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Factor Incomes in Global Value Chains
The Role of Intangibles

Wen Chen, Bart Los, and Marcel P. Timmer

10.1 Introduction

The long-run decline in the income share of labor in GDP since the 1980s is one of the most debated macroeconomic trends in recent years. Various studies have documented that the trend is widely shared across industries and countries. While it has been particularly strong in the United States, it has also been observed for other advanced countries and, perhaps surprisingly, also for various emerging and poor countries.[1] Recent research zooms in on potential drivers. Barkai (2017) and Karabarbounis and Neiman (2018) document a large increase in so-called factorless income in the United

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1. See Elsby, Hobijn, and Şahin 2013; Karabarbounis and Neiman 2014; Rognlie 2015; Barkai 2017, and Dao et al. 2017.

States: a residual that remains after subtracting payments to labor and cost of capital from GDP. Karabarbounis and Neiman (2018) argue that it can be alternatively interpreted as economic profits arising from firms' pricing power, as income that accrues to forms of capital that are unmeasured in current national accounts statistics, or as a wedge between imputed rental rates for assets and the rate that firms perceive when making the investment. They argue that it is likely a combination of the three, concluding that the latter is most promising in explaining long-term trends in US GDP income shares.

So far, the discussion on factor incomes has been about shares in GDP of single countries. This chapter argues for the need for a multicountry approach in better understanding the drivers of increasing "factorless income." In today's world, goods are typically produced and distributed in intricate networks with multiple stages of production and extensive shipping of intermediate goods, services, and information. We refer to this as global value chain (GVC) production.[2] So-called factoryless goods producers like Apple provide an iconic example: they sell and organize the production of manufacturing goods without being engaged in the actual fabrication process (Bernard and Fort 2015; Fontagné and Harrison 2017). They capture a major part of the value as compensation for provision of software and designs, market knowledge, intellectual property, systems integration, and cost management, as well as a strong brand name. These assets are key in the coordination of the GVC and in the creation of value. Yet we have no way to directly infer the income that accrues to these "intangibles" due to their nonphysical nature such that their use cannot be attributed to a geographic location. In contrast, tangible assets (such as machinery) and labor have a physical presence, and their use is recorded in the national account statistics of the countries where they are located. A further complication is the fact that GVC production opens up the possibility for profit-shifting of multinational enterprises across countries.[3] More generally, increased cross-border sharing of intangibles is undermining the very notion of country-level factor incomes and GDP. This problem of income attribution is not new and has been discussed in the context of the system of national accounts for quite some time. The 26 percent jump in Irish GDP in 2015 also brought this "statistical problem" to public light and scrutiny.[4] Guvenen et al. (2017) find that US multinationals have increasingly shifted income from intellec-

2. See UNECE (2015) for examples of various types of global production arrangements.

3. Through profit shifting, including transfer pricing and other tax strategies, transnational companies can allocate the largest share of their profits to subsidiaries (Dischinger, Knoll, and Riedel 2014). A firm might not be fully free to do so, as it is bound by cost-pricing rules. Yet, in practice, profit shifting is abundant, involving complex IP arrangements, and this practice is not restricted to affiliated firms only; see Neubig and Wunsch-Vincent (2017). Tørsløv, Wier, and Zucman (2018) estimate that close to 40 percent of multinational profits are shifted to tax havens globally each year.

4. See Halpin (2016). UNECE (2015) and Landefeld (2015) report on the discussions in (inter)national statistical organizations.

tual property rights to foreign jurisdictions with lower taxes, suggesting an understatement of the labor share decline in US GDP.

The presence of GVC production suggests that there is a need to complement conventional factor income studies (at the country-industry level) by study of global value chains (that cross borders). Factor income analysis in GVCs will not be affected by the attribution problem and offers a unique opportunity to track the payments to intangible assets. This chapter is the first to provide such a study at the macroeconomic level.[5] To fix ideas, consider a firm selling shoes using local labor L and tangible capital K. This requires two activities: fabrication and marketing. Both activities require firm-specific knowledge B (e.g., market intelligence on consumers' preferences for particular types of shoes). Next suppose the fabrication stage is offshored to country 2. In this case the (vertically integrated) production function is $Y = F(K_1, L_1, K_2, L_2, B)$. To infer payments to B, we calculate residual profits in the chain as the sales of a good minus the payments to tangible factor inputs needed in any stage of production:

$$rB = pY - \Sigma_n w_n L_n - \Sigma_n r_n K_n,$$

with w_n the wage rate and r_n the rental rate of tangible capital used in country n. pY is the output value of the final good. rB is measured as the residual after subtracting the sum of payments to labor L and to tangibles K across all countries involved in production. We will refer to this residual as payment for intangible assets in the GVC.

It should be noted that, given the residual approach, we measure the combined income to all intangible assets used in a chain and do not attempt to measure the stock of intangibles and their rates of return separately. In their seminal work, Corrado, Hulten, and Sichel (2005, 2009) showed how stock estimates for certain types of intangibles that are currently not treated as investment in the national accounts (such as market research, advertising, training, and organizational capital) could be derived. This requires data on intangibles' investments as well as additional information on their depreciation rates and asset prices. Corrado et al. (2013) provide an updated analysis expanding measurement to a large set of countries. Yet the industry detail currently provided is too aggregate for our purposes. At this stage we therefore remain agnostic about the type of intangibles, their separate stocks, and returns. This is left for future research. Our main aim is to establish the overall importance of payments to intangibles compared to tangible assets and labor.

5. Studying factor incomes in GVCs has a much longer history in case study research going back at least to Gereffi (1994); see Kaplinsky (2000) for an overview. Studies in that tradition are typically more qualitative and analyze how interactions between buyers and sellers in the chain are governed and coordinated. In a seminal case study, Dedrick, Kraemer, and Linden (2010) apply the residual income approach to the value of an Apple iPod, using technical "teardown" reports to trace inputs. They find that Apple retains up to half of the iPod value.

The rest of the chapter is organized as follows. In section 10.2, we outline our GVC accounting methodology. The main measurement challenge is the fact that GVCs are not directly observable in the data and need to be inferred from information on the linkages between the various stages of production. We will build upon the approach to measuring value added in global production networks as introduced by Los, Timmer, and de Vries (2015). They showed how one can derive the value-added contributions of country-industries in a given GVC. This allows for a decomposition of the ex-factory value of a final product into the value added in each stage of production. We use information from so-called global input-output tables that contain (value) data on intermediate products that flow across industries as well as across countries. These are published in the World Input-Output Database (WIOD; see Timmer et al. 2015). This is combined with information on factor incomes in each stage, as discussed in section 10.3. We collected additional information from national accounts statistics on industry-level wages and investment in tangible assets in a wide set of countries. We built capital stocks using the perpetual inventory method and imputed the income payments to tangible capital by multiplying with a standard Hall-Jorgenson type of rental rate. Crucially, we use an ex-ante rate of return such that a residual remains.

Throughout the chapter, we will study factor income distribution in the global production of manufacturing goods. Worldwide consumption of manufactured goods (at purchasers' prices) makes up about a quarter of world GDP (in 2000). This includes value that is added in manufacturing industries as well as nonmanufacturing, such as in transport, communication, finance, and other business services, and also raw materials production. These indirect contributions will be explicitly accounted for by using information on input-output linkages across sectors. Section 10.4 provides main results on trends in factor incomes in GVCs over the period 2000–14 (the beginning and end points of the analysis are dictated by data availability in the WIOD 2016 release). Our main finding is that the share of intangibles in the value of final goods has increased, in particular in the period 2000–2007. Its share is generally (much) higher than the tangible capital income share. This is found at the aggregate as well as for more detailed manufacturing product groups. Nevertheless, there is clear heterogeneity in the pace of the increase. For some nondurable products, such as textiles or food, the intangible share in GVCs increased only marginally. In contrast, the share increased rapidly in durable goods' GVCs, such as machinery and electronic equipment products. We provide suggestive evidence that this variation is linked to variation in the speed of international production fragmentation. Taking the results together, one could consider the 2000s as an exceptional period in which global manufacturing firms benefited from reduced labor costs through offshoring while capitalizing on existing firm-specific intangibles, such as brand names, at little marginal cost. Section 10.5 provides a discussion of the robustness of the main results, concluding that the current system of national accounts is likely to still miss out on a large range of intangible assets, confirming Corrado, Hulten, and Sichel (2005). Section 10.6 offers concluding remarks. The measurement framework puts high demand on the data, and our results should thus be seen as indicative only. This study is explorative and mainly aimed at stimulating further thinking about the interrelatedness of factor incomes across industries and countries.

