



# **Comparing productivity patterns from MultiProd across different sources**

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# 1. Introduction

## 1.1 Background

In recent work, the OECD provides international evidence showing that there appears to be a growing gap between high-productive and low-productive firms worldwide (e.g. Andrews et al. 2016). The study was carried out using cross-country firm-level data from ORBIS obtained from Bureau Van Dijk. The results therefore concern a divergence between the *international* frontier and followers based on 24 countries for the period 2001-2013.

Currently, the MultiProd project collects a broad range of firm-level based statistics on productivity from sources available at national statistical offices. In that project, the analysis of frontier firms relates to the *national* frontier. While so far the OECD has not drawn any conclusions specifically for the Netherlands, the pattern of a widening productivity distribution<sup>1</sup> is confirmed to exist within countries as well for the period 2001-2012, although not in all (Berlingieri et al. 2017, see also section 3.3). Moreover, most of the widening can be attributed to the growing gap between the bottom 10 percent and the median of the distribution.

For the Netherlands, the Netherlands Bureau for Economic Policy Analysis (CPB) has carried out a study that is similar to the MultiProd setting, in that the national frontier and followers are considered (CPB, 2018a and 2018b). For the period 2006-2015, the study concludes that there is no evidence regarding a widening pattern within the Netherlands, based on a comparison of the median frontier firm to the median follower, whereas the widening with respect to the bottom 10 percent is not explored.

## 1.2 Scope of this study

The question arises whether the Netherlands belongs to the countries displaying no widening, or whether differences in data or method could contribute to the heterogeneity of effects across countries. This report describes the results of the OECD MultiProd analyses using data from the Statistics on Non-Financial Enterprises (NFO), similar to the dataset used by CPB. These results are compared to those using the Production Statistics (PS), which is the source used earlier by CBS in the MultiProd program.

Moreover, the results will be compared to those obtained by CPB for the Netherlands, and by OECD for other countries contributing to MultiProd. For purpose of comparison, the results are also compared to those concerning the global frontier and laggards in Andrew et al. (2016), although in this report we observe the national counterparts only. In the comparison of the results from the different studies, it is important to keep in mind various mutual differences between sources. The key ones are listed in table 1a. Table 1b shows the different coverage of the studies in terms of time period, which also impacts on the comparability of the results. One goal of this report is to clarify these differences.

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<sup>1</sup> Often the increasing differential between the top and bottom of the distribution is described as a “divergence”. In this report, we prefer to describe this as a widening of the distribution, since this formulation is neutral to the causes of the growing differential, in particular whether frontier firms remain at the frontier.

The focus will be on comparing the change in productivity of firms at the top of the distribution to that in lower parts of the distribution. While the OECD and CPB research is much richer, these statistics are one of the eye-catchers, and the main source of the current discussion. Unless stated otherwise, the analyses concern Dutch firms only, and therefore also the national frontier.

It should be emphasized that this report aims to make a purely numerical comparison between the outcomes of the MultiProd program across two sources, and to compare these to outcomes from the existing studies. It is not intended to draw any conclusions about the economic “reality”, the “right” method, or the “right” data. Moreover, the report will only briefly touch upon conceptual differences between PS and NFO.

Table 1a. Selection of differences between various studies.

		Andrews et al	Berlingieri et al	CPB	CBS
Frontier	Global	✓			
	National		✓	✓	✓
	Time-averaged*			✓	
Widening	frontier/non-frontier**	✓	✓	✓	✓
	top/bottom decile		✓		✓
Labour input	Fte		✓		✓
	Headcount	✓	✓		
	hours worked			✓	

\* CPB determines the TFP-level by averaging across two consecutive years.

\*\* Frontier firms refer to the top decile or top 5%.

Table 1b. Time period covered by various studies.

	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10	'11	'12	'13	'14	'15
Andrews et al	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Berlingieri et al	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
CPB							✓	✓	✓	✓	✓	✓	✓	✓	✓
CBS*	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

\* Figures for the 2001-2005 are indicative only because of a lower quality employment measure, and a break in the Dutch business register between 2005 and 2006.

## 2. Data

To be able to do firm-level productivity analyses, one needs information on inputs and output. Two options for sources containing such information at CBS are the Production Statistics (PS) and the Statistics on Finances for Non-Financial Enterprises (NFO). These two sources will be described briefly in turn.

### 2.1 Source description

The PS is a compulsory survey carried out by Statistics Netherlands. The unit of observation is the enterprise, as defined by Eurostat,<sup>2</sup> i.e. it is the smallest homogeneous unit of production that can be described in a meaningful way. The survey concerns enterprises with 10 or more employees. Firms with 10 to 50 employees are a sample; larger firms are all surveyed, although firms in both size groups can be missing in the ultimate sample data due to non-response.<sup>3</sup> Non-response or implausible information is corrected or estimated for the purpose of making aggregate statistics. As these records are not suitable for use in firm-level analyses, they have been excluded in the analysis. A large part of the non-financial business economy is covered, but not the financial sector and public administration.<sup>4</sup>

The NFO data is partly based on a survey (for larger firms, currently the threshold is a balance total of 40 Mln euro), and partly based on tax register data from the Ministry of Financial Affairs. The unit of observation is the enterprise group, i.e. groups of enterprises that are bound together through their financial structure.<sup>5</sup> Thus, this is a higher level of aggregation as compared to enterprises used in PS, although in practice most of the enterprise groups consist of a single enterprise. The main differences are for larger enterprise groups.<sup>6</sup> In principle, the data concern consolidated balance sheets and income statements. Implausible data is corrected after plausibility checks, and imputations are used to correct for non-response (about 10% of the observations); these records can however not be identified in the micro-data, and can therefore not be excluded. All non-financial enterprises groups that are liable to pay corporate income tax are covered in this source.<sup>7</sup> In this respect, the NFO is nearly comprehensive: up to 90% of these firms are captured according to the documentation on the CBS website.

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<sup>2</sup> <https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Enterprise>

<sup>3</sup> For some economic activities the threshold is 100 employees. Moreover, in industries where tax information is not useful, smaller firms are surveyed.

<sup>4</sup> In practice, the PS does cover firms with less 10 employees. However, this concerns specific, detailed industries, or incidental coverage due to firms occasionally dropping below 10 employees as well as due to errors in the sampling frame. By default we will discard these firms, for the non-random character of their coverage, which could bias the results.

<sup>5</sup> [https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Enterprise\\_group](https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Enterprise_group)

<sup>6</sup> Note that here, "larger" does not have to correspond with the criterion for being included in the survey.

<sup>7</sup> Liability to pay corporate profit tax depends on the legal structure of the firm. Natural persons that are sole proprietors or work in partnerships pay taxes on their profits through their (personal) income taxes, and are therefore not covered in the NFO. Private (limited) and public (listed) companies pay corporate profit tax (Dutch: Vennootschapsbelasting), which are the firms included in the NFO. Note that firms with negative profits are still covered.

## 2.2 Variable description

Table 2 gives an overview of the variables used as input into the productivity calculations for both sources. The definitions of the PS variables follow the European Regulation of the Structural Business Statistics.<sup>8</sup> The NFO data follow the international accounting standards of balance sheet and income statements (such as IFRS and GAAP). There are conceptual differences between the variables in the different sources. The extent to which these differences affect the productivity figures is an important question, which however is beyond the scope of this report.

Table 2. Variable description.

	PS	NFO
Gross output	Production (SBS12120)	Turnover
Intermediate inputs	Total purchases of goods and services (SBS13110)	Cost of turnover
Value added	Value added at factor cost (SBS12150)	Turnover minus cost of turnover
Capital input	Depreciation cost (proxy) <sup>9</sup>	Book value of fixed assets
Labour input	Full-time equivalent	Full-time equivalent (business register)
Labour cost	Personnel cost (SBS13310)	Labour cost

## 2.3 Further notes to the data used

In this note, the MultiProd analyses will be run on datasets based on either PS or NFO, combined with business register data for sample weighting. To assess the impact of including smaller firms in the sample, a separate analysis is carried out based on the NFO data for firms with 10 employees or more. We will focus on the manufacturing and (non-financial) services sectors.

