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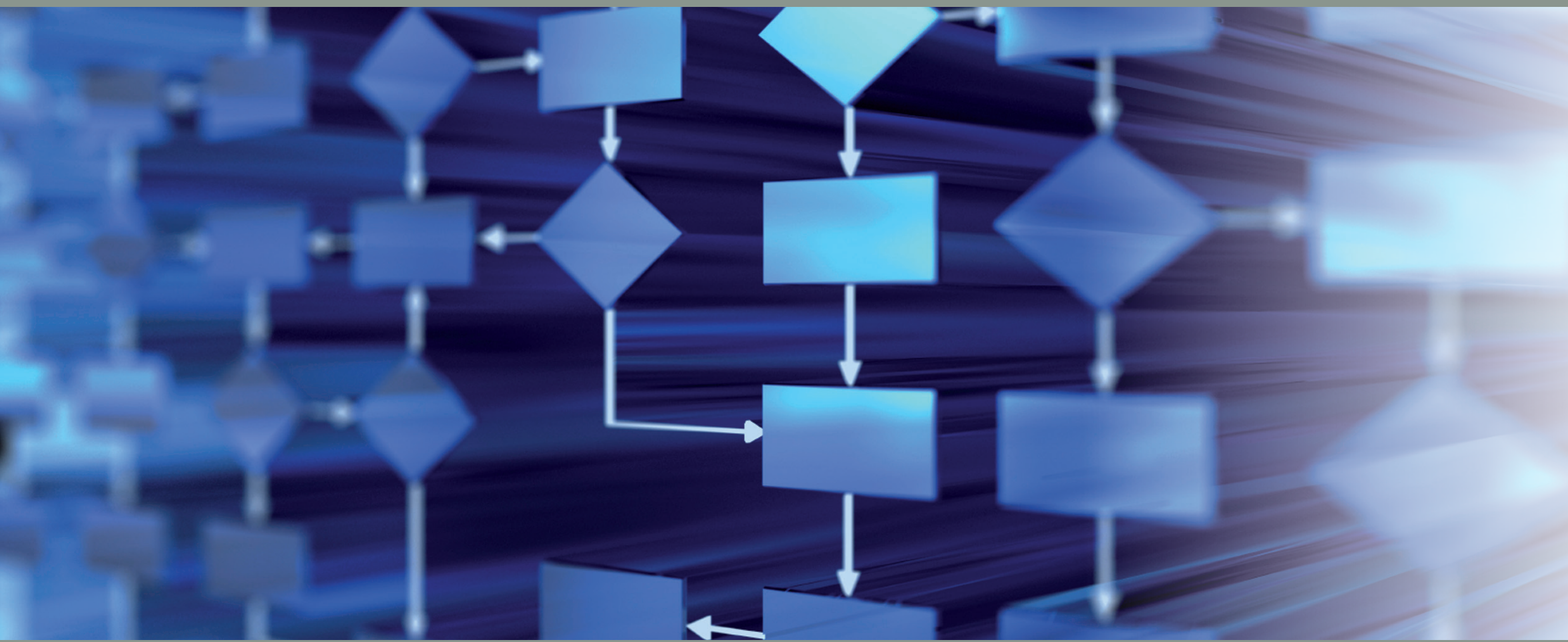

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# Measuring the income to intangibles in goods production: a global value chain approach

**Wen Chen, Reitze Gouma, Bart Los and Marcel P. Timmer**[1]

## Abstract

Today's production processes are fragmented across countries and industries. Intangibles play an important role, but their measurement is elusive. Their use is not bound by a location and they can be shared across plants. We propose a new empirical framework to measure factor incomes in production that spans industries and countries. We define intangible capital income residually as the difference between the value of a final product and the costs of all tangible factor inputs (capital and labour) in any stage of production. We bring this to the data using the WIOD and additional national account statistics on capital stocks. For manufactured products we find that the share of intangible capital income in final output increased rapidly since 2000, levelling off after 2008. In 2014 it stood at about 31 per cent. This is much higher than the tangible capital income share (18 per cent). For pharmaceuticals, furniture, textiles and food the intangible income share remained roughly constant over 2000-2014. In contrast the share increased rapidly for machinery and equipment products until 2008, slightly declining afterwards. We find that across all products about one quarter of the intangibles incomes is realised in the distribution stage (from factory to consumer). One quarter is realised in the final production stage and half in other production stages. The latter has increased in particular in the early 2000. We discuss measurement problems and stress the explorative nature of the exercise.

**Keywords:** global value chain, intangibles, tangible and intangible capital, national accounts

## Disclaimer

The views expressed in this article are those of the authors and do not necessarily reflect the views of the World Intellectual Property Organization or its member states.

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## 1. Introduction

**What is the importance of intangibles in today's production of goods?** We argue in this paper that to answer this question one needs to take a global value chain perspective. Today's production processes are fragmented across countries and industries. Factory-free goods producers provide an iconic example: they sell and organise the production of manufacturing goods without being engaged in the actual fabrication process. More generally, goods are typically produced and distributed in intricate networks with multiple stages of production and extensive shipping of intermediate goods and services. We refer to this as the **global value chain** (GVC) production.

Intangibles play an important role in these production networks, but their measurement is elusive (see Box 1 for a case study of the iPod). A major issue is that their use is not bound by a location, in contrast to tangible assets (such as machinery) that by nature have a presence at a particular location. Moreover, due to their non-rival nature they can be shared across plants and countries. This implies that income to intangibles (as recorded in national statistics) can be accounted for in various stages. Single stage studies of intangibles, that is, focused on one industry in a country, are very likely to obscure the role of intangibles in global production processes. **In this paper we use the empirical framework of GVC production to measure the income shares of labour, tangible assets and intangibles assets**. This will provide for the first time a comparison of their relative importance in the production of manufactured consumer or capital goods.

To fix ideas, we think of the global market for manufacturing goods in the following way. Final goods are supplied by large firms that organise production in vertically integrated processes spanning 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. The firms derive their monopoly power from investment in firm-specific assets. We refer to these as intangibles, such as patents, trademarks, brands, (customer) databases and management of production and supplier networks.

They differ from other factor inputs because, by and large, companies cannot freely order or hire them. Viewed this way, intangible capital is the "yeast" that creates value from labour and purchased assets (see also Prescott and Visscher, 1980 and Cummins, 2005, for similar views). In line with this we **define intangible capital income residually as the difference between the value of a final product and the costs of all tangible factor inputs (capital and labour) in any stage of production.**

**BOX 1: Example: intangibles in the production of the iPod**

The study of Apple's iPod by Dedrick et al. (2010) nicely illustrates the concepts involved in measuring intangible income in GVC production. [2] In their seminal case studies of electronic products they decomposed the retail price of a product into earnings for the various participants in the chain. The production process of the iPod is exemplary for the global fragmentation of production processes with intricate regional production networks feeding into each other. It was assembled in China from several hundreds of components and parts sourced from around the world. So-called "teardown" reports provided technical information on the parts and components used in the assembled product (such as the hard-disk drive, display and memory) as well as their market prices. All in all, the intermediate inputs were estimated to cost US$ 140. The cost of assembly was estimated to be no more than 4$. The *retail price* of the 30GB Video iPod at the time of study was 299$. This left a residual value of 145$ (see Dedrick at al., 2010, Table 2). An unknown share was captured by local distribution and retailing services in the country where the iPod was sold. The remaining balance was assumed to accrue as income to Apple, the lead firm in the chain. This was considered as compensation for Apple's provision of software and designs, market knowledge, intellectual property, system integration and cost management skills as well as a high-value brand name.

Note that the authors were not able to directly measure the returns to Apple's intangibles. This is because these returns could be realised in various stages, depending on Apple's (unknown) accounting practices that involve royalty payments for licenses, transfer pricing of intermediates and more generally profit shifting across locations. As such, our approach can be considered as the macro-economic equivalent of Dedrick at al. (2010). The macro-economic counterpart to the teardown reports is information from so-called global input-output tables that contain (value) data on intermediate products that flow across industries as well as across countries. In parallel to the development of this report, Dedrick et al (2017) produced similar estimates for the iPhone 7 and some competing high-end smartphones.

Our approach to the measurement of intangibles is a **complement to the "capitalisation" approach** introduced by Corrado et al. (CHS, 2005). We differ in a number of ways. First, in the latter approach, intangible assets are treated as being much like any other (quasi-fixed) factor of production, replacing it when it is worn-out. Rates of return are assumed to be equal across all assets, following the Jorgenson-Griliches capital cost approach. An ex-post rate of return is set such that capital and labour costs exhaust value added. We follow the Schumpeterian approach instead, and allow for heterogeneity in returns across assets. We use an ex-ante rate of return to derive the costs of tangible capital such that there is a wedge between value added and factor input costs (see e.g. Barkai, 2017 for similar calculations for the US economy).[3] This wedge is generally known as a mark-up. We view the existence of mark-ups as being the consequence of firm-specific intangible assets that sustain monopoly power. The size of the mark-up reflects the (net) income to intangibles (see next section for the formal accounting set-up)

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[2] Dedrick at al. (2010) provide similar decompositions for some other high-end electronic products such as notebooks, see also Ali-Yrkkö et al. (2011) for a study of mobile phones. Kaplan and Kaplinsky (1999) is a seminal contribution on South African peaches. The GVC approach has a much longer history going back at least to Gereffi (1994), see Kaplinsky (2000) for an overview. Studies in that tradition are typically more qualitative and analyse how interactions in these increasingly complex systems are governed and coordinated.

[3] In a recent study Clausen and Hirth (2016) derive a firm-level excess rate of return by dividing (value added minus labour cost) by the book value of tangible assets. They show for a set of U.S. firms that this residual measure serves as an additional factor to explain firm stock value.

Second, given the residual approach we limit ourselves to measuring the overall incomes to all intangibles in the chain. This is in contrast to the capitalisation approach that aims at deriving stock (and income) estimates for detailed asset types. The latter requires data on intangibles investments as well as additional data on their depreciation rates and asset prices.

Third, we expand our understanding of the role of intangibles in multi-stage production chains. Our unit of analysis is the vertically integrated production chain of a good, rather than individual industries or a firms. This is important as income to intangibles (as recorded in national statistics) can be accounted for in various stages (see discussion in Box 2). We will identify in what stage of production the intangible profits are realised, and show that it differs across products.

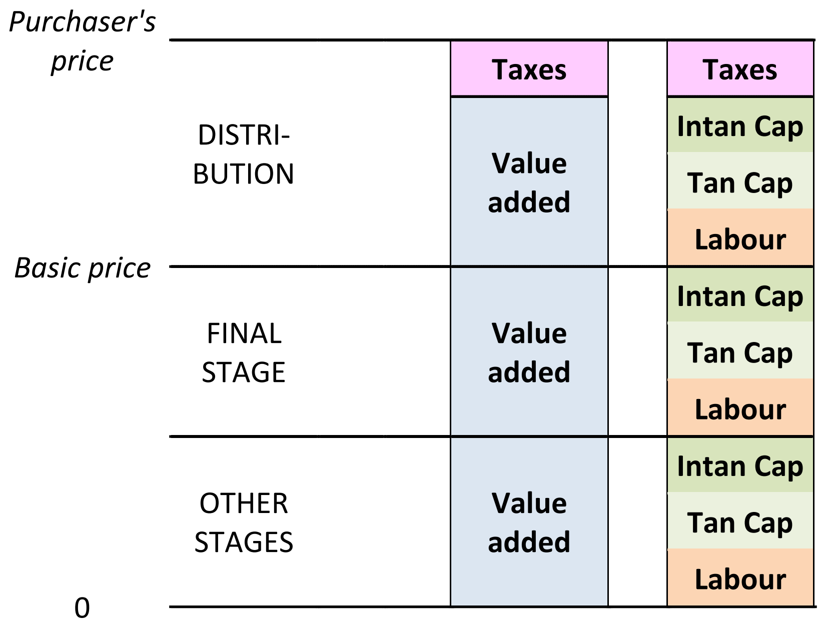
Finally, it is important to note that conceptually the distinction is not so much between tangible and intangible assets, but rather between in-house produced ("own account") assets and market mediated ("purchased") assets. We will use the terms (in)tangibles nevertheless as empirically most of the tangibles will be purchased, while most of the intangibles will be produced by the firm itself (this is further discussed in section 4).

**BOX 2: Intangibles in stages of the GVC**

Consideration of all stages in the GVC is paramount in the measurement of income to intangibles. For example, when a company like Dell is selling PCs manufactured in China through its own retailing channels in the US the profit is likely to be recorded in the distribution sector. Alternatively, when the car body of a Porsche is completed in the Czech Republic and the car is finalised in Germany by adding the engine, then profits are likely to be recorded in German car industry (the last production stage). But in other cases profits might even be recorded deeper down the production chain, for example when Windows software is used as an input in PC assembly by a non-brand manufacturer. Much depends on the configuration of the GVC and in particular the position of the firms that control the intangibles and secure profits through creating high entry barriers into these activities (Shin et al., 2012). For example, compare a situation in which Apple charges the iPod assembler for the intellectual property used with a situation in which it does not. The basic price of the iPod (ex-factory) would be higher in the former case and the return to the intangibles consequently lower in the distribution stage. But the return to intangibles would be higher in one of the earlier stages of production as it would involve a payment for use of Apple´s intangibles. It will thus lead to a shift in the location of the profit in a particular stage, but not affect the overall profits to intangibles in the GVC.

**We confront various measurement challenges**. Most prominently, GVCs are not observable and need to be inferred from information on the linkages between the various stages 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. An example is the delivery of inputs from the steel industry in China to the automobile industry in Japan. This information is taken from the world input-output database (WIOD, see Timmer et al. 2015). GVCs for products are defined by the country-industry where the final stage of production is taking place, e.g. cars finalised in the German vehicle manufacturing industry. We built upon the GVC decomposition approach introduced by Los et al. (2015). This allows for a decomposition of the ex-factory value of a product into the value added in each stage of production. The next challenge is to identify factor incomes in each stage. We measure income to intangibles as a residual by subtracting the costs for tangible capital and for labour from value added in each country-industry.

**Figure 1: Global value chain decomposition**




**We illustrate the outcome of our approach in Figure 1.** We distinguish the distribution stage of the product to the consumer, the final production stage and other (upstream) stages of production. The final stage can be thought of as a low-value added activity such as assembly or packaging, but might also involve high value-added activities such as customisation of products or producing and adding an engine to a car. Other stages of production involve the production of intermediates to be used in the final stage, or in any earlier stage of production.[4] The sum of value added across the final and other production stages makes up the value at basic (ex-factory) prices. We add the value added in the distribution stage plus (net) taxes payed by the final consumer to arrive at the value of a final product at purchasers' prices (see first pillar in Figure 1). As a result we can decompose the value of a final product (as paid for by the consumer) into value added by tangible and intangible production factors in a second step (last pillar in Figure 1).

[4] The fragmentation of production processes can take many forms, sometimes characterized as "snakes" and "spiders" (Baldwin and Venables, 2013). Snakes involve a sequence in which intermediate goods are sent from country A to B, and incorporated into intermediate goods sent from B to C, and so on until they reach the final stage of production. Spiders involve multiple parts coming together from a number of destinations to a single location for assembly of a new component or final product. Most production processes are complex mixtures of the two. To stick with commonly used terms, we refer to all fragmented production processes as "chains", despite the "snake"-like connotation of this term. The validity of our approach is not depending on a particular configuration of stages.

This new approach allows us to provide novel insights. For the first time, we will be able to study the evolution of the income to intangibles and compare this with the incomes to tangibles and labour. Throughout the paper we will study the GVCs of final manufacturing goods. It is important to note that these GVCs do not coincide with all activities in the manufacturing sector. They also include value-added outside the manufacturing sector (such as business services, transport, and communication and finance) and value-added in raw materials production. These indirect contributions will be explicitly accounted for by the modelling of input-output linkages across sectors. On average, they make up about 40 to 50% of the overall value added in manufacturing GVCs (Timmer et al., 2013).

**The main findings are as follows:**

1. The share of capital income has rapidly increased in the first half of the 2000s. But there was a clear levelling off after the financial crisis.

2. The share of intangible income rapidly increased in the first half of the 2000s, levelling off after 2008. In 2014 it stood at about 31 per cent. This is much higher than the tangible capital income share (18 per cent).

3. There is large heterogeneity across manufacturing product groups. For some products (such as pharmaceuticals, furniture, textiles and food) the intangible income share remained roughly constant over 2000-2014. In contrast the share increased rapidly in machinery and equipment products (computer, optical, other electrical as well as non-electrical) until the crisis, slightly declining afterwards.

4. We find the intangible income share in 2014 to be higher than the tangible share for all nineteen manufacturing product groups. The intangible income share is even more than double the tangible share for pharmaceuticals, chemical products and oil refining products.

5. On average, we find that about one quarter of the intangibles incomes is realised (accounted for) in the distribution stage. One quarter is realised in the final production stage and half in other production stages. The latter has increased in particular in the early 2000s.

6. We find large heterogeneity across products. For products like textiles and furniture, more than half of the intangible income is realised in the distribution stage. In contrast, for machinery we see a strong shift of intangible incomes to be realised in stages *before* the final production stage.

The rest of the paper is organised as follows. In section 2 we provide a parsimonious model that provides a foundation for our empirical approach. This provides a model-based interpretation of the GVC profit residual. It also illustrates the need to take all stages of production into account. In section 3 we outline our GVC accounting methodology. In section 4 we discuss data sources. Section 5 presents the main results and section 6 provides concluding remarks. We stress that this study is explorative and mainly aimed at setting out a new framework. It puts high demand on the data and our results should thus be seen as indicative only.

**Section 2 A simple intangible accounting model**

In this section we will outline some simple accounting equations that motivate our empirical approach and provide a more formal definition of our intangible income concept.

Analyses of intangible incomes confront three main challenges. First, production is internationally fragmented into stages taking place in distinct geographical locations. Value is added in each stage and these stages along the chain need to be identified. Second, the *stock* of intangible capital used in each of these stages is typically unknown. And third, the *returns* to an intangible, while belonging to a firm in a particular stage, can be statistically recorded in the value added of any of the stages. This does not necessarily correlate with the actual ownership. Our proposed solution is to analyse intangible returns through the lens of a global value chain, and not for individual production stages.

The starting point of the analysis is the value of a final good at the price paid for by the consumer. And we will measure how much of this value ends up as income for owners of intangible capital used in its production. By focusing on this simpler statistic we abstain from a more ambitious attempt to measure a capital *stock* of intangibles (which entails measuring investment prices and depreciation rates as well). Compared to the ongoing research on intangible investments by industries and countries (originating from the seminal study by CHS 2005) we are thus taking one step back. But at the same time we extend the analysis in another direction by studying the role of intangibles in production chains that extend across industries and countries.

The key observed variable in our data is **residual profits measured as gross output minus tangible input costs**. We first show how this residual can be interpreted as net intangible income. To do so we rely on the capital accounting approach. We then turn to analysing the role of intangibles in a vertical production chain.

### 2.1 Interpreting profits as a measure of intangible capital return

To fix ideas, let us start with the example of an archetypical firm that sells goods, but does not produce them. This firm imports a good, say shoes, and sells them (at a premium) under its brand name. The firm only employs marketing staff. We model the production function of this firm as $Y(L,S)$, with Y sales, L number of workers and S number of shoes.[5] Let $P$ denote prices, with superscripts indicating the output or input to which it refers. Gross profit of the firm, $\pi$, is then given by:

$$(1) \qquad \pi = P^Y Y - P^L L - P^S S$$

All these variables are observed in the data. The crucial assumption we make is that we allocate all profits to the firm as income to intangible capital, $B$, so:

$$(2) \qquad B = \pi$$

Using (1):

$$(3) \qquad P^Y Y - P^S S = B + P^L L$$

This provides us with a straightforward distribution of value added, $(P^Y Y - P^S S)$, into income for labour, $P^L L$, and for the owner of intangible capital, $B$. We refer to the latter as *intangible income* in the remainder of this study.

How to interpret *B*? In short, we will argue that, under weak assumptions, it is a **net (pre-tax) income concept.** In order to link this to intangible capital, we need to model this firm alternatively using the capitalization approach (as in CHS). Intangibles are created with a view of generating profits over a longer time period and hence should be considered as a capital input. In this approach the firm is using a new input, namely the intangible capital stock (R, say “brand name”) so that: $Y(L,R,S)$. I n each period intangible capital services are used given by $P^R R$, with $P^R$ its user cost. New intangible capital is produced (*I*) and added to the stock in each period. Importantly, the firm is producing this asset using its own workers.

[5] We only use the time subscript in cases where its omission might generate confusion. Otherwise it will be suppressed for expositional simplicity. The production factor tangible capital will be introduced later in an extension.

In this set up the nominal output of the firm is now given by $P^Y Y + P^I I$. Input costs for the firm are now given by $P^S S + P^L L + P^R R$. [6] We have covered all inputs, and hence we can assume that profits in this case are zero: input costs equals output.[7] Rearranging we can write:

(4) $$P^R R = P^Y Y + P^I I - P^S S - P^L L.$$

Using (3) and rearranging:

(5) $$B = P^R R - P^I I.$$

According to theory, the user cost of capital consist of four elements: depreciation, capital taxes (net of subsidies), (expected) capital gains and a (net) rate of return (Jorgenson and Lin, 1991). For simplicity of exposition we abstain from (net) tax and capital gain considerations here. Then, user costs are given by:

(6) $$P^R = (\rho^R + \delta^R)\, P^I,$$

where $\rho^R$is the net rate of return to intangible capital, and $\delta^R$ its depreciation rate.

The stock of intangibles ($R$) is generated by the usual accumulation of investments:

(7) $$R_{t+1} = (1 - \delta^R) R_t + I_t \;,$$

To simplify, let us further assume that the firm is in a steady-state such that depreciation is equal to new investment. [8]

(8) $$\delta^R P^I R = P^I I.$$

Substituting (8) and (6) in (5) we find:

(9) $$B = P^R R - P^I I = \rho^R P^I R.$$

Thus we have shown that in this case ***B* is a measure of *net intangible income*.**

A number of characteristics of *B* need to be noted. First, the rate of return on intangibles, $\rho^R$, is an *ex post* rate. It is calculated to exhaust value added minus tangible costs, such that there is no residual profit left. This ex post rate contains a 'normal' rate of return to capital, $\bar{\rho}$, which is the opportunity cost of the invested capital. This is similar to other capital assets. Any returns above this can be referred to as 'supra-normal' such that *B* can be split into normal returns and supra-normal returns:

(10) $$B = (\rho^R - \bar{\rho}) P^I R + \bar{\rho}\, P^I R$$

There are many reasons why the rate of return to intangibles can be different from the rate of return to other (tangible) capital. Beyond the standard business risk, it may include additional compensation for its unusual risk-profile (Hansen, 2005). It

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6 Note that these are notional input and output values. They are not observable in the data as no actual payments is being made for intangible services. They are on "own account".

7 Put otherwise, the user cost of intangibles is determined using an ex-post endogenous rate of return that exhausts output, as further discussed in the main text.