10.2 Accounting for Factor Incomes in Global Value Chains: Method

In this section, we outline our empirical method to slice up incomes in GVCs. The basic aim is to decompose the value of a final good into worldwide factor incomes. By representing the global economy in an input-output account in the tradition of Leontief, we can use his famous insight to map consumption value of products to value added in industries.[6] We first outline our basic accounting framework and intuition (section 10.2.1). Next, we outline how we trace value added in production stages of the GVC, building upon the method of Los, Timmer, and de Vries (2015; section 10.2.2). We extend this approach by including the distribution stage (section 10.2.3). This stage is ignored in all previous input-output based studies. Yet by overlooking distribution, one might miss out on up to half of incomes generated in GVCs. This is particularly the case for nondurable goods, where retailers capture a major part of the value in delivery from producer to consumer, as shown in section 10.4. This way we are also much more likely to fully capture intangible income in the production of goods, particularly in the case of factory-less goods producers (FGPs). In the current US statistical system FGPs might be classified in wholesaling, and their output is recorded as a wholesale margin rather than as manufacturing sales. See also contributions in Fontagné and Harrison (2017) on this topic.

10.2.1 Preliminary Notation and Intuition

We illustrate our empirical approach in figure 10.1. We distinguish three sets of activities in a global value chain. These are activities in

- the distribution of the final product from factory to consumer (D). This includes transportation, warehousing and retailing activities.

6. This approach of mapping final demand to value added is also used in related settings by Johnson and Noguera (2012), Valentinyi and Herrendorf (2008), and Herrendorf, Rogerson, and Valentinyi (2013). It should be noted that this type of analysis does not depend on, or presume, the production process being linear (“chain”). It is equally valid in any network configuration that can be described by individual stages of production that are linked through trade. To stick with commonly used terms, we refer to all fragmented production processes as “chains,” despite the linear connotation of this term.

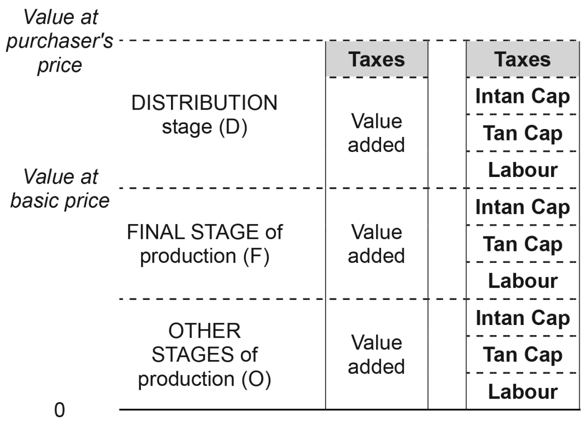

Fig. 10.1 Decomposition of factor incomes in global value chains

- the final stage of factory production (F). This can be thought of as a low-value-added activity such as assembly, packaging, or testing but might also involve high-value-added activities such as placing an engine in a car body.
- all other stages of production (O). This might include the manufacturing of parts and components as well as business services (e.g., legal advice, finance, or consulting) and raw material production (e.g., mining and agriculture).

The sum of value added across the production stages makes up the value of the product at basic (ex-factory) prices. When one adds the value added in the distribution stage plus (net) taxes payed by the final consumer, one arrives at the value of a final product at purchasers' prices (see first pillar in figure 10.1). Subsequently, we decompose the value added in each stage into income payments to labor and tangible and intangible assets (second pillar in figure 10.1). Income to labor and tangible assets can be tracked in the data, and we define income to intangible assets residually.

The three activity sets (D, F, and O) are mutually exclusive and together cover all activities that contribute to the value of the final product. More formally, let p be the consumer (purchaser's) price of a good (adjusted for net product taxes), Y the quantity consumed, and V_x value added in stage x. Then we can state the following accounting identity:

$$pY \equiv V_D + V_F + V_O. \quad (1)$$

In each activity, factor inputs are being used, and we will distinguish between labor (L), tangible capital (K), and intangible capital (B) inputs. Using this notation, we can write the production function of the final good as

$$(2) \qquad \underset{\text{DISTRIBUTION}}{Y = f(B_D, K_D, L_D;} \qquad \underset{\text{FINAL STAGES}}{B_F, K_F, L_F;} \qquad \underset{\text{OTHER STAGES}}{B_O, K_O, L_O)}.$$

The corresponding cost equation is given by multiplying the factor quantities with their respective prices:

$$(3) \qquad pY = \underset{\text{INTAN CAPITAL}}{\sum_{x\in F,O,D} (r_x^B B_x)} + \underset{\text{TAN CAPITAL}}{\sum_{x\in F,O,D} (r_x^K K_x)} + \underset{\text{LABOR}}{\sum_{x\in F,O,D} (w_x L_x)},$$

with w the wage rate and r the rental price for capital. This is our basic decomposition of the output value of a final product into three elements: the income to intangible capital, to tangible capital, and to labor. Some of these variables are observable in the data, while others need to be imputed.

In brief, V_x, $w_x L_x$, and K_x can be observed for each stage, r_x^K will be imputed based on an ex-ante rate of return, and $r_x^B B_x$ will be derived residually in each stage as $V_x - r_x^K K_x - w_x L_x$ (see section 10.3 for more explanation). Our main variable of interest will be the income share of intangibles in the GVC:

$$(4) \qquad \frac{\sum_{x\in F,O,D}(r_x^B B_x)}{pY},$$

to be compared with similarly derived shares for tangible capital and labor. The three shares add to one by construction.

10.2.2 Factor Incomes in Production Stages

Stages in GVCs can be inferred from information on the linkages between the various stages of production. A GVC is defined for a country-industry where the final stage of production is taking place—for example, the GVC of cars finalized in the German transport equipment manufacturing industry. We use information from so-called global input-output tables that contain (value) data on intermediate products that flow across industries as well as across countries. An example is the delivery of inputs from the steel industry in China to the automobile industry in Japan. More formally, our decomposition method builds upon the approach outlined in Los, Timmer, and de Vries (2015). It is a multicountry extension of the method suggested by Leontief (1936).