The NFO dataset resembles closely the dataset used in CPB (2018). However, a couple of differences are worth to point out. Firstly, CPB has used industry deflators derived from the Dutch Input-Output tables. The MultiProd program comes with its own set of deflators, at a slightly higher level of aggregation, taken from the OECD Structural Analysis (STAN) database. While both sets of deflators are based on National Accounts data, it cannot be ruled out that they are not exactly consistent.

In addition, to measure labour input, MultiProd works with either the number of persons employed or full-time equivalents (fte), also including proprietors or family members etc. The NFO data does not contain an employment measure. In their study, CPB has therefore derived a labour input measure based on the hours worked by employees, from the Dutch tax administration. As the MultiProd code assumes that labour input is in fte or headcount, the hours worked information cannot be used directly. Therefore, in this report the labour input measure from the Dutch business register will be linked to the NFO data, which concerns fte.

<sup>8</sup> <https://ec.europa.eu/eurostat/web/structural-business-statistics/methodology-classifications/legislation>

<sup>9</sup> It is assumed that the depreciation cost are proportional to a firm's capital inputs.

This measure is also largely based on the tax administration, but has a slight delay. However, the drawback of this measure is that it is rounded to integers. Especially for small firms, this means that productivity is determined with less accuracy.

In terms of outlier correction, neither data source has been corrected for outliers before being fed into the MultiProd program. The program has its own routines for checking for outliers. These checks could be different from any corrections used by CPB. In the analyses below, also a variant without outlier filtering will be considered.

Finally, in the calculation of MFP some methodological issues have to be considered. While OECD and CPB both use the same econometric method (Wooldridge, 2009), it cannot be ruled out that there are differences in the exact implementation, the analysis of which is out of scope for this exercise.

Table 3. Average number of firms per year (2001-2015, PS: enterprises, NFO enterprise groups), unfiltered input datasets

	services	manufacturing	total
NFO	176,746	17,017	193,763
NFO10+	31,161	6,508	37,669
PS	15,283	4,630	19,913

Table 4. Averages and medians of output variables and labour input.

		NFO			NFO 10+			PS		
		turnover	value added	fte	turnover	value added	fte	turnover	value added	fte
services	mean	4260	1049	17	20271	4901	84	16546	7345	93
	median	364	163	2	3479	1256	21	3465	1755	28
manufacturing	mean	15664	3183	34	39354	7863	82	50088	10664	127
	median	1123	427	7	4498	1637	25	8596	2877	48
total	mean	5262	1236	18	23568	5413	83	24346	8116	101
	median	404	175	2	3645	1313	22	4185	1941	39

## 2.4 Sample characteristics

Three input datasets will be used in this report: the PS and the NFO, and a subsample of the NFO of enterprise groups with more than 10 employees. The latter selection is used to investigate the consequence of excluding smaller firms.

Table 3 shows the average number of firms by year (NFO: enterprise groups, PS: enterprises) in the input datasets. Clearly the NFO has a higher coverage, especially of smaller firms. Excluding firms with less than 10 employees, the sample size of the NFO is more comparable to that of the PS. Taking into account the actual target population in terms of firm size, the coverage of the PS is quite high. For example, in 2007 the PS cover more than half of the firms with more than 10 employees in both manufacturing and (non-financial) services.

Table 4 show the (unweighted) summary statistics for output/production, value added, and employment. The full NFO sample show smaller averages and medians. Naturally, excluding the smaller firms increases the averages and medians. In manufacturing, the statistics are then roughly comparable across the sources.

### 3. Results of comparisons across sources

In this section the NFO and PS based results are presented, which follow from the application of the MultiProd program. Moreover, we investigate different potential explanations for any differences.

A key aspect of both the OECD and CPB analyses is the comparison of the productivity growth at the top of the productivity distribution (so-called leaders or frontier firms) with the productivity growth at the bottom of the productivity distribution. To this end, the annual growth of the top and bottom decile can be compared, i.e. the 90<sup>th</sup> and 10<sup>th</sup> and percentiles. Alternatively, one can compare the top decile with the median firm. We will refer to these productivity differentials as top-bottom and top-median gaps, or respectively the frontier-laggard or frontier-follower gaps.

Table 1 provides an overview of the degree of widening across the whole time period, for the different dimensions: type of productivity (labour productivity or MFP), source (NFO or PS), type of gap (top-bottom or top-median), and sector (manufacturing or services). The figures concern the differences in the growth of the frontier versus the bottom group or median. For instance, if the frontier productivity level has grown by 10% and the productivity growth of the bottom 5%, the difference in growth would be 5 percentage points. Labour productivity is defined as (real) value added over labour input expressed in full-time equivalents. MFP is defined as the residual in an estimated production function, using the methodology by Wooldridge (2009), which is applied by both OECD and CPB in their respective studies.<sup>10</sup>

Table 1. Overview of results for growth of productivity gaps, 2006-2015  
(percentage point difference of productivity indices, 2006 = 100)

		NFO		PS	
		Top-bottom	Top-median	Top-bottom	Top-median
Labour productivity	Manufacturing	4.1	6.5	19.0	10.4
	Non-financial services	7.9	-3.6	29.4	5.2
Multifactor productivity	Manufacturing	17.1	12.7	0.9	4.2
	Non-financial services	5.2	-1.8	8.0	-2.7

#### 3.1 Comparison of benchmark NFO and PS results

Figure 1a and 1b show the productivity patterns based on NFO and PS, for both labour productivity and MFP, and distinguishing between manufacturing and services. The PS results

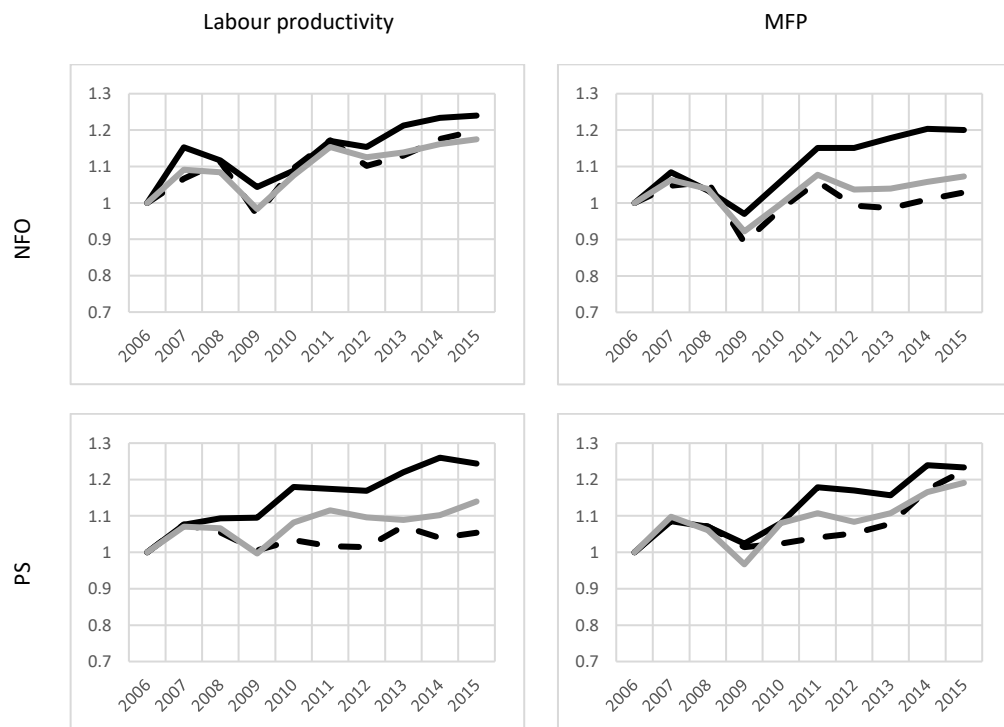
<sup>10</sup> The MultiProd output data include two measures of MFP, namely the Solow residual and one based on the estimation of a production function using a method by Wooldridge. To be somewhat concise in this report, the results will be confined to the Wooldridge version.



are based on a selection of firms with more than 10 employees, and are sample-weighted, correcting for any sample selection (based on population counts from the business register).<sup>11</sup> For the NFO, the results are unweighted, as the data concern a census of tax paying firms.<sup>12</sup>

Starting with manufacturing, the NFO data up to 2011 show alternating periods of widening and narrowing for labour productivity. In the more recent years, the labour productivity differential increases to the benefit of the top decile, which can be attributed to the years 2012 and 2013. On the other hand, a pattern of widening can clearly be observed in the PS. Strikingly, we observe the opposite for MFP, where there is a clear growth of the gap in the NFO data, but not in the PS.

