share of total value added, and each with identical labor's share variance, σ^2. If the shares are statistically independent then aggregate labor's share variance will be σ^2/k – less than the common industry σ^2. Just because aggregate labor's share is less volatile than industry shares, this in and of itself does not imply relative stability.

Departing from this benchmark, the variance of aggregate labor's share will be a weighted average of the industry labor's share variances and covariances with weights

[2] All data discussed in this introductory section is described in the section that follows.

constituted by industry shares in total value-added. Therefore, relative (to industry labor's shares) stability of aggregate labor's share may arise from (a) negative comovement between industry labor's shares and/or (b) changes in the relative value-added shares.

In his 1958 paper, Robert Solow attempted to demonstrate that neither (a) nor (b) was important from 1929–1954. He constructed time-varying U.S. aggregate labor's share from industry labor's shares and industry shares in aggregate value-added. He then calculated aggregate labor's share's variance and compared it to that of a hypothetical labor's share calculated under the assumption of constant industry value-added shares: "the fixed-weight series showed approximately the same amplitude of fluctuation as the observed series"(p. 622).[3] He also calculated a hypothetical variance assuming zero covariances between industry labor's shares: "If anything, the aggregate [labor's share] fluctuated a bit *more* than the hypothesis of independence would indicate" (p. 624). Conclusion: apparently the relative stability of labor's share just ain't so.

Furthermore, in the specific sense outlined above, it *still* ain't so. I find that, during 1959–1996, neither the changes in value-added shares nor comovement of industry labor's shares decrease the volatility of the aggregate labor's share in an economically important way. (In fact, comovement *increases* the volatility of the aggregate share.) U.S. aggregate labor's share is not stable relative to the behavior of industry labor's shares.

This is not only a confirmation of Solow's conclusions for a more recent time period. Solow's work was severely limited by data availability. The present analysis

[3] Kalecki (1938) and Denison (1954) demonstrated similar results for US manufacturing, 1879 – 1937, and corporations, proprietorships, and partnerships organized for profits, 1929 – 1952.

brings considerably better data to bear on the issue. Furthermore, borrowing a tool from the productivity literature, I decompose labor's share changes into within- and between-industry components, as well as a covariance component. This yields three time series for analysis that together sum to the observed aggregate labor's share and that pinpoint the nature of labor's share variance. Section 1 describes the data used in the present analysis. Section 2 provides the decomposition of aggregate labor's share and demonstrates the lack of relative stability (in Solow's suggested interpretation of the term). Alternatively, a meaningful interpretation of the great macroeconomic ratio in relation to industry labor's shares is offered in Section 3. Section 4 discusses the importance of both interpretations for macroeconomic research. Specifically, U.S. labor's share's inconsistency with Solow's interpretation of relatively stable presents difficulties to business cycle theories that imply strong, positive comovement across industry labor's shares. As well, the alternative interpretation of relatively stable lends credibility to recent long-run theories of unbalanced growth where offsetting industry trends produce the Kaldor stylized facts in the aggregate. Section 5 concludes.

1. DATA

Solow worked with annual data from 1929–1954 but discarded observations on all but 8 years to avoid times of deep contraction and the WWII period. His data was for 7 broad industries, one of these being manufacturing and subdivided into 18 industries. On the other hand, I use annual data from 1958–1996 that includes 35 industries (roughly 2-digit SIC level) and spans the entire U.S. economy. These data consists of longer, continuous time series; it has broader coverage of the economy and starts at a lower level of aggregation.

The data are from the U.S. industry database developed by Dale Jorgenson and his colleagues.[4] The database combines industry data from the U.S. Bureau of Labor Statistics and the U.S. Bureau of Economic Analysis. Variables include the quantity of output (Q) and the price of output (P_Q); the value and price of capital services (V_K and P_K); the value and price of labor inputs (V_L and P_L); the value and price of energy inputs (V_E and P_E); and the value and price of materials inputs (V_M and P_M). Dividing service values by prices yields the quantities K, E, and M.

Value added is computed for each industry, i, as $VA_i = Q_i \cdot P_{Q,i} - V_{E,i} - V_{M,i}$. Then labor's share in value-added is computed as $\alpha_i = S_{L,i}/(1 - S_{M,i} - S_{E,i})$ where $S_{X,i} = V_{X,i}/\ Q_i \cdot P_{Q,i}$ for $X = L$, M, and E. Then aggregate value-added is $VA = \Sigma_i\ VA_i$ and industry shares in value-added are $w_i = VA_i/VA$. These are then used as weights to construct aggregate labor's share: $\alpha = \Sigma_i\ w_i \alpha_i$.

2. IS U.S. LABOR'S SHARE STABLE RELATIVE TO INDUSTRY SHARES?

The mean of aggregate labor's share from 1958–1996 is 0.675 and its standard deviation is 0.011. To ask how changes in the economic importance of different industries contribute to the variance of aggregate labor's share, I begin by following Solow (1958) and imagine that shares in value-added did not change over the time period. This means that every observation, $\alpha_t = \Sigma_i\ w_{i,t} \alpha_{i,t}$, t = 1958, . . . , 1996, is

[4] For a description of the database beyond the scope of this paper, see Jorgenson, Gollop and Fraumeini (1987). The data is available at "http://post.economics.harvard.edu/faculty/jorgenson/data/35klem.html".

recomputed as $\alpha_t^* = \Sigma_i w_{i,1958}\alpha_{i,t}$. The mean of this fixed-weight series is 0.691 and its standard deviation is 0.011; virtually identical to the actual series. The relative (to the actual series) standard deviation of the fixed-weight labor's share is 1.023. Holding value-added shares constant adds to the volatility of aggregate labor's share by less than 2.5 percent.

Next, I compute a hypothetical variance under the additional assumption that industry labor's share movements are all independent from one another. If this were the case the variance of the aggregate series would be $\sigma^2 = \sum_i w_{1958}^2 \sigma_i^2$. The resultant hypothetical standard deviation is 0.009, which divided by that of the actual series is 0.817. Comovement of industry labor's shares appears to *increase* the aggregate share's volatility (by about 18 percent). (Interestingly, this is precisely what Solow (1958, p. 624) found. "If anything, the aggregate share fluctuated a bit *more* than the hypothesis of independence would indicate.") A summary of the above is provided in **Table 3**.