Leontief started from the fundamental input-output identity, which states that all products produced must be either consumed or used as intermediate input in production. This is written as $\mathbf{q} = \mathbf{Aq} + \mathbf{c}$, in which $\mathbf{q}$ denotes a vector of industry-level gross outputs and $\mathbf{c}$ is a vector with final consumption levels for the outputs of each of the industries. Both vectors contain SN elements, in which N stands for the number of countries and S for the number of industries in each country. $\mathbf{A}$ denotes the SNxSN matrix with input coefficients that describe how many intermediates are needed from any country-industry to produce a unit of output. The identity can be rewritten as $\mathbf{q} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{c}$, in which $\mathbf{I}$ represents an identity matrix. The matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is famously known as the Leontief inverse. It can be used to derive output that is generated in all stages of the production process of one unit of a specific final product. To see this, let $\mathbf{z}$ be an *SN* column vector with a one for the element representing, say, iPhones assembled in China, and all other elements are zero. Then $\mathbf{Az}$ is the vector of intermediate inputs, both Chinese and foreign, that are assembled, such as the hard-disk drive, battery, and processors. But these intermediates need to be produced as well, and $\mathbf{A}^2\mathbf{z}$ indicates the intermediate inputs needed to produce $\mathbf{Az}$. This continues until the mining and drilling of basic materials such as metal ore, sand, and oil required to start the production process. Summing up across all stages, one derives the gross output levels for all *SN* country-industries generated in the production of iPhones by $(\mathbf{I} - \mathbf{A})^{-1}\mathbf{z}$, since the summation over all rounds converges to this expression.[7]

To find the value added by a particular factor—for example, labor—we additionally need wages paid per unit of output represented in an *SN*x*SN* diagonal matrix $\mathbf{H}$. The elements in this matrix are country- and industry-specific: one element contains the wages paid per dollar of output in the Chinese electronics industry, for example. To find the income of all labor that is directly and indirectly involved in the production of $\mathbf{z}$, we multiply $\mathbf{H}$ by the total gross output value in all stages of production given above such that

$$\mathbf{L} = \mathbf{H}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{z}. \tag{5}$$

A typical element in the *SN* vector $\mathbf{L}$ indicates the wages of labor employed in country *i* and industry *j* in the production of $\mathbf{z}$. A similar procedure can be followed to find the incomes of tangible and intangible capital with a suitable chosen requirement matrix (see next section on data). Following the logic of Leontief's insight, the sum over incomes by all factors in all countries that are involved in the production of this good will equal the output value of that product at basic prices. Thus we have measures for production stages F and O in decomposition equation (3).

10.2.3 Factor Incomes in the Distribution Stage

The Leontief method can be applied to decompose value added in various stages of *production*. It remains silent on the value added in *distribution* of the final product to the consumer, however. This is due to the nature of the data used: the distribution sector is represented in input-output tables as a so-called margin industry. This means that the goods bought by the distribution sectors (to be resold) are not treated as intermediate inputs. The gross output of the distribution sector is measured in terms of the

7. This is under empirically mild conditions. See Miller and Blair (2009) for a good starting point on input-output analysis.

"margin"—that is, the value of goods sold minus the acquisition value of those goods. Accordingly, we define the value added in the distribution stage by a margin-to-sales ratio (m) such that

$$V_D \equiv m(pY). \tag{6}$$

We use the factor shares in the wholesale and retailing industries to derive the factor requirements in the distribution stage.

10.3 Data Sources

For our empirical analysis, we use three types of data: world input-output tables, information on distribution margins, and data on factor incomes of industries. The input-output tables and data on labor compensation and value added are derived from the WIOD 2016 release and have been extensively described in Timmer et al. (2015). Important to note here is that the WIOD contains data on 56 industries (of which 19 are manufacturing) in 43 countries and a rest-of-the-world region such that all value added in GVCs is accounted for. In this section, we provide more information on two new pieces of empirical information that are needed additionally: the income shares of tangible (and intangible) capital and data on distribution margins.

10.3.1 Capital Income Shares at the Country-Industry Level

Gross value added (V) and labor compensation (wL) can be derived from national accounts statistics (with appropriate adjustment for the income of the self-employed), and this information is taken from the WIOD. As in Karabarbounis and Neiman (2018), we impute the income to tangible assets and derive intangible income as the residual for each industry i as

$$r_i^B B_i \equiv VA_i - w_i L_i - r_i^K K_i. \tag{7}$$

Tangible asset income for industry i is derived through multiplying tangible capital stock K_i with an (ex-ante) rental price r_i^K. According to neoclassical theory, the rental price (user cost) of capital consists of four elements: depreciation, capital taxes (net of subsidies), (expected) capital gains, and a (net) nominal rate of return (Hall and Jorgenson 1967). For want of data, we abstain from capital taxes in our empirical analysis. The rental price is then given by

$$r_i^K = (\delta_i^K + \rho_i^K) p_i^I, \tag{8}$$

with the depreciation rate δ_i^K, the real (net) rate of return ρ_i^K and the tangible investment price p_i^I. The rate of return is ex ante such that a residual remains in (7), which is the income for intangible capital. The rate of return reflects the opportunity cost of capital in the market. We set it to 4 percent for all tangible assets, following long-standing practice (at least before the financial crisis in 2007). We show in additional robustness analysis that using time-varying rates based on government bond yields, or another alternative instead, will have no significant impact on our main results (reported in section 10.5).

Our definition of tangible capital assets follows the tangible asset boundary in the System of National Accounts (SNA) 2008, including buildings, machinery, transport equipment, information technology assets, communication technology assets, and other tangible assets. Country-industry tangible asset stocks are derived from the EU KLEMS database December 2016 release (Jäger 2016) for Australia, Japan, and the United States and 12 major European countries (Austria, Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Slovenia, Spain, Sweden, and the United Kingdom). For the other countries, we only have stocks by industry but not by asset type. These countries are mostly reporting under the rules of SNA93, which means that the industry-level asset stocks may include some intangible assets—most notably software. They typically constitute a small share, though, as most countries still reporting in SNA93 are poor. Geometric depreciation rates for detailed asset types are taken from EU KLEMS. These rates take into account the differences in the composition of capital assets both across countries and industries as well as over time. We carefully distinguish between various data environments across countries. The appendix in Chen et al. (2017) provides elaborate discussion on a country-by-country basis.

10.3.2 Value Added in Distribution Stage

To measure the value that is added in the distribution stage, we need to have information on the margin-to-sales ratios for final manufacturing goods (m). We derive this from the ratio of output valued at basic and at purchaser's prices. The purchaser's price consists of the basic price plus trade and transport margins in the handling of the product and any (net) product taxes. Put otherwise, the margin is the difference between the price paid by the consumer and the price received by the producer. Margins are calculated from information on final expenditures at purchaser's and basic prices as given in national supply and use tables. This data can be found for most countries in the WIOD (under the heading of national supply-use tables). For China, Japan, and the US, only data at producer prices is given in the WIOD, however. We complemented this with data from detailed retail and wholesale sector censuses. We adjust purchaser's prices for (net) taxes on the products, as these are paid for by the consumer to the government and do not constitute payment for factor inputs in any stage of production.

10.4 Main Results

In this section, we will present our main findings on the factor income shares in global value chains of manufactured goods. As background, it is useful to note that consumption of manufactured goods (at purchasers' prices) makes up about 27.9 percent of world GDP (in 2000, derived from the WIOD). This high number might be surprising given that gross value added in the manufacturing sectors, aggregated across all countries in the world, is only 18.4 percent of world GDP. This is because consumption value of manufactured goods also includes value added from primary goods and services sectors (including distribution).[8] We will map the consumption value of final manufactured goods into income generated for labor and capital in all countries that contributed to production and distribution of these goods. We will do this for 19 detailed manufacturing product groups and also present aggregate results.

The production processes of goods have been fragmenting across borders with major impetuses from the North American Free Trade Agreement (NAFTA) in the early 1990s and China's accession to the World Trade Organization (WTO) in 2001. Previous work on manufactured goods, reported in Timmer et al. (2014), found that the share of labor income in final output was declining over the period from 1995 to 2007. Surprisingly, this was the case not only in those stages carried out in advanced countries but also in stages carried out in less-advanced regions. The former was expected given that offshored stages are typically labor intensive, but the latter finding was not. This highlighted the increased importance of capital in production, as its income share increased in virtually all GVCs. Timmer et al. (2014) hypothesized that this was related to the increased importance of intangibles. With our new data, we are in the position to test this hypothesis, distinguishing between tangible and intangible incomes. We can also investigate trends in the period after 2007.

10.4.1 Finding 1: Declining Share of Labor Income in GVCs

The GVC decomposition results, aggregated across all manufacturing goods, are given in table 10.1. It shows the income shares for labor and tangible and intangible capital as defined in equation (4). Figure 10.2 charts the cumulative changes in factor income shares with the year 2000 as base. We find a strongly increasing capital share and a concomitantly declining trend in the share of labor. The labor share dropped from 56.4 percent in 2000 to 51.8 percent in 2007. This resonates well with previous findings (Timmer et al. 2014).[9] It stabilized afterward: in 2014, the share was 51.2 percent. We conclude that the declining trend in labor share did not continue after

8. And not all manufacturing value added ends up in final manufacturing goods (e.g., when used in production of final services). See Herrendorf, Rogerson, and Valentinyi (2013) for results from a similar exercise mapping consumption to sectoral value added for the US economy.

