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ABSTRACT

Measuring Factor Income Shares at the Sector Level - A Primer*

Many applications in economics use multi-sector versions of the growth model with Cobb--Douglas production functions at the sector level. In this paper, we measure the U.S. income shares of capital and labour for five sectors that encompass the typical sectors used in the literature. We also split the capital shares of these five sectors into the sector income shares of land and of structures and equipment. We find that the factor income shares differ widely across sectors. For example the capital share in agriculture is about twice that in construction. Moreover, the land shares in agriculture and in services are sizeable whereas the land shares in all other sectors are small. Our findings suggest that the general practice of using the economy-wide factor income shares also at the sector level is not a good practice.

JEL Classification: O41 and O47
Keywords: industry-by-commodity total requirement matrix, input-output tables and sector factor shares

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1 Introduction

Many questions in economics require the disaggregation into at least two sectors. For example, trade theorists distinguish between tradeables and nontradeables, growth theorists between consumption and investment, and development economists between agriculture and nonagriculture. If one disaggregates in these ways, one needs to specify the technologies at the sector level. The common practice is to employ the Cobb Douglas functional form. Accepting this, the question arises which income shares one should assign to the factors of production at the sector level. Our purpose in this paper is to answer this question for the U.S. economy.

We start by defining what we mean by a sector. Our idea is to aggregate the industries of the U.S. input–output tables to a sector split fine enough so that we can aggregate it further to the different multi–sector splits typically employed in the literature. This leads us to consider the following five sectors: agriculture (tradable consumption produced in agriculture), manufactured consumption (tradable consumption produced in manufacturing), services (nontradeable consumption), equipment (tradable investment), and construction (nontradeable investment). These five sectors can be aggregated in the following ways: agriculture, manufacturing (manufactured consumption, construction, equipment), and services; consumption (agriculture, manufactured consumption, services) and investment (equipment, construction); tradeables (agriculture, manufactured consumption, equipment) and nontradeables (services, construction); agriculture and nonagriculture (manufactured consumption, services, equipment, construction).[1]

To map the industry input–output tables into these five sectors is challenging because industries may produce more than one good and the same good may get produced in different industries. Moreover, industries in the input–output tables use intermediate inputs, capital, and labor to produce intermediate inputs for other industries and final output. In contrast, sectors in multi–sector models typically use only capital and labor to produce final output, so there are no intermediate inputs.

[1]Note that our methodology would work equally well for any other sector split.

We show how to measure the factor shares in industry value added from information of 1997 benchmark year of the input–output tables of the US. This involves splitting proprietors' income at the industry level between capital and labor income. The factor shares in final sector output are then the aggregate of the factor shares in the industry outputs that belong to this sector, both as intermediate inputs and as value added in some final goods that belong to this sector. We show how to measure these sector factor shares employing the industry–by–commodity total requirements matrix published by the BEA.[2]

We find that the largest capital share is in agriculture, followed by manufactured consumption, services, equipment investment, and construction. Moreover the differences between these sector capital shares are sizeable: the capital share in agriculture is about twice as large as in construction. This questions the common practice of using the economy–wide capital share as an approximation for the sector shares.[3] Aggregating our sectors to the common two–sector splits, we also measure the capital shares of consumption and investment, of tradeables and nontradeables, and of agriculture and nonagriculture. For each of these two–sector splits the differences between the capital shares remain large, with the possible exception tradeables and nontradeables.

Our findings imply that tradeables are more capital intensive than nontradeables. This confirms the conjecture of Bhagwati (1982) and contradicts the claim of Stockman and Tesar (1995). Moreover, they imply that consumption is more capital intensive than investment. This confirms the claim of Huffman and Wynne (1999) who took the short cut of assigning entire industries either to consumption or to investment.

The capital shares in agriculture and services are large relative to our expectations. Since capital is comprised of land and of structures and equipment, one possible reason is that agriculture and services have large land shares. To measure the land shares, we

[2]Total requirements matrices show the relationship between final uses and gross output. The industry–by–commodity total requirements matrix shows the production values required by the different industries, both directly and indirectly through intermediate inputs, to deliver a unit of each commodity to final users.

