Deindustrialization

SUMMARY

Manufacturing in high-income countries is on the decline and Denmark is no exception. Manufacturing employment and the number of firms have been shrinking as a share of the total and in absolute levels. This paper uses a rich linked employer-employee dataset to examine this decline from 1994 to 2007. We propose a different approach to analyze deindustrialization and generate a series of novel stylized facts about the evolution. While most of the decline can be attributed to firm exit and reduced employment at surviving manufacturers, we document that a non-negligible portion is due to firms switching industries, from manufacturing to services. We focus on this last group of firms before, during, and after their sector switch. Overall this is a group of small, highly productive, import intensive firms that grow rapidly in terms of value-added and sales after they switch. By 2007, employment at these former manufacturers equals 8.7 percent of manufacturing employment, accounting for half the decline in manufacturing employment. We focus on the composition of the workforce as firms make their transition. In addition, we identify two types of switchers: one group resembles traditional wholesalers and another group that retains and expands their R&D and technical capabilities. Our findings emphasize that the focus on employment at manufacturing firms overstates the loss in manufacturing-related capabilities that are actually retained in many firms that switch industries.

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Rethinking deindustrialization

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1. INTRODUCTION

Manufacturing in high-income countries is on the decline and Denmark is no exception. Manufacturing employment peaked at well over half a million workers in 1986 and fell by over 40% over the next twenty six years, see Figure 1.[1] Similarly the number of manufacturing firms dropped in every year from 1988 to 2012 and the share of manufacturing in value-added fell from 18% to 11% from 1980 to 2012 (Statistics Denmark, 2012).[2] This trend has been a major concern for policymakers and has

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The Managing Editor in charge of this paper was Thorsten Beck.

1 These numbers reflect employment at manufacturing firms as defined in Section 2.

2 Manufacturing employment as a share of total employment fell from over 20% to 15% from 1993 to 2007.

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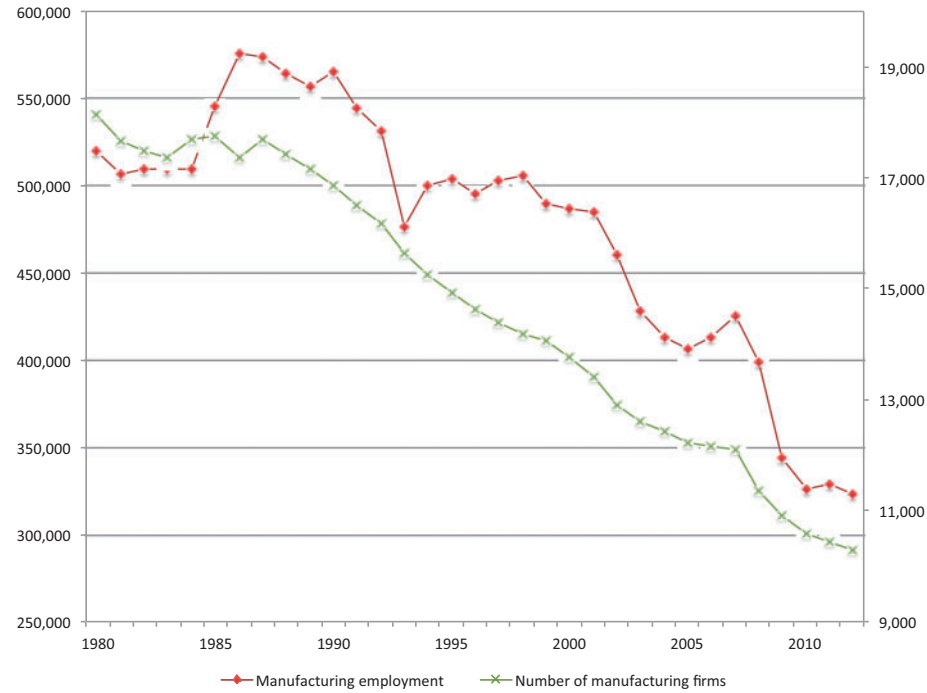

Figure 1. **Manufacturing firms and workers over time.**

Source: Statistics Denmark and authors' own calculations.

contributed to increasing fear of globalization in public opinion as the decline has coincided with increased offshoring by manufacturing firms and with the rise of China, India, and Eastern Europe in the global economy.

Deindustrialization is the subject of an enormous body of work offering explanations from differential productivity changes across sectors to comparative advantage and the emergence of China. Policymakers devote enormous energy to developing proposals to stem or reverse this fall in manufacturing jobs. In particular, there are worries about the consequences for individual employment and well-being of laid-off manufacturing workers as well as the prospects for continued long-term productivity growth. In the case of the workers, manufacturing is perceived to offer relatively high wages to workers with lower or middle levels of education. In terms of growth, industrial sectors have long been among those with the highest growth rates of productivity. Deindustrialization is viewed as a threat both to the current standard of living as well as to future income levels. These concerns are at the heart of this paper and our attempt to rethink the process of deindustrialization.

In this paper, we ask two questions: are we measuring deindustrialization properly and what are the implications for understanding the future path of an advanced economy? We try to rethink deindustrialization by focusing less on the manufacturing label assigned to the firm and focusing more on the set of activities that are associated with manufacturing. To be engaged in the production of a good involves a wide range of tasks from design and engineering to finance and accounting to marketing and

distribution in addition to the specific act of production or assembly. Firms that are considered to be manufacturers are likely performing most, if not all, of the tasks, but in particular they must be involved in the production process. Firms outside of manufacturing may, in fact, be doing every task associated with the creation and delivery of the product except the production process itself. We ask whether part of the loss of manufacturing is in fact due to the changing nature of firms and production and look at firms that remain in the manufacturing sector and, especially, those that switch out of manufacturing.