9. The 2014 study used a previous version of the WIOD (the 2013 release) and did not include distribution activities but only production stages (F and O)—that is, it decomposed output at basic prices. Our extension to output at purchaser's prices did not appear to have a major impact on factor income distribution.

Table 10.1	Factor income shares in GVCs of manufacturing goods (%-share)					
	Labor		Tangible capital		Intangible capital	
	Share (%)	Change	Share (%)	Change	Share (%)	Change
2000	56.4		15.8		27.8	
2001	56.2	−0.2	16.1	0.3	27.7	−0.1
2002	55.1	−1.1	16.2	0.1	28.7	1.0
2003	54.6	−0.5	16.3	0.1	29.1	0.4
2004	53.5	−1.1	16.3	0.0	30.2	1.1
2005	52.7	−0.8	16.2	−0.1	31.2	1.0
2006	52.1	−0.6	16.1	−0.1	31.8	0.6
2007	51.8	−0.3	16.3	0.2	31.9	0.1
2008	51.8	0.0	16.8	0.5	31.4	−0.5
2009	52.2	0.4	17.6	0.8	30.2	−1.2
2010	50.5	−1.7	17.8	0.2	31.7	1.5
2011	50.6	0.1	17.6	−0.2	31.8	0.1
2012	51.0	0.4	17.7	0.1	31.3	−0.5
2013	51.1	0.1	17.8	0.1	31.1	−0.2
2014	51.2	0.1	18.1	0.3	30.7	−0.4

Notes: Share of factor income in worldwide output of final manufacturing products valued at purchaser's prices, before product tax (in percentages). Labor income includes all costs of employing labor, including self-employed income. Tangible capital income includes gross returns to tangible assets based on a 4 per cent real (net) rate of return. Intangible capital income is calculated as a residual (gross value added minus labor and tangible capital income). Own calculations based on the WIOD 2016, extended with data on tangible capital stocks and distribution margins as described section 10.3.

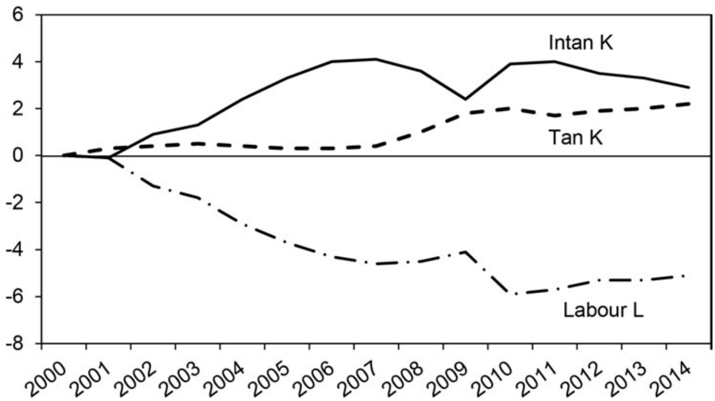

Fig. 10.2 Cumulative percentage point change in factor income shares (2000 base)
Note: See table 10.1.

2007 but also did not reverse. This is suggesting that the decline was not a temporary phase in some kind of business-cycle pattern.

10.4.2 Finding 2: Increasing Share of Intangible Income Share up to 2007 but Not After

A novel finding of this study is that the increasing share of capital after 2000 is mainly due to increasing incomes to intangibles. The income share of tangible capital grew only slowly, from 15.8 percent in 2000 to 16.3 percent in 2007. The low volatility of the tangible share is partly by virtue of its measurement: it is based on a stock estimate multiplied by an ex-ante rental rate, and both variables move only slowly over time. The decline in the labor share was thus mainly mirrored by an increase in the intangible share, which is measured as a residual after subtracting labor and tangible capital incomes. Its share jumped from 27.8 percent in 2000 to 31.9 percent in 2007. This increase was not sustained, however, and even reversed in 2011, declining to 30.7 percent in 2014.

10.4.3 Finding 3: Income Share of Intangible Assets in GVCs Is (Much) Higher Than That of Tangible Assets

Another interesting, and perhaps most surprising, finding is the high income share of intangibles relative to tangible assets. For all manufacturing goods combined, intangible income was 27.8 percent of final output value in 2000 relative to only 15.8 percent for tangible assets, so about 1.8 times as high (table 10.1).[10] The ratio reached a peak in 2007 at 2.0 and gradually declined again to 1.7 in 2014. Similarly high ratios are found for more detailed product groups. In table 10.2, we provide an overview of the factor income shares in 2014 for 12 major manufacturing product groups.

Factor income shares are informative on the factor intensity of production. Traditionally, products are classified as labor or capital intensive depending on the factor intensity of production in the parent industry. With production fragmentation, this classification is less straightforward as factor intensities of all contributing industries need to be considered. The intangible income share is shown to be more than double the tangible share for pharmaceuticals, chemical products, and oil-refining products (see last column in table 10.2). The high ratio for petroleum products is likely related to the importance of brand names, tightly controlled distribution systems, and restricted resource access generating supranormal profits that end up in our

10. In related research, Karabarbounis and Neiman (2018) find what they call the "factorless" income share to be 15 percent of value added in the 2000s in the US private business sector. This is the share that is not attributable to labor or measured capital stocks, using the asset boundary of the SNA 2008 (thus including IPP). Factorless income is found to be larger than measured capital income. In a different exercise, Bhandari and McGrattan (2018) also find a high ratio of intangible to total assets: their estimate of what they call "sweat equity" (firm-specific intangibles) is close to the estimate of marketable fixed assets used in production by private businesses.

Table 10.2 **Factor income shares in GVCs (%-share), major product groups, 2014**

Final product group name	ISIC rev. 4 code	Labor share	Tangible capital share	Intangible capital share	Ratio of intangible to tangible
Petroleum products	19	37.9	20.0	42.1	2.1
Chemical products	20	44.9	17.5	37.5	2.1
Pharmaceuticals	21	48.8	16.5	34.7	2.1
Food products	10t12	52.6	16.4	31.0	1.9
Furniture and other	31t32	53.7	16.3	30.1	1.8
Textiles and apparel	13t15	52.4	17.7	29.9	1.7
Electronic products	26	50.0	18.6	31.3	1.7
Motor vehicles	29	51.3	19.0	29.7	1.6
Electrical equipment	27	50.6	20.0	29.5	1.5
Nonelec. machinery	28	53.9	18.8	27.2	1.4
Other transport equipment	30	55.2	18.5	26.3	1.4
Fabricated metal products	25	55.2	20.8	24.0	1.2
All manufacturing products		51.2	18.1	30.7	1.7

Notes: See table 10.1. Twelve major manufacturing product groups, ranked by ratio of intangible to tangible income share (last column).

residual intangible measure. Pharmaceuticals are known to be highly R&D and patent intensive, which is reflected in the high intangible to tangible income ratio. Perhaps more surprising is the finding that the ratio is also high for textiles and apparel and "other" manufacturing products, which includes, among others, furniture and toys. These products are mainly produced in extensive international supply networks, and value-added generation relies on chain orchestration as well as strong marketing and branding of the products. The ratio between intangible and tangible incomes is lower, but still well above one, for electrical equipment (not including electronics), nonelectrical machinery, and other transport equipment. Their production is characterized by large tangible investments with high minimum efficient scales. The ratio is lowest for metal industries that are characterized by heavy reliance on tangible assets in the form of large-scale smelters and metal processing plants. The ranking of product groups is rather stable of time (not shown).