A more precise way to get at the issue is to decompose changes in aggregate labor's share into "within-industry," "between industry," and "covariance" component time series. I employ the decomposition of Foster et al (2001):[5]

(1) $$\Delta\alpha_t = \sum_i w_{i,t-1}\Delta\alpha_{i,t} + \sum_i (\alpha_{i,t-1} - \alpha_{t-1})\Delta w_{it} + \sum_i \Delta\alpha_{it}\Delta w_{it} \ .$$

The first term on the right-hand-side of (1) is the "within-industry" component and is the contribution of time *t* industry labor's share changes, holding value-added shares at their *t*-1 values. The second term is the "between-industry" component and is the contribution of time *t* changes in value-added shares, holding industry labor's shares at their *t*-1

[5] Foster et al use (1) to decompose industry productivity into within-firm, between-firm, and covariance components associated with continuing firms, as well as components for exiting and entering firms. However, the decomposition is equally useful in the present case, except that there is no need for the last two components because all industries are continuing over this time period.

values.[6] Finally, the "covariance" component is the contribution arising from the comovement between industry labor's shares and value-added shares.

An advantage of (1) is that it cleanly separates the contributions of industry labor's share changes from those of value-added share changes, while counting separately the comovement between the two share types that offsets or amplifies the contributions. However, while (1) separates out the "within-industry" component, it does not speak explicitly to the contribution of industry labor's shares' comovement. This shortcoming is addressed below.

Figure 2 displays the three time series resulting from the decomposition and **Table 4** lists some statistics of interest. Aggregate labor's share changes are in largest part accounted for by the within-industry component; its standard deviation is slightly larger than that of total labor's share changes and its correlation with total labor's share changes is 0.967. The remaining two components have correlations with total labor's share changes below 0.150 in absolute value. So changes in industry value-added shares contribute little to aggregate labor's share changes. (This finding is consistent with that of Solow's method above.)

The standard deviation of the within-industry component is 0.010. To address how industry labor's share comovement contributes to this component I separate the $\Sigma_i w_{i,t\text{-}1}\Delta\alpha_{i,t}$ time series into 35 $w_{i,t\text{-}1}\Delta\alpha_{i,t}$ times series. I then imagine that these 35 time series are all independent of one another; the variance of the $\Sigma_i w_{i,t\text{-}1}\Delta\alpha_{i,t}$ time series is simply the sum of the 35 $w_{i,t\text{-}1}\Delta\alpha_{i,t}$ variances. This can be compared to the actual standard deviation. This approach is unfortunately not precise because comovement

[6] More precisely: "holding industry deviations from aggregate labor's share at their t-1 values."

between the $w_{i,t-1}\Delta\alpha_{i,t}$s is linked to the $w_{i,t-1}$s' as well as the $\Delta\alpha_{i,t}$s, but it may still be informative.

Performing the above, I compute a 0.007 hypothetical standard deviation – just over 67 percent of the actual within-industry component standard deviation. So the comovement between the $w_{i,t-1}\Delta\alpha_{i,t}$s *increases* the volatility of aggregate labor's share changes. Again, this could be arising from the $w_{i,t-1}$s'. However, there is no evidence that the $\Delta\alpha_{i,t}$s comovement is stabilizing labor's share changes, and the lower standard deviation is consistent with the result from Solow's approach above. In fact, the evidence suggests that industry labor's shares comovement increases the volatility of the aggregate labor's share between 18 and 33 percent.

3. AN ALTERNATIVE INTERPRETATION OF RELATIVELY STABLE

Section 2 demonstrated that, disaggregating U.S. labor's share into 35 industry contributions, the aggregate labor's share is not stable relative to the time series behavior of the industry labor's shares.[7] So is the great macroeconomic ratio simply a historical accident? This seems implausible. Gollin (2002) demonstrated that, in a sample of 31 countries at various stages of development, aggregate labor's shares all range between 65 to 80 percent. This would be a large number of historical accidents indeed!

What if instead of looking at industry labor's share changes *in general*, we focus on their trends over time? **Table 5** presents the cumulative changes in labor's shares, as well as value-added shares, for the 35 U.S. industries from 1958 to 1996. At the 35

[7] Borrowing the productivity decomposition used in this paper, Garrido Ruiz (2005) demonstrated that similar results hold for Spanish data.

industry level of disaggregation, the most striking feature is the coincidence of negative cumulative labor's share and value-added changes in a majority (18 out of 35) of industries. Most of these are manufacturing industries; "Agriculture" is also included.

Also of note, there are very few (3 out of 35) industries where both labor's share and value-added increased from 1958 to 1996. Of these, two of them – "Finance, Insurance & Real Estate" and "Services" – fall under what most economists would refer to generally as *service* industries. This is in contrast to the negative labor's share and value-added share coincidences which are *goods* industries.

Changes in the relative importance of goods industries (manufacturing and agriculture) and service industries have long been intimately linked to the process of economic development, e.g., Kuznets (1957) and Kongsamut et al (2001): the idea of *unbalanced growth*.

Figure 3 presents agriculture, manufacturing and services labor's shares, constructed from aggregating the data from 35 industries.[8] Both manufacturing and agriculture labor's shares have fallen from 1958 to 1996; services labor's share, on the other hand, has risen. Likewise, **Figure 4** presents agriculture, manufacturing and services shares of total value-added.[9] Similar to labor's share, value-added shares for manufacturing and agriculture have fallen; the value-added share of services has risen.

Table 6 summarizes the time series plotted in **Figures 3** & **4** in means, standard deviations and correlations. Notable are the large fall (over 20 percent) in agriculture's labor's share and the large increase (over 10 percent) in service's value-added share.

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[8] The categorization of (roughly) 2-digit SIC industries into the 3 aggregates is, admittedly, somewhat arbitrary. (The categorization is explicit in the notes to **Figure 3**.) Only 23 industries were included – those which clearly fit into either agriculture or manufacturing or services. As well, "Government Enterprises" were excluded in this exercise to focus on the private sector.

[9] Because some industries were excluded, these do not sum to unity at any given date.

Furthermore, even though historically (from 1900 on; Kongsamut et al (2001)) manufacturing's value-added share was stable relative to the markedly falling agriculture share and growing services share, over 1958-1996 manufacturing's value-added share has fallen more than agriculture's; its correlation with service's value-added share is -0.964.