8 In the remainder we continue to work under this simplifying assumption. This does not affect the major insights we wish to derive from the accounting framework.

may also be interpreted as a mark-up in monopolistic competitive goods market (Barkai, 2017). As outlined in the introduction we view this monopoly mark up as the result of intangible investments by the firm. But it might also contain pure monopoly rents.

Second, for simplicity we abstained from tax and capital gain considerations in the discussion above. Also in our empirical work we will not be able to measure these. This is not to say that they are unimportant, but simply unknown and further work is needed in this direction.

Third, equation (8) shows that intangible income measured by *B* can increase because of an increase in its rate of return $\rho^R$, or because an increase in the stock $P^I R$. Without quantifying the stock, we are not able to distinguish between the two.

Fourth, the firm might not be in a "steady state", driving a wedge between depreciation and new investment. This wedge will also be absorbed in *B*. However without further information on $\delta^R, R, P^I$ and $I$ we will not be able to know this.[9]

So in conclusion, our intangible income measure is a **net pre-tax income concept**. As we cannot measure the stock of intangibles, we are not able to relate changes in the intangible income to changes in the stock or changes in the (net) rate of return, supra-normal profit rates and/or depreciation. This is a limitation of the approach. But the advantage is that we are now in the position to extend the analysis to a situation where production is fragmented into geographically distinct stages. This is our novel contribution to the study of intangibles.

[9] Continuing our example, when the firm stops to produce its intangible (no labor employed anymore) but continues selling, it can be said to "exhaust" its brand name. In that case *B* will contain also the depreciation of the intangible. See Barkai (2017) for further discussion.

## 2.2 Intangible income in a global value chain

It is obvious, but important, to see that the measured income to intangibles of the firm depends crucially on the price it is paying for the shoes. Profits can be shifted across locations making the geographical attribution of income to intangibles arbitrary.[10] Put otherwise, by observing the profit in the selling stage only, we are likely to mismeasure the returns to intangibles. The solution is to consider the profits in the two stages together. So see this, we continue our example and model the fabrication stage of shoes as $S(L^F, K^F)$. Shoes are produced with labor ($L^F$) and tangible capital ($K^F$), say machines. We can then write:

$$(11) \qquad \pi^F = P^S S - P^{LF} L^F - P^{KF} K^F \,,$$

where $\pi^F$ is the residual measure after subtracting cost of tangible inputs from gross output. Recall that for selling of the shoes: $\pi^R = P^Y Y - P^{LR} L^R - P^S S$, where superscripts *R* have been added where needed to refer to the selling stage. Both profit measures depend on $P^S S$. The overall profit in the chain is independent of this and equal to

$$(12) \qquad B = \pi^R + \pi^F = P^Y Y - (P^{LR} L^R + P^{LF} L^F) - P^{KF} K^F.$$

In order to bring this measure to the data we need to use the GVC approach to trace the labour *L* and tangible capital *K* involved in any of the stages. In addition we need to measure the user cost of tangible capital *K*:

$$(13) \qquad P^{KF} = (\bar{\rho} + \delta^K)\, P^{IK} \,,$$

with $\delta^K$the depreciation rate, $P^{IK}$ the price of tangible investment and $\bar{\rho}$ an ex-ante real rate of return. In the empirical application we will use a rate of 4 per cent. This allows us to derive the residual profit B.

Summarising, we calculate residual profits in the chain as sales minus the costs of tangible inputs. This can be interpreted as (net) income for intangible capital in the GVC of shoes.

[10] This is due to so-called transfer pricing. For tax reasons the firm might not be fully free to do so, and bound by cost-pricing rules. In practice profit shifting is abundant, involving complex IP arrangements. Note also that this practice is not restricted to affiliated firms only, see Neubig and Wunsch-Vincent (2017).

## 3. Global Value Chain (GVC) accounting

In this section we outline our method to slice up global value chains (GVCs). The basic aim of this empirical analysis is to decompose the value of a final good into a stream of factor earnings around the world. By modelling the world economy as an input-output model in the tradition of Leontief, we can use his famous insight that maps consumption of products to value added in industries. We first outline our basic accounting framework in section 3.1. In section 3.2 we outline how we trace value added in production stages of the GVC. This follows the approach outlined in our previous work (Los et al., 2015). I n section 3.3 we discuss our measurement of value added in the distribution stage, which has been ignored in macro GVC studies so far. All our measures are based on statistics collected within the framework of the SNA and typically refer to gross measures (inclusive of depreciation) unless otherwise noted (see section 4 for more discussion).

### 3.1 Basic accounting framework

In our empirical approach we focus on three sets of activities in a global value chain (see also Figure 1). These are activities in:

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

- 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.

- all other stages of production (*O*). This might include the manufacturing of components to be used in the final stage, but also business services or more upstream activities in e.g. raw material production.

These 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, *Y* the quantity consumed and *VA* value added then we can state the following accounting identity:

$$PY \equiv VA_F + VA_O + VA_D. \tag{14}$$

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

$$Y = f(\underbrace{KI_F, KT_F, L_F}_{\text{FINAL STAGE}};\ \underbrace{KI_O, KT_O, L_O}_{\text{OTHER STAGES}};\ \underbrace{KI_D, KT_D, L_D}_{\text{DISTRIBUTION}}) \tag{15}$$

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

$$\begin{aligned} PY = {} & (r_F^{KI} KI_F + r_F^{KT} KT_F + w_F L_F) && \text{FINAL STAGE} \\ & + (r_O^{KI} KI_O + r_O^{KT} KT_O + w_O L_O) && \text{OTHER STAGES} \\ & + (r_D^{KI} KI_D + r_D^{KT} KT_D + w_D L_D) && \text{DISTRIBUTION} \end{aligned} \tag{16}$$

with *w* the wage rate and *r* the rental price for capital that may differ across tangible and intangible assets. It may also differ across stages, since the asset-mix is likely to vary over these. Note that we do not observe the capital rental prices in the data and that these are imputed (see next section).

Equation (16) shows how one can decompose the output value of a product into the incomes for factor inputs in various stages of production. Based on this we derive two measures that play a central role in our empirical analysis. Rearranging (16) we arrive at:

(17)
$$PY = \underbrace{\sum_{x \in F,O,D} (r_x^{KI}\, KI_x)}_{\text{INTAN CAPITAL}} + \underbrace{\sum_{x \in F,O,D} (r_x^{KT}\, KT_x)}_{\text{TAN CAPITAL}} + \underbrace{\sum_{x \in F,O,D} (w_x L_x)}_{\text{LABOUR}}$$

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 labour. We will report on the share of intangibles:

(18)
$$SHARE\ (KI) = \frac{\sum_{x \in F,O,D} (r_x^{KI}\, KI_x)}{PY}$$

and similarly for the other factor inputs.

In a second decomposition, we will focus on the location of intangible returns in the three sets of activities. For intangibles in the final stage the share is given by:

(19)
$$SHARE\ (KI, F) = \frac{r_F^{KI} KI_F}{\sum_{x \in F,O,D} (r_x^{KI}\, KI_x)}$$

and similarly for the other stages

### 3.2 Accounting for value added in production stages

Measuring factor incomes in the distribution and final stage of production is relatively straightforward, as discussed in the next section. But the GVC approach also requires the identification of the upstream stages of production. This requires an additional method to trace out these stages. Our decomposition method for the value added in the production stages of GVCs is grounded in the approach outlined in Los, Timmer and de Vries (2015). It relies on a multi-country extension of the method outlined 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, $\mathbf{c}$ is a vector with final consumption levels for the outputs of each of the industries. Both vectors contain $SN$ elements, in which $S$ stands for the number of countries and $N$ for the number of industries in each country. $\mathbf{A}$ denotes the $SN$x$SN$ matrix with intermediate input coefficients. These coefficients describe how much intermediates are needed to produce a unit of output of a given product, split between the countries from which these intermediates can be sourced. Hence, it is a representation of the world production structure. $\mathbf{Aq}$ then gives the total amounts of each of the $SN$ intermediates used in the global economy. The identity can be rewritten as $\mathbf{q}=(\mathbf{I}-\mathbf{A})^{-1}\mathbf{c}$, in which $\mathbf{I}$ represents an identity matrix. The $SN$x$SN$ matrix $(\mathbf{I}-\mathbf{A})^{-1}$ is famously known as the Leontief inverse. It gives the gross output values of all products that are 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 of which the first element represents the global consumption of iPods produced in China, and all other elements are zero. Then $\mathbf{Az}$ is the vector of intermediate inputs, both Chinese and foreign, needed to assemble the iPods in China, 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 directly 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 iPods by $(\mathbf{I}-\mathbf{A})^{-1}\mathbf{z}$, since the summation over all rounds converges to $(\mathbf{I}-\mathbf{A})^{-1}\mathbf{z}$ under empirically mild conditions.[11]

To find the value added by factors we additionally need factor inputs per unit of gross output represented in and $SN$x$SN$ diagonal matrix $\mathbf{V}$. An element in this matrix indicates the value added generated by a particular production factor as a share of gross output. These are factor-, country- and industry-specific: one element contains the value added by labour per dollar of output in the Chinese electronics industry, for example.

[11] See Miller and Blair (2009) for a good starting point on input-output analysis.

To find the value added by all factors that are directly and indirectly involved in the production of a particular final good, we multiply **V** by the total gross output value in all stages of production given above such that

(20) $\mathbf{k}=\mathbf{V}(\mathbf{I}-\mathbf{B})^{-1}\mathbf{z}$.

A typical element in the *SN* vector **k** indicates the value added in the production of the final good by each production factor employed in country *i* and industry *j*. Following the logic of Leontief's insight, the sum over value added by all factors in all countries that are directly and indirectly involved in the production of this good will equal the output value of that product. By repeating this procedure for all final goods and production factors, we have completed our decomposition of final output into the value added by various production factors around the world.

### 3.3 Value added 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 final products bought by the distribution sectors (to be resold) are not treated as intermediate inputs. The gross output of the distribution sector is measured in the SNA in terms of the margin (value of goods sold minus the purchase value of those goods) and not sales. This precludes the treatment of the distribution sector in a Leontief type of decomposition. In this section we outline a novel approach to analyse the distribution stage alongside the production stages. Key is information on margins rates derived from differences in valuation of final goods at basic prices and at purchaser's prices.

A basic distinction in the System of National Accounts is between a value at basic prices and at purchaser's prices. The basic price can be considered as the price received by the producer of the good. The purchaser's price is the price paid by the final consumer. It consists of the basic price plus trade and transport margins in the handling of the product and any (net) product taxes. We use this price concept to measure final output (represented by P in the formula's above). Accordingly, we define the value added in the distribution stage by a margin rate (*m*) derived from the ratio of the basic and purchaser's price (adjusted for net product taxes) such that:

(21) $VA_D \equiv m(PY(1-\tau))$

with $\tau$ the net tax rate on products. We use the factor shares in the industries responsible for distribution (wholesale and retailing) to derive the shares of labour and capital in value added, see below.

We provide an illustrative example of the value decomposition of cars that are finalised in Germany in Table 1. It shows for 2014 the distribution of value added across the three stages and across the three factor inputs. We find that the value added is concentrated in production, in particular in the non-final stages. The majority of value added is captured by labour (57.5%) followed by intangible income (27.5%) and tangible costs (15 %).

**Table 1: Decomposition of value of a German "car"**

| | Distribution | Final stage of production | Other stages of production | Total |
|---|---|---|---|---|
| Intangible capital | 1.9 | 13.2 | 12.4 | 27.5 |
| Tangible capital | 0.9 | 3.6 | 10.5 | 15.0 |
| Labour | 7.6 | 17.9 | 32.0 | 57.5 |
| Total | 10.4 | 34.7 | 54.9 | 100.0 |

Notes: Decomposition of final output of the Motor vehicles, trailers and semi-trailers manufacturing industry in Germany (ISIC rev. 4 industry 29) valued at purchaser's prices (net of product taxes). Value added by factor inputs at various stages in the GVC. Numbers may not sum due to rounding.
Source: Own calculation based on WIOD, November 2016 release complemented with capital stock and compensation data.

## 4. Data sources

For our empirical analysis we use three types of extensive data sources: world input-output tables (including supply and use tables), information on distribution margins and data on factor costs of industries. The input-output tables and data on labour compensation and value added are derived from the World Input-Output Database (WIOD), 2016 release and have been extensively described in Timmer et al. (2015). In an Appendix we provide a summary of the main characteristics of this database such that the reader of this study can appreciate its particular strengths and weaknesses. 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. Gross output, value added and labour compensation are provided at the industry level. These can be used to derive the share of labour in value added at the industry level. In this section we provide more information on two new pieces of empirical information: the cost share of tangible capital and data on margins.

### 4.1 Tangible asset costs

We measure intangible income through a “residual claimant” approach and define it for any given industry i as:

(22) $$B \equiv VA_i - r_i^K K_i - w_i L_i.$$

Gross value added (*VA*) and labour compensation (*wL*) can be derived from national accounts statistics (with appropriate adjustment for the income of self-employed) and this information is taken from the WIOD (see data appendix). We measure $K$ as tangible capital stock and the rental price $r^K$using the Jorgenson-Griliches user-cost approach as the sum of the depreciation rate plus a real rate of return.

(23) $$r_i^K = \delta_i^K + 0.04$$

The real rate of return is set to 4 per cent for all tangible assets. Note that we choose an ex-ante rate of return for tangible capital such that the incomes to intangibles will pick up the residual in (22). This is a standard rate used in many studies. Alternatively, we could base it on a more sophisticated approach, see e.g. CHS (2005) or Barkai (2017). Barkai (2017, Fig 1) shows that for the US debt costs (set to the yield on Moody’s Aaa bond portfolio) declined from about 7% in 2000 to 5% in 2014. Expected capital inflation (calculated as a three-year moving average of realized capital inflation) oscillated around 2%. This suggests a small, but steady, decline in the real rate of return from 5% to 3% over our period. Using these rates instead of 4% will have no significant impact on our results.

We base our estimates on national accounts statistics such that our definition of tangible capital follows the System of National Accounts (SNA) convention. Tangible asset types include: buildings, machinery, transport equipment, information technology assets, communication technology assets, and other tangible assets. Asset depreciation rates are based on the year- and industry-specific geometric depreciation rates for Spain (obtained from the EU KLEMS database December 2016 revision), which are calculated using each assets’ nominal capital stock as weights. Geometric depreciation rates for detailed asset types *j* are taken and aggregated such that the rate is industry specific (see data appendix for details): $\delta_i^{KT}\, KT_i = \sum_j \delta_j^{KT}\, KT_{ij}$. These rates take into account the differences in the composition of capital assets both across countries, industries as well as over time.

Country-industry tangible asset stock estimates over time are derived from EU KLEMS (O’Mahony and Timmer, 2009). We have capital stock data by asset type for Australia, Japan and the United States and twelve major European countries (Austria, Czech Republic, Denmark, Finland, France, Germany, Italy, the Netherlands, Slovenia, Spain, Sweden and the United Kingdom). It should be noted the recent version of the system of national accounts (SNA 08) also covers investments in some types of intangibles, namely intellectual property products (R&D, computer software and databases, mineral exploration and entertainment and artistic originals.) We do *not* include these assets in our set of tangible assets. Yet, for the other countries we typically have stocks by industry only, but not by asset type. Thus we are not are not able to split off the intangibles in case. In practice though, most of these countries do not collect data according to SNA08 rules and we need to carefully distinguish between various data environments, see data appendix for elaborate discussion on a country-by-country basis.

A final issue that needs to be discussed is the measurement of gross value added. In our framework, this is measured without any imputations for intangibles. For countries that still publish national accounts according to SNA68 or SNA93 these imputations will be nil or only small. For countries publishing on SNA08 basis, expenditures on intellectual property products (IPP) are "capitalised" rather than "expensed" in the value added data. As discussed in the introduction, we distinguish conceptually between own-account and purchased assets, so ideally we want only to strip out imputations for own-account IPP. There is no way to identify these imputations unfortunately. Value added will thus be overestimated in some country-industries.[12] Fortunately, we can provide an estimate of this by using information on IPP stocks. Typically, the imputation for value added is cost-based. We calculated cost for IPP in the same way as we did for tangible capital: based on IPP depreciation rates (see appendix) plus a real rate of return of 4 percent. We find that in manufacturing GVCs, IPP cost was 2.4% of gross value added in 2000, staying rather constant over the period (between 2.2 and 2.7%). To set this in perspective: we find that intangible income is more than 27% of value added in 2000 increasing to more than 30% in 2014 (see next section). This shows that our main results are very robust to this data issue.

### 4.2 Margins and value added in distribution

Ideally, we need to have information on the margins for each final manufacturing product. Unfortunately, this is not available because of the sparseness of data on the magnitude of distribution margins for detailed product flows, either by supply (import or domestically produced) or use (intermediate use, domestic final use or exported). In particular, as final goods are traded internationally, we cannot trace the margins paid by final consumers around the world for a particular product. Instead we proxy the margin by using country specific domestic margins. As an example, to measure the value added in the distribution stage in the GVC of a car finalised in Germany, we need information on the total margins paid by all consumers (domestic and foreign) of these cars. We use information on the margins paid by German consumers of cars instead. This includes margins on cars finalised in Germany as well as cars finalised abroad (and imported). We thus assume that these margins (and tax) rates are the same. This approximation holds when a product finalised in a country is mostly consumed domestically, or when margins for this product are the same across countries.

[12] A comparison of pre- and post-2008 SNA numbers suggest that at the aggregate GDP level these imputations were relatively minor, ranging from 2 to 4% of GDP, see http://www.oecd.org/std/na/new-standards-for-compiling-national-accounts-SNA2008-OECDSB20.pdf. More detailed industry information on this is urgently needed.

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 also be found in the WIOD (under the heading of national SUTs for most countries). For China, Japan and the U.S. only data at producer prices is given in WIOD however. We complemented this with data from detailed retail and wholesale sector censuses. We adjust for (net) taxes ($\tau$ in equation 21) on the product as these are paid for by the consumer to the government and do not constitute payment for factor inputs in any stage of production.

## 5. Empirical findings

Our new approach to the measurement of intangible incomes allows us to provide novel insights. For the first time, we will be able to study the evolution of the income to intangibles in the production of manufacturing goods and compare this with the incomes to tangibles and labour. In this section we present two types of results. First we present evidence on the increasing importance of intangibles in the GVCs of manufacturing goods. This is a pattern shared by all manufacturing products. Next we show how the incomes to intangibles are realised in different stages, depending on the characteristics of the product groups.

### 5.1 Importance of intangibles (aggregate)

In Table 2 we show the incomes to labour, tangible and intangible capital as shares in the total value of final manufacturing products, as derived in equation (18). This covers all products finalised in any country in the world and the total value thus represents the total worldwide expenditure on manufacturing goods (excluding net product taxes). We find increasing capital shares over the period 2000-2007, and a steadily declining trend in the returns to labour during the same period. This resonates with the findings in our previous research (Timmer et al., 2014) which did not consider distribution activities though.

Interestingly, the increasing share of capital is mainly due to increasing returns to intangibles. The share of tangible capital grows slowly, from 15.8% in 2000 to 16.3 % in 2007. In the same period, the share of intangibles jumped from 27.8% to 31.9% (see Figure 2). A simple interpretation of these findings would be that during this period global manufacturing firms benefitted from increased opportunities for offshoring of labour-intensive activities to low-wage locations. When competition is high, final output prices will fall due to the wage cost savings and the share accruing to labour would decline (if factor substitution possibilities are limited). If the production requirements (and prices) for tangible capital remained unaltered, the share of intangibles must go up by virtue of its definition as a residual. For example, German car producers took increasing advantage of the opportunities to offshore to lower labour costs locations, in particular in Eastern Europe. Concomitantly, the income share of capital in the GVC increased over this period. Interestingly, this was predominantly due to the increasing returns to intangibles. This trend is representative for many manufacturing GVCs as shown in the next section.

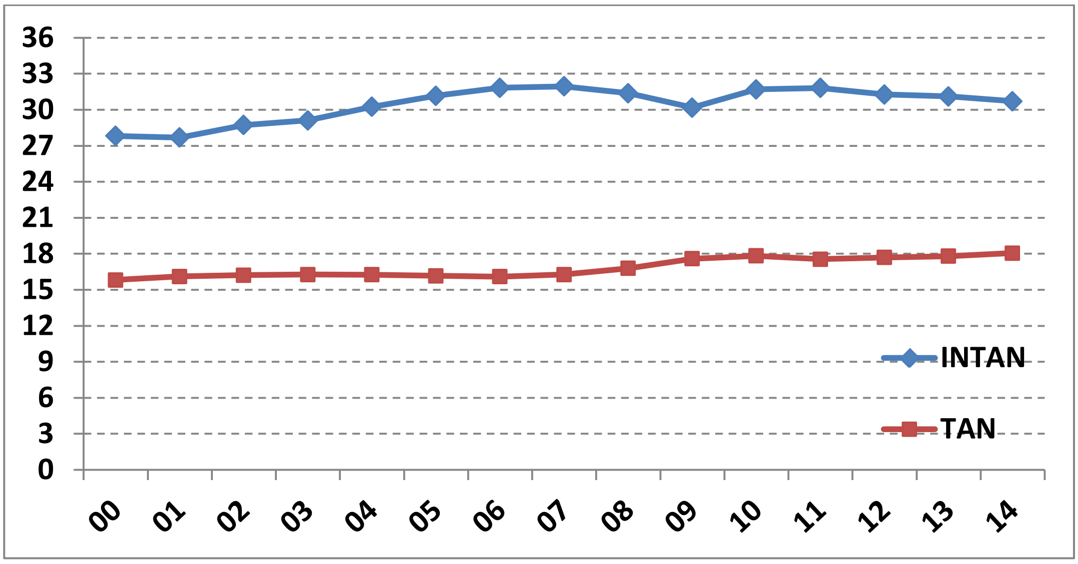
This trend did not continue however. There was a clear levelling off in the increase in capital income after the financial crisis. Conversely, the labour income share has declined and stabilised at about 51 per cent in 2014. The share of intangible income rapidly increased in the first half of the 2000s, levelling off after the crisis in 2008. In 2014 it stood at about 31 per cent of the final output value of manufacturing products. This is much higher than tangible capital income share (18 per cent).