[3]Examples that make that assumption include Boldrin et al. (2001), Hsieh and Klenow (2003), and Kongsamut et al. (2001).

need to split the capital shares of our five sectors into the shares of land and of equipment and structures. Unfortunately the BEA does not provide separate information on land income. However, it turns out that only four industries use the input factor land in sizeable amounts: the two agricultural industries crop production and animal production and the two service industries real estate and owner-occupied dwellings. We impute the land shares of these four industries, assume that the land shares in all other industries are zero, and then follow the same procedure as before to aggregate to our five sectors.

To impute the land shares for crop and animal production we combine information from the BEA about land rents paid to nonoperator landlords with information from the USDA about the ratio of owned to rented agricultural land. To impute the land shares for real estate and owner-occupied dwellings we use information from Davis and Heathcote (2004) about the market value of residential land, the replacement cost of residential structures, and the price indices for residential land and residential structures. We find that the land shares in agriculture and services are sizeable whereas the land shares of the other three sectors are small. Moreover, if we take the land share out, then agriculture and services have capital shares that are much closer to the economy–wide average.

Our work is closely related to that of Gollin (2002) and Bernanke and Gürkaynak (2001), who measured the capital and labor shares in cross–sections of countries. Our ways of splitting proprietors' income between the income to capital and labor are similar as in these studies. Gollin (2002) and Bernanke and Gürkaynak (2001) found that the country capital shares are uncorrelated with country incomes and that country capital shares average one third. Our findings agree with their findings on the aggregate capital share for the U.S. We add to their findings the disaggregate information that many U.S. sector capital shares are very different from the U.S. aggregate capital share.

The paper is organized as follows. In section 2, we explain how to map the input–output tables into our multi–sector model. In section 3, we measure the capital shares in the value added of the industries of the input–output tables. In section 4, we measure the capital shares in the final output of our sectors. In section 5, we split the capital shares into the shares of land and of structures and equipment. Section 6 discusses the robustness of our findings. Finally, section 6 concludes and offers some directions for further research.

2 Mapping Input–Output Tables into Multi –Sector Models

Let there be $j \in \mathcal{J}$ final goods. Standard multi–sector models assume that each good is produced in a different sector. As motivated in the introduction, we are interested in the five sectors that produce agriculture, manufactured consumption, services, equipment, and construction. We follow the literature and assume that the production function of sector j is

$$\frac{y_j}{p_j} = A_j k_j^{\alpha_j} h_j^{1-\alpha_j}, \tag{1}$$

where y_j are the dollar expenditure on good j, p_j is its price (so y_j/p_j is the real output of good j), A_j is TFP, k_j is capital, h_j is labor, and α_j is the capital share, all in sector j.

Our goal is to measure $\{\alpha_a, \alpha_m, \alpha_s, \alpha_e, \alpha_c\}$ from the 1997 benchmark of the input–output tables published by the BEA. To this end, we need to map the industries in the input–output tables into our five sectors. This is challenging because industries in the input–output tables may produce more than one good and the same good may get produced in different industries. Moreover, most goods in the input–output tables are both final and intermediate for the production of other goods. In contrast, multi–sector models abstract from intermediate goods and have only final goods. We therefore need to determine all capital and labor inputs in the production of the final good y_j. The direct ones are the capital and labor inputs in the value added of the industries that sell to category j. The indirect ones are the capital and labor inputs in the production of intermediate goods that are used by the industries that sell to category j. Once we have determined all these components, we can measure the factor income shares in each of them and sum them up.

The key concepts for mapping industries of the input–output tables into sectors or our model are the "use" and the "make" matrix as described by the United Nations Statistics Division's System of National Accounts 1993.[4] To explain their roles, we need some more notation. Let there be m goods and n industries. $\boldsymbol{B}$ denotes the $(m \times n)$ use matrix. Rows are associated with commodities and columns with industries. Entry ij shows the dollar amount of commodity i that industries j uses per dollar of output it produces. $\boldsymbol{D}$ denotes the $(n \times m)$ make matrix. Rows are associated with industries and columns with commodities. Entry ij shows for industry i which share of one dollar of commodity j it produces. $\boldsymbol{q}$ denotes the $(m \times 1)$ commodity output vector. Each element records the sum of the dollar amounts of a given commodity delivered to other industries as intermediate inputs and to final expenditure. $\boldsymbol{g}$ denotes the $(n \times 1)$ industry output vector. Each element records the total dollar amount of output of a given industry. Finally, $\boldsymbol{e}$ denotes the $(m \times 1)$ vector of dollar final expenditures. Each element records the total final dollar expenditure on a given good.