Figure 1a. Development of productivity levels in manufacturing  
top 10% (—), bottom 10% (- - -), and median (—)

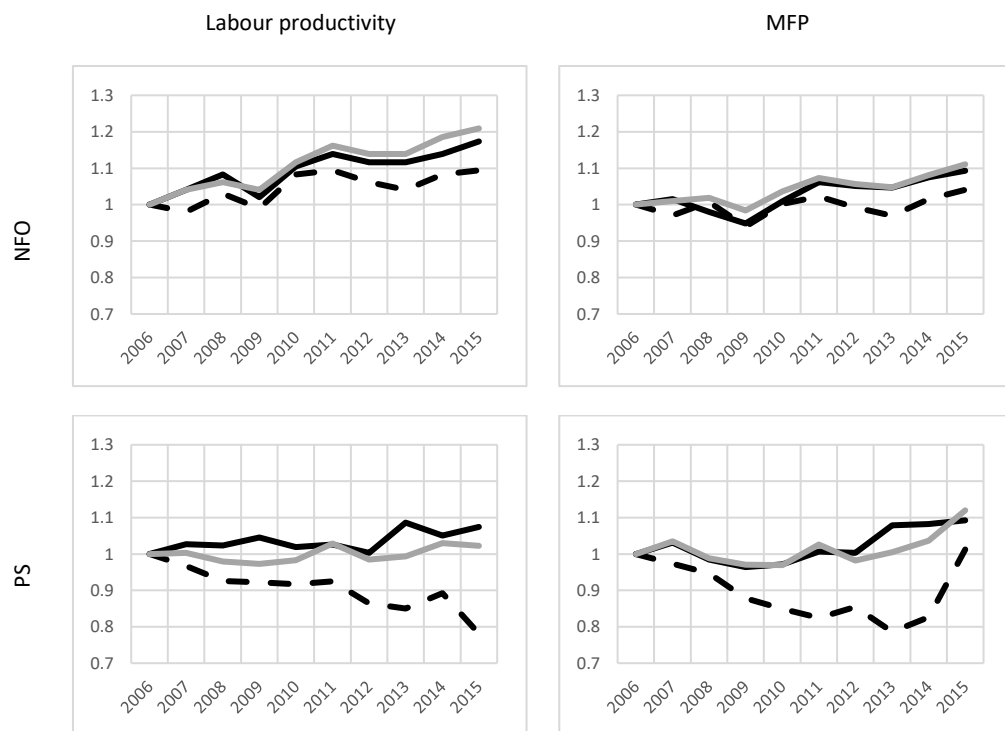


<sup>11</sup> Coverage of small firms is incidental and non-random in the PS, leading to implausible results when applying sample weighting, see also section 3.2.2. The results are not size-weighted, i.e. the productivity distribution is not rescaled to take into account the firm size distribution. (Firm-level size-weighted productivity levels would amount to the firm-level contribution to aggregate productivity.)

<sup>12</sup> Note that the number of firms in the NFO is smaller than in the full business register, but the latter also includes legal forms that do not pay corporate taxes, such as sole proprietors. Sample weighting to the full population would then involve the assumption that the corporate tax paying firms (mainly B.V. (limited liability) and N.V. (incorporated) firms)) are representative for the entire population of firms. As the firms that do not pay any corporate taxes are typically small but are by far the majority in the Business Register, this is not an innocent assumption. Instead, we restrict the interpretation of the results to apply solely to the corporate tax paying firms.

Turning to services, the NFO data show a widening of the distribution regarding the top and bottom decile in labour productivity, and more moderately concerning MFP. However, there is virtually no widening between the top and median; there is even some convergence. In this sector, the patterns from the NFO are also roughly confirmed in the PS, although the differential with respect to the bottom decile is much more pronounced. Moreover, the bottom decile shows a striking catch-up in MFP in 2015, a result which needs more investigation. Below we will argue that the magnitude of the widening and observed jumps in the PS results deserve more research, as they could be related to limited coverage in certain parts of the firm population, in combination with sample weighting.

Figure 1b. Development of productivity levels in services  
top 10% (—), bottom 10% (---), and median (—)



In sum, the conclusion from this section is that the source matters for the observed productivity distribution:

- In manufacturing, there is a clear indication of widening in labour productivity in the PS, but this is less clear in the NFO data, where the widening is more moderate and can be attributed to the more recent years only.<sup>13</sup> For MFP in manufacturing, it is the other way around, with the NFO clearly showing a widening pattern, while the PS does not.
- In services, both sources agree that there is a widening between the top and the bottom decile, and not in the top and median. The magnitude of the widening, however, is much more pronounced in the PS.

<sup>13</sup> In section 3.3 we will see that the magnitude in the NFO data for manufacturing is in fact larger than or comparable to that in the MultiProd results for other countries for the period up to 2012.

## 3.2 Testing some explanations for differences between NFO and PS

In the next subsections, different aspects of the analyses and the data will be investigated that could affect the resulting productivity patterns and the comparison across the two sources.

### 3.2.1 Restricting the NFO sample to larger firms

A major difference between the NFO and PS sample is the fact that the former includes smaller firms (i.e. firms with less than 10 employees). Thus, an explanation for the stronger widening of the productivity distribution in the PS, could be the different coverage of these sources in terms of size classes. To test this, the NFO sample was restricted to firms with more than 10 employees.<sup>14</sup>

Figure 2 displays the results for this comparison. In terms of widening, growth at the bottom decile and the top decile is more in line. This is true for both labour productivity and MFP, and in both manufacturing and services, although for MFP in manufacturing this result follows from a significant catch-up of the bottom decile in the last years of the sample period. In this sense, excluding the small firms, eliminates most of the widening found in the full sample between the top and bottom deciles. The gap between the top and the median does increase a bit however in services, as compared to the full sample, especially for labour productivity.

Overall, the impact of the exclusion of small firms on the productivity distribution is therefore somewhat complex. However, considering only the larger firms does not seem to bring the patterns observed in the NFO in line with those in the PS. The gap between the top and the bottom decile, in particular, does not become larger, but smaller. This is somewhat striking, as the CPB research suggested that the coverage of small firms is an explanation for the lack of widening in their results. This could be related to the fact that CPB focused on the comparison of frontier and non-frontier firms. The growth in the top-median gap is indeed slightly more pronounced for the larger firms, in particular for labour productivity.

A caveat to the interpretation of these results concerns the labour input measure used in the NFO dataset, which is sourced from the business register. As mentioned above, this variable concerns full-time equivalents rounded to integers, which makes the productivity level estimates for smaller firms less accurate, although it is not clear if and how this affects any conclusions about the distribution over time.<sup>15</sup> A suggestion for further research is to investigate the impact on the results of using a more precise measure such as the hours worked used in the CPB study.