**Table 2: Value added by production factors (as %-share in final output value of manufacturing products)**

| | Labour (1) | Tangible capital (2) | Intangible capital (3) | Final output at purchaser's prices (4) |
|---|---|---|---|---|
| 2000 | 56.4 | 15.8 | 27.8 | 8,837 |
| 2001 | 56.2 | 16.1 | 27.7 | 8,206 |
| 2002 | 55.1 | 16.2 | 28.7 | 8,251 |
| 2003 | 54.6 | 16.3 | 29.1 | 9,004 |
| 2004 | 53.5 | 16.3 | 30.2 | 9,971 |
| 2005 | 52.7 | 16.2 | 31.2 | 10,499 |
| 2006 | 52.1 | 16.1 | 31.8 | 11,094 |
| 2007 | 51.8 | 16.3 | 31.9 | 12,172 |
| 2008 | 51.8 | 16.8 | 31.4 | 12,917 |
| 2009 | 52.2 | 17.6 | 30.2 | 11,344 |
| 2010 | 50.5 | 17.8 | 31.7 | 12,845 |
| 2011 | 50.6 | 17.6 | 31.8 | 14,139 |
| 2012 | 51.0 | 17.7 | 31.3 | 14,010 |
| 2013 | 51.1 | 17.8 | 31.1 | 14,022 |
| 2014 | 51.2 | 18.1 | 30.7 | 14,013 |

Notes: Percentage shares in the worldwide output of final manufacturing products valued at purchaser's prices (before product tax). (1) Labour includes all costs of employing labour, including self-employed income. (2) Tangible capital includes gross returns to tangible assets as defined in the SNA08 based on a 4% real rate of return and geometric depreciation rates. (3) Returns to intangible capital is calculated as a residual (final output minus labour and tangible capital costs). (4) expressed in 2000 US dollars, deflated with BLS CPI (All Urban Consumers, Current Series, Series Id CUUR0000SA).
Source: Own calculations based on the WIOD, 2016, extended with data on capital compensation and stocks as described in this paper.

**Figure 2: Value added by intangible capital (INTAN) and tangible capital (TAN) (as %-share in total value of manufacturing products)**




Notes*:* Share of value added by intangible capital (INTAN) and tangible capital (TAN) in the worldwide value of final manufacturing products (%). The remainder of the output value is added by labour (not shown). Source: See Table 2.

### 5.2 Importance of intangibles (detailed product groups)

Which product GVCs are the most intensive in the use of intangibles? In Table 3 we provide an overview of the factor income shares for detailed product groups for the year 2014. In the main text tables we only show, and discuss, results for twelve main manufacturing product groups (defined by final output value). Full information on the nineteen groups can be found in the appendix tables.

We find the intangible income share in 2014 to be higher than the tangible share for all nineteen manufacturing product groups. The intangible income share is more than double the tangible share for pharmaceuticals, chemical products and oil refining products (see last column). It is also relatively high for food products and furniture, toys and other manufacturing products. The ratio between intangible and tangible incomes is lowest (but still well above one) for motor vehicles, other transport equipment electrical equipment and non-electrical machinery.

**Table 3: Factor income shares (as % of total final output value), major product groups, 2014**

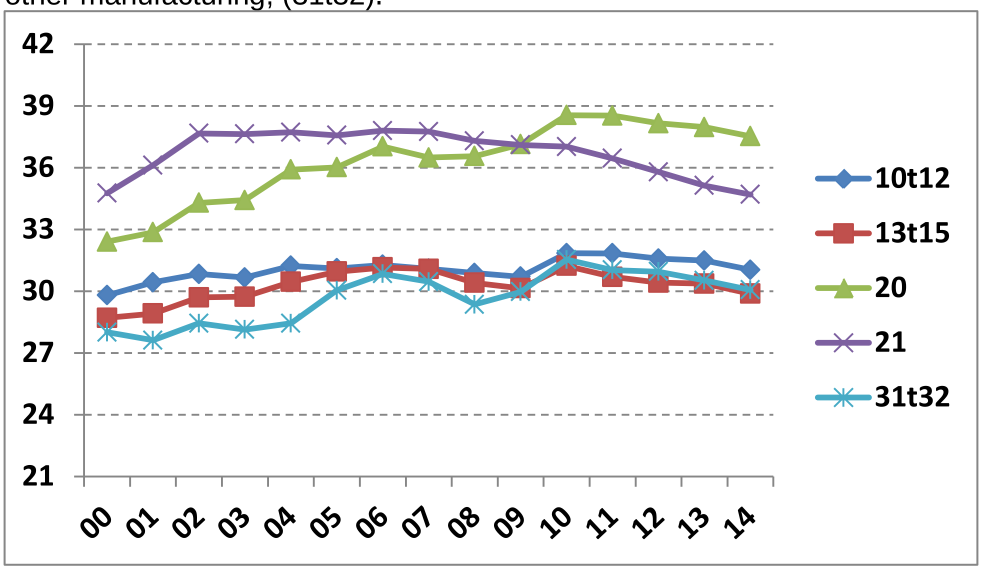
| Final product group name | ISIC rev. 4 code of final industry | Labor share | Tangible capital share | Intangible capital share | Intangible capital share, of which | | Final output of products worldwide (bil US$) | *Pro memoria: intan / tan ratio* |
|---|---|---|---|---|---|---|---|---|
| | | | | | IPP-NA | Other | | |
| Food, beverages and tobacco prod. | 10t12 | 52.6 | 16.4 | 31.0 | 1.2 | 29.8 | 4,926 | *1.9* |
| Motor vehicles and trailers | 29 | 51.3 | 19.0 | 29.7 | 3.1 | 26.6 | 2,559 | *1.6* |
| Textiles, apparel and leather products | 13t15 | 52.4 | 17.7 | 29.9 | 1.0 | 28.9 | 1,974 | *1.7* |
| Non-elec. machinery and equipment | 28 | 53.9 | 18.8 | 27.2 | 2.8 | 24.4 | 1,834 | *1.4* |
| Computer and electronic products | 26 | 50.0 | 18.6 | 31.3 | 4.8 | 26.6 | 1,452 | *1.7* |
| Furniture and other manufacturing | 31t32 | 53.7 | 16.3 | 30.1 | 2.3 | 27.7 | 1,094 | *1.8* |
| Petroleum products | 19 | 37.9 | 20.0 | 42.1 | 1.6 | 40.5 | 1,024 | *2.1* |
| Other transport equipment | 30 | 55.2 | 18.5 | 26.3 | 3.8 | 22.5 | 852 | *1.4* |
| Electrical equipment | 27 | 50.6 | 20.0 | 29.5 | 1.9 | 27.6 | 838 | *1.5* |
| Chemical products | 20 | 44.9 | 17.5 | 37.5 | 6.6 | 30.9 | 745 | *2.1* |
| Pharmaceuticals | 21 | 48.8 | 16.5 | 34.7 | 6.3 | 28.4 | 520 | *2.1* |
| Fabricated metal products | 25 | 55.2 | 20.8 | 24.0 | 1.7 | 22.3 | 435 | *1.2* |
| All manufacturing products | | 51.2 | 18.1 | 30.7 | 2.5 | 28.2 | 19,2565 | *1.7* |

Source: Appendix table 1. Product groups ranked by final output

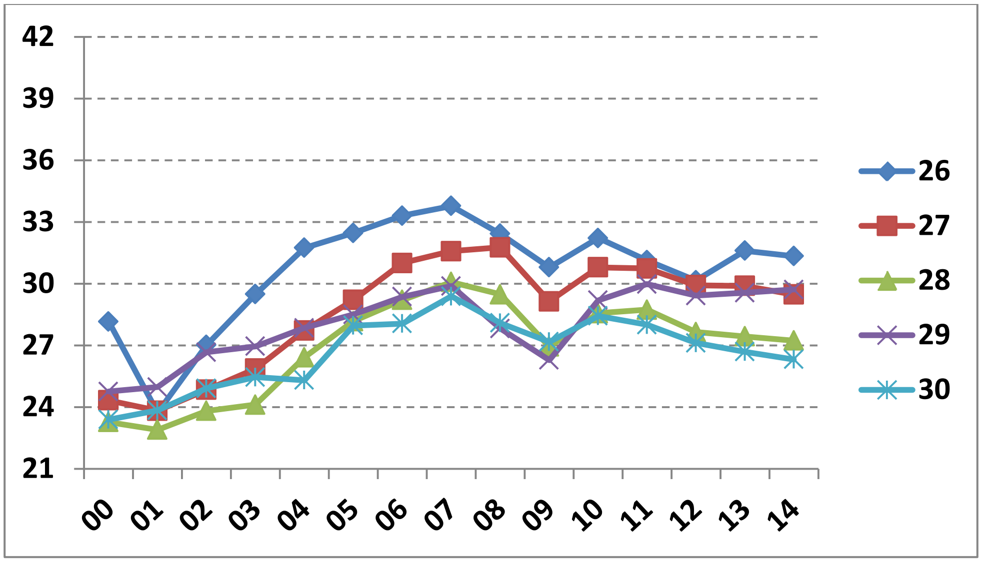
Figure 3 and Table 4 show that within each product group the share of intangibles in value added has risen. But there is clear heterogeneity in the speed and pace of the increase. The aggregate trend in intangible income shares is not shared across all nineteen manufacturing product groups that we study. For some products (such as pharmaceuticals, furniture, textiles and food) the intangible share remained roughly constant over 2000-2014. In contrast the share increased rapidly in machinery and equipment products (computer, optical, other electrical as well as non-electrical) until the crisis in 2008, slightly declining afterwards. Arguably, this is related to the rapid international fragmentation of the production processes of these goods speeded up by the opening up to China and its joining the WTO in 2001. In contrast, production of textiles and furniture was already quite fragmented before this period. Other products are arguably less susceptible to international fragmentation trends, such as food and pharma.

**Figure 3: Value added by intangible capital (as %-share of total value) by major product groups.**

(a) Food, beverages and tobacco products (10t12); Textiles, apparel and leather products, (13t15); Chemical products, (20); Pharmaceuticals, (21) and Furniture and other manufacturing, (31t32).




(b) Computer, electronic and optical products, (26); Electrical equipment, (27);Other Machinery and equipment, (28); Motor vehicles and trailers, (29) and Other transport equipment, (30).




Notes: Share of value added by intangible capital in the final output value (in %).
Source: Appendix Table 2.

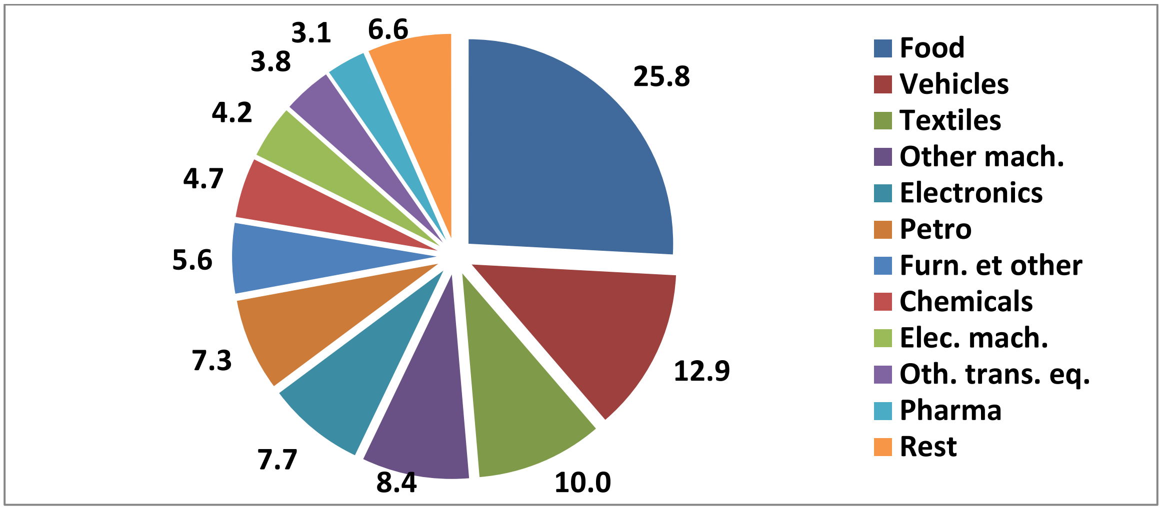
**Table 4: Income for intangible capital (as %-share in total value), major product groups**

| Final product group name | ISIC rev. 4 code | 2000 | 2007 | 2014 | Change 2000-07 | Change 2007-14 | Change 2000-14 |
|---|---|---|---|---|---|---|---|
| Food | 10t12 | 29.8 | 31.1 | 31.0 | 1.3 | -0.1 | 1.2 |
| Vehicles | 29 | 24.8 | 29.9 | 29.7 | 5.1 | -0.2 | 5.0 |
| Textiles | 13t15 | 28.7 | 31.1 | 29.9 | 2.4 | -1.2 | 1.2 |
| Non-elec. 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 |
| Furn., toys 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 |
| Other transport eq. | 30 | 23.4 | 29.4 | 26.3 | 6.0 | -3.1 | 2.9 |
| 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 |
| Pharmaceuticals | 21 | 34.8 | 37.7 | 34.7 | 3.0 | -3.1 | -0.1 |
| Metal products | 25 | 19.3 | 25.6 | 24.0 | 6.3 | -1.6 | 4.7 |
| 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 (%).
Source: Appendix table 2. Product groups ranked by final output.

Which final products are most important in terms of intangible incomes? Figure 4 provides additional information on the distribution of intangible returns over 14 manufacturing product groups. We provide the share of each group in the overall returns to intangibles for all manufacturing products. This share is determined by the share of a group in overall consumption of manufacturing goods and the share of intangibles in its GVCs. Three product groups appear to be together responsible for more than half of the intangible returns: Food products making up 25.8% of total intangible income in manufacturing goods production in 2014, vehicles manufacturing (12.9%) and textiles (10%). Appendix Table 3 provides the time-series information. As consumption expenditure patterns change only slowly, these shares do not vary much over time. Most notable is the increasing share of Refined oil, almost doubling its share. This is likely to be related to the rapid increase in fuel prices in the mid-2000s.

**Figure 4: Value added by intangible capital (%-share of product group in all manufacturing products), 2014**




Notes: Value added by intangible capital in any stage of GVC of product groups. Expressed as share in total value added by intangible capital in the worldwide final output value of manufacturing products (%). Source: Appendix Table 3.

### 5.3 Intangible incomes by stage

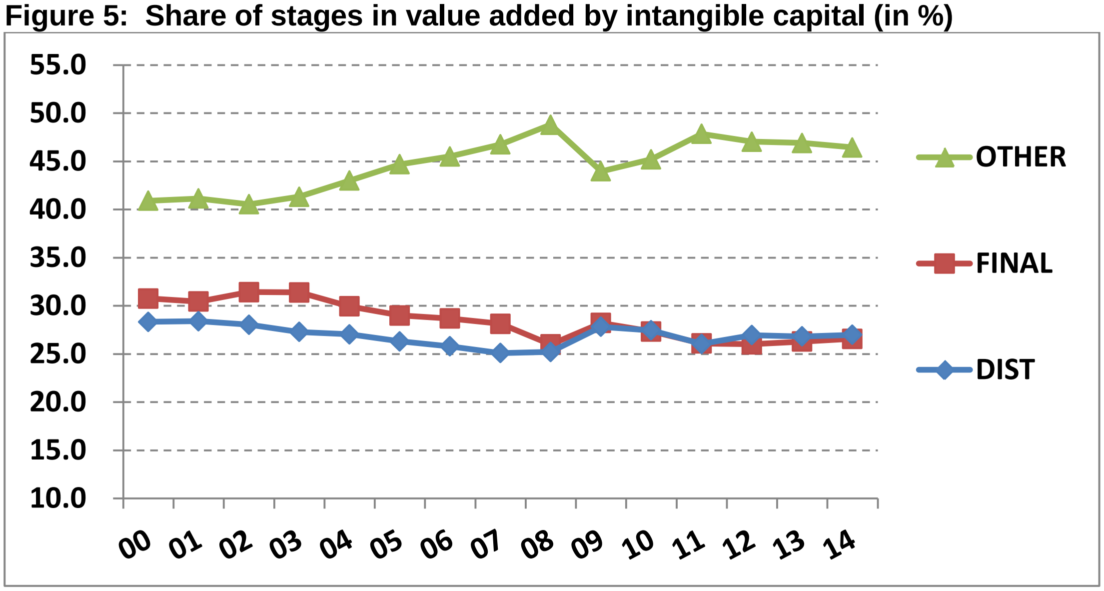
In this section we report on findings related to the stage in which returns to intangibles are realised. Using the ratio given in equation (19), we will show the shares in the distribution stage, the final stage of production and in other stages of production. We find that about one quarter of the intangibles incomes is realized (accounted for) in the distribution stage, that is, in delivery of the final product to the consumer. One quarter is realized in the final production stage and halve in other production stages. The latter has increased in particular in the early 2000s, see figure 5 and Table 5.

**Table 5: Share of stages in value added by intangible capital (in %)**

| | Distri-bution | Final production stage | Other production stages |
|---|---|---|---|
| 2000 | 28.3 | 30.8 | 40.9 |
| 2001 | 28.4 | 30.5 | 41.1 |
| 2002 | 28.0 | 31.4 | 40.5 |
| 2003 | 27.3 | 31.4 | 41.3 |
| 2004 | 27.0 | 29.9 | 43.0 |
| 2005 | 26.3 | 29.0 | 44.7 |
| 2006 | 25.8 | 28.7 | 45.5 |
| 2007 | 25.1 | 28.1 | 46.8 |
| 2008 | 25.2 | 26.0 | 48.8 |
| 2009 | 27.8 | 28.2 | 44.0 |
| 2010 | 27.5 | 27.3 | 45.2 |
| 2011 | 26.0 | 26.1 | 47.9 |
| 2012 | 27.0 | 26.0 | 47.0 |
| 2013 | 26.8 | 26.3 | 46.9 |
| 2014 | 27.0 | 26.6 | 46.4 |

Notes: Value by intangible capital can be added in the final or other production stages, or in distribution to the final consumer. Expressed as share in total value added by intangible capital in the worldwide final output value of manufacturing products (%). Source: see Table 2.

**Figure 5: Share of stages in value added by intangible capital (in %)**




Notes: Value by intangible capital can be added in the final production stage (FINAL), in other production stages (OTHER) or in distribution to the final consumer (DIST). Source: see Table 5.

Results for all major manufacturing GVCs together are given in Table 6 and Figure 6. More than half of the intangible returns are realised in the non-final stages of production (46.8% in 2007). The final production stage and distribution are each responsible for about a quarter (25.1% and 28.1% in 2007). This signifies the importance of intangibles in upstream activities for manufacturing GVCs which include the production of parts, components and materials but also a wide variety of business services as well as agriculture and mining activities. Over time there is a clear shift away of intangible returns in the final production stage (minus 4.2 %-points over the period 2000-2014), mainly to the other production stages (plus 5.4 %-points). This shift mainly occurred before the crisis of 2008.

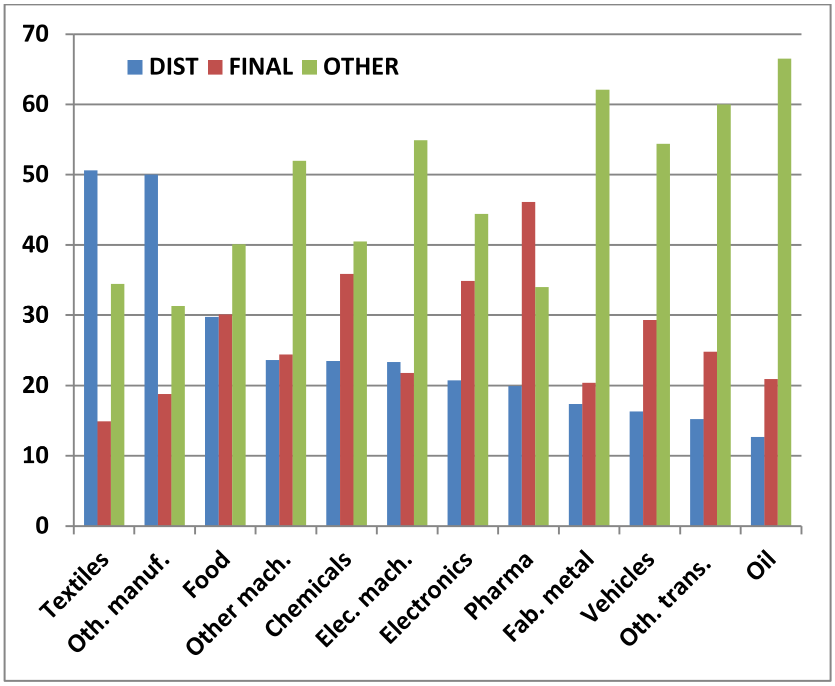
The shift in intangible earnings away from the final production stage is shared across most manufacturing product groups, except for vehicles and chemicals (Table 6). Interestingly, we find sizeable differences in the direction of this shift. In some chains, the share of intangibles in the distribution stage increased the most, while in other chains the share increased most in other production stages (Figure 6). For example, in textiles, electronics, electrical machinery and furniture, toys and other manufacturing the distribution share in intangible income increased over 2000-2014. In contrast, it dropped strongly for vehicles, fabricated metal and other transport equipment. Share of other production stages in intangible incomes increased for all, in particular for oil, food, other transport and fabricated metal.

**Table 6: Share of stages in total value added by intangible capital (in %), major product groups**

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

Notes: Value added by intangible capital in each stage of GVC, as share in total value added by intangibles. Source: Appendix Table 5.

**Figure 6: Share of stages in total value added by intangible capital (in %), major product groups**




Based on these findings we can group products following the basic distinction between buyer- and producer-driven GVCs (Gereffi, 1999).[13] According to Gereffi (1999) GVCs are governed by so-called lead firm that decide on specifications and have a large share of control. 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.[14] We find that for buyer-driven GVCs (like food, textiles and furniture) returns to intangibles are increasingly realised in the distribution stage. In contrast, in producer-driven GVCs (like machinery, automotive and electronics) the returns are shifting to activities before the final production stage.

[13] See Gereffi and Fernandez-Stark (2011) for a primer on GVC analysis.
[14] 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 a buyer, e.g. in the case of a generic not-branded product, or in a producer driven chain, e.g. in the case of a high-end branded product. Nevertheless we will show that there are significant and substantial differences in the level of intangible returns across product groups.

### 5.4 Interpretation and caveats

In interpreting the results, one should be mindful however of the measurement problems posed by transfer pricing practices. International transaction flows, in particular between related parties, might be recorded at transfer prices that bear little relationship with the underlying value. In an analysis of all stages in a GVC (as reported on in section 4.1) this was not a problem (in principle) as transfer pricing would mainly result in shifting reported profits from one stage in the chain to another. However it might affect the attribution of returns to a specific stage and this should be kept in mind when interpreting the results on the breakdown in stages. Another complicating issue is in the industrial classification of lead firms in GVCs, some of which are so-called factory-free goods producers, like Dell. If classified as manufacturers, the intangible returns are likely to show up in the production stages, while if classified as wholesalers these will be recorded in the distribution stage.[15] Shifts over time in profit reporting practices and/or classification of firms by statistical agencies might thus affect the trends reported here.

Second, our residual measure of intangibles incomes can be affected by many factors that are not necessarily related to the productivity of intangible assets. Most prominently it will be sensitive to overall business cycle variation. Related, one might point to differences in competitive environments driving variation in mark ups over time and across products. To the extent that the mark ups are the result of market power built up through intangible investments (in e.g. brands) (and not the result of e.g. a natural monopoly of government regulation) we want to include them in our intangible income measure. We are not able to distinguish between these different types of mark-ups and hence include all in our residual measure (apart from the difficulties in their empirical measurement). Measurement errors are included as well, for example in the costs for tangible capital which rely on estimates for depreciation rates and a real rate of return.