Two identities link these matrices and vectors:

$$\boldsymbol{q} = \boldsymbol{B}\boldsymbol{g} + \boldsymbol{e}, \tag{2a}$$

$$\boldsymbol{g} = \boldsymbol{D}\boldsymbol{q}. \tag{2b}$$

The first identity says that the dollar output of each good equals the sum of what the different industries use as intermediate goods plus the final expenditure on that good. The second identity says the dollar output of each industry equals the sum of what that industry contributes to the outputs of the different goods. Eliminating $\boldsymbol{q}$ from these identities leads to:

$$\boldsymbol{g} = \boldsymbol{D}(\boldsymbol{I} - \boldsymbol{B}\boldsymbol{D})^{-1}\boldsymbol{e}. \tag{2c}$$

[4]For further explanation see ten Raa (2005) and Bureau of Economic Analysis (2006). For a critical discussion of the methodology used see Krueger (1999). To facilitate comparison, we use the language and the notation of the BEA to the extent possible.

$\boldsymbol{D}(\boldsymbol{I}-\boldsymbol{BD})^{-1}$ is called the industry–by–commodity total requirements matrix, and it is published by the BEA. Rows are associated with industries and columns with commodities. Entry ij shows the dollar value of industry i's production that is required, both directly and indirectly, to deliver one dollar of commodity j to final use.

The industry–by–commodity total requirement matrix allows us to calculate the capital shares α_j of the production function (1) from the capital and labor incomes of the different industries. Let the final expenditure vectors $\{\boldsymbol{y_a}, \boldsymbol{y_m}, \boldsymbol{y_s}, \boldsymbol{y_e}, \boldsymbol{y_c}\}$ record the dollar amounts of final expenditures on the different goods in each category j. For example, $\boldsymbol{y_a}$ tells us which dollar amounts of the final expenditures belong to agriculture.[5] To go from a vector $\boldsymbol{y_j}$ to total sector output y_j we simply add all components: $y_j = \boldsymbol{1'y_j}$ where $\boldsymbol{1'}$ is a row vector of ones. Moreover, we have $\boldsymbol{y}_c = \boldsymbol{y}_a + \boldsymbol{y}_m + \boldsymbol{y}_s$, $\boldsymbol{y}_i = \boldsymbol{y}_e + \boldsymbol{y}_b$, $\boldsymbol{y}_c + \boldsymbol{y}_i = \boldsymbol{e}$, and $\boldsymbol{1'e} = GDP$.

We divide the industry factor incomes by total industry output g_i and denote the resulting ratios by s_{ki} and s_{hi}. Multiplying the corresponding row vectors with the expenditure vectors, we obtain the capital shares of our five sectors:

$$\alpha_{kj} = \frac{\boldsymbol{s_k}'\boldsymbol{D}(\boldsymbol{I}-\boldsymbol{BD})^{-1}\boldsymbol{y_j}}{(\boldsymbol{s_k}' + \boldsymbol{s_h}')\boldsymbol{D}(\boldsymbol{I}-\boldsymbol{BD})^{-1}\boldsymbol{y_j}}. \tag{2d}$$

Note that we can calculate the aggregate capital share in the same way. We just need to replace $\boldsymbol{y_j}$ by $\boldsymbol{e}$ in (2d).

The next order of business is to measure $\boldsymbol{s_k}$ and $\boldsymbol{s_h}$.

3 Industry Capital Shares

We start by splitting industry value added into the payments to capital and labor. In the 1997 Benchmark Input–Output Tables (IO Tables) at purchasers' prices the Bureau of Economic Analysis (BEA) reports the value added of each industry as the sum of the "compensation of employees", "indirect business tax and nontax liabilities", "gross

[5] Below we will explain in detail how to construct $\boldsymbol{y_j}$.

operating surplus" (which is also called "other value added").[6] We take indirect business tax and nontax liabilities out. Compensation to employees is labor income and most of gross operating surplus is capital income. The exception is "proprietors' income" (which is also called "other gross operating surplus – noncorporate"). Proprietors' income contains both capital and labor income, and so we need to split it between the two.