The basic premise of our analysis is quite simple. We ask whether firms that are leaving manufacturing for another industry are still performing many of the basic activities or tasks associated with manufacturing. Have they lost the capability to innovate and add value or is the only change at these switching firms the lack of production activity? Our findings emphasize that the focus on employment at manufacturing firms overstates the loss in manufacturing-related capabilities that are actually retained in many firms that switch industries.

We divide our analysis into five parts. First, we consider the aggregate implications if these firms are reclassified as manufacturing. Second, we ask which firms are most likely to switch out of manufacturing and how they performed in the years leading up to their switch. Third, we examine their post-switch performance including the evolution of their employment levels and composition, their productivity and output and their engagement in international markets. We try to distinguish between different types of switchers: those that have transformed themselves into traditional wholesalers, and those that have kept most of their manufacturing capabilities. Finally, we track the employment and wage outcomes of workers at switching and exiting firms.

Switchers are small yet productive in the year they leave manufacturing and their post-switch performance is very strong. As a result, by the end of our sample in 2007, these former manufacturers are a sizable presence in the Danish economy. Employment at firms that have switched out of manufacturing equals 8.7% of total manufacturing employment, sales of switchers are 14.3% of those at continuing manufacturing firms, and switchers have higher value-added to sales ratios. Furthermore, we can clearly identify two types of firms among our switchers: on the one hand, there are firms that have stopped any involvement in manufacturing and are conducting the traditional activities of wholesalers. On the other hand, there is a group of firms that are still involved in some manufacturing activities, mostly focused on the design and distribution, but not in production. These firms have also upgraded their workforce and employ a larger proportion of high-tech workers. In sum, many of these switching firms are no longer counted as manufacturers, but they retain many of the characteristics of producers, minus the production itself.

Compared to switchers, firms that have maintained their activities within the manufacturing industry have also evolved quite substantially, although not as dramatically as switchers. The share of workers involved in high-tech activities has grown from 9.2% in 1994 to around 13% in 2007. Manufacturing in Denmark has definitely become more high tech as deindustrialization has proceeded. The share of sales workers

has also risen, suggesting that this type of activity has also received more weight relative to traditional production tasks.

We look at the factors determining the switch, comparing the switchers, firms exiting (exiters) and firms continuing their activities in manufacturing (stayers). We find that switchers are on average more productive and smaller, have a more skilled workforce and are more import intensive than both exiters and stayers. After the switch, they become even more productive, skill intensive and import oriented.

Moving beyond the firm, we also consider the consequences for individual workers at firms that switch out of manufacturing and those exiting entirely. While switching firms seem to thrive, it is possible that workers who lose their jobs around the switch fair poorly. We compare the wage trajectory of individuals losing their job in switchers compared to those losing their job as a consequence of firm exit. Individuals losing their jobs at switchers experience negative labour market outcomes in the first year after separation, both a higher probability of unemployment and a larger wage loss. However, these negative effects dissipate quickly, and five years after losing their jobs, their labour market status is better than workers at ex-ante comparable firms that remain in manufacturing. This suggests that, in the Danish context, workers were not too badly hurt by the change in the economic environment, as individuals reallocated relatively smoothly to new sectors of activity.

We think of our empirical findings in terms of a conceptual framework based on Antràs and Helpman (2004) and Antràs and Chor (2013) to interpret our results. In this framework, firms differ in three attributes: design capability, production capability and distribution/marketing capability. Until relatively recently, firms operated with strong complementarities between these three functions. When these three business functions can be unbundled, due to new outsourcing opportunities and the ICT revolution, firms decide which activities they should maintain within their boundaries and which ones they should outsource depending on their capabilities. In this framework switchers have strong capabilities in design and post-production activities, but not necessarily in production. The option to outsource the production process is therefore a way to focus on their core capabilities.

The decline in manufacturing employment in the industrialized world is not a new phenomenon and there are a raft of potential explanations ranging from productivity to globalization.[3] Perhaps the most common is an argument based on the 'relative productivity hypothesis'. Rowthorn and Ramaswamy (1999) argue that deindustrialization is explained by developments that are internal to an advanced economy stimulated primarily by faster growth in manufacturing productivity which, in turn, leads to relative price changes and shifts in the structure of the economy.[4] An alternate hypothesis is that

3 Rodrik (2016) documents that deindustrialization is occurring at earlier levels of development for some countries especially in Latin America.

4 See also Nickell *et al.* (2008), Buera and Kaboski (2009) and Matsuyama (2009) for additional contributions.

the manufacturing employment decline is primarily due to globalization and the rise of manufacturing in developing economies. Several recent contributions relate the decline of manufacturing employment to episodes of globalization and in particular the rise of China in the global economy. Pierce and Schott (2016) document the 'swift decline' of US manufacturing after China's entry into WTO and link the decline to changes in US trade policy that eliminated the threat of tariff hikes. Autor *et al.* (2013, 2014) argue that the rise of imports from China explains both the decline in manufacturing employment in the United States as well as poor subsequent outcomes for individual workers and local communities. Our paper does not focus on the potential explanations of deindustrialization but rather emphasizes a new aspect of the transition related to the changing activities at firms that used to be considered manufacturers.