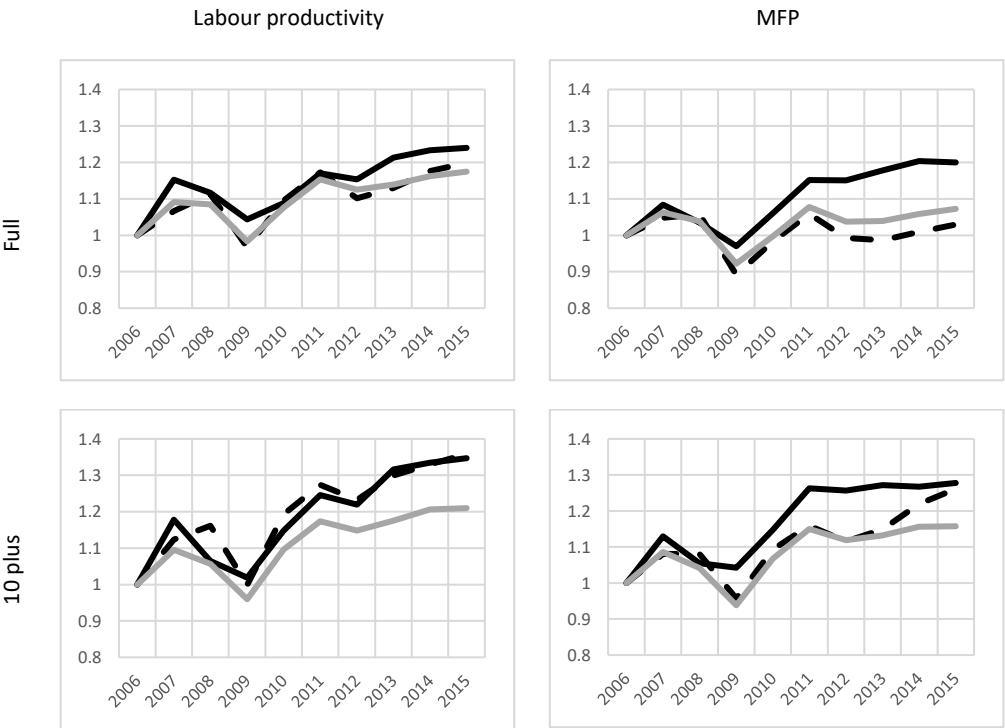
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<sup>14</sup> Results were also obtained for the sample of 20 employees or more. These were very similar to the ones presented for the firms with 10 employees or more.

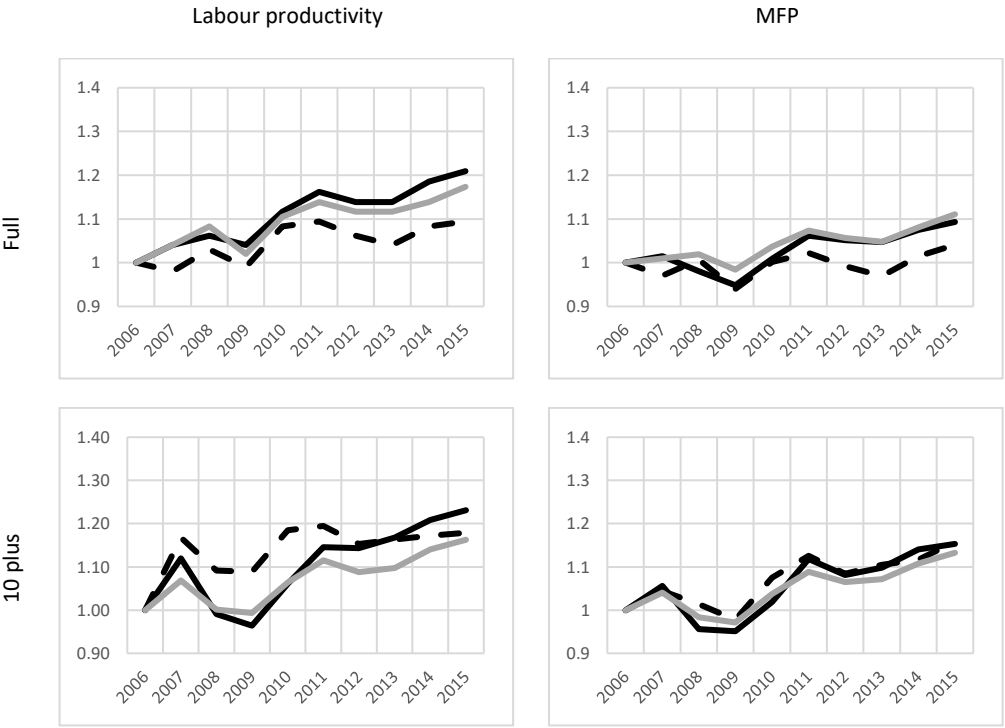
<sup>15</sup> Note that the rounding implies that firms will be classified with error in the productivity distribution. As long as this error is random, and samples are large, this would not majorly affect any of the conclusions.

Figure 2. Productivity of frontier and following firms based on NFO (2006 = 1).

(a) Manufacturing



(b) Services



### 3.2.2 The impact of sample weighting in the PS

Another difference between the NFO and PS is that the latter is sample based, and the results therefore involve sample weighting in order to achieve representativeness at the aggregate level.<sup>16</sup> In order to investigate the impact of the sample weighting on the results, Figure 3 shows a comparison of the PS based productivity patterns with and without sample weighting.

In manufacturing, sample weighting does not seem to affect the labour productivity pattern much, but the widening in MFP since 2009 is somewhat higher in the unweighted results. By contrast, in the unweighted results for services, it can be observed that the bottom decile develops in a more similar way as the top decile and the median. For labour productivity there is still some degree of widening, while in terms of MFP it disappears. This is a striking result given the strength of widening in the weighted PS results for services.

In principle, sample weighting is preferred in the PS sample, as it corrects for possible selectivity in the data. However, when the coverage is low for specific groups of firms in terms of industry and size class, a small number of firms will receive large weights and this can have a disproportional impact on the ultimate outcomes. For example, unreported results show the impact of weighting in the full PS sample, which includes a relatively low number of small firms. Here, sample weighting clearly exacerbates the volatility at the bottom of the distribution here. This is why for the benchmark results a sample of firms from the PS with firms that have more than 10 employees is used.

Whether such a mechanism is driving the differences in the PS results in services is not clear from the current analysis. A suggestion for further research is therefore to look further into this issue, for example by looking at the outcomes at a more detailed industry level. In particular, it should be investigated whether the PS provides an adequate coverage of all industries and size classes at the level of aggregation at which the sample weights are calculated.

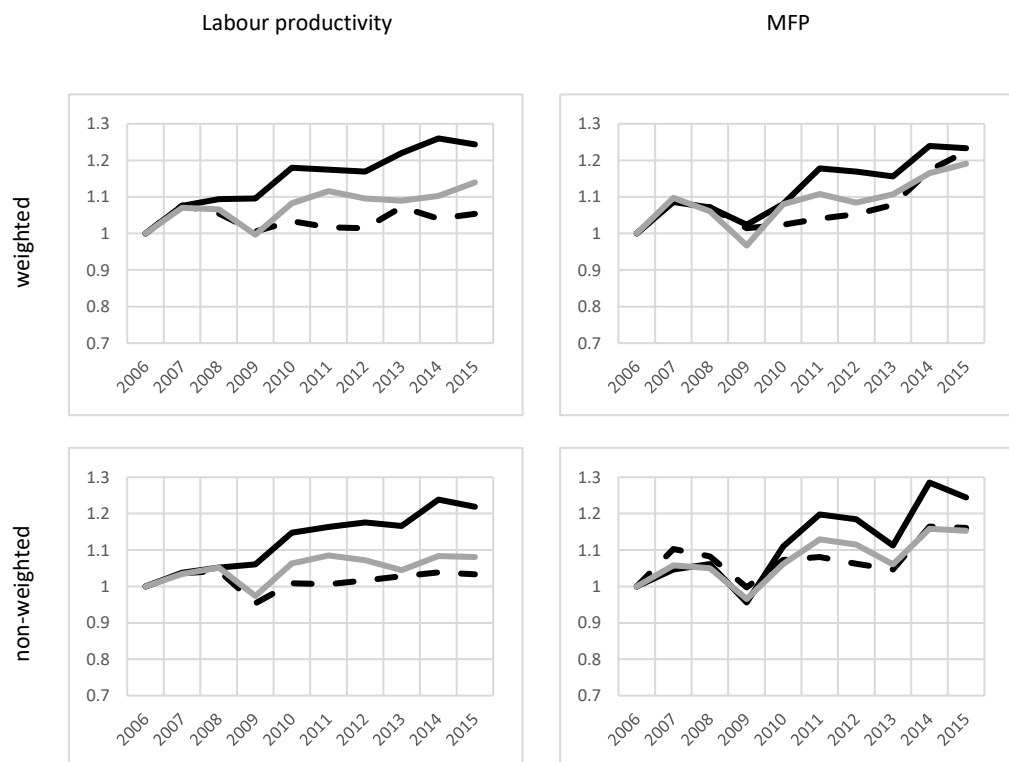
For the time being, the possibility should be left open that the degree of widening found in the PS as presented in this report, especially that between the top and bottom deciles in services, can be partly related to issues of low coverage in combination with sample weighting.

