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Research article

Income shifting by multinational enterprises as a source of mismeasurement in aggregate statistics

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Abstract: This paper studies income shifting by European multinational enterprises as a potential source of mismeasurement in aggregate statistics, with a focus on labour productivity. We use firm level data to implement different types of formulary apportionments and to reattribute earnings among entities of multinational groups operating across the European Union (EU). The results suggest that income shifting affects the measurement of the output-per-worker in the corporate sector. Bottom-up approaches grounded in representative microdata can improve its computation.

Keywords: mismeasurement; official statistics; multinational enterprises; income shifting; labour productivity; firm-level data

JEL Codes: E01, E24, F23

1. Introduction

Aggregate statistics are a key tool to evaluate, analyse and forecast economic phenomena. They are computed using national accounts, which are based on an internationally recognized set of rules known as the System of National Accounts (SNA). These rules are implemented to provide comparable measures of a country's economic activity in accordance with established accounting conventions based on economic principles. To construct national accounts, the starting point is information provided by institutional units, such as the financial statements provided by firms. In the context of unprecedented global market integration, the way in which corporate transactions are attributed to

countries becomes relevant for official statistics to depict a reliable picture of the actual economic activity taking place within national borders. Specifically, the SNA framework applies the residence principle, whereby a transaction made by a specific firm is attributed to the country where the firm is deemed to have its primary location.[1]

The implications of the residence principle become evident when considering multinational enterprises (MNE) that may adapt their location strategies in response to local incentives, including those that are publicly provided. As an illustrative example, consider a simple world where a multinational decides to produce and sell a product following three steps: first, the product is designed and developed in country A, with the corresponding concentration of investment into intangible assets there; then, the product is physically built in country B through a subsidiary located there, for instance, to exploit the local cost advantages, such as a cheap labour force; and finally, the product is sold in country C, where the relevant destination market is located, possibly using another controlled firm. In this case, the profits would be generated by the subsidiary located in country C, while the research and development (R&D) and physical production costs are de facto concentrated in countries A and B, respectively. From the multinational's point of view, the consolidated financial statements at the level of the parent company would reflect the whole process from production to sale, while the country's national accounts reflect each resident firm's accounting records (Avdjiev et al., 2018). In technical words, applying the residence principle implies adopting the method of separate accounting.

To add a further complication, the multinational group may create an ad hoc company structure to exploit the international differences in taxation and relocate profits from high to low-tax countries. The issue of profit shifting naturally arises when international taxation is based on separate accounting (SA). A framework where the accounts of a multinational group are separated between the entities operating in different countries and taxing rights on active business income are conventionally assigned to the source countries, and the total tax burden that falls on the multinational group may be strategically reduced. Against the backdrop of persisting differences in corporate tax rates across jurisdictions, multinationals have elaborated sophisticated strategies, including, for instance, the use of special purpose entities located in low-tax countries (Sanchirico, 2015; Bruner et al., 2018). Moreover, ownership strategies have become very complex, thus leading to de facto control structures that range from a full direct control via foreign direct investments (FDI) to a market relationship such as subcontracting (Buckley and Ghauri, 2004). National governments themselves often implement policies to attract MNEs through FDIs in the attempt to increase employment and, more broadly, to foster economic growth. The dichotomy between the limit of nations, which have control within national borders and policies, and the international view and incentives of MNEs could pose a challenge to the national statistics' residence approach, thus leading to the potential mismeasurement in relevant variables from aggregate statistics.

In this paper, we put forward a very simple empirical exercise to gauge the extent of such potential mismeasurement. The focus of this study is labour productivity, proxied by the value added per employed person (as detailed in Section 2). The European Union (EU) is characterized by large and persisting cross-country differences in the level and growth of labour productivity (see Figure 1)—a primary source of concern for economists and policymakers in the last decades. Since productivity is a crucial element in guaranteeing economic growth and adequate living standards (CompNet, 2020), its low and sluggish growth has a negative effect on the economic and social systems. Therefore,

[1] For further details on SNA, see EC et al. (2009) and Eurostat (2011).

addressing the potential mismeasurement in this variable due to MNE location strategies has important implications than those that go beyond simple accounting considerations (Bloom et al., 2012).