Third, we do not estimate the distribution of intangible earnings over *countries*. As is well-known the (geographical) distribution of profits along the global value chain does not necessarily correspond with the distribution of value added or intangible assets. Through profit shifting, including transfer pricing and other tax strategies, transnational companies can allocate the largest share of their profits to subsidiaries (Dischinger et al., 2014). More generally, even in the absence of purposeful profit shifting, increasing cross-border ownership and sharing of intangibles is undermining the very notion of location-bound assets and earnings.

Finally, we would like to stress that this study is explorative. Our ambition to trace macro-economic trends in intangible incomes puts high demand on the data. The validity of the findings relies heavily on the quality of the data used. Put otherwise, it depends crucially on the capabilities of our current statistical systems to keep track of globalised production networks and associated income flows. Much progress has been

[15] This will ultimately depend on the classification of the so-called factory-less goods producers (FGPs) in industry statistics. These are firms that are manufacturer-like in that they perform many of the tasks and activities in the GVCs of final goods themselves, except for the physical production process. In the current U.S. statistical system they are often classified in wholesaling, and their output is recorded as a wholesale margin, rather than as manufacturing sales. Bernard and Fort (2013) suggest that reclassifying the FGPs to the manufacturing sector would increase reported manufacturing output in 2007 by about 5 percent in a conservative estimate and by a maximum of 17 percent using a more liberal set of assumptions. See also contributions in Fontagné and Harrison (2017).

made in the past decade, but many gaps in our understanding remain (UNECE 2015; Landefeld 2015). Our results should thus be seen as indicative only.

## Conclusions

In this paper we provide a novel attempt to derive the incomes to intangibles in global production networks. We rely on a residual claimant approach where we derive the incomes to intangibles by subtracting the costs for tangible factors (capital and labour) from the value of the final product. Importantly, these factor costs are identified in all stages of production including delivery to the final consumer.

Our main finding is that the share of intangibles in the value of final products has increased from 2000 onwards. This is found for all manufacturing product groups. We also find that for buyer-driven GVCs (like food, textiles and furniture) returns to intangibles are increasingly realised in the distribution stage, that is, in delivery of the final product from factory to the consumer. In contrast, in producer-driven GVCs (like machinery, automotive and electronics) the returns are shifting to activities before the final production stage, such as development and manufacturing of parts and components. Most of these trends manifested themselves in the period from 2000 to 2007 and were continued after the crisis.

It is likely that investments in intangibles also increased in this period, for example in order to organise the associated complex supply chains. Shin et al. (2012) found that gross margins to tangibles differ across participants in the GVC of electronics, being highest in pre- and post-production stages. However, they suggest that the (fixed) costs of sustaining a position on either end of the GVC is so high that ultimately returns on investment might very well be similar across all activities and assets. Without additional information on these investments, one cannot determine possible changes in rate of return to intangible investments as opposed to changes in the volume of intangible assets.

Although our accounting model to measure intangible returns is relatively straightforward, it is clear that the validity of 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 a proof-of-concept, and it is up to the statistical community to bring international input-output tables into the realm of official statistics. The development work done by the OECD is certainly a step in the right direction.[16] From the perspective of measuring intangibles' returns, one of the biggest challenge is in the concept and measurement of trade in services of intangibles. Part of these cross-border transactions are market mediated and potentially measurable. But in many cases there is no recorded flow of payments for the use of intangibles within a particular GVC. This is compounded by transfer pricing and other tax evasion practices of multi-national enterprises. As argued above this might be particular binding in determination of the stage in which intangible returns are realised.

We also noted the crude nature of current available data on distribution margins which lacks specificity and typically refers to very broad product groups including both domestic and imported goods. Related to this is the classification of factory-free producers. The

[16] See http://oe.cd/tiva for more information. For example, one currently has to rely on the assumption that all firms in an economy-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 non-exporters 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.

stage in which the profits are recorded is likely to depend on the industry in which the lead firm (with most of the intangible capital in the GVC) is classified. For example, if a firm like Dell is considered to be a manufacturer rather than a wholesaler, the profits would not be recorded in the distribution stage.

Can these measurement challenges be overcome? We believe that a global value chain framework provides useful suggestions for improving our understanding of intangibles through the national accounts. This is shared by important developments in the international statistical community. Recently, the UNUCE published its *Guide to Measuring Global Production* (De Haan et al, 2014). Building on this are new initiatives, most notably the initiative towards 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).[17] A deeper understanding of the workings of global value chains is needed before our measurement systems will adequately capture the importance of intangibles in today's economy.

[17] See also contributions in Houseman and Mandel (2015).

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**Appendix table 1: Value added by factor inputs (as %-share of total final output value), manufacturing product groups, 2014**

| Final product group name | ISIC rev. 4 code of final industry | Labor share | Tangible capital share | Intangible capital share | Intangible capital share, of which | | Final output of products worldwide (bil US$) |
|---|---|---|---|---|---|---|---|
| | | | | | IPP-NA | Other | |
| Food, beverages and tobacco products | 10t12 | 52.6 | 16.4 | 31.0 | 1.2 | 29.8 | 4,926 |
| Textiles, apparel and leather products | 13t15 | 52.4 | 17.7 | 29.9 | 1.0 | 28.9 | 1,974 |
| Wood products | 16 | 52.5 | 20.0 | 27.5 | 1.5 | 26.1 | 90 |
| Paper products | 17 | 51.1 | 20.9 | 28.0 | 2.4 | 25.6 | 140 |
| Printing products | 18 | 51.7 | 21.2 | 27.1 | 2.4 | 24.6 | 64 |
| Petroleum products | 19 | 37.9 | 20.0 | 42.1 | 1.6 | 40.5 | 1,024 |
| Chemical products | 20 | 44.9 | 17.5 | 37.5 | 6.6 | 30.9 | 745 |
| Pharmaceuticals | 21 | 48.8 | 16.5 | 34.7 | 6.3 | 28.4 | 520 |
| Rubber and plastics products | 22 | 51.1 | 19.7 | 29.2 | 2.6 | 26.6 | 244 |
| Other non-metallic mineral products | 23 | 48.9 | 21.5 | 29.7 | 1.7 | 28.0 | 136 |
| Basic metals | 24 | 43.0 | 25.6 | 31.4 | 1.0 | 30.4 | 179 |
| Fabricated metal products | 25 | 55.2 | 20.8 | 24.0 | 1.7 | 22.3 | 435 |
| Computer, electronic and optical products | 26 | 50.0 | 18.6 | 31.3 | 4.8 | 26.6 | 1,452 |
| Electrical equipment | 27 | 50.6 | 20.0 | 29.5 | 1.9 | 27.6 | 838 |
| Other Machinery and equipment | 28 | 53.9 | 18.8 | 27.2 | 2.8 | 24.4 | 1,834 |
| Motor vehicles and trailers | 29 | 51.3 | 19.0 | 29.7 | 3.1 | 26.6 | 2,559 |
| Other transport equipment | 30 | 55.2 | 18.5 | 26.3 | 3.8 | 22.5 | 852 |
| Furniture and other manufacturing | 31t32 | 53.7 | 16.3 | 30.1 | 2.3 | 27.7 | 1,094 |
| Repair and installation of machinery | 33 | 63.2 | 13.2 | 23.6 | 2.5 | 21.2 | 160 |
| All manufacturing products | | 51.2 | 18.1 | 30.7 | 2.5 | 28.2 | 19,265 |

**Appendix table 2: Value added by factor inputs (as %-share of total final output value), manufacturing product groups.**

**(2A) Value added by intangible capital**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 29.8 | 30.4 | 30.8 | 30.7 | 31.2 | 31.1 | 31.3 | 31.1 | 30.9 | 30.7 | 31.8 | 31.8 | 31.6 | 31.5 | 31.0 |
| Textiles | 13t15 | 28.7 | 28.9 | 29.7 | 29.7 | 30.5 | 30.9 | 31.2 | 31.1 | 30.4 | 30.1 | 31.2 | 30.7 | 30.4 | 30.4 | 29.9 |
| Wood | 16 | 24.9 | 25.7 | 25.5 | 25.2 | 25.7 | 26.0 | 25.8 | 26.8 | 26.0 | 25.4 | 26.6 | 26.5 | 27.3 | 27.5 | 27.5 |
| Paper | 17 | 26.0 | 25.2 | 26.4 | 25.7 | 27.0 | 27.2 | 28.2 | 27.9 | 26.9 | 27.5 | 28.2 | 28.2 | 27.8 | 28.0 | 28.0 |
| Printing | 18 | 21.7 | 21.7 | 23.6 | 23.3 | 24.8 | 26.1 | 27.0 | 26.6 | 26.0 | 26.0 | 27.5 | 27.5 | 27.6 | 27.8 | 27.1 |
| Oil | 19 | 40.5 | 41.3 | 39.5 | 42.2 | 44.4 | 47.5 | 47.6 | 47.0 | 47.7 | 42.8 | 44.8 | 46.6 | 45.6 | 43.3 | 42.1 |
| Chemicals | 20 | 32.4 | 32.9 | 34.3 | 34.4 | 35.9 | 36.0 | 37.0 | 36.5 | 36.6 | 37.1 | 38.6 | 38.5 | 38.1 | 38.0 | 37.5 |
| Pharma | 21 | 34.8 | 36.1 | 37.7 | 37.6 | 37.7 | 37.6 | 37.8 | 37.7 | 37.3 | 37.1 | 37.0 | 36.4 | 35.8 | 35.1 | 34.7 |
| Rubber | 22 | 26.5 | 27.2 | 28.2 | 27.8 | 29.0 | 29.7 | 30.1 | 29.9 | 29.3 | 28.6 | 30.0 | 29.8 | 29.9 | 30.1 | 29.2 |
| Non-mineral | 23 | 26.9 | 27.6 | 28.1 | 28.1 | 29.2 | 30.4 | 31.1 | 31.3 | 30.6 | 28.1 | 29.3 | 30.0 | 29.9 | 29.9 | 29.7 |
| Basic metals | 24 | 23.8 | 24.0 | 24.5 | 26.0 | 29.5 | 31.9 | 33.2 | 32.8 | 33.3 | 31.3 | 31.5 | 33.0 | 33.0 | 32.5 | 31.4 |
| Fab. metal | 25 | 19.3 | 18.8 | 19.4 | 20.0 | 22.3 | 23.9 | 25.0 | 25.6 | 25.1 | 21.8 | 23.6 | 24.6 | 24.1 | 24.1 | 24.0 |
| Electronics | 26 | 28.2 | 23.7 | 27.0 | 29.5 | 31.7 | 32.5 | 33.3 | 33.8 | 32.4 | 30.8 | 32.2 | 31.1 | 30.2 | 31.6 | 31.3 |
| Elec. mach. | 27 | 24.3 | 23.8 | 24.8 | 25.9 | 27.7 | 29.2 | 31.0 | 31.6 | 31.8 | 29.1 | 30.8 | 30.7 | 29.9 | 29.9 | 29.5 |
| Other mach. | 28 | 23.3 | 22.9 | 23.8 | 24.1 | 26.4 | 28.2 | 29.2 | 30.1 | 29.5 | 26.9 | 28.6 | 28.7 | 27.6 | 27.4 | 27.2 |
| Vehicles | 29 | 24.8 | 25.0 | 26.7 | 27.0 | 27.9 | 28.5 | 29.4 | 29.9 | 27.8 | 26.3 | 29.2 | 30.0 | 29.4 | 29.6 | 29.7 |
| Oth. trans. eq. | 30 | 23.4 | 23.8 | 24.9 | 25.5 | 25.3 | 28.0 | 28.1 | 29.4 | 28.1 | 27.2 | 28.4 | 28.0 | 27.1 | 26.7 | 26.3 |
| Oth. manuf. | 31t32 | 28.0 | 27.6 | 28.4 | 28.1 | 28.4 | 30.0 | 30.8 | 30.5 | 29.4 | 30.0 | 31.5 | 31.0 | 31.0 | 30.5 | 30.1 |
| Repair | 33 | 21.6 | 20.4 | 20.6 | 19.7 | 20.5 | 21.6 | 22.2 | 22.7 | 21.6 | 19.9 | 22.5 | 22.9 | 23.7 | 23.3 | 23.6 |
| 3 ALL MANUF. | | 27.8 | 27.7 | 28.7 | 29.1 | 30.2 | 31.2 | 31.8 | 31.9 | 31.4 | 30.2 | 31.7 | 31.8 | 31.3 | 31.1 | 30.7 |

**(2B) Value added by tangible capital**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 15.6 | 15.7 | 15.6 | 15.5 | 15.5 | 15.5 | 15.4 | 15.4 | 15.8 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.4 |
| Textiles | 13t15 | 15.2 | 15.4 | 15.5 | 15.7 | 15.8 | 16.0 | 16.2 | 16.2 | 16.5 | 17.4 | 17.4 | 17.3 | 17.4 | 17.5 | 17.7 |
| Wood | 16 | 16.6 | 16.8 | 16.9 | 17.1 | 16.7 | 16.7 | 17.2 | 17.6 | 18.3 | 19.8 | 19.8 | 19.8 | 20.2 | 20.0 | 20.0 |
| Paper | 17 | 18.9 | 19.4 | 19.3 | 19.4 | 19.3 | 19.2 | 19.0 | 19.1 | 19.9 | 20.7 | 20.9 | 20.8 | 20.9 | 20.9 | 20.9 |
| Printing | 18 | 16.8 | 17.5 | 18.1 | 18.2 | 18.2 | 18.1 | 17.9 | 18.4 | 19.4 | 20.1 | 20.7 | 20.8 | 20.9 | 21.1 | 21.2 |
| Oil | 19 | 18.7 | 18.8 | 20.1 | 19.1 | 18.2 | 17.3 | 17.2 | 17.5 | 17.0 | 20.0 | 19.6 | 18.2 | 18.6 | 19.2 | 20.0 |
| Chemicals | 20 | 16.1 | 16.0 | 15.9 | 16.0 | 15.9 | 16.0 | 15.8 | 16.3 | 16.4 | 17.1 | 17.3 | 17.1 | 17.1 | 17.3 | 17.5 |
| Pharma | 21 | 15.0 | 14.7 | 14.3 | 14.0 | 14.0 | 14.0 | 14.3 | 14.4 | 14.7 | 15.1 | 15.5 | 15.8 | 16.0 | 16.3 | 16.5 |
| Rubber | 22 | 17.0 | 17.1 | 17.2 | 17.5 | 17.6 | 17.6 | 17.7 | 18.2 | 18.6 | 19.9 | 19.9 | 19.6 | 19.5 | 19.5 | 19.7 |
| Non-mineral | 23 | 19.7 | 18.9 | 18.9 | 18.8 | 18.5 | 18.2 | 18.4 | 18.8 | 19.3 | 21.4 | 21.7 | 21.4 | 21.6 | 21.3 | 21.5 |
| Basic metals | 24 | 25.2 | 26.1 | 27.0 | 26.5 | 25.4 | 24.3 | 23.8 | 24.9 | 24.4 | 27.3 | 25.2 | 24.7 | 24.7 | 24.7 | 25.6 |
| Fab. metal | 25 | 18.4 | 18.7 | 19.0 | 18.7 | 18.3 | 18.2 | 18.3 | 18.9 | 19.2 | 20.7 | 20.9 | 20.2 | 20.3 | 20.7 | 20.8 |
| Electronics | 26 | 15.2 | 16.9 | 17.3 | 17.0 | 16.9 | 16.9 | 16.7 | 16.9 | 17.5 | 18.5 | 18.5 | 18.6 | 18.5 | 18.4 | 18.6 |
| Elec. mach. | 27 | 18.3 | 17.7 | 17.8 | 18.3 | 18.1 | 17.9 | 17.4 | 17.8 | 18.0 | 19.1 | 19.0 | 18.5 | 19.0 | 19.5 | 20.0 |
| Other mach. | 28 | 15.7 | 16.1 | 16.2 | 16.6 | 16.5 | 16.3 | 16.1 | 16.1 | 16.6 | 18.3 | 18.4 | 18.0 | 18.3 | 18.5 | 18.8 |
| Vehicles | 29 | 16.5 | 16.8 | 16.9 | 17.0 | 17.0 | 16.9 | 16.7 | 17.0 | 18.4 | 18.4 | 19.3 | 18.3 | 18.7 | 18.8 | 19.0 |
| Oth. trans. eq. | 30 | 16.2 | 16.2 | 16.9 | 17.2 | 17.3 | 16.5 | 16.4 | 16.1 | 17.1 | 18.2 | 18.5 | 18.6 | 18.4 | 18.6 | 18.5 |
| Oth. manuf. | 31t32 | 12.3 | 12.6 | 12.9 | 13.2 | 13.3 | 13.1 | 13.1 | 13.6 | 14.6 | 15.5 | 15.4 | 15.5 | 16.0 | 16.1 | 16.3 |
| Repair | 33 | 12.5 | 12.7 | 12.7 | 12.9 | 13.0 | 13.2 | 13.4 | 13.2 | 13.4 | 14.1 | 14.5 | 14.3 | 13.8 | 13.6 | 13.2 |
| | | | | | | | | | | | | | | | | |
| ALL MANUF. | | 15.8 | 16.1 | 16.2 | 16.3 | 16.3 | 16.2 | 16.1 | 16.3 | 16.8 | 17.6 | 17.8 | 17.6 | 17.7 | 17.8 | 18.1 |

**(2C) Value added by labour**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 54.6 | 53.9 | 53.6 | 53.9 | 53.3 | 53.4 | 53.3 | 53.5 | 53.3 | 53.1 | 51.9 | 52.0 | 52.2 | 52.3 | 52.6 |
| Textiles | 13t15 | 56.1 | 55.7 | 54.8 | 54.6 | 53.8 | 53.0 | 52.6 | 52.7 | 53.1 | 52.5 | 51.3 | 52.0 | 52.2 | 52.2 | 52.4 |
| Wood | 16 | 58.5 | 57.6 | 57.6 | 57.7 | 57.6 | 57.3 | 57.0 | 55.6 | 55.7 | 54.8 | 53.6 | 53.7 | 52.6 | 52.5 | 52.5 |
| Paper | 17 | 55.2 | 55.4 | 54.2 | 54.9 | 53.8 | 53.7 | 52.8 | 53.0 | 53.2 | 51.8 | 50.9 | 51.0 | 51.3 | 51.1 | 51.1 |
| Printing | 18 | 61.5 | 60.7 | 58.3 | 58.5 | 57.0 | 55.8 | 55.1 | 55.0 | 54.7 | 53.9 | 51.9 | 51.7 | 51.5 | 51.1 | 51.7 |
| Oil | 19 | 40.8 | 39.9 | 40.4 | 38.7 | 37.4 | 35.2 | 35.2 | 35.5 | 35.3 | 37.2 | 35.6 | 35.1 | 35.8 | 37.5 | 37.9 |
| Chemicals | 20 | 51.5 | 51.1 | 49.8 | 49.5 | 48.2 | 48.0 | 47.2 | 47.2 | 47.0 | 45.8 | 44.1 | 44.4 | 44.8 | 44.7 | 44.9 |
| Pharma | 21 | 50.2 | 49.2 | 48.0 | 48.3 | 48.3 | 48.4 | 47.9 | 47.9 | 48.0 | 47.8 | 47.4 | 47.8 | 48.2 | 48.6 | 48.8 |
| Rubber | 22 | 56.5 | 55.7 | 54.6 | 54.7 | 53.5 | 52.7 | 52.2 | 51.8 | 52.1 | 51.5 | 50.1 | 50.7 | 50.6 | 50.5 | 51.1 |
| Non-mineral | 23 | 53.4 | 53.4 | 53.1 | 53.2 | 52.3 | 51.4 | 50.5 | 50.0 | 50.1 | 50.5 | 48.9 | 48.5 | 48.6 | 48.9 | 48.9 |
| Basic metals | 24 | 51.1 | 49.9 | 48.5 | 47.5 | 45.1 | 43.8 | 43.0 | 42.4 | 42.3 | 41.4 | 43.3 | 42.3 | 42.4 | 42.8 | 43.0 |
| Fab. metal | 25 | 62.2 | 62.5 | 61.6 | 61.3 | 59.3 | 57.9 | 56.7 | 55.5 | 55.6 | 57.5 | 55.5 | 55.2 | 55.6 | 55.2 | 55.2 |
| Electronics | 26 | 56.6 | 59.3 | 55.7 | 53.5 | 51.4 | 50.6 | 50.0 | 49.4 | 50.1 | 50.8 | 49.3 | 50.2 | 51.4 | 50.0 | 50.0 |
| Elec. mach. | 27 | 57.4 | 58.5 | 57.3 | 55.8 | 54.2 | 52.9 | 51.6 | 50.7 | 50.2 | 51.8 | 50.2 | 50.8 | 51.1 | 50.6 | 50.6 |
| Other mach. | 28 | 61.1 | 61.0 | 60.0 | 59.3 | 57.1 | 55.6 | 54.7 | 53.9 | 53.9 | 54.8 | 53.1 | 53.3 | 54.1 | 54.0 | 53.9 |
| Vehicles | 29 | 58.8 | 58.2 | 56.5 | 56.0 | 55.2 | 54.6 | 53.9 | 53.1 | 53.8 | 55.4 | 51.5 | 51.7 | 51.9 | 51.7 | 51.3 |
| Oth. trans. eq. | 30 | 60.5 | 59.9 | 58.2 | 57.3 | 57.4 | 55.5 | 55.5 | 54.5 | 54.9 | 54.6 | 53.1 | 53.4 | 54.5 | 54.7 | 55.2 |
| Oth. manuf. | 31t32 | 59.7 | 59.7 | 58.7 | 58.7 | 58.3 | 56.8 | 56.1 | 56.0 | 56.1 | 54.5 | 53.1 | 53.4 | 53.1 | 53.3 | 53.7 |
| Repair | 33 | 65.9 | 66.9 | 66.7 | 67.4 | 66.5 | 65.2 | 64.4 | 64.1 | 65.0 | 66.0 | 63.0 | 62.8 | 62.6 | 63.1 | 63.2 |
| ALL MANUF. | | 56.4 | 56.2 | 55.1 | 54.6 | 53.5 | 52.7 | 52.1 | 51.8 | 51.8 | 52.2 | 50.5 | 50.6 | 51.0 | 51.1 | 51.2 |

**(2D) Value added by IPP-NA (intellectual property products as defined in the SNA 08)**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.1 | 1.1 | 1.2 |
| Textiles | 13t15 | 0.9 | 0.9 | 1.0 | 1.0 | 1.1 | 1.0 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 1.0 |
| Wood | 16 | 1.3 | 1.3 | 1.4 | 1.4 | 1.4 | 1.5 | 1.4 | 1.4 | 1.3 | 1.1 | 1.4 | 1.5 | 1.3 | 1.4 | 1.5 |
| Paper | 17 | 1.8 | 1.8 | 1.9 | 2.0 | 2.0 | 2.0 | 1.9 | 2.0 | 2.0 | 2.2 | 2.2 | 2.2 | 2.2 | 2.3 | 2.4 |
| Printing | 18 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.0 | 2.0 | 2.0 | 2.0 | 2.2 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 |
| Oil | 19 | 1.7 | 1.6 | 1.7 | 1.6 | 1.6 | 1.4 | 1.4 | 1.4 | 1.3 | 1.5 | 1.4 | 1.4 | 1.4 | 1.6 | 1.6 |
| Chemicals | 20 | 4.5 | 4.8 | 5.0 | 5.1 | 4.9 | 4.9 | 4.7 | 4.7 | 4.7 | 5.7 | 5.6 | 5.4 | 5.7 | 6.1 | 6.6 |
| Pharma | 21 | 4.9 | 5.0 | 5.1 | 5.3 | 5.4 | 5.3 | 5.4 | 5.5 | 5.5 | 6.1 | 5.8 | 5.8 | 5.9 | 6.0 | 6.3 |
| Rubber | 22 | 1.9 | 1.9 | 2.0 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 | 1.9 | 2.1 | 2.2 | 2.1 | 2.2 | 2.5 | 2.6 |
| Non-mineral | 23 | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.5 | 1.5 | 1.6 | 1.7 |
| Basic metals | 24 | 1.1 | 0.9 | 0.9 | 1.0 | 1.1 | 1.0 | 1.0 | 0.9 | 0.9 | 0.6 | 1.1 | 1.0 | 0.9 | 1.0 | 1.0 |
| Fab. metal | 25 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 |
| Electronics | 26 | 4.7 | 3.1 | 5.0 | 5.6 | 5.3 | 5.1 | 4.9 | 4.8 | 4.5 | 4.8 | 4.4 | 4.3 | 4.0 | 4.8 | 4.8 |
| Elec. mach. | 27 | 2.6 | 2.5 | 2.7 | 2.7 | 2.7 | 2.5 | 2.3 | 2.2 | 2.0 | 2.1 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 |
| Other mach. | 28 | 3.0 | 2.8 | 3.1 | 3.1 | 3.2 | 3.0 | 2.9 | 2.9 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| Vehicles | 29 | 2.9 | 3.1 | 3.7 | 3.7 | 3.6 | 3.8 | 3.6 | 3.6 | 3.3 | 2.0 | 3.0 | 2.8 | 2.7 | 2.9 | 3.1 |
| Oth. trans. eq. | 30 | 4.8 | 4.8 | 5.2 | 5.2 | 5.2 | 4.9 | 4.7 | 4.4 | 4.4 | 4.6 | 4.5 | 3.9 | 4.0 | 3.9 | 3.8 |
| Oth. manuf. | 31t32 | 1.6 | 1.7 | 1.8 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 2.0 | 2.1 | 2.2 | 2.2 | 2.2 | 2.3 | 2.3 |
| Repair | 33 | 2.3 | 2.2 | 2.2 | 2.4 | 2.5 | 2.5 | 2.4 | 2.3 | 2.3 | 2.5 | 2.4 | 2.4 | 2.4 | 2.4 | 2.5 |
| ALL MANUF. | | 2.4 | 2.2 | 2.6 | 2.7 | 2.6 | 2.6 | 2.5 | 2.4 | 2.3 | 2.3 | 2.4 | 2.3 | 2.3 | 2.4 | 2.5 |

Notes: Factor shares in in the worldwide final output value of manufacturing product groups (in %). See Table 2 in main text.
Source: Own calculations based on the WIOD, 2016 release complemented with additional data on capital compensation and stocks.