These features of the data provide a meaningful interpretation of "relatively stable" in regards to aggregate labor's share. Goods industries' labor's shares have been decreasing; services industries' labor's shares have been increasing. In other words, *labor's shares' evolution at the industry level has been unbalanced (unstable); at the aggregate level labor's share's evolution has been balanced (stable).* The great macroeconomic ratio has maintained despite the fall in goods labor's share being considerably larger than services labor's share. (Both agriculture and manufacturing labor's shares, individually, decreased by more than that of services.) The reason for relative stability, then, is that the share of services in total value-added has increased.

However, perhaps this is not an alternative interpretation of relative stability, but rather a result that would arise from the decomposition (1) and would be driven by the alternative level of aggregation across industries. This is not the case. I perform the same decomposition using the services, agriculture and manufacturing aggregates; to be complete the omitted industries are grouped into aggregates of mineral; construction; transportation communications, and utilities; and government enterprises.[10]

Figure 5 plots the within-industry, between-industry and covariance components from the decomposition. The picture is strikingly similar to that **Figure 2**. Indeed, once

[10] Minerals include "Metal Mining," "Coal Mining," "Oil and Gas Extraction," and "Non-metallic Mining"; construction is "Construction"; transportation, communication and utilities includes "Transportation," "Communications," "Electrical Utilities," and "Gas Utilities"; and government enterprises is "Government Enterprises".

again the within-industry component slightly more volatile than the aggregate. (The relative volatility is 1.053.) Also, the within-industry component's correlation with the aggregate is 0.985. Evidently industry labor's shares, at either level of aggregation, behave as statistically independent time series. Furthermore, despite the offsetting value-added movements in goods versus services labor's shares and value-added described in this section, the covariance component's relatively volatility, even at the higher level of aggregation, is only 0.034.

4. RELATIVE STABILITY IN RELATION TO MACROECONOMICS

So what Robert Solow showed ain't so; it still isn't: U.S. aggregate labor's share is not stable relative to individual industry labor's shares. However, it *is* relatively stable if we interpret the balanced nature of its evolution *relative to* the unbalanced nature of the development of industry labor's shares.

Of course, if one simply defines relatively stable as remaining somewhere between 65 and 70 percent, then, yes, aggregate labor's share is *arbitrarily* stable; and there is undoubtedly something remarkable about its enduring in this range.[11] Most economists seem be comfortable with this arbitrary interpretation of stability and I doubt that Robert Solow's demonstration – much less mine! – will relieve aggregate labor's

[11] Commonly this "enduring nature" is thought of as a horizontal trend, but that would somehow not be as remarkable if the band around that trend was, say, 40 to 95 percent.

share of its status as a "stylized fact".[12] Yet the specific interpretation of relative stability that we consider and/or accept has important implications for macroeconomic research.

4.1 Business Cycle Theory/Monetary Theory

By the Solow's interpretation, aggregate labor's share was not stable from 1958 to 1996. Indeed, industry labor's shares behaved as if they were statistically independent of one another. However, this may imply that aggregate labor's share was stable *relative to the implications of various models of business cycles and the effects of monetary policy*.[13]

Many such models imply positive correlations across industry labor's shares. Section 2 indicates that, indeed, industry labor's share comovement may positively contribute to aggregate labor's share volatility, but by less than 33 percent. Consider, again, a benchmark of 35 industries, each with equal share of total value-added and identical labor's share variance, σ^2. Also assume that all industry labor's shares are positively related by a common correlation, ρ. Then the variance of the aggregate labor's share is,

$$\sigma^2_{Aggregate} = \frac{\sigma^2}{35} + 2(595)\left(\frac{1}{35}\right)^2 \rho\sigma^2 \approx \left[\frac{1}{35} + 0.971\rho\right]\sigma^2 . \quad (2)$$

If $\rho = 0$, (2) solves out to $\sigma^2_{Aggregate} = 0.029\sigma^2$. If $\rho = 0.3$, then $\sigma^{*2}_{Aggregate} = (0.320)\sigma^2$ and the relative volatility, $\left(\sigma^*_{Aggregate} / \sigma_{Aggregate}\right)$, is 3.32. Even for $\rho = 0.1$ the relative volatility is 2.08! Very small positive correlations across 35 industry labor's shares

[12] Nor do I claim that Solow aimed to do so. "I don't mean to conclude from this example," he wrote, "that yet another problem evaporates. But before deciding that observation contradicts expectation, there is some point in deciding what it is we expect"(1958, p. 630). This is a fine point.
[13] I thank John Conlon for raising this point during a seminar.

result in much higher aggregate labor's share volatility than the 1958–1996 U.S. data support.

The above must be recognized when considering business cycle models such as those of Gomme and Greenwood (1995) and Boldrin and Horvath (1995) where unemployment insurance and/or labor contracts produce countercyclical labor's share in the aggregate. If unemployment rates are positively correlated across industries then labor's shares will be positively correlated as well.

Likewise consider the large and influential New Keynesian/New Neoclassical Synthesis literature. Ball et al (2005, p. 709) have noted that, in this literature, "Markup shocks are becoming a standard feature of models used to analyze monetary policy." If these shocks are interpreted as true aggregate shocks, then industry labor's shares will be negatively correlated to the shocks and positively correlated to one another. Woodford (2003, p. 450) has interpreted such shocks variously: "distortions resulting from the market power of the supplier of each differentiated good and from the existence of distorting taxes on output, consumption, employment or wage income." However, Steinsson (2003, p. 1429) has noted that, even interpreting such shocks as the outcome of industry-level shocks, the aggregate manifestation implies "either [that] they are correlated between industries or because more of the economy is made up of a relatively few large industries." The same argument applies to the biased technology shocks (in the form of an exogenously time-varying Cobb-Douglas parameter) in Young's (2004) real business cycle model.

Of course, to know whether or not the implied labor's share correlations are necessarily problematic would involve calibration exercises with given models and evaluation on a case by case basis (which is beyond the scope of the present paper). The results presented in this section are at best suggestive; they should only be interpreted as a caveat that seemingly small correlations across industry labor's shares may imply counterfactually large aggregate labor's share volatility.

4.2 Theories of Development/Unbalanced Growth

When considering the interpretation of relatively stable offered in this paper – i.e., the balanced evolution of aggregate labor's share relative to the unbalanced evolution of industry labor's shares – this suggests that attention should be paid to the recent resurgence of models of unbalanced growth and development. These models are designed to be consistent both with the Kaldor observations (i.e., balanced evolution in the aggregate) and the Kuznets observations (i.e., unbalanced evolution at the industry level).