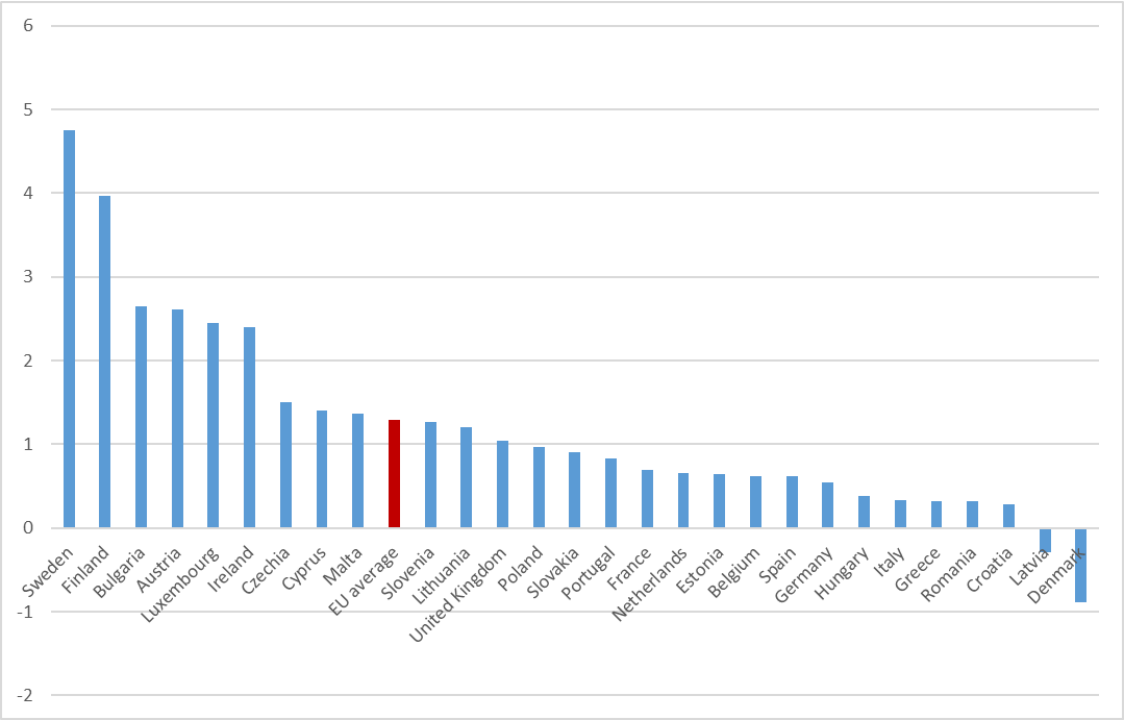

Figure 1. Real labour productivity growth (average 2011–2017). Source: Authors' elaborations on Eurostat data.

In this paper, we investigate the extent to which income shifting implemented by European MNEs could be a source of mismeasurement in the measurement of the output per worker for these companies. To this purpose, we employ internationally harmonized firm-level data for the years 2011–2017. The use of microdata allows a bottom-up approach to the measurement of aggregate variables, thereby offering an alternative view compared to the aggregate data, thus allowing us to decompose the labour productivity based on the firm's characteristics.

This paper contributes to different strands of the literature. First, it is related to the literature about tax-induced mismeasurement in the macroeconomic indicators in a globalized economy, Guvenen et al. (2022) studied mismeasurement in several US macroeconomic variables, including productivity, due to offshore profit shifting by American MNEs between 1973 and 2014. The authors documented that the bearing of international profit shifting on measurement changed over time. Reattribution of the MNE profits to the United States would contract the trade deficit, decrease the return on US foreign direct investment abroad, and boost the productivity growth rates in the late 1990s and early 2000s. In addition, the authors found that adjustments related to profit shifting were sizable in R&D intensive industries, thus leading to a bigger increase in the adjusted productivity as compared to non-R&D intensive industries. In an extension of this analysis, Bruner et al. (2018) applied the Guvenen et al. (2022) methodology to assess how the impact of offshore income shifting cascades onto other key macroeconomic indicators. They found that the official US gross domestic product (GDP) in 2014 was underestimated by a striking 1.5 percent and the operating surplus was underestimated by 3.5 percent, while the measured income receivable from the rest of world was corrected downwards by 33.5 percent.

Syverson (2017) challenged explanations of mismeasurement underlying the US productivity slowdown recorded from 2004. He highlighted the difficulties of disentangling among the potential concurring causes, such as quality improvements in information and communication technology (ICT)-linked products. In a similar vein, Ahmad et al. (2017) studied the potential mismeasurement of the GDP and productivity for the Organization for Economic Co-operation and Development (OECD) countries due to the digital economy, especially concerning the price and output volume measurement. The authors suggest that even if mismeasurement occurred, its magnitude was small enough disallow the explanation of the slowdown in GDP and productivity encountered by many advanced economies. A strong focus on the MNE profit shifting activities is apparent in more recent literature. Tørsløv et al. (2023) estimated that 36% of the global MNE profits were shifted toward tax havens, with a significant erosion of the tax base of high-tax countries. Additionally, they suggested that the capital share of corporations and the trade balance would increase vis-à-vis official statistics once corrected for profit shifting. Using on French firm-level data, Vicard (2023) showed that France's balance of payments in 2015 was inflated by €16 to €32 billion (or 0.7–1.5% of GDP) due to income shifting. Furthermore, still making use of micro-data, Bricongne et al. (2023) found that profit shifting in France implemented by MNE implied an annual loss in terms of the aggregate annual labour productivity growth in the range of 5.7%.