What type of intangible assets might be responsible for the large income share found in GVCs? One might suspect that intellectual property plays a major role. In the 2008 System of National Accounts (SNA08), investment in intellectual property products (IPP) is tracked. This includes computer software and databases, research and development, mineral exploration, and artistic originals. Thus we can carry out a simple back-of-the-envelope exercise to impute the income accruing to IPP, using information on IPP capital stocks (from national accounts statistics, as reported in EU KLEMS), and proxy the rental price by the IPP depreciation rate (taken as 30 percent) plus

Table 10.3 Income shares for intangible capital in global value chains (percent of final output)

Final product group name	ISIC rev. 4 code	2000	2007	2014	Change 2000–2007	Change 2007–2014	Change 2000–2014
Elec. machinery	27	24.3	31.6	29.5	7.3	−2.1	5.1
Chemicals	20	32.4	36.5	37.5	4.1	1.0	5.1
Vehicles	29	24.8	29.9	29.7	5.1	−0.2	5.0
Metal products	25	19.3	25.6	24.0	6.3	−1.6	4.7
Nonelec. mach.	28	23.3	30.1	27.2	6.8	−2.8	4.0
Electronics	26	28.2	33.8	31.3	5.6	−2.4	3.2
Other transport eq.	30	23.4	29.4	26.3	6.0	−3.1	2.9
Furn. and other	31t32	28.0	30.5	30.1	2.5	−0.4	2.1
Oil products	19	40.5	47.0	42.1	6.5	−4.9	1.6
Food	10t12	29.8	31.1	31.0	1.3	−0.1	1.2
Textiles	13t15	28.7	31.1	29.9	2.4	−1.2	1.2
Pharmaceuticals	21	34.8	37.7	34.7	3.0	−3.1	−0.1
All products		27.8	31.9	30.7	4.1	−1.2	2.9

Notes: Share of intangibles in the final output value of manufacturing products (%). Product groups ranked by change during 2000−2014 (last column).

a real (net) rate of return of 4 percent, as we did for tangible assets.[11] Doing so, we find that the income share to IPP in manufacturing GVCs would amount to 2.4 percent in 2000, hovering between 2.2 and 2.7 percent during the period 2000–2014. It thus can explain only a minor part of the intangible income share that stood at 27.8 percent in 2000. We conclude that there must be a major set of intangible assets that is still outside the asset boundary currently covered in the SNA08. This reinforces the findings of Corrado, Hulten, and Sichel (2005, 2009) and Corrado et al. (2013). They provide estimates for market research, advertising, training, and organizational capital that are currently not treated as investment in the national accounts. Yet the industry detail currently provided is too aggregate to be used for analysis of GVCs of manufacturing products. “Aggregate manufacturing” is the lowest level of industry detail for which data are given.[12] This is a fruitful avenue for future research.

10.4.4 Finding 4: Increase in Intangible Income Is Driven by International Production Fragmentation

In table 10.3 we provide an overview of the changes in intangible income shares for 12 manufacturing product groups. They are ranked according to the change over the 2000–2014 period. There is clear heterogeneity. For some products, such as pharmaceuticals, textiles, and food, the intangible

11. Not all countries have implemented the SNA08, however (most notably China, India, and Japan), so we are not able to carry out a full exercise, but it seems plausible that the majority of IPP is in Europe and the United States.

12. See http://www.intaninvest.net/ for a database covering a large set of countries.

share barely increased over the whole period 2000–2014. An initial increase up to 2008 was almost nullified in the period after. In contrast, the share increased over 2000–2014 by 4.0 percentage points or more in electrical machinery, chemicals, vehicles, metal products, and nonelectrical machinery. For some of these product groups, the intangible income shares increased strongly until 2008, followed by a moderate decline afterward. Yet the share continued to increase in the production of chemicals and barely declined in the production of vehicles.

The variation in intangible income shares across products invites further investigation into possible drivers. One possible hypothesis centers around the speed of international production fragmentation. The period from the mid-1990s until 2008 is characterized by a strong process of fragmentation across borders, sped up by the opening up of China and its joining the WTO in 2001. Yet the impact varied across product groups (Timmer et al. 2016). International fragmentation was, for example, high in the production of electronics (including computers), electrical machinery, and metal products in the 2000s. But production of textiles and furniture was already quite fragmented before 2000. Other products are arguably less susceptible to international fragmentation trends, such as food manufacturing (which has strong domestic supply links for intermediate inputs) and pharmaceuticals manufacturing. To test this hypothesis more formally, we combine our estimates of intangible income shares with information on international fragmentation of production processes. Timmer et al. (2016) provide a new measure that tracks all imports made along the production chain and argue that this is a good indicator for international production fragmentation. In figure 10.3 we plot the change in this indicator for our 19 manufacturing product groups against the change in the share of intangible income in those GVCs from table 10.3 for the period 2000–2008. We find that there is a clear positive correlation (0.52), which fits our conjecture. Yet unexplained variation is still high, and further investigation into the drivers of intangible income shares is warranted.

10.4.5 Finding 5: Increasing Importance of Intangibles in Upstream Production Stages

So far, we have reported on income for factors aggregated over all stages and remained agnostic about the division across stages. Yet our methodology allows one to also track in which stage of the GVC the returns to intangibles are recorded using a straightforward disaggregation of equation (4) by stage: distribution stage, final stage of production, and other upstream stages of production. Results are reported in table 10.4. We find that in 2014 about one quarter of the intangibles income is accounted for in the distribution stage. One quarter is accounted for in the final production stage and about half in other upstream production stages. There is a clear shift away from intangible income recorded in the final production stage (minus 4.2

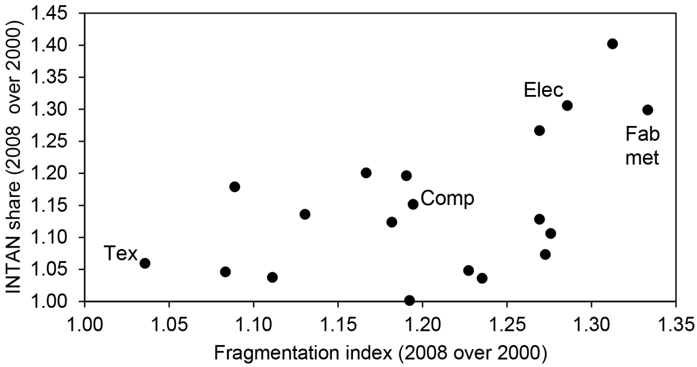

Fig. 10.3 Intangible income shares and international production fragmentation

Notes: Fragmentation index from Timmer et al. (2016) based on all imports made along the production chain (2008 as ratio of 2000 level). Intangible income share in 2008 as ratio of level in 2000. Observations for 19 manufacturing product groups. Observations for textiles (tex), electrical machinery (elec), electronics and computers (comp), and fabricated metal products (fab met) are indicated.

percentage points over the period 2000–2014) to the other production stages (plus 5.5 percentage points). This shift mainly occurred before the crisis of 2008. This finding is consistent with a story of offshoring of final production stages (such as assembly, testing, and packaging) from advanced to low-wage economies such that the incomes in this stage decline rapidly compared to the other stages that remained.

Interestingly, the aggregate trend is not shared across all product groups, which might be related to the type of governance in the chain. Gereffi (1999) proposes a distinction between what he refers to as buyer-driven and producer-driven GVCs. GVCs are governed by so-called lead firms that have a large share of control over the activities that take place in the chain. The lead firm in a buyer-driven chain is typically a large retail chain or a branded merchandiser and often has little or no goods-production capacity. The lead firm in a producer-driven chain is a manufacturer that derives bargaining power from superior technological and production know-how.[13] We find that for buyer-driven GVCs like textiles, furniture, toys, and other manufacturing, the returns to intangibles are mostly realized in the distribution stage (up to 50 percent; see table 10.4). In contrast, in producer-driven GVCs like vehicles, fabricated metal, and other transport equipment, intangible returns are mostly realized in the upstream production stages (up to 60 percent). All

13. Most GVCs are governed in complex ways and combine elements of both governance modes. Governance modes are not necessarily product-group specific. An electronic gadget can be produced in a chain driven by an international retailer (e.g., in the case of a generic nonbranded product) or in a producer-driven chain (e.g., in the case of a high-end branded product).