The BEA reports proprietors' income in the "GDP–by–Industry" data for 1998–2005 at the three–digit level. Since the IO tables are at the four–digit level, we assume that all four–digit industries with the same three–digit code have the same labor income share in their proprietors' income. Moreover, we average over 1998–2005. This is motivated by the presence of some outliers. For example, in 2005 "air transportation" reported a large negative share of proprietors' income in other gross operating surplus whereas in all other years this share was a small positive number.

To split proprietors' income into labor and capital income we assume that its capital and labor shares equal the industry–wide shares.[7] This implies the following factor shares in total industry output:

$$s_{ki} \equiv \left(gos_i - \frac{com_i}{com_i + gos_i - pro_i} \, pro_i \right) \frac{1}{g_i}, \tag{3a}$$

$$s_{hi} \equiv \left(com_i + \frac{com_i}{com_i + gos_i - pro_i} \, pro_i \right) \frac{1}{g_i}, \tag{3b}$$

where s_{ki} and s_{hi} are as in (2d), gos is gross operating surplus, com is compensation of employees, and pro is proprietors' income.

Some authors use the capital shares in industry value added as a proxy for those in industry final output. To evaluate how good this approximation is we calculate value added in industry final output according to the same logic that underlies (2d). Calling $\boldsymbol{f_i}$ the vector of final goods that industry i produces the capital share in the final output

[6]We use the 1997 Beanchmark Year because this is the most recent one.

[7]We will discuss this assumption below and evaluate how robust the implied results are.

of industry i is given by

$$\alpha_{ki} = \frac{\boldsymbol{s_k}'\boldsymbol{D}(\boldsymbol{I} - \boldsymbol{BD})^{-1}\boldsymbol{f_i}}{(\boldsymbol{s_k}' + \boldsymbol{s_h}')\boldsymbol{D}(\boldsymbol{I} - \boldsymbol{BD})^{-1}\boldsymbol{f_i}}. \tag{4}$$

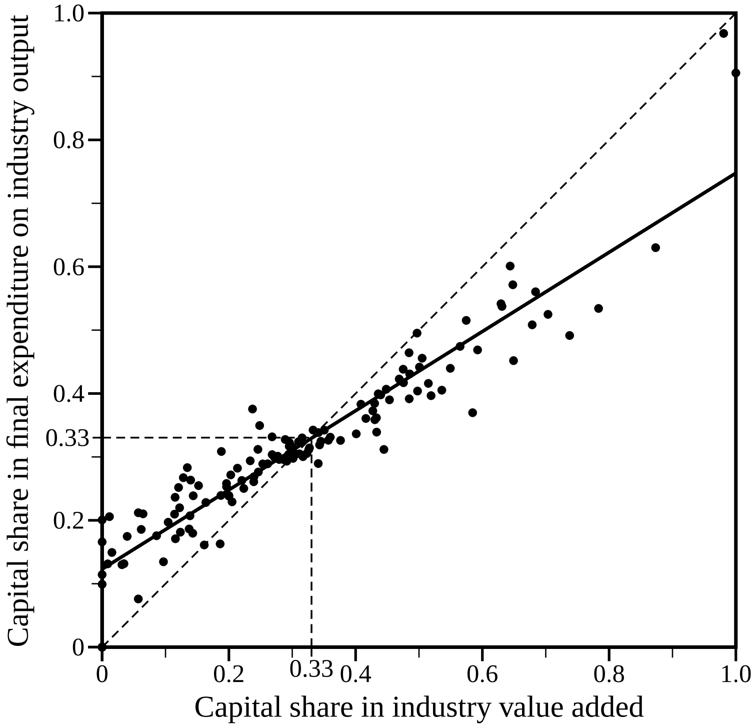
Figure 1 plots the capital shares in industry value added against the capital share in final industry output. The key finding is that industries with capital shares in value added close to the economy–wide capital shares of 0.33 lie on the 45 degree whereas industries with capital shares in value added below (above) the economy–wide capital share tend to have higher (lower) capital shares in final expenditure than in value added. A possible reason is that industries tend to use a broad set of intermediate inputs with an average capital share close to the economy–wide capital share.

The fact that there is a systematic difference between the capital share in industry value added and in industry final output implies that one cannot simply take the former as an approximation for the latter. This suggest that our exercise has some merit.