Our study complements this evidence by providing a European perspective on the implication of profit shifting with a specific focus on labour productivity. Moreover, our approach exploits the formulary apportionment methods.[2] Indeed, we also relate and contribute to the literature that implements the global formulary apportionment (FA) to allocate profits within an MNE group. As discussed by Weiner (2005) and OECD (2010), the FA has been considered a tool to determine the proper level of profits across national taxing jurisdictions. Röder (2012) suggested that while the FA relied on the Common Consolidated Corporate Tax Base, a different approach without consolidation could represent an alternative effective method to reduce tax obstacles in the EU internal market. Krchniva (2014) compared the different principles behind the FA applied in the EU, Canada, and United States, and showed that the distribution of the tax base among MNE's affiliates differed in relation to the specific formula implemented. Clausing (2016) studied the FA applied by U.S. states over the period 1986 to 2012, and highlighted how it effectively neutralized the incentives to shift the income towards low-tax states. Nevertheless, the tax difference could still affect other corporate outcomes, such as employment, investments, and sales.

In our study, we exploit information from the firms' accounts to identify European multinational groups, and then reallocate the profits among the entities of each group. As a last step, we recalculate the output per worker for multinational firms across each European country. In that, our work relates to Guvenen et al. (2022) and Bruner et al. (2018). Indeed, these authors implemented FA on MNE-level data to study macroeconomic mismeasurements. Similarly, De Mooij et al. (2019) provided an assessment of different ways to design the formulary apportionment and the related implications for economic incentives for multinationals. Our results suggest that income shifting affects the measurement of labour productivity, and the use of adequately corrected microdata can improve its computation.

[2] While the paper focuses on income shifting activities, there is a broader literature that investigates also the other channels through which corporate and capital taxation induce investment (mis)allocation. See, for instance, Fernald and Neiman (2011), and Fatica (2017).

The reminder of the paper is structured as follows: Section 2 discusses the different formulary apportionment's approaches; Section 3 presents the dataset; Section 4 shows the results; and Section 5 provides the conclusion.

2. Formulary apportionment

To gauge the implications of profit shifting for aggregate statistics, we focus on a specific macroeconomic indicator, namely the labour productivity (hereafter LP), which is measured as the value added (VA) per employed person.[3] First, we compute the LP using available financial statements, and then recalculate the same variable, thereby implementing different versions of FA.[4] LP is obtained by dividing the value added (VA) by the number of employees, where VA is defined as the net output of intermediate consumption. Thus, at the firm level, VA is computed by summing up the earnings before interest, tax, deduction, and amortisation (EBITDA) and the cost of employees.[5] In the formula, the LP per employees can be written as follows:

$$LP_{igt} = \frac{E_{igt} + wL_{igt}}{L_{igt}} \tag{1}$$

where LP_{igt} is the labour productivity of firm i part of the multinational group g at time t, E represents the earnings before interest, taxes, deduction, and amortization (i.e., EBITDA), w is the average cost of each employee, and L is the number of employees. The VA is obtained summing E and wL.

Our aim is to compute a measurement of LP that closely reflects the actual location of the production factors. As reported, the firm-level outcomes factor into the potential profit shifting activities; this 'adjusted' LP can be obtained by implementing the adequate correction to the firms' balance sheets. For instance, consider that the VA includes earnings. Hence, if the amount of earning is misspecified due to the income shifting activities, then the VA is affected and, in turn, the LP is mismeasured. We implement the so-called "global formulary apportionment", which is an approach that has been extensively used in the literature (see, among others, Röder, 2012; Clausing, 2009, 2016; Guvenen et al., 2022; OEDC, 2017; Bruner et al., 2018),[6] to reallocate the global earnings of a MNE among its entities (i.e. parent firm and its affiliates). We use the FA to compute the corrected amount of earnings that corresponds to the "actual production" for each firm and to compute the new level of LP. By aggregating the LP at the country level pre- and post-correction, we gauge the extent to which

[3] The use of country-sector averages for working hours per employee could help approximate the actual number of hours worked, but in the meanwhile they would lower the power of the firm-level approach, as individual information would be combined with country-sector ones. While there are different ways to compute labour productivity, within national accounts and structural business statistics, labour productivity is often defined as the value added per employed person. See Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Labour_productivity.

[4] While FA might be an imperfect measure, we base our approach on the literature that exploit the FA as a tool to determine the proper level of profits across national taxing jurisdictions, especially because the FA allow us to create a counterfactual for labour productivity vis-à-vis direct measures of profit shifting (Weiner, 2005; Huizinga and Laeven, 2008; OECD, 2010; EC, 2016; Fatica and Gregori, 2020).

[5] See Gal (2013) and Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Value_added.

[6] The FA approach has been challenged (Hines Jr, 2010), but it is still widely used in the literature.

the measurement of the variable is affected by tax planning activities.[7] Ultimately, the identified discrepancy is also informative on the contribution of microdata in detecting mismeasurement in macroeconomic data.