Table 10.4 **Share of stages in intangible capital income (in %)**

		Distribution stage			Final production stage			Other (upstream) production stages		
Final product group name	Code	2000	2014	Change	2000	2014	Change	2000	2014	Change
Furn. and oth.	31t32	48.3	50.0	1.7	23.1	18.8	−4.3	28.7	31.3	2.6
Textiles	13t15	44.1	50.6	6.5	21.6	14.9	−6.7	34.3	34.5	0.2
Food	10t12	30.6	29.8	−0.8	36.9	30.1	−6.7	32.5	40.1	7.6
Chemicals	20	25.8	23.5	−2.2	35.7	35.9	0.3	38.6	40.5	2.0
Nonel. mach.	28	25.2	23.6	−1.6	26.3	24.4	−1.9	48.5	52.0	3.5
Metal	25	23.2	17.4	−5.7	20.7	20.4	−0.3	56.1	62.1	6.0
Vehicles	29	22.7	16.3	−6.5	26.4	29.3	2.9	50.9	54.4	3.5
Pharma	21	22.1	19.9	−2.1	48.6	46.1	−2.5	29.3	34.0	4.7
Elec. mach.	27	19.7	23.3	3.6	28.1	21.8	−6.3	52.2	54.9	2.7
Oth. trans.	30	17.7	15.2	−2.6	30.5	24.8	−5.7	51.7	60.0	8.3
Electronics	26	17.6	20.7	3.0	38.6	34.9	−3.6	43.8	44.4	0.6
Oil	19	16.8	12.7	−4.1	26.0	20.9	−5.2	57.2	66.5	9.3
All products		28.3	27.0	−1.3	30.8	26.6	−4.2	40.9	46.4	5.5

Notes: Intangible capital income in each stage of GVC, as share in total income for intangibles across all stages, see table 10.1 for sources.

products share the trend of a declining share of the final production stage in intangible income, with the notable exception of vehicle production.

10.4.6 Interpretation

So far, we have interpreted the residual income share in GVCs of goods as payments to intangible assets. Other interpretations are possible. For example, Barkai (2017) suggests that the increase in the residual in US GDP is related to a decline in competition.[14] In our view, competition and the buildup of intangible assets are interrelated. More specifically, we prefer to think of the global market for manufacturing goods in the following way. Final goods are supplied by large firms that organize production in vertically integrated processes spanning across borders. The market structure for final goods is monopolistic competition: each firm supplies a differentiated good and is able to charge a price higher than average costs.[15] A firm derives monopoly power from investment in intangible assets that are specific to the firm. Conceptually, they differ from other factor inputs because, by and

14. Karabarbounis and Neiman (2018) contend that the residual, which they dub "factorless income," also contains a possible wedge between imputed rental rates for assets and the rate that firms perceive when making the investment. In the robustness section that follows, we show that this wedge needs to be extremely large in order to explain away the residual.

15. Romalis (2004) provides a many-country version of a Heckscher-Ohlin model with a continuum of (final) goods produced under monopolistic competition and with transport costs. Mark ups might of course also be the result of a natural monopoly or government regulation. This situation is less likely to be relevant for manufacturing goods that are heavily traded worldwide (with the exception of petroleum products).

large, companies cannot freely order or hire them in markets. Instead, these assets are produced, and used, in-house: they are not reported in balance sheets and not tracked as investment in national accounts statistics. Viewed this way, intangible capital is the firm-specific "yeast" that creates value from hired labor and purchased assets. The residual that remains can thus be interpreted as income to own-account intangibles.

The "yeast" perspective on residual income has old antecedents harking back at least to Prescott and Visscher (1980). See Cummins (2005) for further analysis on firm-level data. It is also related to the concept of sweat equity, defined as the time that business owners spend in building up firm-specific intangibles; see Bhandari and McGrattan (2018) for recent work. They emphasize the importance of organizational capital that is typically built at own-account and not (adequately) picked up as investment in national account statistics. In the appendix, we show through a capitalization-of-intangibles exercise as in Corrado, Hulten, and Sichel (2005) that residual income in a GVC is equal to the income for own-account intangibles when (part of the) workers are assumed to build up firm-specific capital. Under a "steady-state" assumption such that the creation of intangibles in each period is equal to depreciation, the intangible income is shown to be a *net* measure. So in terms of disposable incomes (Bridgman 2018; Rognlie 2015), intangible earnings might be even larger relative to tangible earnings, as the latter is inclusive of depreciation. Yet this is only under the steady-state assumption, which cannot be verified through direct observation.

Taking our findings together, we argue that the 2000s was a unique period in the global economy where supranormal returns to tangibles were (temporarily) captured based on firm-specific intangible assets that went largely unrecorded in national account statistics. Our results support a story in which global manufacturing firms benefitted from increased opportunities for offshoring. Changes in the global economic environment in the early 2000s—in particular China's accession to the WTO and developments in information and communications technology (ICT)—made it profitable to develop extensive global production and distribution networks. Multinational firms built up firm-specific coordination systems, benefitting from increased opportunities for offshoring of labor-intensive activities to low-wage locations. The income accruing to labor in the GVC declined due to wage cost savings. This matches our finding that incomes in final production stages (such as assembly, testing, and packaging) declined rapidly compared to upstream production stages. If the production requirements (and prices) for tangible capital remain unaltered, the share of intangibles must go up by virtue of its definition as a residual.[16] In addition, the growth in purchasing power in the global economy (such as growing consumer demand in

16. This is true only under the assumption that factor substitution possibilities between labor and capital are limited. See Reijnders, Timmer, and Ye (2016) for an econometric analysis of factor substitution and technical change in global value chains. They find wage elasticities to be well below one.

China) might have benefitted incumbent multinational firms that were able to capitalize on existing intangibles such as brand names and distribution systems at little marginal cost. Apparently, this process was interrupted by the financial crisis in 2007, likely related to subsequent heightened uncertainty on future global demand.

10.5 Discussion of Robustness of Main Findings

How robust are our main findings presented in section 10.4? Gross value added and the income payments to labor are recorded in the national accounts. The payments to tangible assets are imputed based on asset stocks and a rental price that includes a chosen rate of return. The higher this rate is set, the higher the tangible income will be and the lower the intangible income, which is measured residually. Setting the real (net) rate of return to tangible assets is not straightforward: from theory it depends on the opportunity cost of capital in the market as well as the expected inflation. It was set at 4 percent in our analysis so far, but alternative choices can be defended as well.

To have an idea about the sensitivity of results, one might ask what rate of return to *tangibles* would exhaust all nonlabor income such that no residual remains. The physical-capital-to-output ratio was about 1.3 (that is, the value of the tangible asset stock relative to final output) in 2000. It follows that the real (net) rate of return to physical capital needs to be as high as 25 percent to exhaust final output, clearly well outside the boundary of plausible rates. For example, Barkai (2017, figure 1) shows that debt costs in the United States, set to the yield on Moody's AAA bond portfolio, declined from about 7 percent in 2000 to 5 percent in 2014. He calculated expected capital inflation as a three-year moving average of realized capital inflation and found it to oscillate around 2 percent. This suggests a small but steady decline in the real rate of return from 5 percent to 3 percent over our period of analysis (2000–2014). Rognlie (2015) took the ten-year Treasury bond yield, subtracting the lagged five-year rate of change of the GDP deflator as a proxy for inflation expectations. This real rate was about 4 percent in 2000, gradually declining to just above 0 percent in 2014. These alternative estimates are relatively close to our chosen 4 percent, so our findings on relative levels of tangible and intangible income appear robust. Moreover, the findings of a *declining* rate of return over the period considered suggests that, if anything, we are *under*estimating the importance of intangibles in later years. For example, using a 0 percent real rate of return instead of 4 percent would indicate that in 2014 the tangible income share was only about 12 percent and the intangible share more than 36 percent: a ratio of 3 rather than barely 2 as we reported. These results suggest that using plausible time-varying instead of a constant real (net) rate of return to tangible assets is strengthening our conclusions on the increased importance of intangibles in manufacturing GVCs.