Our work is closely linked to a recent set of papers that focus on the evolution of the producing firm. Bernard and Fort (2015) examine the characteristics and prevalence of Factoryless Goods Producing firms (FGPFs) in the United States. FGPFs are firms in the wholesale sector that perform activities related to the production of goods, both the design, R&D and engineering processes before production and the branding and distribution to customers after production.[5] We document the prevalence of the switch from manufacturing to services and the evolution of firm performance and workforce composition during the transition. We also discuss the evolution of the workforce in firms that remain in manufacturing and how it contrasts with that of switchers and service firms. Our research provides systematic evidence about the way firms reorganize when they transition from manufacturing to services and how it affects their performance.

Our work is also related to a new literature that emphasizes job polarization and shrinking employment for occupations in the middle of the skill distribution.[6] We find that firms switching out of manufacturing can be divided into two types, those that retain most of their manufacturing-related activities such as design, engineering and branding, and those that are more similar to traditional wholesalers making connections between customers and producers. The two types of firms have very different occupational structures with workers at the high and low end of the education distributions respectively. We contribute to a large body of research that follows workers following job displacement and massive layoffs due to firm exit.[7] In contrast with this previous literature, we evaluate how the labour market outcome of individuals losing their job at switchers differs from those losing their jobs at exiters.

The rest of the paper is organized as follows. Section 2 describes the various datasets we combine for our analysis. Section 3 documents the aggregate evolution of the Danish

5 Fort (forthcoming) looks inside the outsourcing decision and analyses how technology affects firms' decisions to purchase contract manufacturing services. Crozet and Millet (forthcoming) show that French firms in manufacturing industries have an increasing share of their revenues coming from services activities and also find an inverted U-shape relationship between 'servitization' and firm's performance.

6 See Goos and Manning (2007), Autor *et al.* (2003), Falvey *et al.* (2010) and Goos *et al.* (2014).

7 See Jacobson *et al.* (1993), Anderson and Meyer (1994) and Davis and von Wachter (2011).

manufacturing sector and the prevalence of switchers. Section 4 discusses the importance of switching firms and their performance relative to continuing manufacturers and firms that shut down operations entirely. Section 5 examines different types of switching firms and their post-switch outcomes. In section 6, we analyse the consequences for workers separated from switchers and exiting firms. Section 7 concludes.

2. DATA

Our main dataset is the Integreret Database for Arbejdsmarkedsforskning (IDA) longitudinal database that provides detailed information about the population of Danish individuals aged between 15 years and 74 years over the period 1980–2013.[8] For every year, it provides a snapshot of Danish individuals in November of each year. The dataset contains information on gender, age, tenure, wages (average hourly wage and wage in Danish kroner (DKK) in November of the year), socioeconomic status, occupation and education level (the highest diploma obtained by the individual).[9]

Workers are linked to the plant, and thus the firm, where they are employed. The dataset also provides a detailed code for the economic activity of the plant.[10] Using this information, we are able to identify firms that have at least one establishment classified in a manufacturing industry, those with no manufacturing establishments, and those firms that switch from manufacturing to non-manufacturing.[11]

The occupational code is the Danish version of the international standard classification of occupations (ISCO) defined by the International Labor Organization. In IDA, every worker is allocated an occupational code when working in a firm. Occupation is very rarely missing but can be 'misclassified'.[12] On average 12% of workers in manufacturing are misclassified, while in non-manufacturing industries, the share of misclassified is 20%. The socioeconomic status variable is broader, identifying individuals not employed in firms, such as individuals in unemployment, early retirement, retirement, education or out of the labour force.

8 The Danish data has been used extensively in labour economics since the 1980s. For a description, see Eriksson and Westergaard-Nielsen (2009).

9 One issue is that individuals can have multiple jobs. When this is the case, we only consider the main activity. Our detailed occupation variable (ISCO) is only available since 1991.

10 Statistics Denmark classifies economic entities (plants and firms) in an industry according to the main activity. The main activity is the one that makes the largest contribution to value added. In practice, when it is not possible to determine the value added of the various activities the industry allocation can be based on other input-based indicators such as cost of employment or number of employees. It can also be based on output, such as production of goods and services, or sales of the product of the various activities.

11 We refer to non-manufacturing industries and service industries interchangeably throughout this paper as the large majority of switches are to service industries.

12 This means that information about the type of job performed by workers is unavailable. This is often the case for newly hired workers.

We use the detailed information about workers to aggregate to the level of the firm in order to compute several variables that reflect the skills embedded in its workforce. We first define the number and share of workers for five different occupational categories: managers; tech workers (R&D workers and technicians), support activities, sales activities and line workers. We further decompose line workers into two separate categories: those involved in transport and warehousing (line 1) and the others, mostly involved in the production process (line 2).[13] Similarly, we define the share of white-collar workers, blue-collar workers, college educated workers and other education categories. In our analysis, we devote particular attention to the tech workers as this is the best available proxy for high-skilled knowledge workers. We also use the socioeconomic status and occupational code to follow individuals after they lose their jobs, in order to observe how individuals reallocate in terms of occupation, industry together with their individual wage dynamics.