One segment of this literature focuses on changes in the marginal rate of substitution in consumption between different types of goods (e.g., goods versus services) as economic growth proceeds.[14] A recent example of a model in this vein is Kongsamut et al (2001) who posited a representative agent with preferences of the form,

$$U = \int_0^\infty e^{-\rho t} \frac{\left[(A_t - \overline{A})^\beta M_t^\gamma (S_t - \overline{S})^\theta \right]^{1-\sigma} - 1}{1-\sigma} dt \qquad (3)$$

where A, M, and S are consumption of agricultural goods, manufactured goods, and services; $\overline{A} > 0$ and $\overline{S} > 0$ are subsistence consumption of food and home production of services; parameters $\times$, σ, γ, β, θ are strictly positive and $\beta + \gamma + \theta = 1$.

[14] Examples include Murphy et al (1989), Matsuyama (1992), Echevarria (1997), Laitner (2000), Caselli and Coleman (2001) and Gollin et al (2002).

With preferences, (3), the income elasticity of substitution is less than unity for *A*; equal to unity for *M*; and greater than unity for *S*. As the economy grows, the output and employment shares of *A*, *M*, and *S* decrease, remain constant, and increase, respectively. The same pattern holds for industry labor's shares; aggregate labor's share converges to a constant.[15]

Acemoglu and Guerrieri (2005) have taken a different approach, demonstrating that, given different capital intensities (capital shares) in different sectors whose goods are gross complements in production of a final consumption good, unbalanced growth at the sectoral level goes along with capital deepening. Specifically, the final good is,

$$(4) \qquad Y = \left[\gamma Y_1^{\frac{\varepsilon-1}{\varepsilon}} + (1-\gamma) Y_1^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}},$$

where $\varepsilon < 1$ (where ε is the elasticity of substitution) and $0 < \gamma < 1$; Y_1 and Y_2 are sectoral outputs produced according to technologies,

$$(5) \qquad Y_1 = B_1 L_1^{\alpha_1} K_1^{1-\alpha_1} \qquad \text{and} \qquad Y_2 = B_2 L_2^{\alpha_2} K_2^{1-\alpha_2},$$

where the B_i's are positive; L_i and K_i are labor and capital in sector *i*; and $\alpha_1 > \alpha_2$.

As capital accumulates, because $\varepsilon < 1$, the relative price of the capital-intensive sector's ($i = 2$) good falls relative to that of sector 1. Because of this, the shares of both total capital and labor employed in the *less* capital-intensive sector ($i = 1$) converge towards unity as the economy grows. Aggregate labor's share converges to a constant from below.[16] Furthermore, Acemoglu and Guerrieri have calibrated the model and

[15] Of course, this need not be consistent with (observationally) balanced evolution of aggregate labor's share if the transition to a constant covers a large range of values. See below the discussion of Acemoglu and Guerrieri (2005).

[16] However, because each sector is Cobb-Douglas, labor's shares at that level remain constant for all time. So it is not a theory of aggregate versus industry labor's shares. Acemoglu (2003) also provided an induced

demonstrated that, e.g., even after 500 years in transition, labor's share may only increase from 62.5 percent to 65 percent. They also demonstrate that the framework is consistent with endogenous technological change via monopolistic competition and innovative efforts.

Yet another approach to modeling unbalanced growth is based on Baumol's (1967) insights into differential rates of technological progress across sectors. Young and Zuleta (2006) have assumed a representative agent with preferences over two types of consumption,

$$max\int_0^\infty e^{-\rho t}\left[\lambda\, log(C_Y)+(1-\lambda)log(C_X)\right], \tag{6}$$

where $0 < \rho < 1$ and $0 < \lambda < 1$. One sector, X, is entirely labor intensive and can only be consumed:

$$C_X = X = BL_X\,, \tag{7}$$

where $B > 0$ and L_X is labor devoted to the X sector (referred to as *services*). The other sector, Y, (referred to as *manufacturing*) uses both capital and labor and produces output that can be consumed or invested:[17]

$$C_Y + I = AK^{\alpha}L_Y^{1-\alpha}\,. \tag{8}$$

The investment can then be devoted towards the accumulation of physical capital, K, or innovating towards more capital intensive methods:

$$\dot{\alpha} = (1-\alpha)(1-\xi)I\,, \tag{9}$$

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innovation model where numerous firms maximize profits by choosing to produce either capital- or labor-intensive intermediate goods; but these firms only produce using linear capital *or* labor technologies. The model's contribution is to demonstrate that allowing for both capital- and labor-augmenting technology at the firm level can still yield balanced growth with (net) labor-augmentation only at the aggregate level. But it is not a theory of aggregate versus industry labor's shares either.

[17] Kongsamut et al (2001) also assumed that only manufacturing output can be invested.

where $(1 - \xi)$ is the chosen share of investment going towards innovation.

This model is a perfectly competitive model of induced innovation and endogenous growth.[18] Labor's share in services is identically zero. On the other hand, as the economy transitions manufacturing's labor's share goes to zero. In the long-run, services absorb all of the economy's labor while manufacturing tends towards "*AK*" production (Jones and Manuelli (1990) & Rebelo (1991)). Aggregate labor's share converges to a constant as the relative price of services increases forever. This is a model of unbalanced growth generally, and also, specifically, of unbalanced evolution of labor's share at the industry level; balanced evolution at the aggregate level.

5. CONCLUSIONS

Robert Solow (1958) argued that, from 1929–1954, U.S. aggregate labor's share was not stable relative to what we would expect given individual industry labor's shares. I confirm and extend this result using data from 1958–1996 that includes 35 industries (roughly 2-digit SIC level) and spans the entire U.S. economy. Changes in industry shares in total value-added contribute negligibly to aggregate labor's share volatility. Industry labor's shares comovement actually *adds to* aggregate labor's share volatility.

The same conclusions are evident when data is aggregated up into major industry groupings, including agriculture, manufacturing and services. This is remarkable at this level of aggregation because, apparently, long-run offsetting shifts in goods industries versus services industries labor's shares and value-added shares (i.e., unbalanced evolution at the industry level) lead to the horizontal trend in aggregate labor's share.

[18] This model is similar to that of Boldrin and Levine (2002) in that both the rate of growth and the rate of technological advance are endogenous under conditions of perfect competition.