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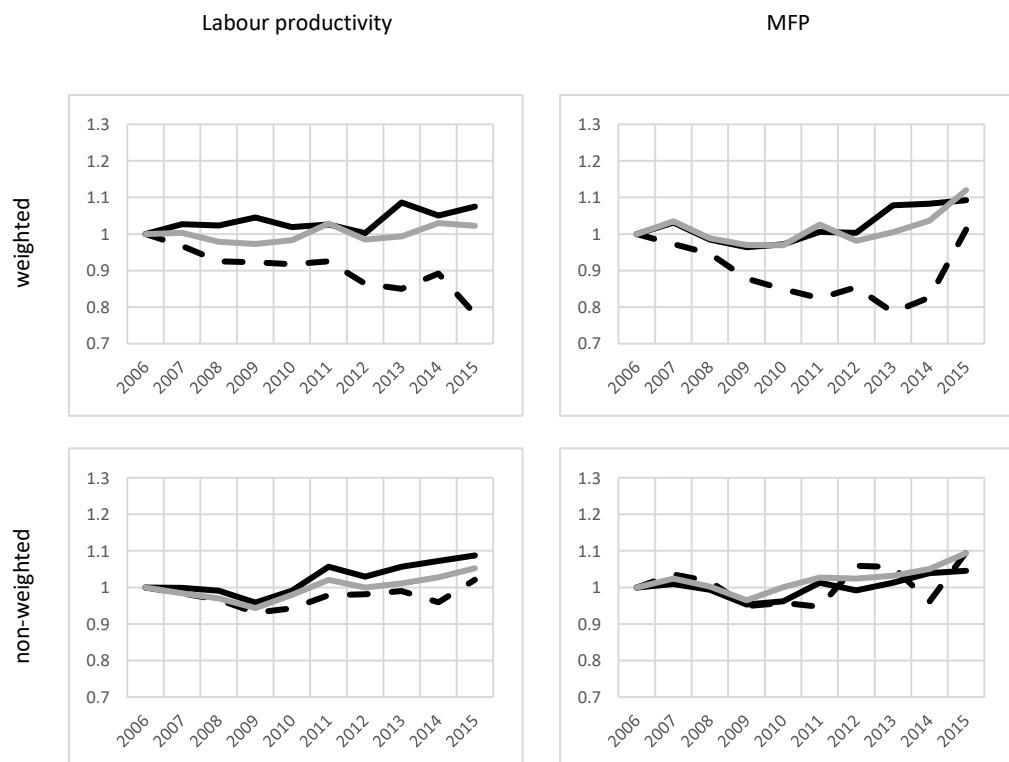
<sup>16</sup> Sample weighting refers to the procedure where firms in the sample receive a weight according to the number of firms they represent in relation to the population. For example, if a sample consists of 10 firms, and the population information (i.e. the business register) indicates that these 10 firms are part of a group that consist of 20 firms, all firms in the sample receive a weight of 2 (i.e. they are counted twice in the overall population statistics). The MultiProd program defines groups (i.e. strata) by industry and size class.

Figure 3. Productivity of frontier and following firms based on PS, weighted and non-weighted (2006 = 1).

(a) Manufacturing



(b) Services



### 3.2.3 The impact of outlier filtering

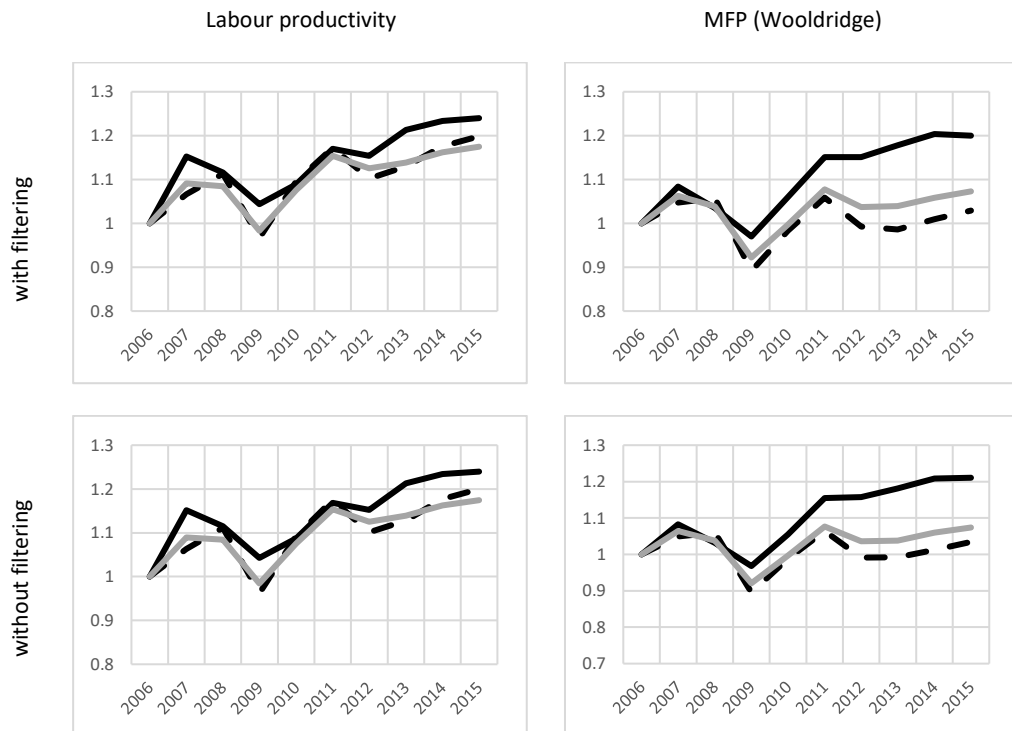
When considering the tails of the distribution, as is the case when analyzing frontier firms and laggards, outlier filtering becomes rather tricky. On the one hand, one does not want the results to be contaminated by any measurement errors or incidental jumps. On the other hand, the interest is specifically in firms that perform exceptionally well (or bad), so one does not want to discard those observations beforehand.

Figure 4 shows the MultiProd results for the full NFO sample with and without the outlier filtering implemented in the program. The outlier filtering concerns the productivity variables, but also the underlying variables, in levels and growth. The metrics considered in this report are in fact already quite robust to outliers, as they concern percentile values, and not sums or averages, which are typically more sensitive. In line with this, it can indeed be observed that switching off the outlier filtering does not have a major impact on the results, with most of the patterns being nearly identical.