One difficulty is related to the several changes in the Danish industrial classification implemented in 1993, 2003 and 2007. The first and third reclassifications were substantial, moving from DB77 to DB93 (the Danish equivalents of the European classification NACE CLIO and NACE Rev. 1) and DB03 to DB07 (the equivalents of NACE Rev 1.1 and NACE Rev 2). The second change was less important and did not involve large modifications. Statistics Denmark made substantial efforts during these periods of industrial reclassification to properly assign plants and firms to their main industries using both the new and old activity codes. Nevertheless, because we want to focus on real switching behaviour coming from a decision of the firm, and not on a statistical reclassification, we concentrate our analysis on the period 1993–2007. All our results are robust when we extend the period of analysis to the entire period (1980–2013).

We define five categories of firms: firms continuing in manufacturing between t and $t + 1$ (continuers or stayers); firms exiting (observed in our dataset in t but no longer in $t + 1$), switchers out of manufacturing (observed in manufacturing in t and out of manufacturing in $t + 1$), switchers into manufacturing (observed out of manufacturing in t and in manufacturing in $t + 1$) and new entrants (firms not observed in t but observed in $t + 1$). We also perform some cleaning to get rid of firms that switch from one category to another several times in order to keep a consistent definition. Importantly for our analysis, we define a firm as being involved in manufacturing if at least one of its establishments is classified in manufacturing and at least 5% of the firm workforce is employed in manufacturing plants. This contrasts with official statistics that define a manufacturing firm as a firm having the highest proportion of its sales or workforce in manufacturing.[14]

Our central dataset does not contain any information about accounting variables such as sales or value added, or about imports and exports. Therefore, we merge the

13 See Table A1 in the Supplementary Online Appendix for the definition of these groups based on the ISCO code.

14 Redoing the analysis with a 10% or 25% cutoff does not change the results in any material manner. Results are available from the authors on request.

IDA dataset with two other datasets: the VAT statistics dataset and the Foreign Trade dataset. We use this information to define simple measures of productivity (sales per worker and value added per worker) and trade orientation (export and import status, export share and import intensity).[15]

3. THE AGGREGATE EVOLUTION OF DANISH MANUFACTURING

The evolution of the Danish manufacturing sector over the last several decades is similar to the well-known path in other developed countries. The number of manufacturing firms peaks in the mid-1980s and continues to fall up to the present. The drop in manufacturing employment begins a few years later and proceeds gradually until the end of the 1990s when it accelerates noticeably. In contrast to manufacturing, both the number of firms and employment share in services and the public sector have risen steadily.

While the decline in manufacturing starts early and continues to the present, to avoid problems with the changes in the classification systems mentioned earlier, we focus for the remainder of the paper on the period from 1993 to 2007. In addition, for consistency, we tabulate up from the underlying establishment and firm data to create our own set of aggregates. Our measure of employment at manufacturing firms is consistently higher than the official statistics but the annual changes in the two series are highly correlated. From 1993 to 2007, the overall decrease in employment at firms in manufacturing is 66,434 (15%) in the official statistics and 51,365 (11%) in our tabulations.

The picture is somewhat different when we focus on value-added and productivity. While the manufacturing sector has had falling employment, both output and value-added remain roughly constant and even grow slightly. A simple measure of labour productivity, real value-added per worker, shows that average productivity growth in manufacturing has been higher than that in services throughout the sample period, see Figure 2.

3.1. Churning

The secular decline in firm numbers and employment in manufacturing has been accompanied by a large amount of churning in the sector throughout the period. Entry (firm birth) and exit (firm shutdown) are common. In any given year, 8–10% of current manufacturers shut down and a smaller number start operations. Net exit is significant in almost every year and, on average, reduces the number of manufacturing firms by 1.4% annually. These entry and exit rates are comparable to those for other advanced economies. A study by the OECD (2004) reports churning rates in manufacturing across the European countries ranging from a low of just under 12% in Germany to highs well

15 All nominal values are deflated using the consumer price index.

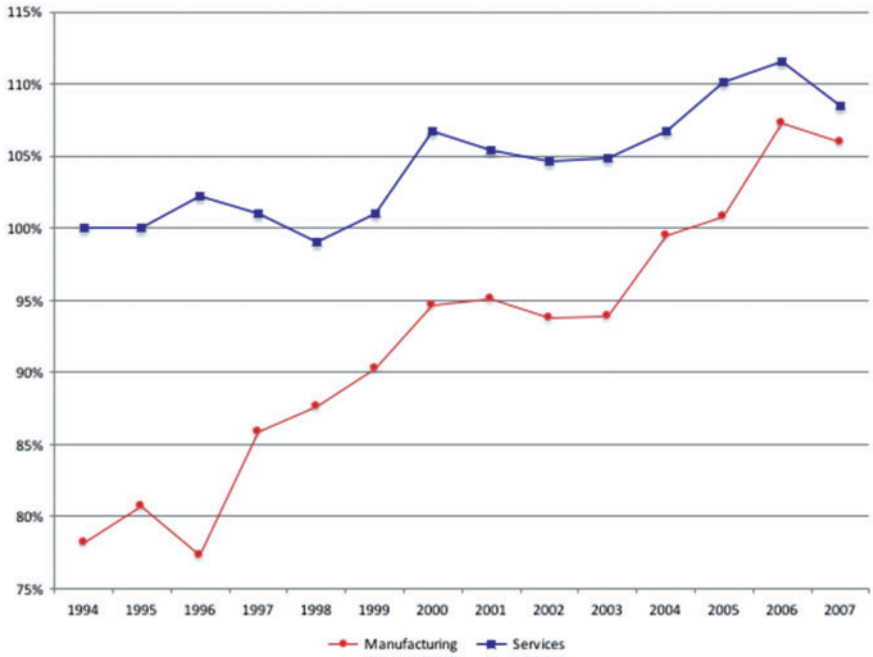

Figure 2. Labour productivity.