The FA reallocates the global earnings of a MNE among its entities based on an apportionment weight, $\omega_{i,g}$. This weight is the entity's share of the total apportionment factors used to reflect the allocation of production for each entity. Specifically, we follow the apportionment formula proposed by the European Commission (hereafter FA^{EU}) in the framework of the "Common Consolidated Corporate Tax Base apportionment" (EC, 2016) to define the weight, which combines three factors—assets, sales and employment, as follows:

$$\omega_{igt}^{EU} = \frac{1}{3}\frac{s_{igt}}{s_{gt}} + \frac{1}{3}\left(\frac{1}{2}\frac{wL_{igt}}{wL_{gt}} + \frac{1}{2}\frac{L_{igt}}{L_{gt}}\right) + \frac{1}{3}\frac{A_{igt}}{A_{gt}} \tag{2}$$

where ω_{igt} is the apportionment factor for entity i of group g at time t, s is the total amount of sales, wL is the total cost of employment, L is the number of employees, and A is the amount of fixed assets. The three apportionment factors—sales, employment and assets—are weighted equally (i.e., 1/3 each). Employment is further divided in two subcomponents—payroll and number of employees—and equally weighted (i.e., 1/2 each). For each factor, the numerator contains the information for the entity, while the denominator contains the total amount of the group of enterprises to which the entity belongs.

The factors included in the apportionment weight affect the attribution of the profit. Therefore, alternative ways of designing the formula may lead to different outcomes. Hence, we implement other approaches to disentangle the contribution and the role played by each factor. Specifically, we include two alternative formulas, FA^1 and FA^2, which are used in Canada and in the United States, respectively (Krchniva, 2014).[8] FA^1 is characterized by two factors which capture the extent of activity of a certain firm in a specific market and how much labour it employs in its production (see Guvenen et al., 2022 and Bruner et al., 2018). The former factor is accounted by using the amount of sales, while the latter is captured by the cost of employees, as follows:

$$\omega_{igt}^{1} = \frac{1}{2} * \frac{wL_{igt}}{wL_{gt}} + \frac{1}{2} * \frac{s_{igt}}{s_{gt}} \tag{3}$$

where ω_{igt} is the apportionment factor for entity i at time t of group g, wL is the cost of labour, s is the amount of sales, and wL_{tg} and s_{tg} are the overall amount at time t for group g of the cost of labour and sales, respectively, which are equally weighted. This formula has been implemented to harmonize the tax system among Canadian provinces. Since it uses firm-specific factors to apportion the earnings, it means that each factor has an effective tax rate that can vary in relation to the location of the specific factor. Compared to the FA^{EU}, the formula does not include fixed assets. Therefore, the investment

[7] Labour productivity at the country level is computed dividing, for each country, the aggregated level of firms value added by the aggregated level of number of employed persons (see, for instance, Bricongne et al., 2023).

[8] We acknowledge that the different formulary apportionment's allocation keys may lead to different results, possibly generating concerns related to the best approach that should be implemented. There is no ex ante preferred approach, has each of them has pros and cons. If, on the one hand, more allocation factors may better represent the complexity of business operations operational, on the other hand focusing only on sales may better target the firm's core business. Yet, regardless of the chosen approach, there is clear evidence of the value added of using micro-data.

does not affect the earning reallocation on the grounds of the potential distortionary effects induced by the investment tax incentives (Wiener, 2005).

At the same time, other incentives granted by the tax system may still be present. For instance, the firms may concentrate their labour-intensive activities in jurisdictions where labour taxes are low. To correct for other tax-related considerations that affect the location of economic activity, FA^2 considers an apportionment weight solely based on the sales factor, as follows:

$$\omega_{igt}^{2} = \frac{s_{igt}}{s_{gt}} \tag{4}$$

Under this formula, the firm's location choices for their factor of production—capital and labour—do not affect the earning reallocation due to FA^2.

Once the apportionment weights for each entity have been defined, we can allocate the total amount of the respective group's profits as follows:

$$E_{igt}^{\alpha} = \omega_{igt}^{\alpha} * E_{gt} \tag{5}$$

where α can refer to either the FA^{EU}, FA^1, or FA^2 formulary apportionment, E_{igt}^{α} is the weighted profit for entity i of group g at time t, and E_{gt} is the global earnings of the MNE group g at time t. Now, we can compute the post-apportionment LP, using the following formulas:

$$LP_{i,g,t}^{\alpha} = \frac{E_{i,g,t}^{\alpha} + wL_{i,g,t}}{L_{i,g,t}} \tag{6}$$

where $LP_{i,g,t}^{\alpha}$ is the weighted labour productivity, and α is equal to FA^{EU}, FA^1 or FA^2 for entity i of group g at time t.

3. Data

To implement the FA described in the previous section, we need to construct a dataset based on the firm's balance sheet and information on the structure of multinational groups. We exploit Orbis,[9] which is a commercial database that provides firm-level data covering more than 100 countries worldwide. Orbis provides comprehensive firm-level information, including the ownership details and the financial accounting variables. The ownership module includes historical information regarding the firm's shareholders, which we employ to identify the group of firms. As for the financial information, harmonized balance sheets, income statements, and profit/loss accounts are provided.[10] We follow the previous literature to map the firm ownership and build the MNE group structures (see, among others, Alviarez at al., 2017) and exploit information about the Global Ultimate Owner (GUO). The GUO is the first independent shareholder in the hierarchy above the firm that holds at least 50.01%

[9] See: https://orbis.bvdinfo.com/. While the Orbis database may not be equally representative in terms of firm coverage in all countries, results are still informative to conduct cross-country analyses given the harmonized nature of the data. The alternative approach, i.e. the use of administrative data to detect profit shifting activities, can be effectively implemented for single-country studies.