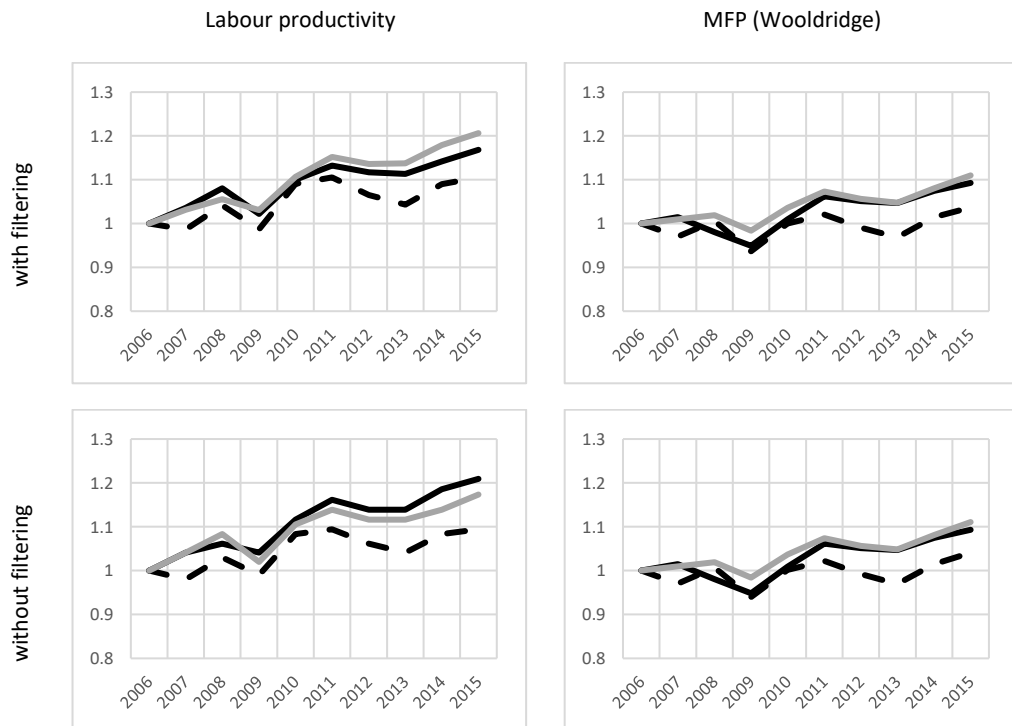
Therefore, abstaining from any filtering of outliers, does not seem to introduce any additional widening in the NFO results.

Figure 4. Productivity of frontier and following firms based on NFO (2006 = 1), with and without outlier filtering.

(a) Manufacturing



(b) Services





## 4. Comparison of productivity differentials to other studies

In this section, the Dutch NFO-based MultiProd results are compared to those from other studies, in particular to those from the CPB study and the MultiProd results from other countries. Moreover, a comparison is made to the global frontier and followers as presented in Andrews et al (2016).

Table 5. Degree of widening across different studies (2006-2012).

		Labour productivity			MFP		
		CBS	CPB	Multi-Prod	CBS	CPB	Multi-Prod
manufacturing	top-bottom	5%	-	3%	15%	-	6% (3%)
	top-median	3%	3%	2%	11%	5%	3%
services	top-bottom	5%	-	5%	6%	-	8% (4%)
	top-median	-2%	0%	2%	0%	4%	3%

Table notes: MultiProd figures concern averages across 14 countries (in brackets the average for 8 countries reported in figure 6; only for top-bottom gap in MFP). CBS figures based on NFO. Top and bottom are the top and bottom deciles. CPB figures refer to 95<sup>th</sup> and 45<sup>th</sup> percentile instead of the 90<sup>th</sup> percentile and the median.

### 4.1 Consolidated comparison of productivity widening in different studies

Table 5 presents an overall comparison of the degree of widening found in different studies discussed above. The studies in table 5 all concern widening *within* countries, that is between the national frontier and national laggards or followers. Moreover, to increase the comparability, only the overlapping time period of 2006-2012 is considered.<sup>17</sup> Further note that the MultiProd results shown here concern averages across countries, so that results of countries with a stronger degree of widening are averaged with those from countries where the widening is more moderate, absent, or where there is even some convergence. Using table 5 we comment on the relative widening in the different studies, but not on whether there is widening in an absolute sense.

In manufacturing, this comparison suggests that widening in labour productivity between the top and median is between 1% and 3%. For the top and bottom decile, however, the NFO-based CBS results, suggest that the widening is stronger, and that this widening is also stronger than on average in the MultiProd country sample. The increase in the top-median gap for MFP is also stronger in the Dutch results, in both the CPB and CBS studies, although the widening suggested by the latter is still much stronger. The increase in the top-bottom MFP gap in manufacturing is also much stronger in the CBS results, compared to those on average in MultiProd.

<sup>17</sup> In the CPB results the TFP levels are averaged over two consecutive years, to determine the frontier and followers. In the CPB reports the resulting average TFP level is then assigned to the second year, and hence the results start in 2007. For our calculations here we have assigned it to the first year instead, thereby allowing the period to start 2006, as in the MultiProd and CBS results.

In services, there is a slight narrowing in terms of labour productivity regarding the top and median in the Netherlands in both CBS and CPB results, as opposed to a slight widening on average in other countries in MultiProd. Regarding the gap between the top and bottom decile, the CBS results are in line with the average from other countries, both for labour productivity and MFP. The top-median gap for MFP in services does not seem to increase much in both the CBS and MultiProd results, although there is slightly more widening in the CPB results.

Overall, the new CBS results based on the MultiProd approach suggest a stronger widening in manufacturing than existing evidence for the Netherlands presented by CPB, and on average in other countries from MultiProd. For services, the growth of the top-bottom gap is in line with the MultiProd average, and there is less (or comparable) widening between top and median than suggested by the other studies.

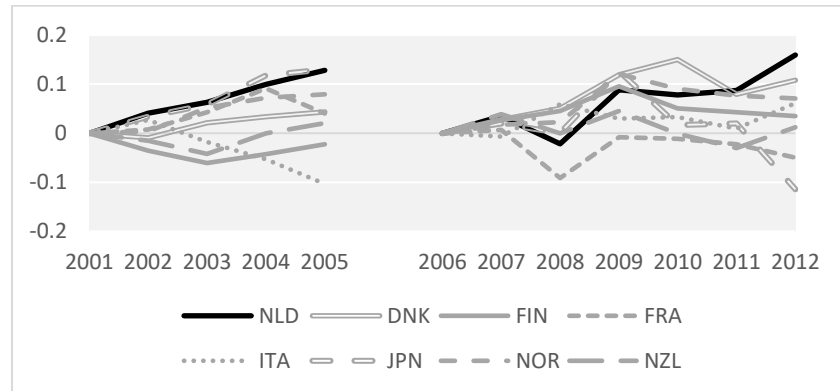
## **4.2 The Berlingieri et al. (2017) study with MultiProd results from selected countries**

Berlingieri et al. (2017) show (preliminary) results from MultiProd for selected countries, reproduced in Figure 5, regarding the development of the top-bottom MFP gap over time. The upshot of these figures is that the degree of the widening of the productivity distribution differs across countries. Another takeaway is that the Dutch results fit well into this picture. In manufacturing, the Dutch results over the whole period show a degree of widening that is slightly stronger than in all of the other countries. In services, the growth of the gap is relatively large, and amounts to 6% in 2012.

Further, the Berlingieri et al. study shows that a large part of the observed widening can be attributed to the growing gap between the median and the bottom decile. In the Dutch NFO data this pattern is confirmed in services, but not in manufacturing (see figure 1a and 1b). However, the exact numbers are hard to compare, because country-level volatility is averaged out in the OECD results.

Figure 5. Dutch MultiProd results vis-à-vis other countries (top-bottom MFP gap; 2001/2006 = 1).

(a) Manufacturing, NFO



(b) Services, NFO

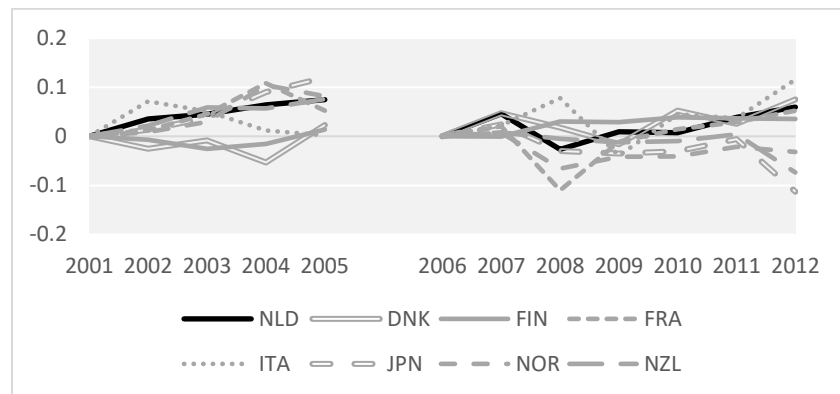


Figure note: The period 2001-2005 concern tentative figures, based on a lower quality labour input measure. The top-bottom MFP gap refers to the difference between the level of MFP between the 90<sup>th</sup> and 10<sup>th</sup> percentile.