The implication is that shorter-term fluctuations dominate industry labor's shares' volatilities.

The features of labor's shares – both aggregate and industry – are relevant to macroeconomic analysis generally. Business cycle models that, explicitly or implicitly, imply positive correlations across industry labor's shares, may therefore imply counterfactually large fluctuations in aggregate labor's share. As well, the balanced nature of aggregate labor's share vis-à-vis the unbalanced nature of industry labor's shares suggests the relevance of long-run models of unbalanced growth for the study of growth and development.

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TABLES

TABLE 1–AVERAGE INDUSTRY LABOR'S SHARES: 1958 – 1996

Industry	Description	Mean Labor's Share	Mean Value-Added Share
1	Agriculture	0.648	0.034
2	Metal Mining	0.524	0.003
3	Coal Mining	0.691	0.004
4	Oil and Gas Extraction	0.279	0.019
5	Non-metallic Mining	0.555	0.002
6	Construction	0.884	0.068
7	Food and Kindred Products	0.665	0.025
8	Tobacco	0.350	0.003
9	Textile Mill Products	0.775	0.005
10	Apparel	0.848	0.011
11	Lumber and Wood	0.710	0.007
12	Furniture and Fixtures	0.823	0.005
13	Paper and Allied	0.658	0.012
14	Printing, Publishing and Allied	0.763	0.017
15	Chemicals	0.566	0.027
16	Petroleum and Coal Products	0.458	0.008
17	Rubber & Miscellaneous Products	0.780	0.009
18	Leather	0.788	0.002
19	Stone, Clay, Glass	0.748	0.009
20	Primary Metal	0.731	0.017
21	Fabricated Metal	0.769	0.021
22	Non-electrical Industry	0.763	0.031
23	Electrical Industry	0.734	0.023
24	Motor Vehicles	0.675	0.017
25	Transportation Equip & Ordinance	0.885	0.018
26	Instruments	0.821	0.013
27	Miscellaneous Manufacturing	0.741	0.005
28	Transportation	0.733	0.047
29	Communications	0.497	0.028
30	Electrical Utilities	0.343	0.022
31	Gas Utilities	0.322	0.007
32	Trade	0.773	0.173
33	Finance, Insurance & Real Estate	0.444	0.114
34	Services	0.689	0.175
35	Government Enterprises	0.601	0.019

Notes: Calculated from 35 annual industries' data. Average labor's share is that of annual value added from 1958 – 1996. Average share is value added is the given industry's value added divided by the sum of value added over the 35 industries.

TABLES (CONTINUED)

TABLE 2–STANDARD DEVIATION OF INDUSTRY LABOR'S SHARES: 1958 – 1996

Industry	Description	Labor's Share Standard Deviation
1	Agriculture	0.066
2	Metal Mining	0.059
3	Coal Mining	0.065
4	Oil and Gas Extraction	0.026
5	Non-metallic Mining	0.035
6	Construction	0.016
7	Food and Kindred Products	0.061
8	Tobacco	0.067
9	Textile Mill Products	0.026
10	Apparel	0.036
11	Lumber and Wood	0.049
12	Furniture and Fixtures	0.024
13	Paper and Allied	0.037
14	Printing, Publishing and Allied	0.023
15	Chemicals	0.035
16	Petroleum and Coal Products	0.087
17	Rubber & Miscellaneous Products	0.024
18	Leather	0.102
19	Stone, Clay, Glass	0.052
20	Primary Metal	0.039
21	Fabricated Metal	0.042
22	Non-electrical Industry	0.032
23	Electrical Industry	0.067
24	Motor Vehicles	0.092
25	Transportation Equip & Ordinance	0.020
26	Instruments	0.034
27	Miscellaneous Manufacturing	0.077
28	Transportation	0.027
29	Communications	0.032
30	Electrical Utilities	0.025
31	Gas Utilities	0.016
32	Trade	0.014
33	Finance, Insurance & Real Estate	0.044
34	Services	0.035
35	Government Enterprises	0.049
	Aggregate	*0.011*

Notes: Calculated from 35 annual industries' data, 1958 – 1996. Labor's share is that of annual value added. Aggregate labor's share is calculated as a weighted average of industry labor's shares with industry shares in total value-added as weights.

TABLES (CONTINUED)

TABLE 3–VOLATILITIES OF ACTUAL & HYPOTHETICAL U.S. AGGREGATE LABOR'S SHARES

Statistic	Labor's Share Actual	Fixed-Weight	Fixed-Weight/ Independent
Mean	0.675	0.691	-
σ	0.011	0.011	0.009
σ/σ_{Actual}	1.000	1.023	0.817

Notes: Actual aggregate labor's share is annual from 1958 – 1996 and calculated as a weighted average of industry labor's shares with industry shares in total value-added as weights. "Fixed Weight" series calculated holding industry shares in total value-added at 1958 values. σ denotes standard deviation. "Fixed-Weight/Independent" σ is from σ^2 calculated as the sum of squared 1958 industry shares in total value added multiplied by actual industry labor's shares' variances.

TABLE 4 – STATISTICS FROM DECOMPOSITION OF U.S. AGGREGATE LABOR'S SHARE

Statistic	Labor's Share Change Component Within-Industry	Between-Industry	Covariance
Mean	-0.000	-0.000	-0.000
σ	0.010	0.002	0.000
σ/σ_{Actual}	1.079	0.252	0.046
$\rho_{Component,Actual}$	0.967	-0.148	-0.072

Notes: Decomposition based on the method by Foster et al (2001) as in equation (1). σ denotes standard deviation. ρ denotes correlation. "*Actual*" refers to actual changes in aggregate labor's share.