4 Sector Capital Shares

We now measure the capital shares for our five sectors. We start by constructing the sectors from the four–digit industries of the input–output tables. We first aggregate final expenditures excluding net exports into consumption and investment. The sale of commodity i to final consumption equals personal and government consumption expenditures. The sale of commodity i to final investment expenditures equals private and government fixed investment expenditures plus changes in private inventories. Since all final sales of agricultural commodities (two digit NAICS code 11) are tradable consumption, we split tradable consumption into agriculture and manufactured consumption goods. Moreover, we classify transportation equipment (three digit NAICS code 336) and the sale of commodities in construction (two digit NAICS code 23) as investments. Finally, we assume that the consumption and investment shares in net exports equal the economy–wide average and split net exports accordingly. This procedure leads to consumption and

Figure 1: Industry capital shares in value added and final expenditures (Proprietors' income split according to industry–wide shares)



investment commodity vectors $\boldsymbol{x}_C$ and $\boldsymbol{x}_I$ that add up to the GDP vector.

Next we classify each commodity as tradeable or nontradeable. All commodities sold to investment are tradable except for construction commodities, which is nontradeable investment. We classify all commodities sold to consumption with a three digit NAICS code higher or equal to 420 as nontradeable. These include all industries which are producing commodities typically viewed as services. In addition, we classify all commodities with the two–digit NAICS code 22 sold to consumption as non-tradable. These are the utilities (distribution of electric power, natural gas and water). Finally, we classify government services as nontradeables. The tradable sector constructed in this way exports 81% of all U.S. exports and imports 99% of all imports.[8]

Table 1 reports the capital shares for our five sectors. The largest capital share is in

[8]Note that the capital shares of the goods the U.S. actually exports and imports are both 0.37. Since the US does not produces the goods it imports, the interpretation of the capital share of imports is that this would be the capital share if the US produced these goods.

Table 1: Sector capital shares
(Proprietors' income split according to industry wide–shares, labor shares equal one minus capital shares)

Agriculture (a)	0.44
Manufactured consumption (m)	0.39
Services (s)	0.34
Equipment investment (e)	0.32
Construction investment (c)	0.20
Agriculture (a)	0.44
Manufacturing (m+e+c)	0.33
Services (s)	0.34
Consumption (a+m+s)	0.35
Investment (e+c)	0.28
Tradeables (a+m+e)	0.36
Nontradeables (s+c)	0.32
Agriculture (a)	0.44
Nonagriculture (m+s+e+c)	0.33
GDP	0.33

agriculture, followed by manufactured consumption, services, equipment investment, and construction. Moreover the differences between these sector capital shares are sizeable: the capital share in agriculture is about twice as large as in construction. Our findings suggest that the economy–wide capital share is a bad approximation at the five–sector level.

Tables 1 also reports our findings when we aggregate the sectors to the common multi–sector splits. The capital shares of consumption and investment are 0.35 and 0.28, of tradeables and nontradeables are 0.36 and 0.32, and of agriculture and nonagriculture are 0.44 and 0.33. Since these differences remain large the economy wide capital share remains a bad approximation at the two–sector level, with the possible exception tradeables and nontradeables.

Two features of our findings deserve further discussion. First, the capital share in construction comes out very low, making construction the most labor–intensive sector. This gives support to the casual observation that typical construction sites are populated by an enormous number of workers, many of which are standing around and drinking beer. Second, the capital shares in agriculture and services are among the largest. Given that capital comprises land, equipment, and structures, one possible reason is that agriculture and services have large land shares. For agriculture this is obvious. For services that is less obvious, although land intensive industries such as real estate or owner–occupied dwellings are part of the service sector. In the next section, we explore this possibility by calculating the land shares in our five sectors.

5 Land Shares

Our aim in this section is to split the capital shares of our five sectors into the shares of land and of equipment and structures. Unfortunately the BEA does not provide separate information on land income. Fortunately, however, only four industries use the input factor land in sizeable amounts: "crop production", "animal production", "real estate", and "owner-occupied dwellings". We will measure the land shares of these four industries, assume that the land shares in all other industries are zero, and then follow the same procedure as before to aggregate to our five sectors.