Notes: Labour productivity is given by value-added per worker with services productivity equal to 100 in 1994. The lines represent sector averages. Value-added is deflated by the CPI.

Source: Statistics Denmark and authors' own calculations.

above 20% in the United Kingdom and France.[16] Denmark's churning rate in manufacturing of 18% lies in the middle of the range and is similar to that of the United States. Decker *et al.* (2014) report firm entry and exit rates around 10% for all sectors combined in the United States in recent years. This churning results in a substantial turnover of active firms. In our data, of the 32,000+ distinct firms that are recorded as manufacturers at some point from 1993 to 2007, only 12,117 are active in the sector in 2007.

Manufacturing firms can leave the sector in one of two ways, through exit or by switching into a non-manufacturing sector. A firm is defined as 'switching out' of manufacturing when it no longer reports any establishment in a manufacturing industry but continues operations in another sector. Industry switching is less common than firm entry and exit but occurs consistently over time. On average in each year, 1.6% of manufacturing firms permanently switch to a non-manufacturing sector and 1.1% of non-manufacturing firms switch into manufacturing. The net switching out of manufacturing increases in the latter half of the sample just as the decline in manufacturing employment accelerates. From 2002 to 2007, 1,316 firms with 24,909 employees switch out of manufacturing to non-manufacturing. These firms account for almost 10% of the active manufacturing firms in

16 The churning rate is defined as the sum of the firm exit and entry rates.

Table 1. Aggregates for all manufacturing and firms switching out

Year	No. of firms	Employment	Value-added	Turnover	Exports	Imports
All manufacturing						
1994	15,250	499,865	167,377	507,723	132,191	68,918
1995	14,934	503,814	162,617	510,082	139,666	72,502
1996	14,627	495,376	171,772	502,922	145,954	73,052
1997	14,384	503,117	169,809	511,263	151,665	78,198
1998	14,175	505,565	160,341	479,351	154,511	77,279
1999	14,075	489,859	166,552	483,248	178,085	77,981
2000	13,778	486,438	167,130	501,913	208,092	93,017
2001	13,423	484,449	171,567	528,513	218,740	94,054
2002	12,908	460,600	166,642	511,419	217,094	93,269
2003	12,623	428,457	159,337	482,014	210,803	87,852
2004	12,431	413,128	161,222	492,860	211,748	88,768
2005	12,234	406,810	160,910	507,438	220,629	92,952
2006	12,167	413,184	167,193	541,681	233,648	106,612
2007	12,117	425,298	175,144	575,571	241,299	112,188
Switchers out						
1994	206	3,918	1,348	4,615	782	773
1995	393	7,099	2,302	9,098	1,645	2,306
1996	583	10,791	3,279	13,102	2,575	3,128
1997	719	14,470	6,096	21,318	5,243	4,476
1998	876	18,696	9,956	29,296	6,040	5,859
1999	957	18,869	9,312	28,971	6,322	6,008
2000	1,026	23,377	7,734	38,760	6,830	8,211
2001	1,167	25,718	8,468	43,609	7,503	8,882
2002	1,320	27,642	8,493	49,669	12,215	13,305
2003	1,388	32,321	10,981	59,206	11,194	13,794
2004	1,449	32,761	12,961	61,770	12,192	14,961
2005	1,471	35,879	13,793	77,119	18,004	21,155
2006	1,500	37,631	14,502	80,862	14,190	19,610
2007	1,680	36,951	16,412	81,639	12,185	18,634

Notes: Manufacturing firms are defined as the sum of stayers, entrants and firms switching into manufacturing and switchers are defined as firms permanently switching out of manufacturing. Value added and turnover are obtained from the VAT statistics (after merging). Export and imports are obtained from the customs data (after merging). Sales, value added, exports and imports are in millions DKK in real terms, deflated using the CPI index with baseline in 1995.

2002 and 42% of the job losses in manufacturing in the period. The cumulative number of firms that switch out of manufacturing from 1994 to 2007 is 3,030. Of those, 1,680 firms are still active in 2007, equivalent to 13.8% of the operating manufacturing firms.

Table 1 reports totals for firms, employment, sales, value-added, exports and imports separately for manufacturing firms and current and former switchers in each year. There are many more firms in manufacturing, and they account for much more employment than switchers. Total employment at switchers is 36,951 compared to 425,298 workers at manufacturing firms in 2007 (8.6%).[17]

17 The service industry increases employment over the period roughly from 920,000 to 1,240,000 workers (see Table A2 in the Supplementary Online Appendix), so 40,000 workers from switchers

Manufacturers account for more total sales, value-added, exports and imports than do switchers. However, it is interesting to look at the evolution of these aggregate variables over time for each group. While overall manufacturing employment is declining, as noted earlier, in contrast employment at switchers is rising dramatically over the period. This rise in employment is due to both the increasing number of switching firms as well as an increase in employment per firm of 17% from 1994 to 2007.

Aggregate turnover at manufacturing firms increases 13% from 1994 to 2007 due to sales per firm that rise 42% from 33 DKK million in 1994 to 47 DKK million in 2007. Sales at switchers are increasing much faster due to an increasing number of firms and much faster growth of sales per firm; sales per firm more than doubles for switchers. By 2007, total turnover at switchers is 14.2% that of manufacturers.