**Appendix table 3: Value added by intangible capital (%-share of product group in all manufacturing products)**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 26.3 | 27.9 | 27.5 | 26.9 | 25.7 | 24.4 | 23.4 | 23.4 | 24.3 | 27.2 | 25.6 | 25.4 | 25.8 | 26.2 | 25.8 |
| Textiles | 13t15 | 10.6 | 10.6 | 10.4 | 10.2 | 9.8 | 9.6 | 9.5 | 9.6 | 9.4 | 10.4 | 9.9 | 9.4 | 9.7 | 10.0 | 10.0 |
| Wood | 16 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Paper | 17 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Printing | 18 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Oil | 19 | 5.5 | 5.7 | 5.0 | 5.6 | 6.2 | 7.5 | 8.0 | 7.7 | 8.8 | 6.8 | 7.4 | 8.6 | 8.5 | 7.7 | 7.3 |
| Chemicals | 20 | 4.4 | 4.6 | 4.8 | 4.7 | 4.8 | 4.7 | 4.8 | 4.7 | 4.7 | 4.9 | 5.0 | 4.8 | 4.7 | 4.7 | 4.7 |
| Pharma | 21 | 3.2 | 3.7 | 4.0 | 4.1 | 3.8 | 3.5 | 3.4 | 3.4 | 3.4 | 4.0 | 3.5 | 3.2 | 3.1 | 3.1 | 3.1 |
| Rubber | 22 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| Non-mineral | 23 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.7 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 |
| Basic metals | 24 | 0.5 | 0.4 | 0.4 | 0.5 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 0.7 | 1.2 | 1.3 | 1.2 | 1.0 | 0.9 |
| Fab. metal | 25 | 1.8 | 1.6 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.0 | 2.0 | 1.7 | 1.7 | 1.8 | 1.8 | 1.7 | 1.8 |
| Electronics | 26 | 10.4 | 8.2 | 8.3 | 8.9 | 9.3 | 9.1 | 9.1 | 9.0 | 8.4 | 7.8 | 8.0 | 7.4 | 7.2 | 7.6 | 7.7 |
| Elec. mach. | 27 | 3.5 | 3.3 | 3.2 | 3.4 | 3.7 | 3.8 | 4.0 | 4.0 | 4.4 | 4.2 | 4.4 | 4.3 | 4.2 | 4.2 | 4.2 |
| Other mach. | 28 | 7.6 | 7.3 | 7.1 | 7.3 | 8.1 | 8.6 | 8.8 | 9.1 | 9.4 | 8.6 | 8.4 | 8.8 | 8.6 | 8.4 | 8.4 |
| Vehicles | 29 | 11.4 | 11.6 | 12.3 | 12.3 | 12.2 | 11.8 | 11.7 | 11.6 | 10.4 | 9.8 | 11.6 | 12.1 | 12.0 | 12.5 | 12.9 |
| Oth. trans. eq. | 30 | 2.6 | 2.9 | 2.9 | 2.8 | 2.7 | 3.0 | 3.0 | 3.3 | 3.2 | 3.5 | 3.6 | 3.5 | 3.6 | 3.6 | 3.8 |
| Oth. manuf. | 31t32 | 7.6 | 7.5 | 7.6 | 7.2 | 6.6 | 7.0 | 7.1 | 6.8 | 6.2 | 6.6 | 6.0 | 5.6 | 5.8 | 5.6 | 5.6 |
| Repair | 33 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Total | | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Notes: Value added by intangible capital in final output of product groups. Expressed as share in total value added by intangible capital in the worldwide final output value of manufacturing products (%). Own calculations based on the WIOD, 2016 release complemented with additional data on capital stocks.

**Appendix table 4: Value added by labour, intangible and tangible capital in final output of manufacturing goods, 2014**

| | | Distribution value added | | | | Final production stage value added | | | | Other production stages value added | | | | Final output at purcha-ser's prices |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Total* | Tangible capital (TAN) | Intangible capital (INTAN) | Labour | *Total* | Tangible capital (TAN) | Intangible capital (INTAN) | Labour | *Total* | Tangible capital (TAN) | Intangible capital (INTAN) | Labour | |
| Food | 10t12 | 26.3 | 2.5 | 9.2 | 14.5 | 23.3 | 4.5 | 9.4 | 9.5 | 50.4 | 9.4 | 12.4 | 28.6 | 4,925,774 |
| Textiles | 13t15 | 39.8 | 3.9 | 15.1 | 20.9 | 21.3 | 5.8 | 4.5 | 11.1 | 38.8 | 8.1 | 10.3 | 20.4 | 1,974,240 |
| Wood | 16 | 18.1 | 1.8 | 6.2 | 10.1 | 30.7 | 7.5 | 8.0 | 15.3 | 51.2 | 10.6 | 13.4 | 27.1 | 90,266 |
| Paper | 17 | 23.9 | 2.4 | 8.2 | 13.4 | 25.3 | 7.7 | 5.6 | 12.0 | 50.8 | 10.9 | 14.2 | 25.7 | 139,997 |
| Printing | 18 | 18.5 | 1.9 | 6.9 | 9.6 | 32.4 | 8.5 | 6.5 | 17.4 | 49.1 | 10.8 | 13.6 | 24.7 | 63,925 |
| Oil | 19 | 15.9 | 1.7 | 5.3 | 8.9 | 13.4 | 2.1 | 8.8 | 2.6 | 70.6 | 16.3 | 28.0 | 26.4 | 1,023,806 |
| Chemicals | 20 | 24.8 | 2.5 | 8.8 | 13.6 | 27.7 | 5.1 | 13.5 | 9.1 | 47.5 | 10.0 | 15.2 | 22.2 | 744,969 |
| Pharma | 21 | 24.3 | 2.4 | 6.9 | 14.9 | 33.6 | 6.2 | 16.0 | 11.4 | 42.2 | 7.9 | 11.8 | 22.5 | 520,236 |
| Rubber | 22 | 19.9 | 2.0 | 6.9 | 10.9 | 24.5 | 5.4 | 5.7 | 13.4 | 55.7 | 12.3 | 16.6 | 26.8 | 243,964 |
| Non-mineral | 23 | 24.4 | 2.4 | 8.5 | 13.5 | 28.1 | 8.3 | 6.2 | 13.6 | 47.5 | 10.8 | 14.9 | 21.8 | 136,496 |
| Basic metals | 24 | 13.1 | 1.4 | 4.7 | 7.0 | 20.3 | 8.8 | 3.0 | 8.5 | 66.7 | 15.4 | 23.8 | 27.5 | 178,826 |
| Fab. metal | 25 | 13.6 | 1.4 | 4.2 | 8.0 | 31.4 | 6.3 | 4.9 | 20.2 | 54.9 | 13.0 | 14.9 | 27.0 | 434,854 |
| Electronics | 26 | 17.6 | 1.7 | 6.5 | 9.4 | 32.4 | 6.2 | 11.0 | 15.3 | 49.9 | 10.7 | 13.9 | 25.3 | 1,451,844 |
| Elec. mach. | 27 | 18.5 | 1.8 | 6.9 | 9.7 | 21.9 | 4.0 | 6.4 | 11.5 | 59.6 | 14.1 | 16.2 | 29.3 | 838,449 |
| Other mach. | 28 | 17.0 | 1.6 | 6.4 | 9.0 | 29.5 | 5.5 | 6.6 | 17.3 | 53.5 | 11.7 | 14.2 | 27.6 | 1,833,585 |
| Vehicles | 29 | 13.8 | 1.3 | 4.8 | 7.6 | 26.9 | 5.3 | 8.7 | 12.8 | 59.4 | 12.3 | 16.2 | 30.8 | 2,558,998 |
| Oth. trans. eq. | 30 | 11.1 | 1.1 | 4.0 | 6.0 | 30.1 | 5.2 | 6.5 | 18.5 | 58.8 | 12.3 | 15.8 | 30.7 | 851,677 |
| Oth. manuf. | 31t32 | 43.0 | 4.1 | 15.0 | 23.9 | 23.3 | 5.1 | 5.6 | 12.5 | 33.7 | 7.0 | 9.4 | 17.3 | 1,093,597 |
| Repair | 33 | 30.4 | 2.9 | 11.4 | 16.1 | 35.8 | 3.8 | 4.1 | 28.0 | 33.8 | 6.5 | 8.1 | 19.1 | 159,835 |
| ALL MANUF. | | 23.2 | 2.3 | 8.3 | 12.7 | 25.4 | 5.1 | 8.2 | 12.2 | 51.4 | 10.7 | 14.3 | 26.4 | 19,265,339 |

Notes: Value added in the worldwide final output value of manufacturing products. Final output in US$. Own calculations based on the WIOD, 2016 release complemented with additional data on capital stocks.

**Appendix table 5: Value added by intangible capital in three stages of GVC, by manufacturing product group.**

**(5A) Distribution stage (as %-share of all stages)**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 30.6 | 29.8 | 29.7 | 29.5 | 29.9 | 30.5 | 30.7 | 30.0 | 29.5 | 29.6 | 30.5 | 29.5 | 29.8 | 29.5 | 29.8 |
| Textiles | 13t15 | 44.1 | 44.2 | 44.4 | 45.2 | 45.9 | 45.0 | 44.8 | 44.6 | 46.0 | 52.0 | 51.1 | 48.7 | 50.6 | 50.4 | 50.6 |
| Wood | 16 | 18.8 | 19.3 | 20.3 | 22.6 | 23.4 | 23.9 | 23.0 | 21.3 | 22.3 | 20.7 | 23.1 | 22.0 | 22.9 | 21.8 | 22.4 |
| Paper | 17 | 23.0 | 24.0 | 23.5 | 24.6 | 25.5 | 26.3 | 25.2 | 25.6 | 27.3 | 27.1 | 29.2 | 29.5 | 30.8 | 29.5 | 29.3 |
| Printing | 18 | 22.3 | 21.8 | 20.6 | 22.1 | 21.3 | 21.3 | 20.9 | 21.3 | 22.6 | 24.2 | 25.3 | 24.8 | 25.8 | 25.3 | 25.6 |
| Oil | 19 | 16.8 | 17.2 | 18.3 | 16.4 | 15.1 | 12.3 | 12.0 | 11.8 | 11.3 | 14.0 | 12.8 | 11.5 | 11.9 | 12.1 | 12.7 |
| Chemicals | 20 | 25.8 | 25.9 | 25.3 | 24.6 | 24.5 | 24.6 | 23.6 | 22.6 | 22.6 | 25.3 | 24.7 | 23.1 | 24.1 | 23.5 | 23.5 |
| Pharma | 21 | 22.1 | 21.5 | 20.2 | 20.1 | 20.5 | 20.4 | 20.1 | 19.5 | 19.5 | 20.5 | 20.2 | 19.6 | 19.8 | 19.7 | 19.9 |
| Rubber | 22 | 24.5 | 23.0 | 22.0 | 21.8 | 22.6 | 22.3 | 21.8 | 21.1 | 21.7 | 23.3 | 23.7 | 22.8 | 24.0 | 23.3 | 23.6 |
| Non-mineral | 23 | 29.5 | 28.7 | 28.4 | 28.6 | 28.0 | 26.9 | 25.0 | 23.9 | 24.5 | 28.6 | 30.2 | 28.5 | 29.7 | 28.4 | 28.7 |
| Basic metals | 24 | 18.9 | 23.7 | 20.2 | 18.2 | 17.5 | 17.6 | 16.3 | 15.3 | 14.7 | 16.4 | 15.7 | 14.1 | 14.9 | 14.2 | 14.8 |
| Fab. metal | 25 | 23.2 | 23.8 | 23.3 | 22.1 | 21.7 | 20.9 | 19.6 | 18.6 | 18.6 | 20.7 | 20.2 | 18.7 | 18.6 | 17.3 | 17.4 |
| Electronics | 26 | 17.6 | 21.4 | 19.5 | 17.9 | 17.4 | 17.1 | 17.0 | 16.9 | 17.9 | 19.5 | 19.3 | 19.5 | 20.4 | 20.3 | 20.7 |
| Elec. mach. | 27 | 19.7 | 20.5 | 21.1 | 20.4 | 20.7 | 20.4 | 19.8 | 19.7 | 20.0 | 22.9 | 23.2 | 22.8 | 23.3 | 23.0 | 23.3 |
| Other mach. | 28 | 25.2 | 24.6 | 23.5 | 22.7 | 22.2 | 21.1 | 20.0 | 19.1 | 19.1 | 22.7 | 23.4 | 22.4 | 23.5 | 23.5 | 23.6 |
| Vehicles | 29 | 22.7 | 21.3 | 20.4 | 19.2 | 19.4 | 18.9 | 18.3 | 17.2 | 18.2 | 18.0 | 17.1 | 16.1 | 16.6 | 16.1 | 16.3 |
| Oth. trans. eq. | 30 | 17.7 | 16.3 | 16.6 | 15.8 | 16.6 | 15.0 | 14.9 | 13.8 | 14.0 | 14.1 | 14.6 | 14.2 | 14.9 | 14.6 | 15.2 |
| Oth. manuf. | 31t32 | 48.3 | 47.7 | 47.7 | 48.4 | 49.2 | 46.9 | 46.2 | 45.6 | 46.1 | 47.6 | 50.6 | 49.8 | 50.7 | 50.5 | 50.0 |
| Repair | 33 | 31.9 | 33.9 | 37.5 | 38.7 | 38.2 | 34.6 | 35.0 | 33.0 | 34.2 | 41.0 | 46.0 | 46.1 | 48.5 | 48.6 | 48.3 |
| ALL MANUF. | | 28.3 | 28.4 | 28.0 | 27.3 | 27.0 | 26.3 | 25.8 | 25.1 | 25.2 | 27.8 | 27.5 | 26.0 | 27.0 | 26.8 | 27.0 |

**(5B) Final stage (as %-share of all stages)**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 36.9 | 37.3 | 37.0 | 35.9 | 33.7 | 32.8 | 32.0 | 30.1 | 29.1 | 33.3 | 31.2 | 29.5 | 30.7 | 30.0 | 30.1 |
| Textiles | 13t15 | 21.6 | 20.9 | 20.4 | 19.4 | 19.3 | 19.1 | 19.0 | 19.1 | 17.7 | 15.9 | 15.4 | 16.0 | 15.6 | 15.1 | 14.9 |
| Wood | 16 | 31.7 | 32.0 | 28.7 | 28.4 | 27.7 | 25.0 | 23.7 | 25.9 | 23.9 | 28.2 | 25.9 | 25.9 | 27.7 | 28.5 | 28.9 |
| Paper | 17 | 30.5 | 26.9 | 28.9 | 25.8 | 26.1 | 22.9 | 24.8 | 22.9 | 18.6 | 25.9 | 21.5 | 19.2 | 18.1 | 19.1 | 19.9 |
| Printing | 18 | 23.8 | 25.4 | 29.3 | 26.2 | 28.6 | 29.7 | 30.0 | 28.6 | 24.8 | 25.5 | 24.7 | 24.3 | 24.5 | 24.8 | 24.2 |
| Oil | 19 | 26.0 | 30.4 | 26.9 | 30.8 | 30.4 | 28.0 | 25.1 | 25.1 | 20.9 | 24.2 | 22.2 | 19.8 | 20.2 | 19.9 | 20.9 |
| Chemicals | 20 | 35.7 | 36.5 | 38.5 | 37.5 | 36.5 | 31.8 | 32.9 | 32.4 | 29.9 | 37.7 | 36.2 | 34.2 | 34.2 | 35.2 | 35.9 |
| Pharma | 21 | 48.6 | 50.5 | 52.5 | 52.4 | 50.8 | 49.1 | 49.0 | 48.9 | 48.5 | 50.8 | 48.3 | 47.0 | 46.7 | 45.9 | 46.1 |
| Rubber | 22 | 24.4 | 26.1 | 26.8 | 25.3 | 24.2 | 22.0 | 21.1 | 20.8 | 18.3 | 21.6 | 20.4 | 18.5 | 19.2 | 20.3 | 19.7 |
| Non-mineral | 23 | 25.8 | 27.4 | 28.7 | 28.0 | 28.0 | 26.2 | 26.5 | 27.6 | 23.6 | 21.3 | 18.5 | 18.6 | 18.0 | 19.9 | 21.0 |
| Basic metals | 24 | 13.7 | 9.5 | 11.1 | 14.0 | 20.2 | 18.1 | 17.9 | 16.1 | 12.3 | 9.9 | 11.3 | 13.5 | 10.2 | 9.8 | 9.4 |
| Fab. metal | 25 | 20.7 | 19.1 | 19.3 | 20.9 | 20.6 | 20.2 | 20.6 | 20.9 | 19.2 | 17.0 | 18.0 | 18.5 | 18.4 | 19.4 | 20.4 |
| Electronics | 26 | 38.6 | 26.5 | 32.9 | 37.9 | 38.0 | 36.6 | 36.2 | 34.9 | 32.5 | 34.2 | 34.0 | 31.7 | 30.7 | 34.7 | 34.9 |
| Elec. mach. | 27 | 28.1 | 27.0 | 28.6 | 29.7 | 27.3 | 26.0 | 27.3 | 25.2 | 25.2 | 25.1 | 24.4 | 22.3 | 22.3 | 22.0 | 21.8 |
| Other mach. | 28 | 26.3 | 26.3 | 26.9 | 26.3 | 27.6 | 28.1 | 28.7 | 29.5 | 28.3 | 25.6 | 25.6 | 25.8 | 23.9 | 23.9 | 24.4 |
| Vehicles | 29 | 26.4 | 28.1 | 31.5 | 31.5 | 27.9 | 26.4 | 26.8 | 27.2 | 21.9 | 23.3 | 28.0 | 28.0 | 28.1 | 28.9 | 29.3 |
| Oth. trans. eq. | 30 | 30.5 | 34.4 | 33.5 | 32.7 | 27.7 | 31.6 | 30.5 | 32.5 | 28.7 | 31.1 | 30.1 | 27.2 | 25.3 | 25.6 | 24.8 |
| Oth. manuf. | 31t32 | 23.1 | 23.2 | 23.3 | 21.2 | 19.2 | 21.7 | 22.7 | 22.2 | 20.5 | 22.5 | 20.6 | 19.8 | 19.4 | 18.8 | 18.8 |
| Repair | 33 | 24.7 | 19.4 | 18.0 | 12.8 | 13.7 | 18.0 | 17.8 | 19.6 | 17.6 | 13.6 | 13.6 | 14.0 | 16.0 | 16.0 | 17.4 |
| | | | | | | | | | | | | | | | | |
| ALL MANUF. | | 30.8 | 30.5 | 31.4 | 31.4 | 29.9 | 29.0 | 28.7 | 28.1 | 26.0 | 28.2 | 27.3 | 26.1 | 26.0 | 26.3 | 26.6 |