### 4.3 Comparison to productivity differentials reported by CPB

In their study, CPB concludes that there is no divergence between frontier and following firms in the Netherlands, based on calculations on NFO data. The median productivity of the followers is compared to the median of the frontier firms. It is concluded that the pattern for both labour productivity and MFP is quite flat.

To compare to the Dutch MultiProd results, we note that the median frontier firm is the median of the top 10%, thus the 95<sup>th</sup> percentile. The median of the followers is the median of the bottom 90%, thus the 45<sup>th</sup> percentile. Lacking information on the 45<sup>th</sup> percentile in the MultiProd output, we use the median and the 90<sup>th</sup> percentile from the Dutch MultiProd results for comparison. Moreover, CPB averages the TFP levels, and thereby the value of the frontier and followers, across two consecutive years. We reassign the productivity levels to the first year, i.e. the TFP level for 2006 is based on the 2006 and 2007 levels.

The labour productivity pattern for both manufacturing and services, is roughly similar to the overall pattern found by CPB, as can be seen in figure 6. Although the pattern over time is a bit different for both sets of results, especially in the beginning of the period, both sets of results line up nicely towards the more recent years. Both sets of results suggest more widening for manufacturing, where for services there is even slight convergence between the top and the median.

For MFP, it can be seen that both sets of results show an increasing gap in manufacturing, stronger than for labour productivity, and more pronounced in the CBS results. For services, the widening is quite moderate in both sets of results. To be sure, this comparison only concerns the relative widening for the top-median gap. As shown for instance in table 5, the CBS results show stronger widening in the top-bottom gap, but this cannot be compared to the CPB results.

In sum, regarding the top-to-median productivity gap, which is the metric used in the CPB reports, the results based on NFO coming from the Dutch MultiProd calculations for this report are quite comparable with the results reported by CPB, although the results for manufacturing show a stronger widening for MFP in the CBS results

Figure 6. Dutch MultiProd results vis-à-vis results in CPB reports.

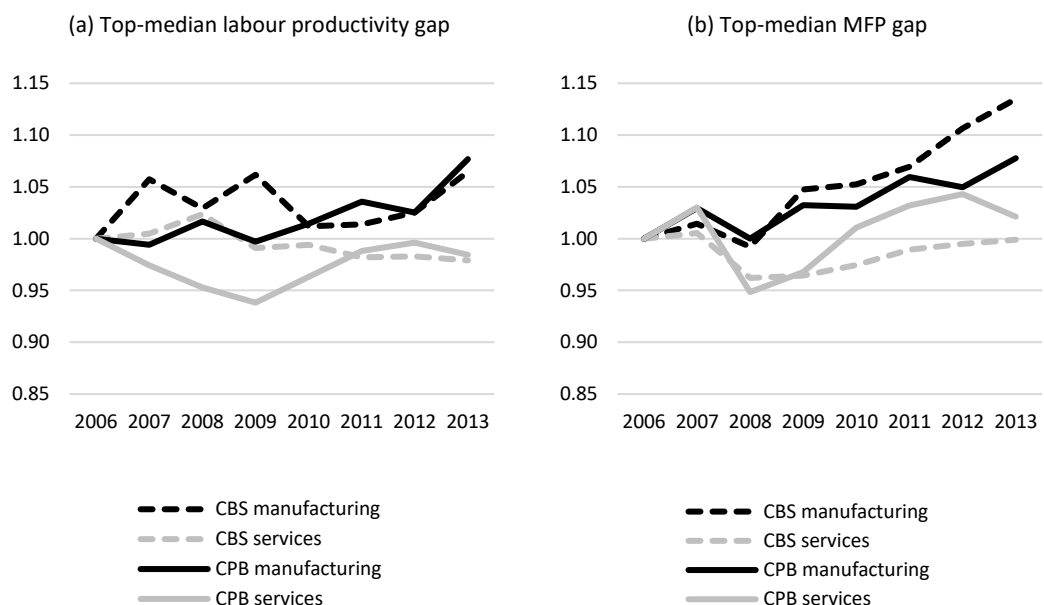


Figure note: 2014 has been discarded as the relevant CPB results by sector were based on the average of 2014 and preliminary 2015 data. The labour productivity results have been produced by CPB on request, as the published results did not include a breakdown by industry.

#### 4.4 The Andrews et al. (2016) study based on ORBIS

One of the first studies putting forward the hypothesis of a growing productivity gap is the Andrews et al. (2016) study, which uses cross-country firm-level data available from ORBIS. This study documents the development of the average productivity at the *global* frontier (top 5%) vis-à-vis that of the *global* followers (all other firms). Figure 7 reproduces the results for manufacturing and services regarding the labour productivity of the top decile versus the bottom decile. For the purpose of comparison, the development of the Dutch 90<sup>th</sup> percentile

(frontier) and median (followers) are plotted as well, although any pattern of widening can be expected to be stronger in the global data,<sup>18</sup> and using averages rather than percentiles. In addition, the results for the 2001-2005 period are plotted separately. Due to a major redesign of the Dutch business register, results for the two sub-periods cannot be compared, which precludes the combination of both to a single longer time series.

Figure 7. Dutch MultiProd results vis-à-vis OECD-ORBIS results (labour productivity, 2001/2006 = 1)

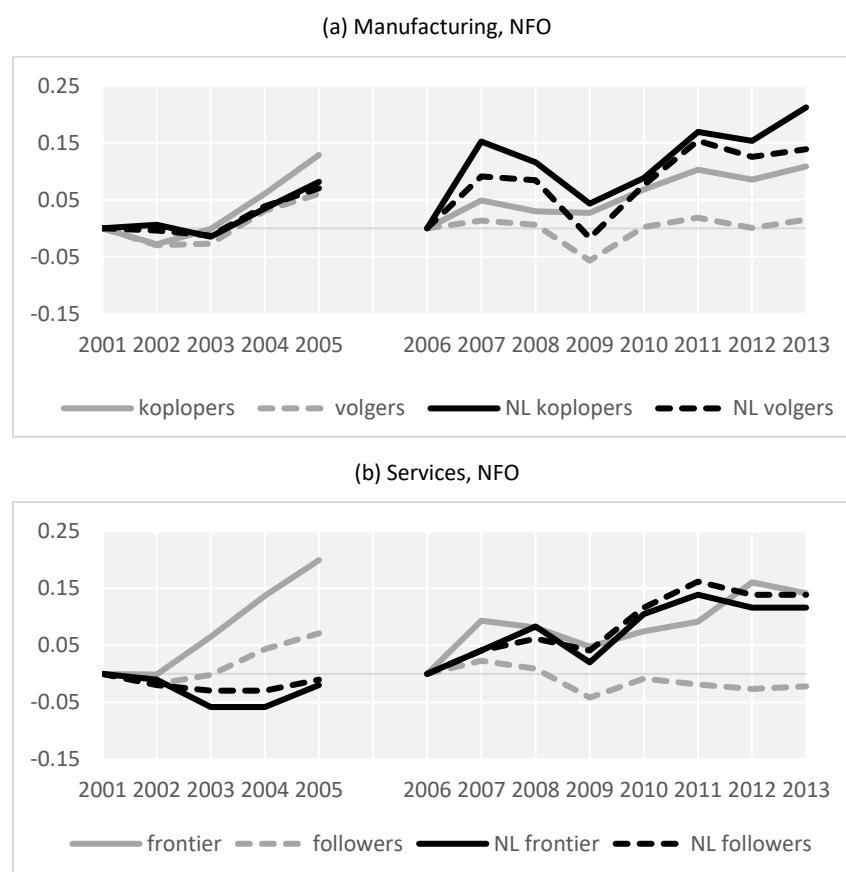


Figure note: The period 2001-2005 concern tentative figures, based on a lower quality labour input measure.

Growth at the Dutch frontier in manufacturing has been larger than at the global frontier, at least in the period from 2006 onwards. In that period, the bottom decile in manufacturing also showed a higher growth than globally. Overall, the national pattern is more volatile, with a deeper impact of the crisis, and a sharper recovery. In addition, the better growth performance largely depends on a jump in 2007. For the 2001-2005 period, the NFO suggests lower growth at the national frontier, where growth off the national frontier was comparable to that of the global followers.