We start with the land shares in crop and animal production, which together comprise the farm sector. The BEA publishes data on "Rent paid to nonoperator landlords" (Table 7.3.5. Farm Sector Output, Gross Value Added, and Net Value Added).[9] The 1997 Census of Agriculture of the U.S. Department of Agriculture (USDA) reports the ratio of "owned land in farms" to "rented or leased land in farms". This ratio equals 1.46. We impute the unreported land rent to operator landlords under the assumption that the per acre rents on owned and rented land are the same:[10]

$$\begin{aligned}&\text{imputed rent paid to operator landlords}\\&\qquad\qquad = \text{rent paid to nonoperator landlords}\ \frac{\text{owned land in farms}}{\text{rented or leased land in farms}}\,.\end{aligned}$$

We split the imputed land rents between crop production and animal production proportional to their capital incomes. We find a land share in gross farm sector output (reported land rents to nonoperator landlords plus imputed land rents to land owners divided by agricultural output) of 0.14. For comparison, Figure 5 of Mundlak (2005) reports a 1997 land share of 0.15.

Next we impute the land share in the values added of real estate and owner-occupied dwellings. First we deal with the housing sector which is comprised of owner–occupied dwellings and the residential part of real estate. To calculate its land share, we impose that there be no arbitrage possibilities between the net returns on residential land and

[9]Note that the BEA reports these rents as an intermediate input purchased from the real estate industry. Hence it is part of the value added of real estate instead of farming.

[10]The Agricultural Land Survey, which is the part Agricultural Census, reports the values of land and buildings for owned and rented land separately. Using this, we also calculated the imputed land rents under the assumption that the rents from land and buildings are the same for owned and rented farm land. The results were very similar.

on residential structures. Assuming a Cobb-Douglas technology, this implies

$$\alpha_l \frac{y}{l} - \delta_l + \frac{\Delta p_l}{p_l} - \frac{\Delta p}{p} = \alpha_s \frac{y}{s} - \delta_s + \frac{\Delta p_s}{p_s} - \frac{\Delta p}{p}, \tag{5}$$

where y is the value of the housing sector's output, l and s are the values of land and structures in the housing sector, α_l and α_s are the shares of land and structures, δ_l and δ_s are the depreciation rates of land and structures, p_l and p_s are the prices of land and structures in the housing sector, and p is the GDP deflator. Note that the assumption of constant returns implies that the share of structures is given by

$$\alpha_s = 1 - \alpha_l - \alpha_z - \alpha_h, \tag{6}$$

where α_z and α_h are the shares of intermediate inputs and labor. The idea is to measure all parameters and variables in (5) except for α_l and then solve for α_l.

We start with the output of housing excluding net taxes, which is y in our formula. The BEA publishes data on output and value added of owner–occupied housing, tenant–occupied housing, and farm housing (Table 7.4.5. Housing Sector Output, Gross Value Added, and Net Value Added).

Davis and Heathcote (2004) provide estimates of the market value of residential land, l, and the replacement cost of residential structures, s, between 1930 and 2000. They also provide estimates of the price indices for residential land and residential structures. We calculate the average values from their data between 1990 and 2000. This gives $y/l = 0.147$, $y/s = 0.097$, $\Delta p_l/p_l = 0.034$, and $\Delta p_s/p_s = 0.031$.

We obtain the depreciation rate of housing structures from the "investment and net fixed asset data on residential structures at constant prices" by taking the 1990–2000 average of $\delta = [i_{st} - (s_{t+1} - s_t)]/s_t$. This gives $\delta_s = 0.016$. Land does not depreciate, so we set $\delta_l = 0$.

Next, we calculate α_z and α_h. α_z is the average between 1990 and 2000 of the intermediate inputs to output ratio in the housing sector as published by the BEA: $\alpha_z = 0.185$.

Table 2: Land shares in the value added of the land–intensive industries (Proprietors' income split according to industry–wide shares, sector capital share equals land share plus share of structures/equipment)

	Land	Structures/Equipment
Crop production	0.29	0.18
Animal production	0.15	0.09
Owner occupied dwellings	0.30	0.70
Real estate	0.22	0.42

Similarly α_h is the average between 1990 and 2000 of the compensation of employees to output ratio from the BEA with adjustments for unreported labor income using imputed labor income for the proprietors: $\alpha_h = 0.014$.