Total value-added at manufacturing firms rises only 4.5% from 1994 to 2007. A decline in manufacturing firms is offset by a 31% increase in value-added per firm. For switchers, value-added rises at a comparable rate to sales. By 2007 firms that have switched out of manufacturing over the sample have total value-added equivalent to 9.3% of the total for firms in manufacturing.

Looking at trade orientation, we notice important differences between the two groups. Manufacturing firms are net exporters and the share of exports in turnover is increasing from 26% to almost 42%, while the share of imports in turnover increases from over the period from 13.5% to 19.5%. For switchers, it is the opposite. They are net importers, and the import share increases from 17% to 23%, while the export share decreases from 17% to 15%.

A SWITCHING EXAMPLE

From Compasses to Maps to E-publishing

Founded in 1775 as a supplier of magnetic compasses for sailing vessels, Iver C. Weilbach & Co. represents a classic example of a firm that switched out of manufacturing in recent years. For its first 100+ years the company focused on the production of magnetic compasses for wooden-hulled sailing vessels. As iron emerged as the preferred material for ship hulls, compasses needed regular onboard corrections and the company added a mix of maintenance services to its portfolio.

In the interwar period, Weilbach entered the field of maritime publishing and started to provide sea charts for Danish merchant and fishing vessels, an activity that developed into its core line of business. With the advent of electronic navigation in the twentieth century, magnetic compasses gradually lost ground to gyro compasses and global positioning systems. Weilbach never engaged in the production of electronic navigational systems and continued to produce

represent 12% of the increase; at the end of the period, workers from surviving switchers represent 3 % of total service employment.

magnetic compasses until 2009–10 and employees of the company performed compass correction until the 1990s.
The compass manufacturing business is now completely shuttered; however, Iver C. Weilbach & Co. is not gone. In the twenty-first century, new technological developments in shipping have again changed the nature of Iver C. Weilbach & Co.'s business. The advent of electronic nautical charts and electronic publishing of maritime handbooks has provided a new opportunity. The company now offers both printed (sourced from other suppliers) and electronic nautical charts (produced in-house) and it is able to offer services and updates to the shipping companies on a 24/7 basis. The evolution of the business continues and includes the development of offshore software development in Bangladesh and the production of nautical data in Poland.

4. SWITCHERS, STAYERS AND EXITS

Table 2 compares switching and exiting firms to the pool of all continuing manufacturing firms. Switchers and exiters are considered two years before they switch or exit. The numbers represent coefficients from a regression of the (log) firm characteristic on dummy variables for switching and exiting firms two years before their change of status. Other controls include log employment and year-industry (two-digit) fixed effects. The baseline group consists of all manufacturing firms who do not exit or switch. There are large differences across the three groups. Continuing manufacturers employ more workers than switchers and are almost double the size of firms that will shut down. Switchers are more productive with higher sales per worker and value added per worker than either continuing manufacturers or, especially, exiting firms.

Switchers are also different in terms of their wage and employment structure relative to continuing or exiting manufacturing firms. The share of medium and, especially, high education workers is higher at switchers, as is the share of white-collar workers. Perhaps unsurprisingly given the differences in employment composition, wages are also higher at these switching firms.[18]

Looking across six occupation groups, we find substantial differences between switchers and the other two groups. Switchers, two years before they exit manufacturing, have a much lower share of blue-collar production workers. In contrast, the shares of managers, sales and support and tech workers are significantly higher. We compare the occupational structure of switchers, manufacturing firms and service firms in Table 3. There are large differences in occupational structure between manufacturing and service firms. While the shares of managers and R&D/tech employees are very similar, the distribution of occupations across blue-collar

18 Looking at firms five years before they switch, we continue to find significant differences. Results are available on request.

Table 2. Firm characteristics differentials of switchers out and exiters with respect to firms staying in manufacturing

	2 years before		
	Switching out	Exiting	Prob > *F*
Employment	−0.326***	−0.566***	0.000
Value added per worker	0.025*	−0.126***	0.000
Sales per worker	0.182***	−0.095***	0.000
Export share (%)	−0.007	−0.028***	0.028
Import intensity (%)	0.077***	−0.006**	0.000
Skill and wages			
Share of low educated workers (%)	−0.043***	0.007***	0.000
Share of medium educated workers (%)	0.019***	−0.008***	0.000
Share of high educated workers (%)	0.024***	0.001	0.000
Share of white-collar workers (%)	0.152***	−0.001	0.000
Average wage	0.093***	−0.010***	0.000
Wage bill share (high education)	0.028***	0.001	0.000
Wage bill share (white collar)	0.156***	−0.003	0.000
Occupations			
Share of managers (%)	0.020***	−0.003**	0.000
Share of tech workers (%)	0.029***	0.005***	0.000
Share of production workers (%)	−0.159***	−0.002	0.000
Share of blue non production workers (%)	0.007**	0.001	0.058
Share of support workers (%)	0.076***	−0.004*	0.000
Share of sales workers (%)	0.027***	0.004***	0.000
Observations (min/max)	63,488/157,205		

Notes: These are coefficients from a regression of the (log) firm characteristic on dummy variables for switching and exiting firms two years before their change of status (respectively). The final column tests the statistical significance of the difference between the coefficients for switchers out and exiters. Other controls include log employment (except for employment), year-industry (two-digit) fixed effects. The baseline group consists of all manufacturing firms who do not exit or switch. Value added per worker, sales per worker, sales and wages are in DKK, all have been deflated using the CPI index with 1995 as the base year. Blue-collar and white-collar groups are constructed according to workers' occupation code (ISCO code). ***/**/* indicates statistical significance at the 1%/5%/10% respectively.

production, support and sales are distinct. Service sector firms have far fewer blue-collar production workers and much higher shares of support and sales staff. None of these differences are particularly surprising but they serve as a reminder of what we would expect if switching firms are merely transforming themselves from typical manufacturing firms to service sector firms that focus on the intermediation of goods produced outside the firm to final customers.