**(5C) Other production stage (as %-share of all stages)**

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Food | 10t12 | 32.5 | 33.0 | 33.3 | 34.6 | 36.4 | 36.7 | 37.4 | 39.9 | 41.4 | 37.1 | 38.4 | 41.0 | 39.5 | 40.5 | 40.1 |
| Textiles | 13t15 | 34.3 | 34.9 | 35.2 | 35.3 | 34.8 | 35.9 | 36.2 | 36.3 | 36.3 | 32.2 | 33.5 | 35.3 | 33.9 | 34.6 | 34.5 |
| Wood | 16 | 49.5 | 48.7 | 51.0 | 49.0 | 49.0 | 51.1 | 53.3 | 52.7 | 53.8 | 51.1 | 50.9 | 52.1 | 49.5 | 49.7 | 48.7 |
| Paper | 17 | 46.5 | 49.1 | 47.7 | 49.6 | 48.5 | 50.9 | 50.0 | 51.4 | 54.0 | 46.9 | 49.3 | 51.2 | 51.1 | 51.4 | 50.8 |
| Printing | 18 | 53.9 | 52.8 | 50.1 | 51.7 | 50.1 | 49.0 | 49.0 | 50.2 | 52.6 | 50.3 | 50.0 | 50.9 | 49.7 | 49.9 | 50.2 |
| Oil | 19 | 57.2 | 52.3 | 54.8 | 52.9 | 54.5 | 59.7 | 62.9 | 63.2 | 67.8 | 61.8 | 65.0 | 68.7 | 67.9 | 68.0 | 66.5 |
| Chemicals | 20 | 38.6 | 37.7 | 36.2 | 37.8 | 39.0 | 43.6 | 43.4 | 45.1 | 47.5 | 37.0 | 39.1 | 42.7 | 41.7 | 41.4 | 40.5 |
| Pharma | 21 | 29.3 | 28.0 | 27.3 | 27.5 | 28.7 | 30.5 | 31.0 | 31.6 | 32.1 | 28.6 | 31.5 | 33.4 | 33.6 | 34.4 | 34.0 |
| Rubber | 22 | 51.1 | 50.9 | 51.2 | 52.9 | 53.3 | 55.6 | 57.0 | 58.2 | 60.1 | 55.1 | 55.9 | 58.7 | 56.8 | 56.5 | 56.7 |
| Non-mineral | 23 | 44.7 | 43.9 | 43.0 | 43.4 | 44.0 | 46.9 | 48.4 | 48.5 | 51.9 | 50.1 | 51.4 | 52.9 | 52.3 | 51.7 | 50.3 |
| Basic metals | 24 | 67.4 | 66.8 | 68.7 | 67.7 | 62.2 | 64.3 | 65.9 | 68.6 | 73.0 | 73.6 | 73.0 | 72.4 | 74.9 | 76.0 | 75.8 |
| Fab. metal | 25 | 56.1 | 57.1 | 57.4 | 57.0 | 57.7 | 58.9 | 59.8 | 60.5 | 62.2 | 62.2 | 61.9 | 62.8 | 63.0 | 63.2 | 62.1 |
| Electronics | 26 | 43.8 | 52.1 | 47.6 | 44.2 | 44.7 | 46.3 | 46.8 | 48.2 | 49.6 | 46.2 | 46.7 | 48.8 | 48.9 | 45.0 | 44.4 |
| Elec. mach. | 27 | 52.2 | 52.5 | 50.3 | 49.9 | 52.0 | 53.6 | 52.9 | 55.1 | 54.8 | 51.9 | 52.4 | 55.0 | 54.4 | 55.0 | 54.9 |
| Other mach. | 28 | 48.5 | 49.1 | 49.5 | 51.1 | 50.2 | 50.8 | 51.3 | 51.4 | 52.6 | 51.7 | 50.9 | 51.8 | 52.6 | 52.5 | 52.0 |
| Vehicles | 29 | 50.9 | 50.6 | 48.1 | 49.4 | 52.7 | 54.7 | 54.9 | 55.6 | 59.9 | 58.7 | 54.9 | 55.9 | 55.4 | 55.0 | 54.4 |
| Oth. trans. eq. | 30 | 51.7 | 49.4 | 49.8 | 51.5 | 55.8 | 53.3 | 54.5 | 53.7 | 57.3 | 54.8 | 55.4 | 58.5 | 59.8 | 59.8 | 60.0 |
| Oth. manuf. | 31t32 | 28.7 | 29.1 | 29.0 | 30.4 | 31.6 | 31.5 | 31.1 | 32.3 | 33.4 | 29.9 | 28.8 | 30.5 | 29.9 | 30.7 | 31.3 |
| Repair | 33 | 43.4 | 46.7 | 44.4 | 48.5 | 48.1 | 47.4 | 47.2 | 47.4 | 48.3 | 45.4 | 40.4 | 39.9 | 35.4 | 35.3 | 34.4 |
| ALL MANUF. | | 40.9 | 41.1 | 40.5 | 41.3 | 43.0 | 44.7 | 45.5 | 46.8 | 48.8 | 44.0 | 45.2 | 47.9 | 47.0 | 46.9 | 46.4 |

Notes: Value by intangible capital in the various stages of GVC. Expressed as share in total value added by intangible capital in the worldwide final output value of manufacturing products (%). Own calculations based on the WIOD, 2016 release complemented with additional data on capital stocks.

## DATA APPENDIX I - THE WORLD INPUT-OUTPUT DATABASE (WIOD)[18]

To implement the new GVC metrics, one needs to have a database with linked consumption, production, and income flows within and between countries and/or economies. For individual countries, this type of information can be found in input-output tables. However, national tables do not provide any information on bilateral flows of goods and services between economies. For this type of information researchers have to rely on data sets constructed on the basis of national input-output tables in combination with international trade data. For this paper, we use the World Input-Output Database (WIOD), 2016 release, that aims to fill this gap. The WIOD provides a time series of world input-output tables from 1995 onwards, distinguishing between 56 industries and 59 product groups. In this Appendix we outline the basic concepts and construction of our world input-output tables.

Basically, a world input-output table (WIOT) is a combination of national input-output tables in which the use of products is broken down according to their origin. In contrast to the national input-output tables, this information is made explicit in the WIOT. For each economy, flows of products both for intermediate and final use are split into domestically produced or imported. In addition, for imports, the WIOT shows which foreign *industry* produced the product. This is illustrated by the schematic outline for a WIOT in Appendix Figure 1. It illustrates the simple case of three regions: Economies/countries A and B, and the rest of the world. In the WIOD we will distinguish 43 economies and the rest of the World, but the basic outline remains the same.

The rows in the WIOT indicate the use of output from a particular industry in an economy. This can be intermediate use either in the economy itself (use of domestic output) or by other economies (in which case it is exported). Output can also be for final use, either by the economy itself (final use of domestic output) or by other economies (in which case it is exported).[19] Final use is indicated in the right side of the table, and this information can be used to measure the C matrix defined in Section 2. The sum over all uses is equal to the output of an industry, denoted by Q in Section 2.

[18] The text in this Appendix is based on Timmer, M., Los, B., & de Vries, G. (2015). "Incomes and Jobs in Global Production of Manufactures: New Measures of Competitiveness Based on the World Input-Output Database". In S.N. Houseman, & M. Mandel (Eds.), Measuring Globalization: Better Trade Statistics for Better Policy, Vol. 2, 121-163, Kalamazoo: W.E. Upjohn Institute for Employment Research.

[19] Final use includes consumption by households, government and non-profit organisations, and gross capital formation.

**Appendix Figure 1: Schematic Outline of World Input-Output Table (WIOT)**

| | | Country A Intermediate *Industry* | Country B Intermediate *Industry* | Rest of World Intermediate *Industry* | Country A Final domestic | Country B Final domestic | Rest of Final domestic | Total |
|---|---|---|---|---|---|---|---|---|
| Country A | *Industry* | Intermediate use of domestic output | Intermediate use by B of exports from A | Intermediate use by RoW of exports from A | Final use of domestic output | Final use by B of exports from A | Final use by RoW of exports from A | Output in A |
| Country B | *Industry* | Intermediate use by A of exports from B | Intermediate use of domestic output | Intermediate use by RoW of exports from B | Final use by A of exports from B | Final use of domestic output | Final use by RoW of exports from B | Output in B |
| Rest of World (RoW) | *Industry* | Intermediate use by A of exports from RoW | Intermediate use by B of exports from RoW | Intermediate use of domestic output | Final use by A of exports from RoW | Final use by B of exports from RoW | Final use of domestic output | Output in RoW |
| | | Value added | Value added | Value added | | | | |
| | | Output in A | Output in B | Output in RoW | | | | |

A fundamental accounting identity is that total use of output in a row equals total output of the same industry, as indicated in the respective column in the left-hand part of the table. The columns convey information on the technology of production, as they indicate the amounts of intermediate and factor inputs needed for production. The intermediates can be sourced from domestic industries or imported. This is the B matrix from Section 2. The residual between total output and total intermediate inputs is value-added. This is made up by compensation for production factors. It is the direct contribution of domestic factors to output.

As building blocks for the WIOT, national supply and use tables (SUTs) were used; these are the core statistical sources from which NSIs derive national input-output tables. In short, we derive time series from national SUTs. Benchmark national SUTs are linked over time through the use of the most recent National Accounts statistics on final demand categories, as well as through the use of gross output and value-added by detailed industry. This ensures both intercountry and intertemporal consistency of the tables. As such, the WIOT is built according to the conventions of the System of National Accounts and obeys various important accounting identities. National SUTs are linked across economies through detailed international trade statistics to create so-called international SUTs. This is based on a classification of bilateral import flows by end-use category (intermediate, consumer, or investment), in which intermediate inputs are split by economy of origin. These international SUTs are used to construct the symmetric world input-output of the industry-by-industry type. Dietzenbacher et al. (2013) provide an in-depth technical discussion.

The construction of the WIOT has a number of distinct characteristics. First, we rely on national supply and use tables (SUTs) rather than input-output tables as our basic building blocks. SUTs are a natural starting point for this type of analysis, as they provide information on both products and industries. A supply table provides information on products produced by each domestic industry, and a use table indicates the use of each product by an industry or final user. The linking with international trade data, which is product-based, and with factor use, which is industry-based, can be naturally made in an SUT framework.[20]

[20] Because industries also have secondary production, a simple mapping of industries and products is not feasible.

Ideally, we would like to use official data on the destination of imported goods and services. But in most economies these flows are not tracked by statistical agencies. Nevertheless, most do publish an import I/O table constructed with the import proportionality assumption, applying a product's economy-wide import share for all use categories. For the United States, researchers have found that this assumption can be rather misleading, in particular at the industry level (Feenstra and Jensen 2012; Strassner, Yuskavage, and Lee 2009).

Therefore, we are not using the official import matrices but instead use detailed trade data to make a split. Our basic data are the bilateral import flows of all countries covered in WIOD from all partners in the world at the HS6-digit product level, taken from the UN COMTRADE database. Based on the detailed description, products are allocated to three use categories: 1) intermediates, 2) final consumption, and 3) investment, effectively extending the UN Broad Economic Categories (BEC) classification. We find that import proportions differ widely across use categories and, importantly, also across country of origin. For example, imports by the Czech car industry from Germany contain a much higher share of intermediates than imports from Japan. This type of information is reflected in our WIOT by using detailed bilateral trade data. The domestic use matrix is derived as total use minus imports. Another novel element in the WIOT is the use of data on trade in services. As yet, no standardized database on bilateral service flows exists. These have been collected from various sources (including the OECD, Eurostat, the IMF and the WTO), checked for consistency, and integrated into a bilateral service trade database.

The WIOD includes data on hours worked and compensation for three labour types and data on capital stocks and compensation. These series are not part of the core set of national accounts statistics reported by NSIs, and additional material has been collected from employment and labour force statistics. For each economy covered, we chose what we considered the best statistical source for consistent wage and employment data at the industry level. In most countries, this was the labour force survey (LFS). In most cases this needed to be combined with an earnings survey, as information on wages is often not included in the LFS. In other instances, an establishment survey or social security database was used. Care has been taken to arrive at series which are time-consistent, as most employment surveys are not designed to track developments over time, and breaks in methodology or coverage frequently occur.

Labour compensation of self-employed persons is not registered in the National Accounts, which, as emphasised by Krueger (1999), leads to an understatement of labour's share. This is particularly important for less advanced economies, which typically feature a large share of self-employed workers in industries like agriculture, trade, business, and personal services. We make an imputation by assuming that the compensation per hour of self-employment is equal to the compensation per hour of employees. For most advanced countries, labour data is constructed by extending and updating the EU KLEMS database (www.euklems.org) using the methodologies, data sources, and concepts described in O'Mahony and Timmer (2009). For other economies additional data has been collected according to the same principles. Capital compensation is derived as gross value-added minus labour compensation as defined above. This is the gross operating surplus (in national accounting terms), including profits and depreciation allowances.

**DATA Appendix II Factor cost shares for WIOD 2016 release**

For the calculation of the share of Labour Compensation (LAB) in Value Added (VA), the general approach is to use the method of assuming wages of the self-employed to be equal to the wages of the employees. When Mixed Income (MIXINC) is available from the Use tables, an upper limit to the LAB share in VA is calculated by adding Compensation of Employees (COMP) to MIXINC and dividing by VA. MIXINC is typically available for only a few benchmark years, therefore we extrapolate the upper limit by calculating the ratio of the LAB-share value using the general approach over the upper limit using the MIXINC approach, in the closest benchmark year. This ratio is then applied to non-benchmark years. The data for European countries stems from EUROSTAT, unless otherwise indicated.

**Economy-specific notes**

### Australia

- LAB shares are taken from Australia KLEMS.
- Data is two-period average shares
- Data for O, P and Q estimated as (COMP*$ratio$)/VA, where $ratio$ is an average ratio of H_EMP/H_EMPE, taken from OECD data for the period 2011-2013. Data from OECD.
- Detailed LAB shares for manufacturing are taken from the WIOD 2013 release

### Austria

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

### Belgium

- Calculations for the general method are based on persons engaged
- MIXINC is available for 2010-2013
- Used full time series 2000-2014

### Bulgaria

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014

### Brazil

- We estimate the labour income share in two ways and take the minimum of them. First, labour income is estimated as:
- LAB1,cit=COMPcit + MIXINCOMEcit
- So the labour income (LAB) is the sum of remuneration of employees (COMP) and mixed income (MIXINCOME) for each industry i in year t (country c is Brazil here). For this we use the information provided in the annual supply and use tables that directly underlies the national accounts, as published by Brazil's statistical office (IBGE).
- We use the detailed SUTs for the year 2010-2014 and extrapolate backwards to 2000 using the less detailed SUTs for the years 2000-2009. The concordance is equal to that underlying the time series SUTs for the 2016 WIOD release.
- Second, labour income is estimated as:
- LAB2, cit = ((COMP cit /EMPE cit)*(EMP cit -EMPE cit))+COMP¬cit
- Where LAB is labour income, COMP is compensation of employees, EMP is persons engaged, and EMPE is employees. We use the share of employees by industry build up from the micro data of the PNAD surveys. COMP is as before from IBGE's SUTs.
- Labour income that is used is

- LABcit=min(LAB1,cit, LAB2, cit)

### Canada

- Employment data is available from OECD.Stat for 2000-2013
- OECD output series are available for 2007-2012
- Explicit data on the renumeration of the self-employed is available from STATCAN.
- NAICS based productivity accounts from CANSIM are used, table 383-0032. It includes total labour compensation and Value Added (GDP calculated as Gross domestic product (GDP) is valued at basic prices), for the period 2000-2012. It is calculated as gross output at basic prices minus intermediate inputs at purchaser prices.) NAICS industries are mapped to ISIC Rev. 4 industries.
- Data on Public Administration is taken from WIOD 2013 release (ISIC Rev. 3 industry L), shares are held constant after 2009.

### Switzerland

- Data is available from EUROSTAT Structural Business Statistics (SBS) on labour cost, turnover and Value Added at Factor Cost, for detailed industries. The ratio of labour cost over value added at factor cost is taken as the LAB share. These data are available for 2009-2014
- The data from SBS does not contain information for the following sectors: Agriculture (A), Manufacture of coke and refined petroleum products (C19), Water Transport (H50), Air Transport (H51), Warehousing and support activities for transportation (H52), Financial services (K), Public Administration (O), Education (P), and Human health and social work activities (Q). For these industries the LAB shares of Germany were used.
- For the period 2000-2008 the LAB shares are extended backwards from the 2009 values using the growth in the German shares.
- For the Mining sector (B), we kept the shares constant at the 2009 level for the 2000-2008 period, since the output for this industry remains very stable, which isn't the case for the German industry, which makes the pattern of the German LAB shares for this industry not representative for Switzerland.

### China

- We estimate labour shares based on the 2002, the 2007 and the 2012 IOT. Years in between are interpolated. 2000-2001 labour shares are equal to 2002 and 2013-2014 labour shares are equal to 2012.
- Labour shares in value added are derived from labour compensation provided in the input-output tables. Before the first Economic Census in 2004, the income of self-employed and their employees are included in labour compensation (NBS, 2003). While profits related to owners (informal entrepreneurs) should be part of gross operating surplus, we consider the labour compensation in the input-output tables before 2004 closest to the definition of labour compensation in value added.
- After the economic census, two changes in the income GDP accounting method introduce a break in the labour share time series by industry (Bai and Qian, 2010). First, profits of state-owned and collective-owned farms are included in labour compensation, introducing an upward break in the agricultural labour shares. Second, income of self-employed owners is subsequently included in gross operating surplus.
- We use the adjustment factors for these changes at the sector level in Bai and Qian (2010) for the 2007 and 2012 IOT (except for H53, O84, P85, and Q), to arrive at consistent time series that correspond most closely to the definition of labour shares before the 2004 Economic Census.

### Cyprus

- Shares are set equal to Greece

### Czech Republic

- Calculations for the general method are based on hours worked
- MIXINC is available for 2000-2014
- Used full time series 2000-2014

### Germany

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014

### Denmark

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

### Spain

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

### Estonia

- Calculations for the general method are based on hours worked
- MIXINC is available for 2010-2013
- Used full time series 2000-2014
- All sub industries of sector Professional, scientific and technical activities (M) are grouped.
- Hourly wage rates seem volatile. Probably due to small numbers introducing large errors.
- For Activities auxiliary to financial services and insurance activities (K66) in 2005 the employment data of the total Financial and insurance activities sector (K), is taken due to missing employment data.
- For Manufacture of paper and paper products (C17) in 2001 the average LAB share of the surrounding years is used, due to a jump in the share as a result of implausible jump in the COMP data.

### Finland

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

### France

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014

### United Kingdom

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Employment data is available up to 2013, shares after 2013 are set equal to 2013
- Used full time series 2000-2014

### Greece

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

- There is an implausible value for COMP in 2012 for Postal and courier activities (H53), this is adjusted by taking the average hourly wage rates of 2011 and 2013

### Croatia

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used time series 2008-2014, shares prior to 2008 are held constant.
- Industries H51 and H53 are grouped (Air transport and Postal and courier activities)

### Hungary

- Calculations for the general method are based on persons engaged
- MIXINC is available for 2010-2013
- Used full time series 2000-2014
- Volatile LAB shares in transportation, due to fluctuations in VA

### Indonesia

- Shares taken from the WIOD 2013 release for now.
- Shares are held constant from 2009 onwards.
- ISIC Rev.3 industries are mapped to ISIC Rev.4 industries in the current release.

### India

- LAB shares are directly taken from India KLEMS[21]. Data is available for 27 sectors (ISIC Rev. 3), these are mapped to WIOD industries. I followed the same rough mapping as was used for the external output series in the SUTs. The last available year is 2011. Shares after 2011 are set equal to their 2011 values.

### Ireland

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014
- Industries C19-C21 (Manufacture of coke and refined petroleum products, Manufacture of chemicals and chemical products, Manufacture of basic pharmaceutical products and pharmaceutical preparations) are grouped.
- The Agricultural industries (A) are grouped together.

### Italy

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014

### Japan

- Used Nominal Labour cost divided by Value Added from the JIP 2015 database
- Data available up to 2012, shares are assumed to be constant afterwards

### Korea

- For Korea there are Use tables available for 2010-2014 for detailed (82) industries, as well as accompanying information on hours worked. The industries are mapped to the industries in the WIOTs.
- LAB shares are calculated in the standard way for 2010-2014.
- In order to derive estimates for 2000-2009 there are two additional sources that were used: The information from the previous WIOD 2013 release in the old SNA and industry classification and information from OECD for 19 distinguished aggregate sectors. The OECD data is available for 2004-2013.

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[21] https://www.rbi.org.in/Scripts/PublicationReportDetails.aspx?UrlPage=&ID=855

- For all non-manufacturing sectors the shares are cast back using the growth in the OECD shares. Aggregate industries from OECD are mapped to detailed WIOT industries.
- For the manufacturing industries the shares in 2009 are assumed to match the 2010 shares. From 2009 back to 2000 the growth of the 2012 WIOD LAB shares are used to cast back the series.
- For the period 2000-2003 approach for manufacturing industries is applied to all industries

### Lithuania

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014

### Luxembourg

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Data is available at a higher industry level, lower level industries get the shares of their parent.

### Latvia

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014
- Replaced the shares for Air transport (H51) by the values from the transport sector as a whole (H).

### Mexico

- We estimate labour shares based on the data published by Mexico's statistical office (INEGI) in its productivity report (Mexico KLEMS)[22]. From that publication we use value added, compensation of employees, and persons engaged by industry. It should be noted that compensation as a share in value added is very low for several sectors, in particular agriculture. A large part of informal labour income is included in gross operating surplus. Using previous estimates of the share of employees in total employment (documented in the socio-economic accounts, released in 2012, see wiod.org) we estimate the labour income as
- LAB cit = ((COMP cit /EMPE cit)*(EMP cit -EMPE cit))+COMP¬cit
- Where LAB is labour income, COMP is compensation of employees, EMP is persons engaged, and EMPE is employees. Subscript c refers to Mexico here, i to each of the 56 industries distinguished and t to year (2000 to 2014).

### Malta

- Shares are set equal to Greece

### Netherlands

- Calculations for the general method are based on hours worked
- MIXINC is available for 2010-2013
- Used full time series 2000-2014

### Norway

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

[22] See http://www3.inegi.org.mx/sistemas/tabuladosbasicos/tabniveles.aspx?c=33687

### Poland

- Calculations for the general method are based on hours worked
- MIXINC is available for 2010-2012
- Used time series 2003-2014, shares prior to 2003 are held constant
- Air transport and Postal and courier activities (H51 and H53) are grouped.

### Portugal

- Calculations for the general method are based on persons engaged
- MIXINC is not available
- Used full time series 2000-2014

### Romania

- Calculations for the general method are based on hours worked
- MIXINC is available for 2010-2013
- Used full time series 2000-2014
- There is an implausible COMP value in 2010 in the source data of 12,387, whereas the value for 2009 was 5,412 and 2011 2,087. This results in an hourly wage rate for employees in 2009, 2010 and 2011 of 18, 35 and 6 respectively. The data is adjusted by setting the hourly wage rate for 2010 equal to that of 2009.

### Russia

- Data taken from Russia KLEMs, supplied by Ilya Voskoboynikov at the National Research University Higher School of Economics. The original source of the primary data is Rosstat.
- The KLEMS data is in the old ISIC Rev. 3 classification for the period 2000-2014, which is mapped to ISIC Rev. 4 industries.

### Slovakia

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014

### Slovenia

- Calculations for the general method are based on hours worked
- MIXINC is available for 2010-2013
- Used full time series 2000-2014

### Sweden

- Calculations for the general method are based on hours worked
- MIXINC is not available
- Used full time series 2000-2014
- The following industries are grouped, and thus get the same shares:
    - Chemicals and pharmaceuticals (C20+C21)
    - Warehousing and Postal (H52+H53)
    - Architectural activities and Scientific R&D (M72+M72)

### Turkey

- Shares are taken from the WIOD 2013 release.
- Shares are held constant from 2009 onwards.
- ISIC Rev.3 industries are mapped to ISIC Rev.4 industries in the current release.