[10] The database includes over 400 million firms as of January 2022, with an extensive coverage of SMEs. However, the level of coverage and representativeness vary by country. Coverage for European countries is considered reasonably good, and better than the one for the U.S. (see Kalemli-Ozcan et al., 2024, for an in-depth comparison of Orbis with official statistics).

(GUO50) of shares independently of its country of incorporation.[11] This approach is line with the profit shifting literature (see, for instance, Dischinger and Riedel, 2014), which suggests that income shifting is more easily implementable by the ultimate owners with either a majority or even full control on their affiliates. Hence, we select only those multinationals with a reported GUO50. The drawback of this choice is that it reduces the sample size.[12] In this approach, stand-alone firms are either those which are owned by themselves or those whose shareholders have stakes lower than the chosen threshold. We only consider GUOs that are identified as legal entities and discard firms with individuals as ultimate owners. While Orbis has worldwide coverage, our interest is to build a sample of European multinational enterprises (MNEs). Thus, we exploit the ownership information and select firms that are part of groups with parents located in EU28.

Table 1. Summary statistics (period 2011–2017).

Balance sheet item	Mean	Median	Std. Dev.	p5	p95
Total Assets (th Euro)	28,106.58	7,060.07	66,331.61	329.54	123,478.60
Fixed Assets (th Euro)	12,825.30	1,353.95	41,816.22	7.92	58,074.09
Sales (th Euro)	28,860.06	8,083.30	57,884.81	368.30	128,557.00
Ebitda (th Euro)	2,415.47	591.53	5,291.55	19.27	11,235.00
Cost of employees (th Euro)	4,539.20	1,392.05	8,638.86	58.56	20,316.27
Number of employees	102.04	33.00	186.75	2.00	446.00
Value Added (th Euro)	6,954.67	2,269.00	12,527.64	132.98	31,293.14
Value Added per employee (th Euro)	98.46	67.49	119.59	18.63	278.36

Notes: Authors' elaborations on Orbis data. The number of observations is 368,290 for each variable.

Next, we merge the ownership dataset with the firm's financial information. We only consider unconsolidated financial statements. Moreover, to avoid bias induced by outliers, we trim the main variables of interest (as detailed in Table 1) at the 1% level on each side of their empirical distribution.[13] Our analysis focuses on firms actively involved in business activities that produce an added value. Therefore, we retain firms with an active status, positive fixed assets, sales, EBITDA, number, and costs of employees. As the coverage of Orbis significantly increases over time, we restrict our sample to the 2011–2017 period. In this way, we exclude the years of the global financial crisis (GFC), which is characterised by troughs in business profitability. Additionally, we exclude those EU countries for which we do not have at least 100 observation per year on average. Moreover, we retain a multinational group only if it has operations in at least two different countries. After all the cleaning steps, the final

[11] We retrieve the ownership information from the off-line version of Orbis, which collects all the vintages of the yearly released data. An important limitation of the on-line version of the database is that only the last available ownership information is provided, which does not allow tracking variation in firms' ownership.

[12] A possible criticism of this approach rests on the consideration that non-EU domiciled MNEs can impact the computation of labour productivity in EU countries. However, we do not benchmark our results against country-level statistics, which would require coverage of the universe of firms in a country. The validity of our results should be assessed still in a within sample exercise.

[13] The cleaning process of the Orbis database to construct a final dataset should consider a series of potential biases, such as the possibility of misreporting which could in turn influence the results (Kalemli-Ozcan et al., 2024). For this reason, we apply a 1% trim approach, as often done in this literature (Besley et al., 2021; Tomiura and Kumanomido, 2023).

dataset includes 366,201 observations for MNEs with headquarters in 22 EU countries[14]. Table 1 shows the summary statistics for the main balance sheet variables of interest.

4. Results

4.1. Labour productivity under the formulary apportionment's lens

In this section, we investigate the effects of income shifting on the LP by comparing measures of this variable obtained with and without the adjustments based on formulary apportionment. We use the reported balance sheet information to proxy the official statistics used as the benchmark. Then, we apply the FA and compute the percentage difference of the FA labour productivity from the benchmark value to gauge the effects of income shifting under different weighting schemes. The results are reported in Table 2. Column 2 shows the values of the LP computed using the balance sheet data, while columns 3, 4, and 5 report the percentage variation once we implement the different FA schemes (i.e., FA^{EU}, FA^{1} and FA^{2}). The last column shows the average variation in the measurement of the LP obtained with these different approaches. As expected, the use of different apportionment factors and weights influence the results. The implementation of FA^{EU} generates a variation that ranges from −2.87% for the United Kingdom to +1.82% for France. This means that the reallocation of earnings among the entities of multinational groups lowers the measured LP in the former country, while the latter records an increase. When we apply the FA^{1}, the differences range from −11.13% for Poland to +2.97% for France. Finally, the FA^{2} shows a minimum variation for Romania (−7.01%) and a maximum for France (+2.13%). Overall, the use of different weighting factors leads to a measured productivity that varies in the same direction with respect to the observed metric. However, somewhat expectedly, the estimated magnitudes may substantially diverge as a result of the choice of apportionment factors. In detail, compared to the other approaches, the FA^{EU} EU-FA comprises more factors, notably including the total fixed assets. As discussed above, the inclusion of fixed assets may incorporate potential distortionary effects due to the localized investment's tax incentives (Wiener, 2005). However, it allows one to account for elements, such as the economies of scale (Cullinane and Khanna, 2000), that act as a potential engine for productivity growth (Coelli and Rao, 2005). A simple average of the outcomes under the three approaches is reported in Column 6. The average productivity gaps range from a minimum of −6.61% recorded for Romania to a maximum of +2.31% in France.