In fact, the occupational structure of switchers is unlike the average firm in either sector. Before changing their industry, switchers are similar to, yet distinct from manufacturers. In some respects, they resemble the typical service sector firm as they employ a much smaller share of production workers and greater shares of support workers and sales staff. However unlike their service sector counterparts, these future switchers already have higher shares of managers and R&D/tech staff.

Over the course of the transition, the switchers dramatically change their occupational structure. In some dimensions, they become more like the typical service firm with far fewer production workers and increasing share of sales employment. However,

Table 3. Occupational structure in 1994 and 2007: manufacturing, services and switchers out

	No. of firms	No. of workers	Managers	Line1	Line2	Tech	Support	Sales
Manufacturing								
1994	14,754	467,382	4.7%	6.6%	58.0%	9.2%	16.7%	4.8%
2007	11,808	403,829	4.3%	7.3%	51.4%	12.9%	16.9%	7.3%
Services								
1994	76,846	861,056	5.7%	11.4%	20.9%	8.8%	38.0%	15.2%
2007	97,972	1,115,350	4.1%	10.8%	18.6%	11.6%	34.0%	21.0%
Switchers out								
1994	1,711	57,899	6.0%	8.2%	44.2%	11.8%	22.2%	7.6%
2007	1,628	34,478	8.1%	7.4%	25.3%	22.1%	24.3%	12.8%

Notes: Manufacturing (services) includes all firms in manufacturing (services) in the year. Switchers includes all past, current and future switching firms: future switchers in 1994 and past switchers in 2007. Line 1 refers to blue-collar workers not involved in production. Line 2 refers to blue-collar workers involved in production. The shares of each occupational group are computed as the share of non-misclassified occupations.

in most respects they differ substantially from both manufacturing and service sectors firms. They have more than twice as many R&D/tech workers and almost twice as many managers. Switchers appear to be something apart from either sector, a form of hybrid between manufacturing and services.

4.1. Switching, staying and survival

We frame the switching decision as one related to expected future profits (in manufacturing or services) of the firm and comparative advantage in tasks. For current manufacturing firms, the decision to switch is in large part a decision about the expected comparative advantage of the firm going forward. During the period in question, firms are facing dramatic changes in the relative cost of locating activities outside the firm and outside the country. Both onshore and offshore outsourcing are on the rise and the lower cost of communications as well as increasing global linkages present opportunities for firms to split their activities across the borders of the firm as well as across national borders.

We would expect that firms with a comparative disadvantage in production would be the most likely to incur any fixed or sunk costs of outsourcing the production process. However, measuring such internal comparative disadvantage is difficult. Instead, we look at the determinants of switching relative to stayers, but also to exiters. We estimate a simple multinomial logit on the choice between continuing to produce in manufacturing, switching out to non-manufacturing activities, or ceasing operations. We ask whether firm characteristics such as size, productivity and trade status are systematically related to the probability of survival/switching after controlling for industry and year effects.[19]

19 Switching could also be related to the location of the firm. Switchers are more likely to be located in Copenhagen (9%) than continuing manufacturers (6%) but otherwise the geographic distributions are similar. Results are available from the authors.

Table 4. Multinomial logit of firm transition (baseline: stayer in manufacturing)

	Exiter		Switcher out	
	coef.	*dy/dx*	coef.	*dy/dx*
Log labour productivity in *t − 1*	−0.124***	−0.014***	0.104***	0.003***
	(0.008)	(0.001)	(0.014)	(0.000)
Log employment in *t − 1*	−0.402***	−0.043***	−0.196***	−0.003***
	(0.006)	(0.001)	(0.010)	(0.000)
Multi-establishments firm	0.401***	0.042***	0.249***	0.004***
	(0.030)	(0.003)	(0.045)	(0.001)
Exporter in *t − 1*	−0.030	−0.003	0.017	0.001
	(0.020)	(0.002)	(0.033)	(0.001)
Importer in *t − 1*	0.040*	0.004*	0.080**	0.002**
	(0.021)	(0.002)	(0.034)	(0.001)
Export share in *t − 1*	−0.072	−0.006	−0.351***	−0.009***
	(0.046)	(0.005)	(0.067)	(0.002)
Import share in *t − 1*	0.125*	0.007	1.277***	0.034***
	(0.074)	(0.008)	(0.086)	(0.002)
Predicted probability	0.089		0.014	
Observations	180,182			

Notes: Multinomial logit analysis, coefficients and marginal effects are reported with standard errors in parentheses. This specification excludes firms in industries 16, 23 and 37. ***/**/* indicates statistical significance at the 1%/5%/10% respectively.

The results are reported in Table 4. The most striking result is the strong positive association of productivity with switching out of manufacturing. Switchers are significantly more productive than stayers who in turn are more productive than firms that exit entirely. This finding is at odds with a portrait of switchers as firms that are 'failing' as manufacturers and can only survive as intermediaries between more efficient, lower cost producers and final customers. In terms of productivity, switchers are among the best firms rather than the worst.