TABLE 5–CHANGE IN INDUSTRY LABOR'S AND VALUE-ADDED SHARES: 1958 – 1996

Industry	Description	Change in Labor's Share	Change in Value-Added Share
1	Agriculture	-0.203	-0.034
2	Metal Mining	-0.027	-0.001
3	Coal Mining	-0.095	-0.002
4	Oil and Gas Extraction	-0.032	-0.007
5	Non-metallic Mining	-0.124	-0.001
6	Construction	0.022	-0.020
7	Food and Kindred Products	-0.187	-0.006
8	Tobacco	-0.160	0.001
9	Textile Mill Products	-0.066	-0.003
10	Apparel	-0.093	-0.008
11	Lumber and Wood	-0.069	-0.002
12	Furniture and Fixtures	-0.064	-0.001
13	Paper and Allied	-0.046	-0.002
14	Printing, Publishing and Allied	-0.042	0.002
15	Chemicals	-0.034	0.005
16	Petroleum and Coal Products	-0.206	0.002
17	Rubber & Miscellaneous Products	0.001	0.003
18	Leather	-0.364	-0.003
19	Stone, Clay, Glass	0.097	-0.006
20	Primary Metal	0.104	-0.016
21	Fabricated Metal	-0.177	-0.008
22	Non-electrical Industry	-0.040	0.001
23	Electrical Industry	-0.179	0.004
24	Motor Vehicles	0.018	-0.001
25	Transportation Equip & Ordinance	0.023	-0.008
26	Instruments	0.023	0.004
27	Miscellaneous Manufacturing	-0.216	-0.002
28	Transportation	0.064	-0.019
29	Communications	-0.062	0.003
30	Electrical Utilities	0.010	-0.002
31	Gas Utilities	-0.061	-0.002
32	Trade	0.000	-0.044
33	Finance, Insurance & Real Estate	0.006	0.033
34	Services	0.074	0.128
35	Government Enterprises	-0.158	0.014

Notes: Calculated from 35 annual industries' data, 1958 – 1996. Labor's share is that of annual value added. Aggregate labor's share is calculated as a weighted average of industry labor's shares with industry shares in total value-added as weights.

TABLES (CONTINUED)

TABLE 6 – SUMMARY STATISTICS FOR THREE U.S. INDUSTRY GROUPS

Statistic for	Agriculture	Manufacturing	Services
Labor's Share			
Mean	0.645	0.722	0.661
σ	0.066	0.021	0.020
$\rho_{x,Agriculture}$	1.000	0.235	-0.510
$\rho_{x,Manufacturing}$	0.235	1.000	0.037
$\rho_{x,Services}$	-0.510	0.037	1.000
$\Delta_{1958,1996}$	-0.203	-0.079	0.015
Value-Added Share			
Mean	0.034	0.285	0.463
σ	0.009	0.023	0.041
$\rho_{x,Agriculture}$	1.000	0.758	-0.781
$\rho_{x,Manufacturing}$	0.758	1.000	-0.964
$\rho_{x,Services}$	-0.781	-0.964	1.000
$\Delta_{1958,1996}$	-0.034	-0.045	0.117

Notes: Data from 35-KLEM database. Methodology described in Jorgenson et al (1987). Manufacturing includes "Food and Kindred Products," Tobacco," "Textile Mill Products," "Apparel," "Limber and Wood," "Furniture and Fixtures," "Paper and Allied," "Chemicals," "Petroleum and Coal Products," "Rubber and Miscellaneous Products," "Leather," "Stone, Clay and Glass," "Primary Metal," "Fabricated Metal," "Non-electrical," "Motor Vehicle," "Transportation Equipment and Ordinance," "Instruments," and "Miscellaneous Manufacturing" industries.

FIGURES

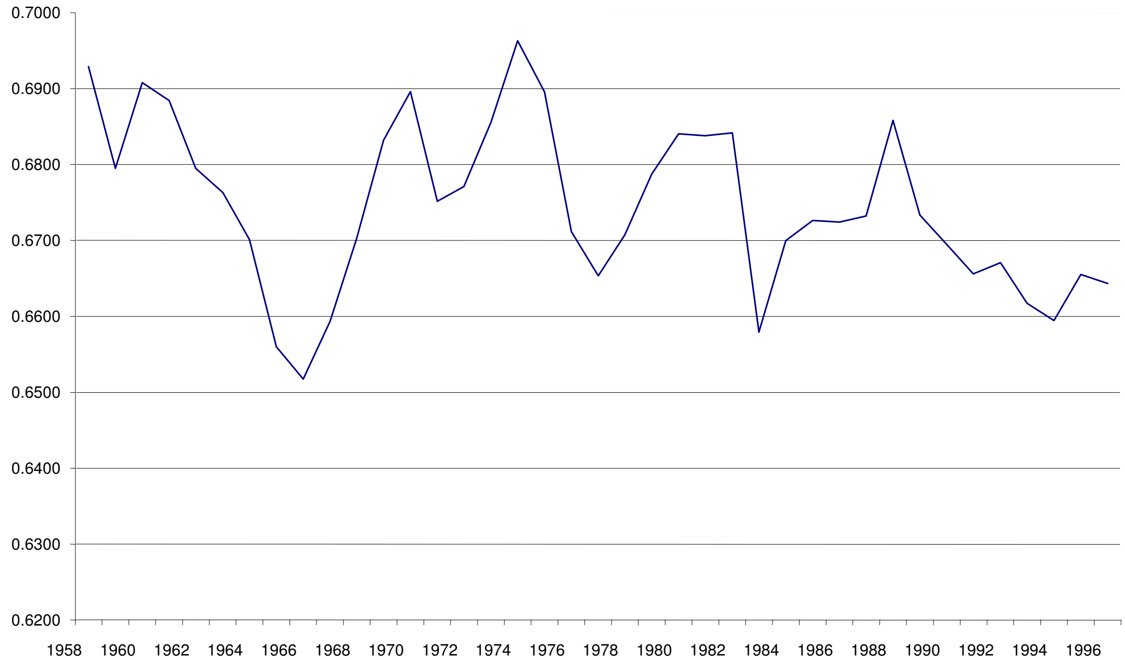

FIGURE 1. US AGGREGATE LABOR'S SHARE: 1958 - 1996

Notes: Calculated from aggregation of 35 industries' data. At the industry level, calculations are of labor's share of value added. At the aggregate level, industries weighted by their share of total value added.