### Taiwan (Province of China)

- Shares are taken from the WIOD 2013 release.
- Shares are held constant from 2009 onwards.
- ISIC Rev.3 industries are mapped to ISIC Rev.4 industries in the current release.

### United States

- Information on persons engaged is collected from the BEA.
- Reported total persons engaged includes FTE employees, rather than persons, therefore total employment numbers have been recalculated.
- Mixed income is available as 'Nonfarm Proprietors' Income by Industry' for aggregate sectors which was used in the following way:
    - The COMP/VA ratio is calculated as the lower limit and (MIXINC+COMP)/VA as the upper limit for aggregate sectors.
    - The ratio of the upper limit divided by the lower limit is computed for the aggregate sectors.
    - These ratios are applied to the lower limit (COMP/VA) for detailed industries to compute the upper limit for the LAB shares for all industries.
    - This upper limit is generally higher than the LAB shares computed using the standard method of applying employee wages to the self-employed for export industries.

**Appendix Table II.A** – Industries in WIOD release 2016 (according to ISIC Rev. 4)

| Nr | Industries | |
|---|---|---|
| 1 | A01 | Crop and animal production, hunting and related service activities |
| 2 | A02 | Forestry and logging |
| 3 | A03 | Fishing and aquaculture |
| 4 | B | Mining and quarrying |
| **5** | **C10-C12** | **Manufacture of food products, beverages and tobacco products** |
| **6** | **C13-C15** | **Manufacture of textiles, wearing apparel and leather products** |
| **7** | **C16** | **Manufacture of wood and of products of wood and cork, except furniture; etc.** |
| **8** | **C17** | **Manufacture of paper and paper products** |
| **9** | **C18** | **Printing and reproduction of recorded media** |
| **10** | **C19** | **Manufacture of coke and refined petroleum products** |
| **11** | **C20** | **Manufacture of chemicals and chemical products** |
| **12** | **C21** | **Manufacture of basic pharmaceutical products and pharmaceutical preparations** |
| **13** | **C22** | **Manufacture of rubber and plastic products** |
| **14** | **C23** | **Manufacture of other non-metallic mineral products** |
| **15** | **C24** | **Manufacture of basic metals** |
| **16** | **C25** | **Manufacture of fabricated metal products, except machinery and equipment** |
| **17** | **C26** | **Manufacture of computer, electronic and optical products** |
| **18** | **C27** | **Manufacture of electrical equipment** |
| **19** | **C28** | **Manufacture of machinery and equipment n.e.c.** |
| **20** | **C29** | **Manufacture of motor vehicles, trailers and semi-trailers** |
| **21** | **C30** | **Manufacture of other transport equipment** |
| **22** | **C31_C32** | **Manufacture of furniture; other manufacturing** |
| **23** | **C33** | **Repair and installation of machinery and equipment** |
| 24 | D | Electricity, gas, steam and air conditioning supply |
| 25 | E36 | Water collection, treatment and supply |
| 26 | E37-E39 | Sewerage; waste collection, treatment and disposal activities; materials recovery; etc. |
| 27 | F | Construction |
| 28 | G45 | Wholesale and retail trade and repair of motor vehicles and motorcycles |
| 29 | G46 | Wholesale trade, except of motor vehicles and motorcycles |
| 30 | G47 | Retail trade, except of motor vehicles and motorcycles |
| 31 | H49 | Land transport and transport via pipelines |
| 32 | H50 | Water transport |
| 33 | H51 | Air transport |
| 34 | H52 | Warehousing and support activities for transportation |
| 35 | H53 | Postal and courier activities |
| 36 | I | Accommodation and food service activities |
| 37 | J58 | Publishing activities |
| 38 | J59_J60 | Motion picture, video and television programme, sound recording and music publishing etc. |
| 39 | J61 | Telecommunications |
| 40 | J62_J63 | Computer programming, consultancy and related activities; information service activities |
| 41 | K64 | Financial service activities, except insurance and pension funding |
| 42 | K65 | Insurance, reinsurance and pension funding, except compulsory social security |
| 43 | K66 | Activities auxiliary to financial services and insurance activities |
| 44 | L | Real estate activities |
| 45 | M69_M70 | Legal and accounting activities; activities of head offices; management consultancy activities |
| 46 | M71 | Architectural and engineering activities; technical testing and analysis |
| 47 | M72 | Scientific research and development |
| 48 | M73 | Advertising and market research |
| 49 | M74_M75 | Other professional, scientific and technical activities; veterinary activities |
| 50 | N | Rental and leasing, Employment activities, Travel services, security and services to buildings |
| 51 | O | Public administration and defence; compulsory social security |
| 52 | P | Education |
| 53 | Q | Human health and social work activities |
| 54 | R-S | Creative, Arts, Sports, Recreation and entertainment activities and all other personal service activities |
| 55 | T | Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use |
| 56 | U | Activities of extra-territorial organisations and bodies |

**Appendix Table II.A2 – Economies in WIOD release 2016**

| ISO | Economy |
|---|---|
| AUS | Australia |
| AUT | Austria |
| BEL | Belgium |
| BGR | Bulgaria |
| BRA | Brazil |
| CAN | Canada |
| CHE | Switzerland |
| CHN | China |
| CYP | Cyprus |
| CZE | Czech Republic |
| DEU | Germany |
| DNK | Denmark |
| ESP | Spain |
| EST | Estonia |
| FIN | Finland |
| FRA | France |
| GBR | United Kingdom |
| GRC | Greece |
| HRV | Croatia |
| HUN | Hungary |
| IDN | Indonesia |
| IND | India |
| IRL | Ireland |
| ITA | Italy |
| JPN | Japan |
| KOR | Korea |
| LTU | Lithuania |
| LUX | Luxembourg |
| LVA | Latvia |
| MEX | Mexico |
| MLT | Malta |
| NLD | Netherlands |
| NOR | Norway |
| POL | Poland |
| PRT | Portugal |
| ROU | Romania |
| RUS | Russia |
| SVK | Slovak Republic |
| SVN | Slovenia |
| SWE | Sweden |
| TUR | Turkey |
| TWN | Taiwan (Province of China) |
| USA | United States |

## DATA APPENDIX III – Construction of capital stock estimates for WIOD 2016 release

Depending on economy-specific data availability, various methods are employed in constructing the capital stock estimates for WIOD 2016 release. This appendix describes in detail the sources and methods used for each of the 43 countries covered in WIOD 2016. The resulting annual capital stock estimates are classified by 56 ISIC Rev.4 industries. The data are expressed in nominal local currency units over the period 2000-2014, unless otherwise indicated in the economy-specific notes. With some exceptions (see Table 1 for an overview), the capital stock series correspond to fixed reproducible assets as defined in the guidelines of System of National Accounts 2008 (SNA08). For the baseline calculations in this paper all the intellectual property products (IPP) excluded.[23]

### Data Availability

Broadly speaking, among the 43 economies that we cover we encounter four different data situations:

1. Economies for which capital stock data is available in current (and/or constant) prices and by detailed ISIC Rev.4 industry classification adhering to the SNA08 definitions. This is for most EU countries as well as the US and Canada.
2. Economies for which capital stock data is available either in current or constant prices, but in a different industry classification than ISIC Rev.4 (e.g. ISIC Rev.3 or a country-specific industry classification). These data adhere either to SNA08 or SNA93 definitions.
3. Economies for which no information on capital stocks can be found but gross fixed capital formation (GFCF) data are available at different levels of industry detail. The industry classification and SNA definitions are country dependent in this case.
4. Economies for which no capital stock or GFCF data can be found at the industry level. The only information can be obtained is their aggregate GFCF series at the total economy level from the UN National Accounts database (UNNA), e.g. Indonesia and Turkey.

### Estimation Methods

For the first two groups of economies we can use the data directly if industry detail is available for the 56 ISIC Rev.4 industries. When the capital stock data is available at a more aggregate industry level, we split the aggregate sectors using either the ***value-added shares split method*** or the so-called ***hybrid split method***, see below for more detailed explanations. For economies that do not have capital stocks data readily available (group 3), an extra step of building up the stock estimates using perpetual inventory method (PIM) is required. We do so by using the capital stocks data provided in the WIOD social economic accounts 2013 release (SEA 2013) as the starting point and we update the SEA 2013 capital stocks based on PIM from 2009 onward up to 2014. This is termed the ***SEA 2013 updated method*** which we discuss in more detail below. Note, there can be a few country exceptions to these three general methods. In the case of Switzerland and Croatia, for each industry and year, we estimated the capital stock using nominal capital stock to value added ratios (K/VA) from an economically similar country, i.e. Germany and Spain, respectively. Other deviations from these general methods can be found in the country specific notes.

[23] Whenever the data allows, capital stock estimates exclude R&D, computer software and databases, artistic originals and mineral exploration. These assets together are classified in SNA08 as intellectual property products.

**Value-added shares split method**

One of the major hurdles in deriving capital stock estimates for the WIOD 2016 release is that the nominal capital stock (or investment) data we extract from external sources are frequently available only at a more aggregated industry level than the required 56 ISIC Rev.4 industries. As a prime solution to split the aggregate estimates into more detailed industries we rely on industry valued added shares from the WIOD 2016 release.

For example, when capital stock data is available only for the aggregate agricultural sector as a whole, we split it into three detailed ISIC Rev.4 agricultural industries (i.e. $A01$ $A02$ and$A03$) that are consistent with the WIOD 2016 release. We use the corresponding value-added shares in total agriculture (i.e. $Share_{i,t}^{VA} = \frac{VA_{i,t}}{VA_t}$) as weights and then multiply these weights by the aggregate nominal capital stock ($\mathrm{K}_{i,t} = K_t \times Share_{i,t}^{VA}$). The underlying assumption is that for the sub-industries the K/VA ratio is the same as for the aggregate. Based on this method, estimates for capital stocks (or investment series) at the 56 detailed ISIC Rev.4 industries can be obtained.

However, a major drawback of this method is that it assumes the same capital intensity for all industries in the aggregate sector that needs to be split. This can be quite problematic for the manufacturing sector where the underlying industries can differ considerably in terms of their capital intensity. For this reason, when only very aggregate data are available (especially in case of the manufacturing sector), we use an additional step to include detailed industry level information on capital intensity from WIOD 2013 in the so-called *hybrid split approach* which we discuss below.

**Hybrid split method**

In order to take into account the potential differences in capital intensity across industries, we use capital to value added ratios (K/VA) for the initial year 2000 and multiply the ratio by value added in the ISIC Rev.4 industry. The K/VA ratios are taken from the WIOD 2013 release, for which we map ISIC Rev. 4 industries to ISIC Rev. 3 industries. The concordance that is used is given in the ISIC Rev. 3 – Rev. 4 mapping table at the end of this appendix.

For illustration:

$$\left(K_j\right)_{2000}^{Rev4} = \left(\frac{K_i}{VA_i}\right)_{2000}^{Rev3} \times \left(VA_j\right)_{2000}^{Rev4}$$

where K/VA ratios capture different levels of capital intensity taken from ISIC Rev. 3 industry $i$ and applied to ISIC Rev. 4 industry $j$. $VA_j$ denotes ISIC Rev.4 value added from the WIOD 2016 release.

The K/VA ratios are applied only for the initial year 2000. In order to complete the series, we extrapolate forward in time using the growth of capital stocks derived from the *Value-added shares split method*. We take this hybrid approach since the capital stock *K* is relatively stable over time, while value added levels can be quite volatile. Applying the growth of the stocks derived from the *Value-added shares split method* to extrapolate the initial capital stock can reduce the VA volatility, but still takes industry redistributions over time into account in terms of their relative output size. In addition, it also helps to mitigate the impact of the imperfect mapping between ISIC Rev. 3 and ISIC Rev. 4 industries, since we use the ratios of capital intensities and not the level of ISIC Rev. 3 capital stocks.

**SEA 2013 updated method**

For countries that do not have any capital stock data available, but do report investment series, we rely on updating the capital stock series from the SEA 2013 release based on the perpetual inventory method (PIM) using the following steps:

1. We convert their SEA 2013 investment series from ISIC Rev.3 (35 industries) to ISIC Rev.4 (56 industries) for the period 2000-2008 using the Value-added shares split method.
2. We estimate the 2000-2008 capital stock series from the WIOD 2013 data using the Hybrid split method.
3. From the external investment data, we calculate Investment to Value Added ratios (I/VA) at the level at which the data is available.
4. For the investment data by 56 ISIC Rev. 4 industries calculated in the first step, we also calculate the I/VA ratios in 2008 and update these with the growth of the ratios from step 3. We use an industry mapping of the domestic industries to the ISIC Rev. 4 industries that is dependent on the available information for the economy. In some cases, only total economy investment and output data are available.
5. The extended I/VA ratios for the 56 ISIC Rev. 4 industries are multiplied by VA series from the WIOD 2016 release to estimate the investment series for all industries.
6. We extend the capital stocks calculated in step 2 using the PIM method for 2009-2014.

Note, the rates of depreciation that we use in PIM is based on the year- and industry-specific geometric depreciation rates for Spain (obtained from the EU KLEMS database December 2016 revision), which are calculated using each assets' nominal capital stock as weights. These rates take into account the differences in the composition of capital assets both across industries and over time. We took Spain as it is an economy for which we have full asset detail data and its GDP per capita is in the mid region of the distribution of WIOD countries. Depending on an economy's capital composition (whether it excludes all or only part of IPP), we applied two different rates of depreciation in capital stock accumulation: one rate that is net of all intangible assets and the other that includes software for countries adhering to SNA93 definitions (see Table 2).

Moreover, in order to apply the PIM-method the data on investments and stocks needs to be denoted in constant base year prices. From the WIOD 2013 data the investment price deflators are available. For countries that have no investment price deflators available from an external source, we use a total economy capital stock deflator calculated from the Penn World Table, excluding the price movements for Residential Structures.[24]

In calculating tangible capital costs, three different depreciation rates are applied when K excludes IPP. Group 1: depreciation for SNA08 countries that exclude all IPP. Group 2: depreciation for SNA93 countries that include all SNA93 assets (thus software is in there). Group 3: Japan and Korea that exclude software (since these two SNA93 countries have detailed data on software, thus their tangible capital stock data can be processed better/'cleaner' than other SNA93 countries).

In calculating tangible capital costs, two different depreciation rates are applied when K includes all assets. Group 1: depreciation for SNA08 countries that include all SNA08 assets Group 2: depreciation for SNA93 countries that include all SNA93 assets. In other words, we no longer need to treat Japan and Korea differently from other SNA93 countries here.

[24] As this asset is almost exclusively used in industry L68 only. Given its potential deviating deflator movement, including this into estimates for other industries would bias the overall investment inflation rate.

## Appendix Table III.1 - Overview of capital stock estimates

| | Economy | Approach | SNA vin-tage | Exclusion of asset types given SNA vintage | Main data sources |
|---|---|---|---|---|---|
| 1 | AUS | Hybrid | 2008 | Excl. IPP | OECD NA |
| 2 | AUT | Directly obtained | 2008 | Excl. IPP | EUROSTAT |
| 3 | BEL | VA shares | 2008 | Excl. IPP | EUROSTAT |
| 4 | BGR | SEA 2013 updated | 1993 | | EUROSTAT, EUKLEMS |
| 5 | BRA | SEA 2013 updated | 1993 | | UNNA, WIOD SEA2013 |
| 6 | CAN | VA shares | 2008 | Excl. IPP | OECD NA |
| 7 | CHE | K/VA ratio of DEU | 2008 | Excl. IPP | WIOD 2016 |
| 8 | CHN | SEA 2013 updated | 1993 | | China statistical yearbook |
| 9 | CYP | SEA 2013 updated | 1993 | | EUROSTAT |
| 10 | CZE | Directly obtained | 2008 | Excl. IPP | EUROSTAT |
| 11 | DEU | Directly obtained | 2008 | Excl. IPP | OECD NA/STAN, EUROSTAT |
| 12 | DNK | Directly obtained | 2008 | Excl. IPP | EUROSTAT |
| 13 | ESP | VA shares | 2008 | Excl. IPP | EU KLEMS |
| 14 | EST | Hybrid | 2008 | Excl. IPP | EUROSTAT |
| 15 | FIN | Directly obtained | 2008 | Excl. IPP | EUROSTAT |
| 16 | FRA | VA shares | 2008 | Excl. IPP | OECD NA, EUROSTAT |
| 17 | GBR | Directly obtained | 2008 | Excl. IPP | EUROSTAT |
| 18 | GRC | Directly obtained | 2008 | Excl. IPP | OECD NA, EUROSTAT |
| 19 | HRV | K/VA ratio of ESP | 2008 | Excl. IPP | WIOD 2016 |
| 20 | HUN | Hybrid | 2008 | Excl. IPP | EUROSTAT |
| 21 | IDN | SEA 2013 updated | 1993 | | UNNA, WIOD SEA2013 |
| 22 | IND | VA shares | 1993 | | World KLEMS |
| 23 | IRL | Hybrid | 2008 | Excl. IPP | OECD NA |
| 24 | ITA | VA shares | 2008 | Excl. IPP | EUROSTAT |
| 25 | JPN | Directly obtained | 1993 | Excl. software | REITI JIP database |
| 26 | KOR | VA shares | 1993 | Excl. software | World KLEMS |
| 27 | LTU | Hybrid | 2008 | Excl. IPP | EUROSTAT |
| 28 | LUX | VA shares | 2008 | Excl. IPP | EUROSTAT |
| 29 | LVA | SEA 2013 updated | 1993 | | EUROSTAT |
| 30 | MEX | VA shares | 1993 | | NISG |
| 31 | MLT | SEA 2013 updated | 1993 | | EUROSTAT |
| 32 | NLD | VA shares | 2008 | Excl. IPP | EUROSTAT |
| 33 | NOR | VA shares | 2008 | Excl. IPP | EUROSTAT |
| 34 | POL | Hybrid | 2008 | Excl. IPP | EUROSTAT |
| 35 | PRT | Hybrid | 1993 | | EUROSTAT |
| 36 | ROU | Hybrid | 1993 | | EUROSTAT |
| 37 | RUS | Hybrid | 1993 | | World KLEMS |
| 38 | SVK | Directly obtained | 2008 | Excl. IPP | EUROSTAT |
| 39 | SVN | Hybrid | 2008 | Excl. IPP | EUROSTAT |
| 40 | SWE | VA shares | 2008 | Excl. IPP | EUROSTAT |
| 41 | TUR | SEA 2013 updated | 1993 | | UNNA, WIOD SEA2013 |
| 42 | TWN | SEA 2013 updated | 1993 | | National development council |
| 43 | USA | Directly obtained | 2008 | Excl. IPP | BEA |

**Appendix Table III.2 - Overview of industry capital stock depreciation rates (all SNA assets excluding IPP, geometric rates in %)**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 7.0 | 6.9 | 6.8 | 6.7 | 6.6 | 6.5 | 6.1 | 6.2 | 6.3 | 6.5 | 6.7 | 6.7 | 6.8 | 6.7 | 6.7 |
| B | 6.5 | 6.3 | 6.2 | 6.1 | 5.9 | 5.6 | 5.5 | 5.4 | 5.4 | 5.5 | 5.7 | 5.9 | 5.9 | 5.8 | 5.9 |
| C10-C12 | 7.1 | 6.9 | 6.8 | 6.6 | 6.5 | 6.4 | 6.4 | 6.4 | 6.5 | 6.7 | 6.7 | 6.7 | 6.7 | 6.6 | 6.6 |
| C13-C15 | 8.1 | 7.9 | 7.7 | 7.6 | 7.4 | 7.2 | 7.2 | 7.2 | 7.2 | 7.1 | 6.9 | 6.7 | 6.6 | 6.4 | 6.3 |
| C16-C18 | 7.6 | 7.5 | 7.4 | 7.3 | 7.2 | 7.1 | 7.1 | 7.2 | 7.3 | 7.4 | 7.4 | 7.3 | 7.3 | 7.2 | 7.2 |
| C19 | 6.0 | 6.0 | 6.0 | 5.9 | 5.8 | 5.9 | 6.0 | 6.1 | 6.3 | 6.5 | 6.6 | 6.6 | 6.5 | 6.3 | 6.2 |
| C20 | 6.8 | 6.7 | 6.6 | 6.5 | 6.3 | 6.2 | 6.2 | 6.4 | 6.6 | 6.8 | 6.8 | 6.8 | 6.8 | 6.9 | 7.1 |
| C21 | 6.8 | 6.7 | 6.6 | 6.5 | 6.3 | 6.2 | 6.2 | 6.4 | 6.6 | 6.8 | 6.8 | 6.8 | 6.8 | 6.9 | 7.1 |
| C22 | 7.3 | 7.1 | 7.0 | 6.9 | 6.7 | 6.6 | 6.6 | 6.7 | 6.8 | 6.8 | 6.8 | 6.6 | 6.6 | 6.4 | 6.3 |
| C23 | 7.3 | 7.1 | 7.0 | 6.9 | 6.7 | 6.6 | 6.6 | 6.7 | 6.8 | 6.8 | 6.8 | 6.6 | 6.6 | 6.4 | 6.3 |
| C24 | 7.0 | 6.9 | 6.8 | 6.7 | 6.6 | 6.5 | 6.5 | 6.5 | 6.6 | 6.6 | 6.5 | 6.4 | 6.4 | 6.2 | 6.1 |
| C25 | 7.0 | 6.9 | 6.8 | 6.7 | 6.6 | 6.5 | 6.5 | 6.5 | 6.6 | 6.6 | 6.5 | 6.4 | 6.4 | 6.2 | 6.1 |
| C26 | 8.1 | 8.0 | 7.7 | 7.3 | 7.1 | 6.8 | 6.6 | 6.6 | 6.6 | 6.6 | 6.5 | 6.4 | 6.3 | 6.2 | 6.1 |
| C27 | 8.1 | 8.0 | 7.7 | 7.3 | 7.1 | 6.8 | 6.6 | 6.6 | 6.6 | 6.6 | 6.5 | 6.4 | 6.3 | 6.2 | 6.1 |
| C28 | 7.7 | 7.5 | 7.4 | 7.3 | 7.1 | 7.0 | 6.9 | 6.9 | 7.0 | 7.1 | 7.0 | 6.9 | 6.8 | 6.6 | 6.6 |
| C29 | 8.6 | 8.4 | 8.3 | 8.1 | 8.0 | 7.9 | 7.9 | 8.1 | 8.2 | 8.2 | 8.1 | 7.8 | 7.6 | 7.4 | 7.2 |
| C30 | 8.6 | 8.4 | 8.3 | 8.1 | 8.0 | 7.9 | 7.9 | 8.1 | 8.2 | 8.2 | 8.1 | 7.8 | 7.6 | 7.4 | 7.2 |
| C31_C32 | 8.5 | 8.3 | 8.2 | 8.0 | 7.9 | 7.7 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 | 7.7 | 7.6 | 7.5 | 7.4 |
| C33 | 8.5 | 8.3 | 8.2 | 8.0 | 7.9 | 7.7 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 | 7.7 | 7.6 | 7.5 | 7.4 |
| D-E | 4.3 | 4.2 | 4.1 | 4.0 | 3.9 | 3.9 | 4.0 | 4.0 | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.5 | 4.6 |
| F | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.7 | 2.8 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 | 2.9 |
| G45-G47 | 6.1 | 6.3 | 6.3 | 6.4 | 6.4 | 6.4 | 6.4 | 6.6 | 6.7 | 6.7 | 6.7 | 6.7 | 6.9 | 7.0 | 7.0 |
| H49 | 5.9 | 5.9 | 5.9 | 5.8 | 5.7 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.5 | 5.6 |
| H50-H53 | 5.9 | 5.9 | 5.9 | 5.8 | 5.7 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.6 | 5.5 | 5.6 |
| I | 5.8 | 6.1 | 6.4 | 6.6 | 6.6 | 6.6 | 6.6 | 6.6 | 6.5 | 6.5 | 6.4 | 6.3 | 6.3 | 6.1 | 6.0 |
| J58 | 6.3 | 6.1 | 5.9 | 5.8 | 5.7 | 5.5 | 5.5 | 5.4 | 5.4 | 5.4 | 5.4 | 5.5 | 5.6 | 5.6 | 5.6 |
| J59_J60 | 6.3 | 6.1 | 5.9 | 5.8 | 5.7 | 5.5 | 5.5 | 5.4 | 5.4 | 5.4 | 5.4 | 5.5 | 5.6 | 5.6 | 5.6 |
| J61 | 6.5 | 6.4 | 6.2 | 5.9 | 5.6 | 5.4 | 5.3 | 5.3 | 5.3 | 5.2 | 5.1 | 5.0 | 4.9 | 5.0 | 5.1 |
| J62_J63 | 8.3 | 7.7 | 7.3 | 7.0 | 6.7 | 6.6 | 6.5 | 6.6 | 6.8 | 7.0 | 7.1 | 7.1 | 7.9 | 8.7 | 8.8 |
| K64-K66 | 6.4 | 6.5 | 6.6 | 6.6 | 6.4 | 6.1 | 6.0 | 6.1 | 6.1 | 5.7 | 5.2 | 4.7 | 4.3 | 3.9 | 3.6 |
| L68 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.3 |
| M-N | 10.7 | 10.6 | 10.4 | 10.3 | 10.2 | 10.2 | 10.1 | 10.1 | 10.0 | 9.7 | 9.2 | 8.9 | 8.7 | 8.6 | 8.6 |
| O84 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 3.5 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 3.4 |
| P85 | 3.9 | 4.0 | 4.0 | 4.0 | 4.0 | 4.1 | 4.1 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 | 4.2 | 4.1 | 4.2 |
| Q | 5.8 | 5.8 | 5.7 | 5.7 | 5.6 | 5.6 | 5.6 | 5.8 | 5.9 | 6.0 | 6.0 | 6.0 | 6.1 | 5.5 | 5.1 |
| R_S | 6.9 | 6.7 | 6.6 | 6.4 | 6.3 | 6.2 | 6.1 | 6.1 | 6.0 | 6.0 | 5.9 | 5.9 | 5.9 | 6.0 | 6.0 |