<sup>18</sup> Intuitively, one can think of global widening as comparing frontier firms in technologically advanced economies to followers in the least technological advanced countries. Though not necessarily the case, one can expect the growth of the national frontier to be below the growth of the global frontier, and the growth of national followers to be at least as high as the global followers.

In services, the growth at the national frontier, tends to be roughly similar to that found for their global counterparts for 2006 and further, whereas the productivity of the Dutch followers experienced an even stronger growth. In the 2001-2005 period, however, the Dutch service sector labour productivity in both parts of the distribution showed much lower growth than globally.

In terms of widening, as stated above, the results can be expected to be stronger in the global data. This is indeed what can be seen in figure 7. Moreover, there is some widening in Dutch manufacturing, but the pattern over time is quite volatile, while the global pattern is one of a steady widening across the whole sample period. In services, the NFO data does not suggest any widening in labour productivity between the top and the median, which is in contrast to the global data. However, one should keep in mind that the widening between the top and the bottom is stronger, see figure 1b.

Before summing up, the reader is reminded that in this section the focus is on the gap between the top and the median labour productivity only. Conclusions do not necessarily carry over to MFP and/or the top-bottom gap. That being said, overall, in Dutch manufacturing both parts of the labour productivity distribution seems to have developed in a similar way, or better, as globally in recent years. As expected, the national widening is smaller than globally in this sector. In services, on the other hand, the global firms have seen a considerably higher productivity growth in the early years of the century, compared to both the national frontier and followers. For the Dutch frontier, this is not completely compensated by a higher growth in the second part of the period, whereas Dutch followers did manage to overcome their lower performance in more recent years. They even managed to slightly narrow the distance to the national frontier, while at the same time there is clear widening in a global sense.

## 5. Summary of findings and possible follow-ups

The goal of this note was to compare patterns of productivity obtained from the OECD MultiProd program, using different datasets, being the PS, NFO, and the NFO restricted to firms with more than 10 employees. In particular, we have looked at the degree of widening of the productivity distribution over time. In addition, the results obtained were compared to those for other countries by OECD, as well as to those obtained by CPB for the Netherlands.

### 5.1 General remarks

Apart from the empirical results, the very first thing to take away from this note is that the notion of divergence or widening in productivity can be looked at in various ways, and that the outcomes could depend crucially on the perspective taken.

Firstly, one can look at this issue from a national perspective only, or take into account the international dimension as well. That is, one can look at the global frontier and compare to other firms globally (Andrews et al. 2016), or compare the global frontier to national firms (Bartelsman et al. 2008; Van Der Wiel et al. 2008), or compare the national frontier to other national firms (e.g. CPB, 2018a,b).

Secondly, productivity can be defined in terms of labour productivity or MFP, where in addition both can be calculated or estimated in various ways. Conclusions about productivity change can be different for both concepts, depending on firm-level capital investment and consequent changes in firm-level capital intensity.

Thirdly, widening can be defined in terms of the distance of the frontier to the average or median non-frontier firm, or the distance between the frontier firms and the bottom of the productivity distribution. If different parts of the productivity distribution develop in different ways, the choice of metric matters for conclusions about widening, as for example illustrated by the results in Berlingieri et al. (2017).

Finally, studies can differ in terms of coverage, in terms of industries and firm size, but also the time period considered.

In sum, one must be (very) careful in comparing the results from one study to another. In fact, it seems that a large part of the (apparent) differences between the CPB research for the Netherlands, and that of the OECD based on ORBIS and MultiProd can be attributed to such issues.

### 5.2 Main findings

The main findings of the current study can be summarized as follows. In the NFO data (used also by CPB) we find:

- For **manufacturing**, the widening between 2006-2015 is found to be 4.1 percentage point for labour productivity with respect to the top-bottom gap, and 6.5 for the top-

median gap (the growth of the gaps is in most cases due to more recent years). For MFP we find more substantial growth of the gaps of 17.1 (top-bottom) and 12.7 percentage point (top-median). When looking at comparable periods of time (2006-2012), the gaps are relatively large compared to the results for other countries documented in MultiProd, and also slightly larger than those obtained CPB.

- For **non-financial services**, the widening between 2006-2015 is 7.9 percentage point for labour productivity with respect to the top-bottom gap, while we find a narrowing of the top-median gap with -3.6 percentage point. Similarly, we find for MFP that the growth of the top-bottom gap amounts to 5.2 percentage point, whereas there is some narrowing between top and median of -1.8 percentage point. When looking at comparable periods of time (2006-2012), the growth of top-bottom gaps are comparable to the results for other countries documented in MultiProd, whereas the growth of the top-median gaps is smaller than the international average. The narrowing of the top-median gap for labour productivity is also found by CPB, but not for MFP.

The NFO results are roughly confirmed by those from the PS for the services sector, although the results provide an indication that the PS could suffer from low coverage in certain parts of the population. The latter issue makes the PS results vulnerable to the use of sample weighting. For manufacturing, the results are not confirmed in the PS, where there is widening in labour productivity, but not in MFP. There is no clear indication that the differences between PS and NFO results can be explained by differences in coverage of small firms. Nor do the differences seem to be associated with outlier filtering. More research is needed to explore where and whether the PS can be used in combination with sample weighting, and what could be other factors explaining the differences (such as conceptual and measurement issues).

Overall, the NFO based results fit well into the picture from those of other countries in the MultiProd project. In manufacturing, the Dutch results show a degree of widening that is slightly stronger than in all of the other countries. Also in services, the growth of the gap is relatively large in the Netherlands, although this is mainly due to the more recent years of the comparison period (2001-2012).

Further, the Berlingieri et al. study shows that a large part of the observed widening can be attributed to the growing gap between the median and the bottom decile. In the Dutch NFO data this pattern is confirmed in services, but not in manufacturing. Regarding the top-to-median productivity gap, which is the metric used in the CPB reports, the NFO based results in this report are well in line with the results reported by CPB for the relevant comparison period (2007-2015).

Finally, comparing the Dutch firms internationally, it was found that in manufacturing both frontier firms and followers seem to have developed in a similar way, or better, as their global counterparts in recent years. The national widening is smaller than globally in this sector. In services, on the other hand, the global firms have seen a considerably higher productivity growth in the early years of the century than both the Dutch frontier and followers. For the national frontier, this is not completely compensated by a higher growth in the second part of the period, whereas Dutch followers did manage to overcome their lower performance in more recent years. While there is clear widening in a global sense, in the Netherlands the top-to-median gap slightly narrowed (bearing in mind however the finding of widening of the top-to-bottom gap in Dutch services).



### 5.3 Suggestions for follow-ups

Suggestions for future research include:

- to look at the MultiProd output at a more detailed industry level (38 industries), aggregating to macro-sector level (i.e. manufacturing and services) using employment or output weights. This could help to understand better the heterogeneity between industries, and possibly illuminate further where sample weighting in the PS appears to be problematic
- in addition, it may prove to be worthwhile to investigate the sensitivity of the results to the definition of frontier firms. CPB defines a frontier firm based on its productivity in two consecutive years. This could have an impact on the comparison to the followers, although it is not clear a priori in which direction.
- in line with the previous point, one could think about broadening the typification of firms to take into account the dynamics and the transitions in the productivity distribution. For instance, one could distinguish firms which are usually highly productive, from those that are usually low productive, from those that move between categories, and firms that are in and out of the distribution due to entry and exit
- next steps could also include documenting the characteristics of firms in different parts of the distribution, for example in terms of economic activity, size, and firm age
- to improve the calculation of productivity in the NFO for small firms, it is worthwhile to investigate the use of information for hours worked, as was done in the CPB study
- to facilitate the discussion about widening, it is helpful to develop standard criteria to judge whether there is significant widening (e.g. a minimum average degree of widening by year, combined with a test of a significant trend)
- a final tempting avenue for further research could be the combination of NFO and PS data into a single dataset. Given the conceptual differences between the variables in both sources, however, such a task would not be straightforward.

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