The literature suggests that a higher level of taxation is generally associated with more intense profit shifting activities (e.g., Huizinga and Laeven, 2008). Figure 2 shows the relation between the corporate income tax rates (CIT), the forward-looking effective average tax rates (ETR), and the FA variation related to our sample. Specifically, we consider the distance of a country's CIT (ETR) with respect to the average CIT (ETR), and the average variation in the calculated labour productivity measures, as detailed in Table 2, Column 6. The correlation between CIT vs FA and ETR vs FA is around 68% on average. Countries with a CIT (ETR) above the average value (i.e., when the blue (grey) dot is above zero) tend to have a higher LP when the FA is implemented, while countries with a CIT

[14] The dataset includes MNEs from the following EU countries: Austria, Belgium, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Luxemburg, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, United Kingdom.

(ETR) below the average tend to have a lower LP. This supports the notion that multinationals exploit low-tax countries to allocate earnings.

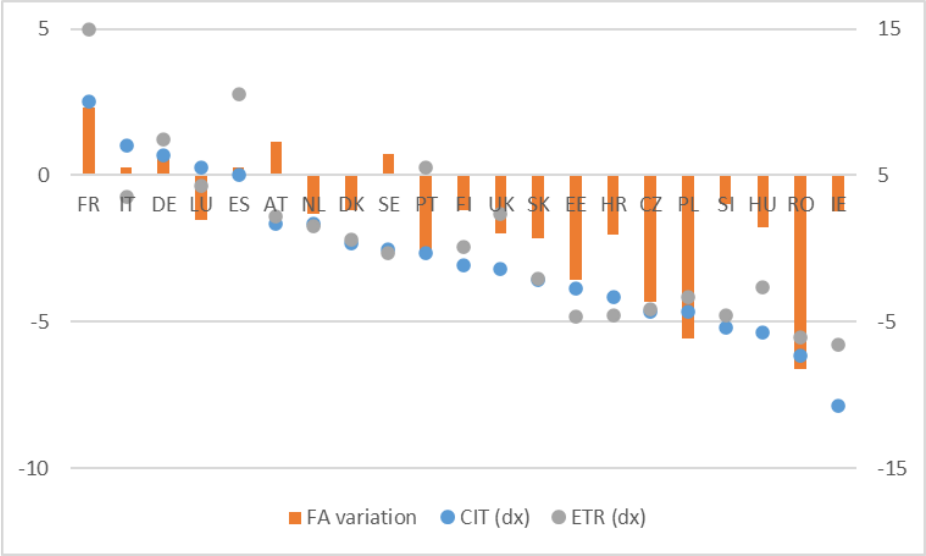

Figure 2. Tax rates and labour productivity variations. Sources: Orbis, KPMG and ZEW—Effective Tax Levels in the European Union Study. Notes: FA variation refers to the average variation of the three FAs implemented (i.e., FA^{EU}, FA^{1} and FA^{2}) as detailed in Table 2, column 6. CIT (ETR) refers to average corporate income (effective) tax rates over the period 2011–2017, considering the distance of a country's CIT (ETR) with respect to the average CIT (ETR).

Table 2. Labour productivity by country and percentage variation implementing the FA.

Country	FS	FA^{EU}	FA^{1}	FA^{2}
AT	82,956	0.49	2.05	0.92
BE	91,375	0.53	0.89	0.81
CZ	31,516	−2.86	−6.42	−3.67
DE	82,987	−0.09	1.63	0.62
DK	99,237	−0.52	−0.84	−2.17
EE	33,640	−1.13	−6.29	−3.27
ES	66,212	1.31	0.04	−0.51
FI	79,928	−1.47	−1.18	−0.89
FR	73,202	1.82	2.97	2.13
HR	29,255	−0.25	−3.32	−2.49
HU	36,491	0.39	−4.90	−0.81
IE	86,284	−0.84	−2.29	−0.57
IT	80,150	0.10	0.20	0.46
LU	81,000	−1.31	−2.45	−0.83
NL	93,531	−2.71	−1.82	0.57
PL	32,308	−2.31	−11.13	−3.21

Continued on next page

Country	FS	FA^{EU}	FA^{1}	FA^{2}
PT	48,887	−2.15	−3.16	−2.38
RO	23,166	−2.04	−10.76	−7.01
SE	94,031	0.06	1.47	0.70
SI	45,133	−0.70	−1.59	−0.70
SK	33,841	−1.11	−4.14	−1.23
UK	78,561	−2.87	−1.42	−1.65

Notes: FS refers to analysis performed on firms' Financial Statements without FA. KIA refers to Knowledge Intensive Activities. FS cover the period 2011–2017.