**Economy-specific notes**

### 1. AUS - Australia

- We obtain SNA08 total capital stocks and intellectual property products (IPP) capital stocks from OECD national accounts for 20 sectors. We subtract IPP capital from total capital to obtain tangible capital stock.
- We use capital stock to value added ratios (K/VA) from SEA 2013 for detailed manufacturing sectors to estimate an initial capital stock for year 2000. For all other sectors, we apply VA shares directly to the reported stock levels.
- For the detailed manufacturing industries, we extrapolate the estimated initial stocks using the growth of the stock series obtained by applying VA shares. We then renormalise the total manufacturing level of stocks to those reported by OECD NA.

### 2. AUT - Austria

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.

### 3. BEL - Belgium

- SNA08 / ISIC Rev. 4 capital stocks are available at the A38 level from EUROSTAT. Stocks in current prices are split using VA shares. The constant price stocks are calculated by applying the implicitly derived stock deflators at the A38 level to the detailed industries.

### 4. BRA - Brazil

- There are no capital stocks data available for Brazil, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We use the investment and Value-Added series from UNNA at the total economy level as external data.

### 5. BGR – Bulgaria

- There are no capital stocks data available for Bulgaria, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investment series for 56 ISIC Rev. 4 industries from EUROSTAT, both in current and constant prices.
- Note, the resulting capital estimates are denoted in US dollar.

### 6. CAN - Canada

- Nominal capital stock data are taken from OECD national accounts for 34 ISIC Rev.4 industries for the period 2000-2014.
- The same level of industry detail is also available by assets. Thus, all IPP can be directly subtracted from total capital stock.
- We use the Value-Added shares split method to split the 34 OECD industry stocks into 56 WIOD industries.
- Note that there is a discrepancy between the total economy-level stock and the summation of stocks across 34 industries. The difference is attributed to the real estate industry as the reported stock is too low. We assume that these numbers refer to productive stocks only. In addition, for industry C21 it is assumed that the data in grouped within C20, and for industry E, data is grouped within industry D.

### 7. CHE - Switzerland

- No capital stocks or investment data are available for Switzerland.
- We used the German K/VA ratios as a proxy for Swiss capital intensity for all sectors and multiplied them by the VA for Switzerland.

## 8. CHN - China

- There are no capital stocks data available for China, therefore, we update the SEA 2013 capital stocks using the SEA 2013 update method.
- We take the investment series for 20 industries from the China Statistical Yearbook 2015.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.

## 9. CYP - Cyprus

- There are no capital stocks data available for Cyprus, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investments for 11 ISIC Rev. 4 broad sectors from EUROSTAT, both in current and constant prices.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.
- Note, the resulting capital estimates are denoted in US dollar.

## 10. CZE - Czech Republic

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.

## 11. DEU - Germany

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are available from OECD STAN database for total net assets.
- From EUROSTAT/OECD NA, the data is available with an IPP split for 20 sectors. We apply the IPP share in total net assets of aggregate industries to the underlying sub-industries.

## 12. DNK - Denmark

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.

## 13. ESP - Spain

- Capital stocks are taken from EU KLEMS December 2016 revision. The data is in SNA 08 and ISIC Rev. 4 for 34 industries.
- Use VA shares from WIOD 2016 to split those 34 industries into 56 WIOD industries.

## 14. EST - Estonia

- We obtain SNA08 total capital stocks and intellectual property products (IPP) capital stocks from EUROSTAT for 20 sectors.
- We use capital stock to value added ratios (K/VA) from SEA 2013 for detailed manufacturing sectors to estimate an initial capital stock for year 2000. For all other sectors, we apply VA shares directly to the reported stock levels.
- For the detailed manufacturing industries, we extrapolate the estimated initial stocks using the growth of the stock series obtained by applying VA shares. We then renormalise the total manufacturing level of stocks to those reported by EUROSTAT.
- Note, the constant price stocks are calculated by applying implicitly derived stock deflators at the A20 level to the detailed industries.
- Note, the resulting capital estimates are denoted in US dollar.

### 15. FIN - Finland

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.

### 16. FRA - France

- Capital stocks data are available at the A38 level from EUROSTAT. Stocks in current prices are split using VA shares. The constant price stocks are calculated by applying implicitly derived stock deflators at the A38 level to the detailed industries.
- Data for 2014 is not available from EUROSTAT. Therefore, we have used data from OECD NA data for 2014.

### 17. GBR - United Kingdom

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.

### 18. GRC - Greece

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- No data available after 2010 from EUROSTAT, however OECD national accounts database does provide provisional estimates. We used these to update the series.
- Note, the resulting capital estimates are denoted in US dollar.

### 19. HRV - Croatia

- No capital stocks data are available for Croatia.
- We used the Spanish K/VA ratios as proxy and multiplied them by the VA for Spain.
- Note, the resulting capital estimates are denoted in US dollar.

### 20. HUN - Hungary

- We obtain SNA08 total capital stocks and intellectual property products (IPP) capital stocks from EUROSTAT for 20 sectors.
- We use capital stock to value added ratios (K/VA) from SEA 2013 for detailed manufacturing sectors to estimate an initial capital stock for year 2000. For all other sectors, we apply VA shares directly to the reported stock levels.
- For the detailed manufacturing industries, we extrapolate the estimated initial stocks using the growth of the stock series obtained by applying VA shares. We then renormalise the total manufacturing level of stocks to those reported by EUROSTAT.
- Note, the constant price stocks are calculated by applying implicitly derived stock deflators at the A20 level to the detailed industries.

### 21. IDN - Indonesia

- See Brazil. The exact same data source and method are used to estimate capital stocks for Indonesia.

### 22. IND - India

- We obtain real net capital stock data from the World KLEMS database (VA and K_GFCF_04) for the period 1980-2011.
- We extrapolate SEA 2013 VA series using the growth of WIOD 2016 VA data (mapped from ISIC Rev.4 to ISIC Rev.3). Then, we derive the K_GFCF_04/VA ratio for 2011 and keep it constant to extrapolate K_GFCF_04 for 2012, 2013 and 2014.
- Apply K_GFCF_04/VA ratios in 2000 to retrieve initial capital stock and then extrapolate using the growth of stocks obtained from the VA shares split approach.

- Note, although data from World KLEMS is in ISIC Rev.3 it is somewhat more aggregated than the EU EUKLEMS Rev.3 classification (27 vs. 35 industries). As a result, we used the SEA WIOD 2013 release by applying the shares to split those 27 industries into 35 industries. For 2010 and 2011, the share from 2009 is applied.

### 23. IRL - Ireland

- We obtain SNA08 total capital stocks and intellectual property products (IPP) capital stocks from OECD national accounts for 20 sectors. Subtract IPP from total capital to obtain tangible capital stock.
- We use capital stock to value added ratios (K/VA) from SEA 2013 for detailed manufacturing sectors to estimate an initial capital stock for year 2000. For all other sectors, we apply VA shares directly to the reported stock levels.
- For the detailed manufacturing industries, we extrapolate the estimated initial stocks using the growth of the stock series obtained by applying VA shares. We then renormalise the total manufacturing level of stocks to those reported by OECD NA.
- Note, for IPP stocks only total economy data is available. Therefore, we apply the total economy share of IPP in total net stocks to all industries to calculate capital stocks excluding IPP.

### 24. ITA - Italy

- Capital stocks data are available at the A38 level. Stocks in current prices are split using VA shares. The constant price stocks are calculated by applying implicitly derived stock deflators at the A38 level to the detailed industries.

### 25. JPN - Japan

- Real capital stocks data are available from REITI JIP database for 107 detailed industries over the period 1970-2012.
- Based on the concordance table, data are directly mapped to ISIC Rev.4 classification.
- We extrapolate capital stocks for 2013 and 2014 by holding the K/VA ratio from 2012 constant.
- To convert real capital stocks to nominal terms we use the capital stock deflators from the Penn World Table capital detail file.
- Note, capital stock does not include software which is subtracted from the total capital stock.

### 26. KOR - Korea

- Data is taken from the World KLEMS database which contains nominal capital stocks and VA data up to 2012 by detailed ISIC Rev.3 classification.
- Extrapolate VA using WIOD2016 for 2013 and 2014 (i.e. apply the growth of VA for these two years). Then, apply the K/VA ratio from 2012 to 2013 and 2014 to back out capital stock for the last two years.
- Follow the hybrid approach where initial stocks are based on K/VA ratios which are then extrapolated based on the growth of capital stocks calculated from VA shares split approach.
- Note, capital stock does not include software which is subtracted from the total capital stock.

### 27. LTU - Lithuania

- We obtain SNA08 total capital stocks and intellectual property products (IPP) capital stocks from EUROSTAT for 20 sectors. Subtract IPP from total capital to obtain tangible capital stock.
- We use capital stock to value added ratios (K/VA) from SEA 2013 for detailed manufacturing sectors to estimate an initial capital stock for year 2000. For all other sectors, we apply VA shares directly to the reported stock levels.

- For the detailed manufacturing industries, we extrapolate the estimated initial stocks using the growth of the stock series obtained by applying VA shares. We then renormalise the total manufacturing level of stocks to those reported by EUROSTAT.
- Note, for IPP stocks only total economy data is available. Therefore, we apply the total economy share of IPP in total net stocks to all industries to calculate capital stocks excluding IPP.
- Note, the resulting capital estimates are denoted in US dollar.

### 28. LUX - Luxembourg

- Capital stocks data are available for 56 industries from EUROSTAT.
- There are inconsistencies for some groups of detailed industries, when comparing their aggregate values to the reported aggregate values. In these cases, stocks in current prices are split using VA shares. The constant price stocks are calculated by applying implicitly derived stock deflators to the detailed industries.
- For the Transport sector *H* we kept the VA shares constant from 2008 onwards in order to split the capital stocks, due to volatile VA shares.
- Note, the resulting capital estimates are denoted in US dollar.

### 29. LVA - Latvia

- There are no capital stocks data available for Latvia, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investment series for 20 broad ISIC Rev. 4 sectors from EUROSTAT, both in current and constant prices.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.
- Note, the resulting capital estimates are denoted in US dollar.

### 30. MEX - Mexico

- Capital stocks data are directly obtained from the National Institute of Statistics and Geography (NISG) of Mexico. Data are expressed in 2008 constant prices across 68 industries and over the period 1990-2015.
- Based on the concordance table, these 68 industries are mapped into 44 ISIC Rev.4 industries. Then, we use the VA shares to split the industries and use the capital stock deflator from the Penn World Tables to convert real capital stock to nominal terms.

### 31. MLT - Malta

- There are no capital stocks data available for Cyprus, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investments for 20 ISIC Rev. 4 broad sectors from EUROSTAT, both in current and constant prices.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.
- Note, the resulting capital estimates are denoted in US dollar.

### 32. NLD - Netherlands

- Capital stocks data are available at the A38 level. Stocks in current prices are split using VA shares. The constant price stocks are calculated by applying implicitly derived stock deflators at the A38 level to the detailed industries.

### 33. NOR - Norway

- Capital stocks data are available for 53 industries. Stocks in current prices are split using VA shares. The constant price stocks are calculated by applying implicitly derived stock deflators at the A38 level to the detailed industries.
- Note, for Norway there is unallocated stocks data of about 30% of the total. It is likely that this is the capital stock of Residential Structures that are excluded from the

industry data in order to show only productive capital stocks. This is corroborated by the fact that total reported capital stock of the real estate sector is only 3% whereas it's between 30% and 45% for other countries. Thus, we attribute all unallocated stocks to the real estate sector.

### 34. POL - Poland

- We obtain SNA08 total capital stocks and intellectual property products (IPP) capital stocks from EUROSTAT for about 20 sectors. Subtract IPP from total capital to obtain tangible capital stock.
- We use capital stock to value added ratios (K/VA) from SEA 2013 for detailed manufacturing sectors to estimate an initial capital stock for year 2000. For all other sectors, we apply VA shares directly to the reported stock levels.
- For the detailed manufacturing industries, we extrapolate the estimated initial stocks using the growth of the stock series obtained by applying VA shares. We then renormalise the total manufacturing level of stocks to those reported by EUROSTAT.
- The constant price stocks are calculated by applying implicitly derived stock deflators at the A20 level to the detailed industries.

### 35. PRT - Portugal

- There are no capital stocks data available for Cyprus, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investments for 56 ISIC Rev. 4 broad sectors from EUROSTAT, both in current and constant prices.
- Note, the resulting capital estimates are denoted in US dollar.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.

### 36. ROU - Romania

- There are no capital stocks data available for Cyprus, therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investments at the total economy level from EUROSTAT, both in current and constant prices.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.
- Note, the resulting capital estimates are denoted in US dollar.

### 37. RUS - Russia

- Data based on updated World KLEMS data in SNA93 and ISIC Rev. 3 classification.
- We use K/VA ratios for initial stock estimates in 2000.
- We split the capital stock data using VA shares and then use these time series to extrapolate from the estimated initial capital stocks in 2000.

### 38. SVK - Slovakia

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.
- No data available before 2004. To back-cast the series, the growth of the capital stock from the SEA 2013 data is used.
- Note, the resulting capital estimates are denoted in US dollar.

### 39. SVN - Slovenia

- SNA08 / ISIC Rev. 4 capital stocks for 20 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.

- We use Hybrid split method for to estimate capital stocks for detailed manufacturing. We normalise the data to ensure that the aggregate stock values for the total manufacturing sectors match the total manufacturing capital stock data from EUROSTAT.
- For all other sectors, we apply the Value-added shares split method.
- Note, the resulting capital estimates are denoted in US dollar.

### 40. SWE - Sweden

- SNA08 / ISIC Rev. 4 capital stocks for 56 industries are directly taken from EUROSTAT.
- Tangible capital stocks are obtained by subtracting IPP from the total SNA08 capital stocks.
- Capital stock data for the chemicals and pharmaceuticals industries are split using Value-added shares.

### 41. TUR - Turkey

- See Brazil. The exact same data source and method are used to estimate capital stocks for Turkey.

### 42. TWN – Taiwan (Province of China)

- There are no capital stocks data available for Taiwan (Province of China), therefore, we update the SEA 2013 capital stocks using the SEA 2013 updated method.
- We take the investment series for 18 industries from the National Development Council.
- We use the Spanish geometric depreciation rates that include Software, but exclude the other IPP assets.

### 43. USA - United States

- SNA08 capital stocks data are taken from the BEA for 63 detailed NAICS industries.
- For consistency with the output data, we use the BEA data directly and applied the same NAICS-ISIC Rev.4 concordance as we did for the SUTs in WIOT 2016 release. We also apply the same output shares for industries that needed to be split. These shares are applied to the net capital stocks data in current and previous years' prices.

## Appendix Table III.3 ISIC Rev. 3 – Rev. 4 mapping

| Rev. 3 code | Rev.3 description | Rev. 4 code | Rev. 4 description |
|---|---|---|---|
| AtB | Agriculture, Hunting, Forestry and Fishing | A01 | Crop and animal production, hunting and related service activities |
| AtB | Agriculture, Hunting, Forestry and Fishing | A02 | Forestry and logging |
| AtB | Agriculture, Hunting, Forestry and Fishing | A03 | Fishing and aquaculture |
| C | Mining and Quarrying | B | Mining and quarrying |
| 15t16 | Food , Beverages And Tobacco | C10-C12 | Manufacture of food products, beverages and tobacco products |
| 17t19 | Textiles and Textile, Leather, Leather And Footwear | C13-C15 | Manufacture of textiles, wearing apparel and leather products |
| 20 | Wood and Of Wood and Cork | C16 | Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials |
| 21t22 | Pulp, Paper, Paper , Printing And Publishing | C17 | Manufacture of paper and paper products |
| 21t22 | Pulp, Paper, Paper , Printing And Publishing | C18 | Printing and reproduction of recorded media |
| 23 | Coke, Refined Petroleum And Nuclear Fuel | C19 | Manufacture of coke and refined petroleum products |
| 24 | Chemicals and Chemical | C20 | Manufacture of chemicals and chemical products |
| 24 | Chemicals and Chemical | C21 | Manufacture of basic pharmaceutical products and pharmaceutical preparations |
| 25 | Rubber and Plastics | C22 | Manufacture of rubber and plastic products |
| 26 | Other Non-Metallic Mineral | C23 | Manufacture of other non-metallic mineral products |
| 27t28 | Basic Metals and Fabricated Metal | C24 | Manufacture of basic metals |
| 27t28 | Basic Metals and Fabricated Metal | C25 | Manufacture of fabricated metal products, except machinery and equipment |
| 30t33 | Electrical and Optical Equipment | C26 | Manufacture of computer, electronic and optical products |
| 30t33 | Electrical and Optical Equipment | C27 | Manufacture of electrical equipment |
| 29 | Machinery, nec. | C28 | Manufacture of machinery and equipment n.e.c. |
| 34t35 | Transport Equipment | C29 | Manufacture of motor vehicles, trailers and semi-trailers |
| 34t35 | Transport Equipment | C30 | Manufacture of other transport equipment |
| 36t37 | Manufacturing nec; Recycling | C31_C32 | Manufacture of furniture; other manufacturing |
| 36t37 | Manufacturing nec; Recycling | C33 | Repair and installation of machinery and equipment |
| E | Electricity, Gas and Water Supply | D35 | Electricity, gas, steam and air conditioning supply |
| E | Electricity, Gas and Water Supply | E36 | Water collection, treatment and supply |
| E | Electricity, Gas and Water Supply | E37-E39 | Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services |
| F | Construction | F | Construction |
| 50 | Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel | G45 | Wholesale and retail trade and repair of motor vehicles and motorcycles |
| 51 | Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles | G46 | Wholesale trade, except of motor vehicles and motorcycles |
| 52 | Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods | G47 | Retail trade, except of motor vehicles and motorcycles |
| 60 | Other Inland Transport | H49 | Land transport and transport via pipelines |
| 61 | Other Water Transport | H50 | Water transport |
| 62 | Other Air Transport | H51 | Air transport |
| 63 | Other Supporting and Auxiliary Transport Activities; Activities Of Travel Agencies | H52 | Warehousing and support activities for transportation |
| 64 | Post and Telecommunications | H53 | Postal and courier activities |
| H | Hotels and Restaurants | I | Accommodation and food service activities |
| 21t22 | Pulp, Paper, Paper, Printing and Publishing | J58 | Publishing activities |
| 21t22 | Pulp, Paper, Paper , Printing And Publishing | J59_J60 | Motion picture, video and television program production, sound recording and music publishing activities; programming and broadcasting activities |
| 64 | Post and Telecommunications | J61 | Telecommunications |

| | | | |
|---|---|---|---|
| 71t74 | Renting Of M&Eq And Other Business Activities | J62_J63 | Computer programming, consultancy and related activities; information service activities |
| J | Financial Intermediation | K64 | Financial service activities, except insurance and pension funding |
| J | Financial Intermediation | K65 | Insurance, reinsurance and pension funding, except compulsory social security |
| J | Financial Intermediation | K66 | Activities auxiliary to financial services and insurance activities |
| 70 | Real Estate Activities | L68 | Real estate activities |
| 71t74 | Renting Of M&Eq And Other Business Activities | M69_M70 | Legal and accounting activities; activities of head offices; management consultancy activities |
| 71t74 | Renting Of M&Eq And Other Business Activities | M71 | Architectural and engineering activities; technical testing and analysis |
| 71t74 | Renting Of M&Eq And Other Business Activities | M72 | Scientific research and development |
| 71t74 | Renting Of M&Eq And Other Business Activities | M73 | Advertising and market research |
| 71t74 | Renting Of M&Eq And Other Business Activities | M74_M75 | Other professional, scientific and technical activities; veterinary activities |
| 71t74 | Renting Of M&Eq And Other Business Activities | N | Administrative and support service activities |
| L | Public Admin and Defense; Compulsory Social Security | O84 | Public administration and defense; compulsory social security |
| M | Education | P85 | Education |
| N | Health and Social Work | Q | Human health and social work activities |
| O | Other Community, Social and Personal Services | R_S | Other service activities |
| P | Private Households with Employed Persons | T | Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use |
| Q | | U | Activities of extraterritorial organizations and bodies |