We have calculated all unknowns in (5) but α_l. Solving we find $\alpha_l = 0.24$. Note that if we use this number and calculate the nominal net rate of return according to (5), we obtain 0.069. Using an average consumer price inflation of 2.4%, the implied real rate of return of 4.4% is reasonable.

We end with the nonresidential and nonagricultural part of the real estate sector. It comprises commercial and industrial real estate and generates 1/3 of the capital income in the real estate sector (residential housing generates 60% and the farm sector generates 6%). Unfortunately, there does not seem to be information on the number of acres of land in commercial and industrial real estate, so we cannot impute the land income for this part of the real estate sector.[11] For lack of better alternatives, we assume that the land share in the commercial and industrial or real estate is the same as in the housing sector.

Table 2 summarizes the land shares in the four land–intensive industries. It lies between ten and thirty percent, depending on the industry. Crop production and owner–

[11]Economic Research Service/USDA (2002) reports that there were 30 million nonresidential urban acres in 1997. While these acres contain commercial and industrial real estate, they also contain roads, parks, etc. Thus the challenge is to identify the relative size of the two components. To the best of our knowledge this information does not exist.

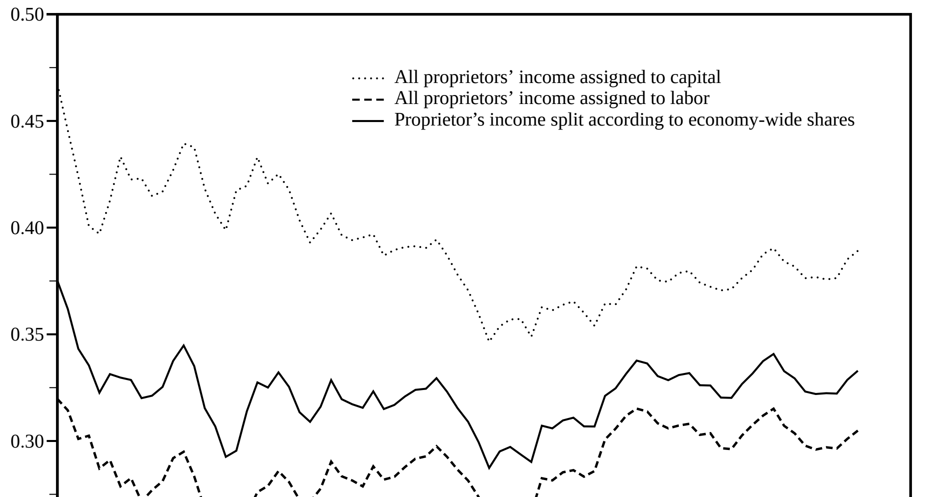
Table 3: Sector shares of land and of structures/equipment (Proprietors' income split according to industry–wide shares, sector capital share equals land share plus share of structures/equipment)

	Land	Structures/Equipment
Agriculture (a)	0.17	0.27
Manufact. consumption (m)	0.02	0.38
Services (s)	0.04	0.30
Equipment investment (e)	0.01	0.31
Construction investment (c)	0.00	0.20
Agriculture (a)	0.17	0.27
Manufacturing (m+e+c)	0.01	0.32
Services (s)	0.04	0.30
Consumption (a+m+s)	0.04	0.31
Investment (e+c)	0.01	0.27
Tradeables (a+m+e)	0.02	0.34
Nontradeables (s+c)	0.04	0.28
Agriculture (a)	0.17	0.27
Nonagriculture (m+s+e+c)	0.03	0.30
GDP (a+m+s+e+c)	0.03	0.30

occupied dwellings are the most land intensive industries with land shares around thirty percent. They are followed by the real estate industry and animal production. Interestingly animal production is only about half as land intensive as crop production. So much about the popularity of free–range chicken and grass–land beef.

Table 3 reports the incomes to land and to structures and equipment for our five sectors, for more aggregate sectors splits, and for the whole economy. We find that agriculture and services have by far the largest land shares. In fact, taking their land income out of their capital income, the resulting shares of structures and equipment are close to the economy–wide average. All other sectors have negligible land shares.