Yet one might argue that we nevertheless overestimate intangible incomes, as we are using gross value-added statistics that are measured according to the SNA08. Gross value added is defined in the SNA as the value of output less the value of intermediate consumption. In the SNA08, expenditures on IPP are treated as capital formation, not intermediate consumption.[17] This increases the value added but not the *tangible* capital stock. Thus if we take value-added statistics recorded in SNA08, gross value added might be overestimated for our purposes, and so will our intangible income measure through its residual nature.[18] To have an upper-limit estimation of the bias, we assume that all IPP is bought in the market and recorded at cost.[19] Costs of IPP can be proxied by multiplying IPP stocks with the sum of the IPP depreciation rate (taken as 30 percent) plus a real (net) rate of return of 4 percent (as we did before). Doing so, we find that value added (and hence intangible income) in the GVC is overestimated within a range of 2.2 to 2.7 percent during the period 2000–2014. This shows that our main results on the relative levels and growth rates of intangible income are robust to this data issue.

A potentially more serious issue is the asset boundary of tangible capital. We follow the convention of the SNA08 and include fixed assets (such as machinery, equipment, and buildings) but not land and inventories. Yet both land and inventories tie up capital, and their use entails an opportunity cost. Estimating stocks of inventory and land is fraught with difficulties, however. The SNA tracks changes in inventories but not necessarily their value. Land is even more problematic, as land improvement expenditures do fall within the SNA asset boundary—in particular when they are tied with (improved) buildings or infrastructure. The US Bureau of Labor Statistics tries to take into account these assets when constructing their multifactor productivity statistics along the lines of Jorgenson (1995). They find for the manufacturing sector that capital compensation for inventories and land adds about a quarter to the income of the tangible assets covered in the SNA. This can go up to 65 percent in retail and even 100 percent in the wholesaling sector due to the important role of inventories in these sectors.[20] Yet these numbers are based on calculations that use an *ex-post* rate of return, which

17. IPP covers R&D, computer software and databases, mineral exploration, and entertainment and artistic originals. See Koh, Santaeulalia-Llopis, and Zheng (2016) for more information on treatment of IPP by the US Bureau of Economic Analysis (BEA).

18. For countries that still publish national accounts according to SNA93, these imputations will be only small, including an imputation for own-account software at best. More discussion of this overestimation can be found in Chen et al. (2017).

19. This is clearly an extreme assumption, as a major part of IPP is own-account and not purchased. In the United States, the share of purchased is about two-third and own-account is about one-third, while it is 50-50 in the United Kingdom (from additional info in national account statistics).

20. The data are taken from *Bureau of Labor Statistics*, Office of Productivity and Technology, Division of Major Sector Productivity, published on line March 21, 2018, at http://www.bls.gov/mfp/.

exhausts value added, rather than an ex-ante rate as required. As such, the reported incomes also contain all income by assets that are not covered in the analysis. Corrado, Hulten, and Sichel (2005) argued forcefully that many intangibles are still outside the SNA asset boundary, echoed in our finding of a large residual income. In that case, the ex-post rate of return will be overestimated and likewise the rental price of land and inventories—more so because their depreciation rates are zero by nature. We conclude that the capital compensation numbers for income to land and inventories as in the Bureau of Labor Statistics data are not suitable for our purposes. This does highlight, however, that more information on these asset types—in particular, on their stocks—is desirable.

A particular caveat is needed for our findings on intangible incomes in each stage (finding 5). For a proper interpretation of the results, one should realize that what is measured here is the stage where the intangible income is recorded. This does not necessarily imply that the income is also captured by the firms that operate in that stage. For example, compare a situation in which Apple charges the iPhone assembler for its intellectual property with a situation in which it does not. The ex-factory price of the iPhone would be higher in the former case and the measured return to the intangibles consequently lower in the distribution stage. But the measured return to intangibles would be higher in one of the earlier stages of production, as it would include a payment for use of Apple's intangibles. The division of intangible incomes across stages is thus sensitive to accounting practices by lead firms, as discussed in the introduction. Results that are based on aggregating across all stages (which underlie findings 1 to 4) are not sensitive to these shifts.

As a final remark, it should be clear that the validity of all the findings relies heavily on the quality of the database used. Data can, and needs to, be improved in many dimensions. For example, the WIOD is a prototype database developed mainly to provide proof of concept, and it is up to the statistical community to bring international input-output tables into the realm of official statistics. For example, one currently has to rely on the assumption that all firms in a country-industry have a similar production structure, because firm-level data matching national input-output tables are largely lacking. If different types of firms—in particular, exporters and nonexporters—have different production technologies and input sourcing structures (i.e., exporters import larger shares of inputs), more detailed data might reveal an (unknown) bias in the results presented here.[21] From the perspective of measuring intangibles' returns, one of the biggest challenges is in the concept and measurement of trade in services (Houseman and Mandel 2015). Fortunately, there are important developments in the international

21. The development work done by the Organisation for Economic Co-operation and Development (OECD) is certainly a step in the right direction; see http://oe.cd/tiva for more information.

statistical community. Recently, the United Nations Economic Commission for Europe (UNECE) published its *Guide to Measuring Global Production* (UNECE 2015). Building on this are new initiatives, most notably the initiative toward a *System of Extended International and Global Accounts (SEIGA)*. In the short run, this would involve mixing existing establishment and enterprise data (in extended supply and use tables) as well as expanding survey information on value-added chains and firm characteristics. In the longer term, this would entail common business registers across countries, increased data reconciliation and linking, and new data collections on value chains beyond counterparty transactions (Landefeld 2015).

10.6 Concluding Remarks

Recent studies document a decline in the share of labor and a simultaneous increase in the share of residual ("factorless") income in national GDP. We argue that study of factor incomes in GVCs is needed to better understand this residual. This is the first chapter to do so. We show how to measure income of all tangible factor inputs (capital and labor) in a GVC. We define intangible capital income residually by subtracting the payments for tangible factors (capital and labor) from the value of the final product. Importantly, these factors are identified in all stages of production (final and upstream stages) as well as in the distribution stage. This is important, as a large share of value might be added in the delivery of the good to the final consumer rather than in the production stages.

We focus on GVCs of manufactured goods and find a declining labor income share over the period 2000–2014 and a concomitant increase in the capital income share. Our main finding is that this increase in capital income in GVCs is mostly due to the increase in income for intangible rather than tangible assets. This is found at the aggregate as well as for more detailed manufacturing product groups. Yet we also find clear heterogeneity: for some nondurable products, the intangible share increased only slightly, contracting later on. In contrast, the share increased rapidly in durable goods (such as machinery and equipment products). We provide suggestive evidence that this variation is positively linked to variation in the speed of international production fragmentation. Taken together, our results suggest that the 2000s should be seen as an exceptional period in the global economy during which multinational firms benefitted from reduced labor costs through offshoring while capitalizing on existing firm-specific intangibles, such as brand names, at little marginal cost.

We discussed robustness of these results to issues like missing information on land and inventories, value added imputations for some intangibles in the SNA08, and choice for (ex-ante) rate of return to tangible assets. We argued that the level of intangible income might be *over*estimated, but the trend over time is likely to be *under*estimated, if anything. In any case, there is a robust large residual income in GVCs that can be attributed neither to tangible assets nor to the wider asset class considered in the SNA08 (which includes intellectual property products). We reinforce the claim made by Corrado, Hulten, and Sichel (2005) that national account statistics are missing out on a sizeable set of intangible assets. Our conjecture is that most of these are own-account. To bring this hypothesis to the data, one would need information on investment in assets that are (or can be) purchased in the market, to be distinguished from "own-account" investment that is firm specific. Unfortunately, investment statistics from the national accounts typically do not separate own-account and market-mediated investment flows, although company balance sheets might provide information (Peters and Taylor 2017). Hopefully this type of information will be systematically collected and separately reported in future national account statistics. We also emphasized that the measurement framework puts high demand on the data, and our results should thus be seen as indicative rather than definitive.