4.2. Knowledge intensive vs less-knowledge intensive activities

We investigate the role of intangible assets as a possible mechanisms for cross-border reallocation of corporate earnings by exploiting information on the sectors where the firms operate. In particular, we single out knowledge intensive activities (KIA) from the pool of industries that are not knowledge intensive (No-KIA). We exploit the categorization of knowledge-intensive activities developed by Eurostat. An activity is considered as knowledge intensive if at least 33% of persons employed in that activity have tertiary educated persons.[15] The indicator is constructed at the NACE-2 digit. We resort to a readily available classification based on KIA, as they are generally linked to the production of intangible assets (Mudambi, 2008), which, in turn, make profit shifting easier to implement (Guvenen et al., 2022).[16]

Table 3 shows the results that distinguish between KIA and No-KIA firms. The columns titled FS present the LP computed using balance sheet data without applying the FA. As is apparent, KIA are, on average, associated with a higher productivity compared to No-KIA. Our ex-ante expectations are that once we apply the FA, the countries with high taxation should gain (i.e., end up with higher productivity levels), especially in knowledge intensive sectors, where income shifting is easier to implement. For instance, Table 3 shows that applying the FA^{EU} to Belgium, a country with a high corporate income tax (see Figure 2), generates an increase in the LP in KIA sectors by 5.78%. This is significantly larger than the average value for the overall economy, +0.53% (Table 2), and especially higher than the corresponding value for the No-KIA sectors, −0.75% (Table 3). While this evidence supports our a priori, it is once again important to stress that other weighting schemes produce different results and provide a more nuanced picture. On average, the increase in the LP is around 1.01% for KIA sectors and 0.68% for No-KIA sectors. By focusing on financial centers such as Luxemburg and the Netherlands, the measured productivity for both KIA and No-KIA sectors overestimates the adjusted values under the FA^{EU}. However, the bias for KIA activities seems much more pronounced.

[15] For further details, see: https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an8.pdf.

[16] FA measures, compared to other direct measures of profit shifting (e.g., Huizinga and Laeven, 2008; Fatica and Gregori, 2020), may be less suited to fully reflect corporate tax bases and thus labour productivity for highly productive firms. For instance, royalty payments can result from highly innovative and productive processes. While these royalty payments are prone to profit-shifting activities, FA measures may not fully allocate royalties (and thus highly productive activities) to actual activities of MNE affiliates, leading to a downward bias in the productivity measure. Nevertheless, the use of different FA formula allows to compare the different apportionment weight factors' effects. In addition, disentangling the analysis between KIA and No-KIA firms highlights different sectoral dynamics.

Table 3. KIA vs No-KIA—Labour productivity and percentage variation implementing the FA by country.

Country	KIA				No-KIA			
	FS	FA^{EU}	FA^{1}	FA^{2}	FS	FA^{EU}	FA^{1}	FA^{2}
AT	94,279	2.24	1.04	−1.11	80,883	0.12	2.28	1.38
BE	106,104	5.78	−0.50	−2.24	88,355	−0.75	1.23	1.56
CZ	34,407	−0.48	−5.96	−9.56	30,985	−3.35	−6.52	−2.45
DE	90,659	0.71	0.70	−2.25	80,531	−0.37	1.97	1.66
DK	118,359	−0.41	−2.41	−3.89	94,030	−0.56	−0.32	−1.60
EE	30,318	4.73	0.35	−2.42	34,174	−1.91	−7.19	−3.40
ES	72,746	0.56	−2.96	−4.84	64,353	1.55	1.01	0.89
FI	80,091	0.19	−1.58	−2.17	79,907	−2.04	−1.04	−0.45
FR	90,436	2.47	0.13	−1.66	68,463	1.58	4.00	3.51
HR	40,033	0.09	−2.83	−5.02	27,417	−0.27	−3.40	−1.82
HU	42,997	2.98	−0.52	−4.28	34,987	−0.39	−6.20	0.13
IE	85,913	0.22	−2.34	−4.10	86,908	−1.69	−2.23	2.24
IT	81,608	1.71	−0.61	−2.49	79,809	−0.26	0.38	1.14
LU	105,716	−1.35	1.66	4.26	76,092	−1.31	−3.55	−2.25
NL	113,947	−3.43	−4.29	−3.62	88,212	−2.51	−0.98	2.03
PL	35,294	0.48	−7.56	−6.55	31,817	−2.91	−11.81	−2.61
PT	57,485	−1.30	−3.94	−7.10	46,841	−2.39	−2.94	−1.01
RO	23,988	5.67	0.11	−6.18	22,984	−3.85	−13.33	−7.20
SE	103,713	0.71	0.50	−0.64	90,471	−0.22	1.88	1.27
SI	52,931	6.62	−5.74	−8.67	44,319	−1.56	−1.13	0.23
SK	40,204	−1.26	−4.50	−6.47	32,838	−1.15	−4.13	−0.24
UK	94,319	−2.01	−1.16	−3.68	73,222	−3.27	−1.56	−0.79

Notes: FS refers to analysis performed on firms' Financial Statements without FA. KIA refers to Knowledge Intensive Activities. FS cover the period 2011–2017.