FIGURES (CONTINUED)

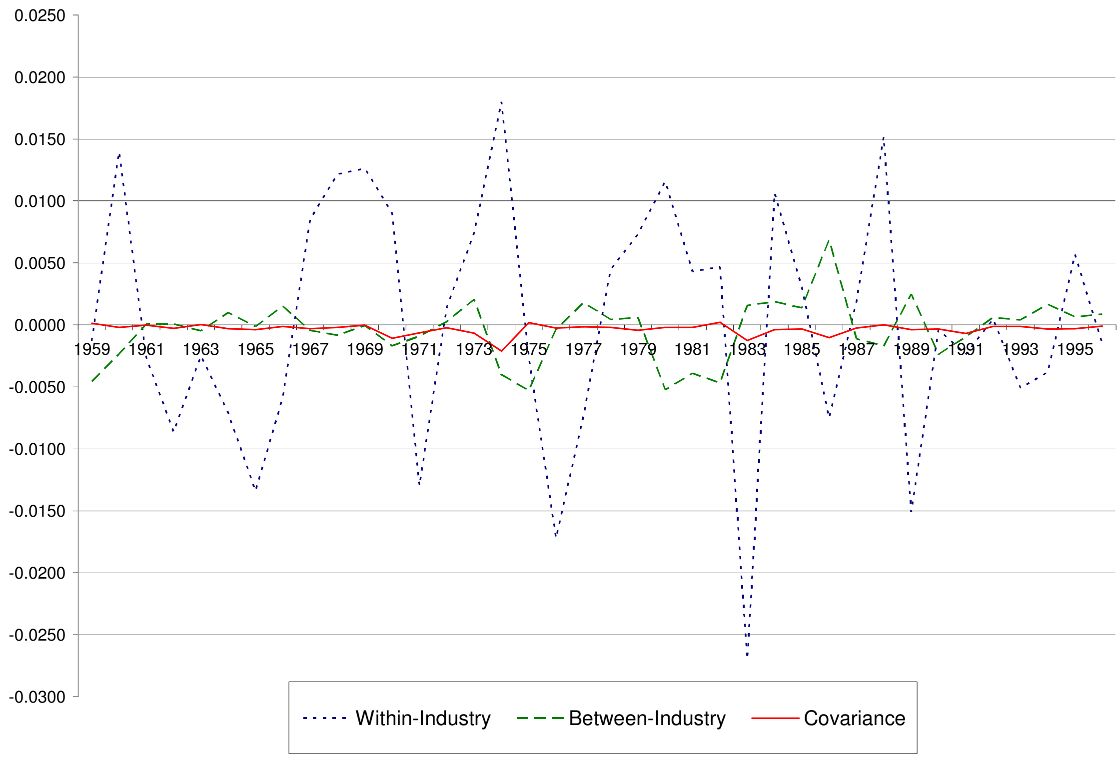

FIGURE 2. DECOMPOSITION OF U.S. AGGREGATE LABOR'S SHARE CHANGES – 35 INDUSTRIES

Notes: Decomposition based on the method by Foster et al (2001) as in equation (1).

FIGURES (CONT.)

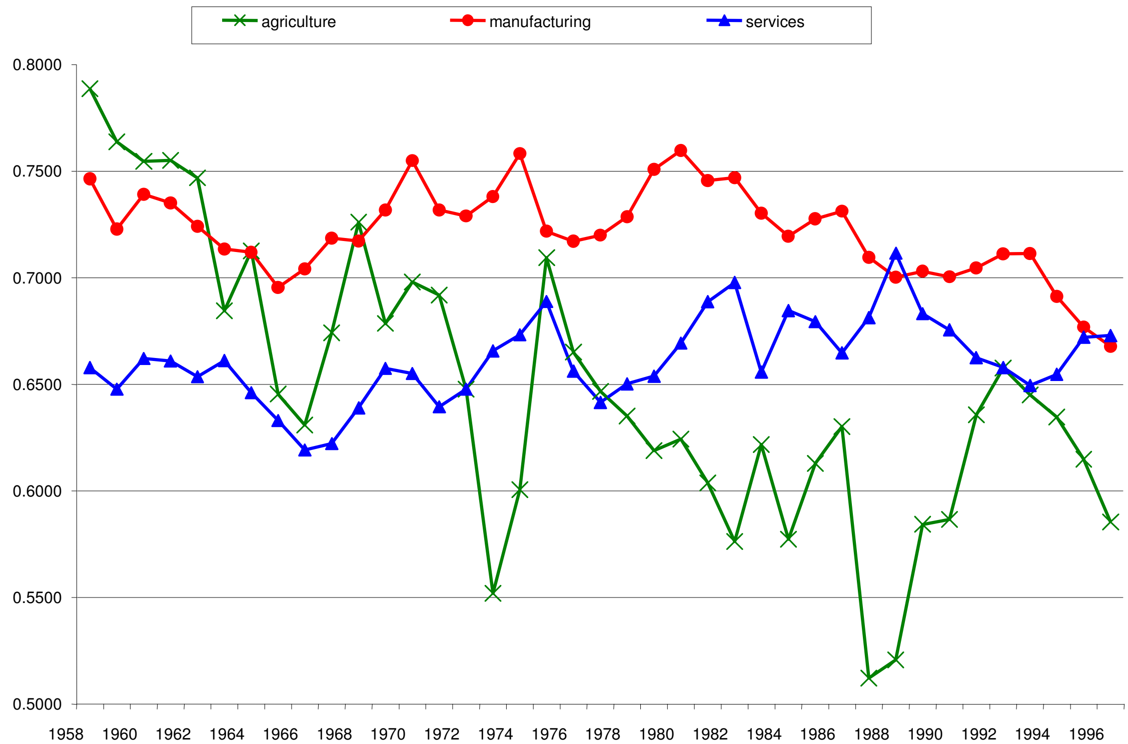

FIGURE 3. SELECT MAJOR U.S. INDUSTRY LABOR'S SHARES

Notes: Data from 35-KLEM database. Methodology described in Jorgenson et al (1987). Agriculture is "Agriculture" industry. Manufacturing includes "Food and Kindred Products," Tobacco," "Textile Mill Products," "Apparel," "Lumber and Wood," "Furniture and Fixtures," "Paper and Allied," "Chemicals," "Petroleum and Coal Products," "Rubber and Miscellaneous Products," "Leather," "Stone, Clay and Glass," "Primary Metal," "Fabricated Metal," "Non-electrical," "Motor Vehicle," "Transportation Equipment and Ordinance," "Instruments," and "Miscellaneous Manufacturing" industries. Services include "Services," "Trade," and "Finance, Insurance and Real Estate" industries.

FIGURES (CONT.)