The main aim of this study was to stimulate further thinking about the interrelatedness of factor incomes across industries and countries. We showed that it mattered in an accounting sense, as the use of intangibles is blurring the attribution of incomes to particular geographical locations and industries in national accounts statistics. In addition, it invites further investigation of the role of governance in global value chains. Gereffi (1994, 1999) highlighted the crucial role of multinational lead firms in the generation and division of value in the chain. In particular, the importance of internationally operating retailers highlights the need to consider the distribution stage alongside production stages that are the traditional confines of empirical GVC studies based on input-output tables. Further research is also needed to identify various types of intangibles and their investment flows, prices, and depreciation rates in macrowork following Corrado, Hulten, and Sichel (2005, 2009) and Corrado et al. (2013) as well as firm-level research, such as in Peters and Taylor (2017). At the minimum, we hope to have convinced the reader that a deeper understanding of global value chains is needed before our measurement systems will adequately capture the importance of intangibles, and their incomes, in today's global economy.

Appendix

Linking "Factorless" Income to Intangible Assets: An Accounting Model

In this appendix, we will outline a simple accounting model that points to a straightforward interpretation of the factorless (residual) income measure in GVCs as reported on in the main text. We will show how, under steady-state conditions, this residual can be interpreted as net income payment to intangible assets. We analyze the case in which the intangible is produced by the firm for own account (i.e., in house). To do so, we follow the capital accounting approach to intangibles as pioneered in Corrado, Hulten, and Sichel (2005).

To fix ideas, we use the example of a multinational firm that sells goods but does not produce them. This firm imports a good—say, shoes—from an affiliate and sells them (at a premium) under its brand name. The firm only employs marketing staff that work on branding. We model the production function of this firm as $Y(L^B,S)$, with Y sales of shoes, L^B number of workers, and S imports of shoes. Let p denote prices, with superscripts indicating the output or input to which it refers.[22] Gross profit of the firm in the distribution stage, π^B, is then given by

$$\pi^B = p^Y Y - w^B L^B - p^S S. \tag{A1}$$

π^B can be observed in the data, yet how should it be interpreted? The brand name is created with a view of generating profits over a longer time period and hence should be considered as a capital input as argued by Corrado, Hulten, and Sichel (2005). In their capitalization approach, the firm is using an intangible asset input—namely, the intangible capital stock B (for "brand"). This stock is generated by the usual accumulation of investments,

$$B_{t+1} = (1 - \delta^B)B_t + I_t^B, \tag{A2}$$

where δ^B is its depreciation rate and I_t^B the investment flow. The firm is producing the brand using its own workers (producing for own account in the jargon of the System of National Accounts). Viewed this way, nominal output of the firm should now also include the value of the assets created—namely, $p^B I^B$ with p^B as the investment price. Factor input costs go up as well: by $r^B B$ with r^B as its user cost, as the brand stock is used. As in the main text, we simplify and write the user cost as

$$r^{B} = (\rho^B + \delta^B)p^B, \tag{A3}$$

where ρ^B is the (net) real rate of return to intangible capital. This rate is pinned down by the requirement that the sum of all factor incomes exhausts output, as we now have included all factors of production. Put otherwise, ρ^B is determined using an *ex-post* endogenous rate of return such that

$$p^Y Y + p^B I^B = w^B L^B + r^B B + p^S S. \tag{A4}$$

It is obvious, but important, to see that the measured returns to intangibles depend crucially on the price the firm is paying for the imported shoes. Suppose the shoes are produced by an affiliated firm, opening up the possi-

22. We only use the time subscript in cases where its omission might generate confusion. Otherwise, it will be suppressed for expositional simplicity.

bility for profit shifting. In that case, returns to intangibles cannot be identified by studying the last stage only. The solution is to consider the profits in the two stages together.

To see this, we also model the fabrication stage (F) of shoes. Assume shoes are fabricated with labor (L^F) and tangible capital (K^F)—say, machines. We can then write

$$\pi^F = p^S S - w^F L^F - r^F K^F, \tag{A5}$$

where π^F is the residual profit measure after subtracting the cost of tangible inputs from gross output in the fabrication stage. The particular division of the profits in the selling and fabrication stages will depend on the price of the shoes, which is an endogenous variable to be set by the lead firm for accounting purposes. However, the overall profit in the chain, ($\pi^R + \pi^F$) is independent of this choice. It equals sales minus the cost of tangible inputs in the integrated production process. Combining (A5) and (A1), we derive

$$(\pi^B + \pi^F) = p^Y Y - (w^B L^B + w^F L^F) - r^F K^F. \tag{A6}$$

Equation (A6) shows how ($\pi^B + \pi^F$) can be measured in the data. The method to do so is outlined in the main text. How can we interpret it? Using (A4) and (A5), we have

$$(\pi^B + \pi^F) = r^B B - p^B I^B. \tag{A7}$$

The left-hand side is observable in the data, but none of the right-hand side variables are. In practice, many alternative combinations of r^B, B, p^B, and I^B are possible that satisfy the accounting restrictions set by the observable data. To simplify, let us consider two extreme cases. First, suppose a start-up firm produced the intangible but is not producing and selling shoes yet. In that case, $w^B L^B = p^B I^B$ and $r^B B = 0$. Alternatively, when the firm stops to produce its intangible but continues selling, it can be said to "exhaust" its brand name. In that case, $(\pi^B + \pi^F) = r^B B$ as $p^B I^B = 0$. An intermediate situation is when the firm is in a steady state such that in each period depreciation of the intangible is equal to new investment:

$$\delta^B p^B B = p^B I^B. \tag{A8}$$

Substituting (A8) in (A7) and using (A3), we find that in this case,

$$(\pi^B + \pi^F) = \rho^B p^B B. \tag{A9}$$

Under a steady-state assumption, the observable profit in the GVC is measuring the returns to intangible assets, net of depreciation. It is thus a net income measure.

A number of characteristics of this measure need to be noted. First, ρ^B is an *ex-post* rate of return. It is calculated to exhaust output minus tangible costs such that all value added is allocated to factors of production. This ex-post rate contains a "normal" rate of return to capital, $\overline{\rho}$, which is the opportunity cost of the invested capital. This rate is by definition similar to the rate for tangible capital assets. Any returns above this can be referred to as "supranormal" such that the rate of return for intangibles can be split into normal returns and supranormal returns: $\rho^B = (\rho^B - \overline{\rho}) + \overline{\rho}$. There are many reasons why the rate of return to intangibles might be different from the rate of return to tangible capital. Beyond the standard business risk, it may include additional compensation for its unusual risk profile (Hanson, Heaton, and Li 2005). Second, for simplicity, we abstained from tax and capital gain considerations in the discussion above as in our empirical work reported on in the main text. This is not to say that they are unimportant; they are simply unknown, and further work is needed in this direction. Third, equation (A9) shows that intangible income measured by $(\pi^B + \pi^F)$ can increase because of an increase in its rate of return, ρ^B, or because of an increase in the nominal stock, $p^B B$. Without quantifying the stock, we are not able to distinguish between the two. More generally, the firm might not be in a "steady state," driving a wedge between depreciation and new investment. This wedge will also be absorbed in $(\pi^B + \pi^F)$. Without further information on intangible depreciation, prices, and quantities (δ^B, I^B, and p^B), we will not be able to separate changes in stocks and in rates of return. Corrado, Hulten, and Sichel (2005, 2009) and Corrado et al. (2013) provide stock estimates for intangible assets that are currently not treated as investment in the national accounts. This is a fruitful avenue for future research.

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