4.3. Productivity growth rate

In this section, we compute the productivity growth rate over the period 2011-2017 and compare the growth rate derived from the financial statements with the one obtained by implementing the FA methods. As in Section 4.2, we distinguish between KIA and No-KIA activities. The results are reported in Table 4. As an example, Germany has a financial statements' productivity growth rate in KIA equal to 2.07%. Once the FA^{EU} is implemented, the growth over the same time span is slightly lower of 11 basis point, and thus equal to 1.96%. A similar reduction is found when implementing FA^{1} and FA^{2}. In relation to the No-KIA activities, the productivity with FA^{EU} is 25 basis points higher compared to the financial statements one, thus moving from 0.70% to 0.95%. The same trend is confirmed, thereby implementing the other two FA approaches. A stronger impact is found for the Netherlands. In fact, the drop in the growth rate for the KIA implementing FA^{EU} is 385 basis point. By contrast, there is an increase of 126 basis points for No-KIA, thus mitigating the negative productivity growth (−2.01%) highlighted by the financial statements.

Table 4. Productivity growth rate—KIA vs No-KIA.

Country	KIA				No-KIA			
	FS	FA^{EU}	FA^{1}	FA^{2}	FS	FA^{EU}	FA^{1}	FA^{2}
AT	1.34%	−1.64	−1.81	−1.58	0.02%	1.32	0.87	0.46
BE	0.59%	0.40	−0.16	−0.01	1.33%	−0.18	−0.10	−0.05
CZ	−1.37%	1.10	1.74	1.48	2.91%	−0.08	0.36	0.24
DE	2.07%	−0.11	−0.11	−0.16	0.70%	0.25	0.24	0.15
DK	2.72%	−0.20	−0.23	−0.20	2.24%	−0.06	−0.08	−0.03
EE	4.85%	0.41	0.77	0.12	2.29%	0.35	0.83	0.68
ES	−0.08%	−0.25	−0.01	0.07	0.46%	−0.28	−0.24	−0.13
FI	1.08%	−0.31	−0.18	−0.17	1.58%	0.02	0.08	0.08
FR	0.13%	0.21	0.16	0.19	1.35%	−0.01	−0.07	−0.03
HR	1.13%	−0.18	−0.11	−0.16	0.82%	0.33	0.35	0.42
HU	−0.10%	0.20	0.02	−0.40	1.93%	0.05	1.07	0.77
IE	0.92%	0.35	0.17	0.12	1.87%	0.03	0.10	0.04
IT	−1.29%	0.35	−0.04	0.14	−0.68%	0.18	−0.14	−0.29
LU	0.88%	−0.38	1.30	1.24	1.08%	−0.29	0.20	0.34
NL	2.29%	−3.85	−4.91	−4.64	−2.01%	1.26	1.14	1.62
PL	8.51%	−0.15	−0.70	−0.46	4.55%	0.36	0.75	0.52
PT	2.66%	−0.58	−1.10	−1.02	2.42%	−0.07	0.05	0.01
RO	−1.43%	−0.89	−0.06	−0.14	−0.44%	−1.04	−0.52	−0.87
SE	2.47%	0.39	−0.03	0.04	4.74%	0.01	−0.08	−0.19
SI	0.79%	1.21	−0.74	−0.68	0.81%	0.01	−0.06	0.10
SK	0.73%	−0.21	0.29	0.14	1.69%	−0.18	0.15	−0.04
UK	2.40%	−0.15	−0.25	−0.24	2.96%	0.07	−0.07	−0.10

Notes: FS refers to analysis performed on firms' Financial Statements without FA. KIA refers to Knowledge Intensive Activities. FS cover the period 2011–2017.

5. Conclusions

In this paper, we investigated the extent to which income shifting implemented by MNEs could lead to mismeasurement in aggregate statistics. We focused on MNEs based in the European Union, and on a specific macroeconomic indicator, namely the LP, using firm-level data for the years 2011–2017. The use of microdata allowed for a bottom-up approach in the measurement of macroeconomic variables and offered a clear advantage in that it rooted aggregated data into the behavior of underlying individual entities.

We implemented the FA methodology to compute an adjusted LP that reflects the location of production, thus purging the reported data from the effect of potential income shifting activities that can result in mismeasurement in corporate balance sheets. Our results suggest that the presence of income shifting affects the LP, with countries and sectors unevenly affected. The sensitivity analysis based on formulas with different factors and weights is suggestive of the important complexities that surround correcting the official statistics for the effect of income shifting in the global economy.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Author contributions

Serena Fatica: Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Conceptualization. Wildmer Daniel Gregori: Writing – original draft, Methodology, Investigation, Data curation, Formal analysis.

Conflict of interest

All authors declare no conflicts of interest in this paper. Responsibility for any errors lies solely with the authors. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission, the Banco de Portugal or the Eurosystem.

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