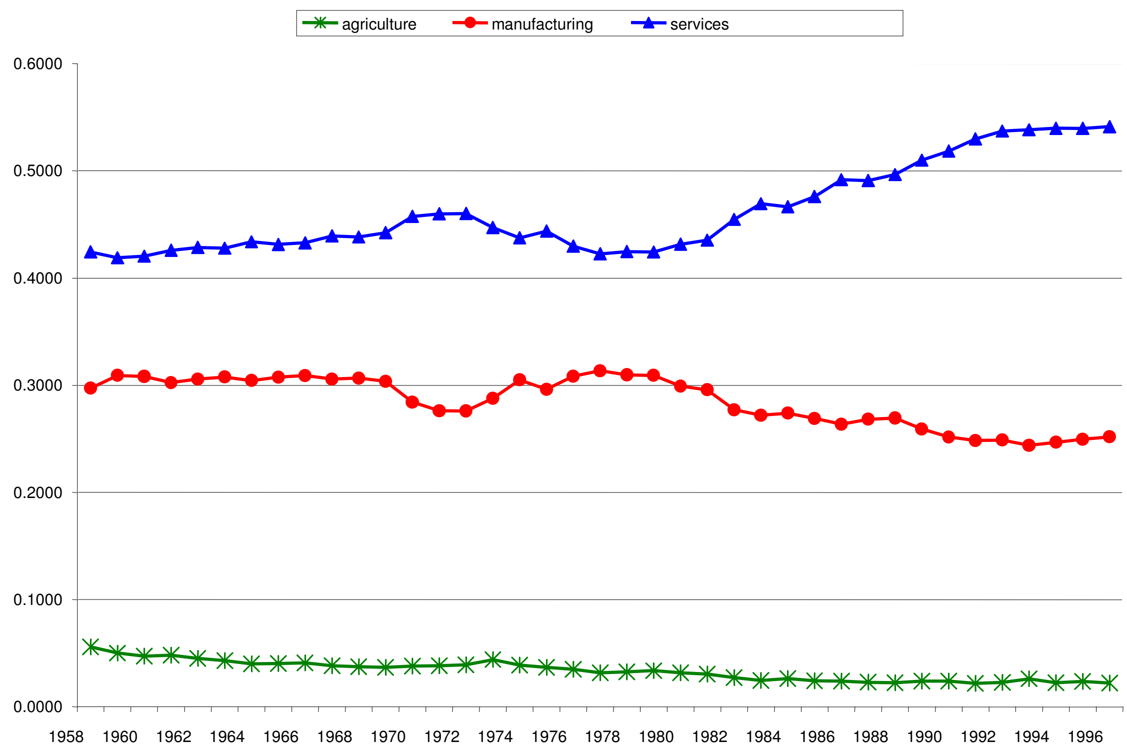

FIGURE 4. SELECT MAJOR U.S. INDUSTRY VALUE-ADDED SHARES

Notes: Data from 35-KLEM database. Methodology described in Jorgenson et al (1987). Agriculture is "Agriculture" industry. Manufacturing includes "Food and Kindred Products," Tobacco," "Textile Mill Products," "Apparel," "Lumber and Wood," "Furniture and Fixtures," "Paper and Allied," "Chemicals," "Petroleum and Coal Products," "Rubber and Miscellaneous Products," "Leather," "Stone, Clay and Glass," "Primary Metal," "Fabricated Metal," "Non-electrical," "Motor Vehicle," "Transportation Equipment and Ordinance," "Instruments," and "Miscellaneous Manufacturing" industries. Services include "Services," "Trade," and "Finance, Insurance and Real Estate" industries.

FIGURES (CONT.)

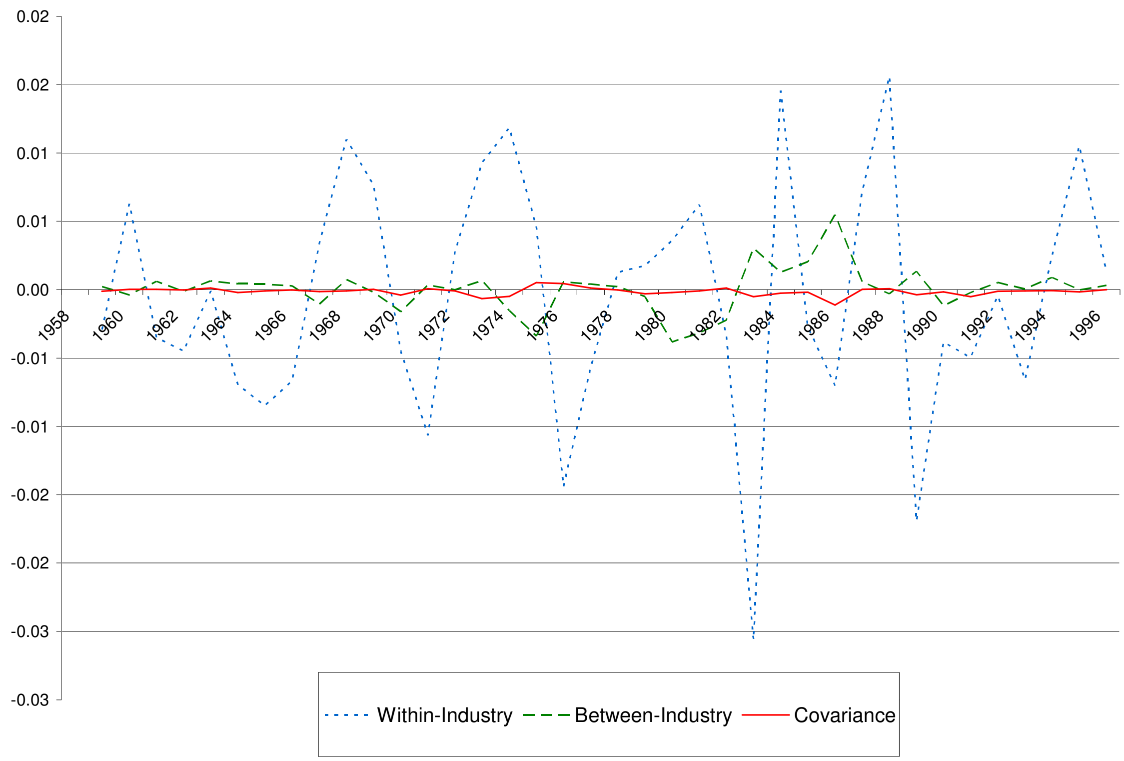

FIGURE 5. DECOMPOSITION OF U.S. AGGREGATE LABOR'S SHARE CHANGES – MAJOR INDUSTRY AGGREGATES

Notes: Decomposition based on the method by Foster et al (2001) as in equation (1).