Figure 2: Aggregate capital share in GDP over time according to different methods



6 Robustness

So far we have split proprietors' income in a given industry by assuming that its capital and labor share is the same as in the rest of the industry. Graph 2 plots the aggregate capital share in GDP that results from this assumption together with lower and upper bounds, which result when we assign the entire proprietors' income either to labor or capital. The data comes from from the BEA's Table 1.10. Gross Domestic Income by Type of Income. We find that the upper and lower bounds are fairly far apart, which makes us wonder about how robust our findings are to other ways of splitting proprietors' income.

In this section, we explore the alternative of imputing proprietors' earnings as the product of the average wage paid in the industry and the number of proprietors. To this end, we use the number of "wage and salary workers" (wsw) and "self-employed and unpaid family workers" (sew) by two-digit industries since 2003 as reported by the Current Population Survey of the Bureau of Labor Statistics. Assuming that these numbers are the same in all three–digit industries that belong to a given two–digit industry, we can impute the factor shares in total industry output:

$$\tilde{s}_{ki} \equiv \left(gos_i - \min\left\{ com_i \frac{sew_i}{wsw_i}, pro_i \right\} \right) \frac{1}{g_i}, \tag{7a}$$

$$\tilde{s}_{hi} \equiv \left(com_i + \min\left\{ com_i \frac{sew_i}{wsw_i}, pro_i \right\} \right) \frac{1}{g_i}. \tag{7b}$$

Note that proprietors' income is an upper bound for the imputed labor income of the proprietors, which can actually bind. Examples include the construction sectors, computer and electronic products manufacturing, whole sale trade, and various service sectors. This might interest the IRS.

Table 4 reports the findings. For comparability column 2 also reports our previous results from table 1. It is reassuring that for both methods of splitting proprietors' income the relative capital shares stay roughly the same, that is, agriculture is the most capital intensive sector, followed by manufactured consumption, services, equipment investment, and construction investment. Moreover, the sector capital shares are not far apart, with the exception of agriculture. Note that agriculture is the sector with the largest ratio of proprietors to employees. Finally, the capital shares come out systematically larger when we impute proprietors' earnings than when we split it according to industry–wide shares. A possible reason is that self-employed and unpaid family workers are not full–time equivalent workers, so ignoring this overstates proprietors' earnings.

7 Conclusion

We have measured the U.S. income shares of capital and labor for the standard sectors used in multi–sector versions of the growth model. We have also split the capital shares into the shares of land and of structures and equipment. We have found that these factor income shares differ widely across sectors. For example, the capital share in agriculture is about twice that of construction. Moreover, agriculture and services are much more land intensive than manufactured consumption, equipment, and construction.

We hope that these findings will be useful to applied economists who work with multi–sector models. For better knowledge to the opposite, the common practice so far has been to use the economy–wide income shares also at the sector level. Our findings suggests that this is not appropriate when factor intensities matter, which for example is the case in many international trade applications.

An interesting question is whether the U.S. income shares are representative for other countries. Gollin (2002) and Bernanke and Gürkaynak (2001) found that on average this is the case for the aggregate capital share. We leave it to future research to explore whether on average this is also the case at the sector level.

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Table 4: Sector capital shares with different ways of splitting proprietors' income between capital and labor

	proprietors' income all to labor	factor shares as industry–wide shares	proprietors' earnings imputed	proprietors' income all to capital
Agriculture (a)	0.23	0.44	0.56	0.66
Manufact. consumption (m)	0.33	0.39	0.44	0.47
Services (s)	0.29	0.34	0.39	0.41
Equipment investment (e)	0.27	0.32	0.35	0.39
Construction investment (c)	0.17	0.20	0.22	0.28
Agriculture (a)	0.23	0.44	0.56	0.66
Manufacturing (m+e+c)	0.28	0.34	0.36	0.40
Services (s)	0.29	0.35	0.39	0.41
Consumption (a+m+s)	0.30	0.35	0.40	0.43
Investment (e+c)	0.23	0.28	0.33	0.36
Tradeables (a+m+e)	0.30	0.36	0.41	0.44
Nontradeables (s+c)	0.27	0.32	0.37	0.40
Agriculture (a)	0.23	0.44	0.56	0.66
Nonagriculture (m+s+e+c)	0.28	0.33	0.38	0.41
GDP (a+m+s+e+c)	0.28	0.33	0.38	0.41

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