Within the same industry, firm size as measured by log employment is positively and significantly correlated with the probability of staying and surviving in manufacturing. In contrast, size is negatively associated with exit and, in particular, switching out. This is in line with our previous observation that switchers are on average smaller. Firms with multiple establishments are more likely to switch out of manufacturing. This may be an artefact of the way in which switching is measured, as a firm only switches when all its establishments are classified as non-manufacturing.

Exporting itself is not significantly related with either switching out or shutting down. However, among exporters, the greater the export intensity, the less likely the firm will switch out to non-manufacturing. From the perspective of within-firm comparative advantage, greater export intensity may indicate a relative capability of the firm in production activities.

The results for importing are comparably nuanced. The coefficient on the import dummy is positive and significant for both exit and switching out. Looking at import

intensity, manufacturing firms with low import intensity are more likely to stay, while intensive importers are much more likely to switch out.

4.2. Post-switching performance

In this section, we examine the performance of switchers around the transition year. We compare switchers to non-switchers in their manufacturing industry (pre-switch industry). Because we find such large differences in firm characteristics such as employment and productivity between switchers and continuing firms, we adopt a matching framework to develop a pool of comparable non-switching manufacturing firms to examine post-switch performance.

The average treatment of the treated has been computed using propensity score matching estimation techniques. The control group contains firms that are active in manufacturing and never switch out of manufacturing. The matching is done by two-digit industry and includes a polynomial in value added per labour and firm size in $t-2$ (two years before the switch) and year fixed effects.[20]

The average treatment effect on the treated (ATT) results are shown in Table 5. The relative evolution of switchers during and after their switch is quite dramatic. Employment levels fall in the years leading up to the switch while relative sales fall slightly, but sales per worker and value-added per worker surge. The decline in employment is concentrated in lower education blue-collar workers, while highly educated white-collar workers rise relative to their manufacturing counterparts. The shift away from production is evident in the shares of workers across occupation types. The share of managers, tech workers, and sales and support rise, offsetting the drop in production employment. Over the transition, switchers also change their international orientation away from their former peers. They start as less export intensive and more import intensive than other firms in their industry and those differences increase over the transition.

5. THE EVOLUTION OF SWITCHING FIRMS

In this section, we use detailed information on individual workers in Danish firms to examine the evolution of these switching firms around their transition dates. We consider the numbers and shares of different types of workers at switching firms before and after their exit from manufacturing. We first look at the overall evolution and then distinguish between the various types of switchers.

20 We use the pscore and psmatch2 stata commands, and identify the five closest neighbours to our treated firms. As the estimated densities of the balancing score have poor overlap in some industries, we impose the following conditions to obtain the best possible matches: joint support, trim by dropping 5% of the treatment observations with the lowest the pscore density and caliper (0.05) leaving us with controls relatively close to the treated in terms of support. The balancing property was achieved in every case. All standard errors have been bootstrapped with 250 replications.

Table 5. Performance of switchers before and after switching out

	Average treatment effect on the treated (ATT)			
	in $t-1$	in t	in $t+1$	in $t+2$
Employment	−0.048***	−0.283***	−0.307***	−0.306***
Value added per worker	0.054***	0.122***	0.103***	0.112***
Sales per worker	0.234***	0.384***	0.402***	0.402***
Export share	−0.037***	−0.070***	−0.097***	−0.086***
Import intensity	0.093***	0.100***	0.109***	0.112***
Skill and wages				
Share of low educated workers	−0.039***	−0.053***	−0.052***	−0.052***
Share of medium educated workers	0.011***	0.021***	0.017***	0.012***
Share of high educated workers	0.029***	0.032***	0.035***	0.040***
Share of white-collar workers	0.158***	0.194***	0.259***	0.265***
Average wage	0.089***	0.098***	0.108***	0.094***
Wage bill share (high education)	0.031***	0.034***	0.037***	0.042***
Wage bill share (white collar)	0.165***	0.196***	0.263***	0.274***
Occupations				
Share of production workers	−0.163***	−0.231***	−0.286***	−0.304***
Share of tech workers	0.032***	0.034***	0.052***	0.051***
No. of treated	1,818	1,818	1,307	1,134
No. of matched controls	8,454	8,454	6,102	5,250

Notes: The average treatment on the treated has been computed using propensity score matching estimation techniques. The control group is firms that are active in manufacturing and never switch out of manufacturing. The matching is done by two-digit industry and includes a polynomial in value added per labour and firm size in $t-2$ (two years before the switch), and year fixed effects. All standard errors have been bootstrapped with 250 replications. ***/**/* indicates significance at the 1%/5%/10% level.

5.1. Overall evolution

Figure 3 shows the evolution of the workforce at both switching firms and the control group of non-switching manufacturing firms for the five-year period centred around the switch date.[21]

The switchers show a noticeable decline in employment in the years leading up to the switch and a small growth in employment afterwards. While the numbers of both white- and blue-collar workers are declining, the drop is particularly pronounced for blue-collar workers. After the switch, the rise in employment at switchers is concentrated in the white-collar workforce. Over the entire transition period, the share of white-collar workers increases from 46% to 60% of the workforce at switching firms. In contrast, the white collar share at non-switchers increases by just 1%. In addition to the changing composition, there is dramatic turnover in workers for switchers. All firms naturally have workers arrive and depart in every year. However, this process is much more active at these switching firms. Two years after the switch, more than 53% of the workforce is

21 The firms in the control group are selected using the algorithm described in Section 4.2.

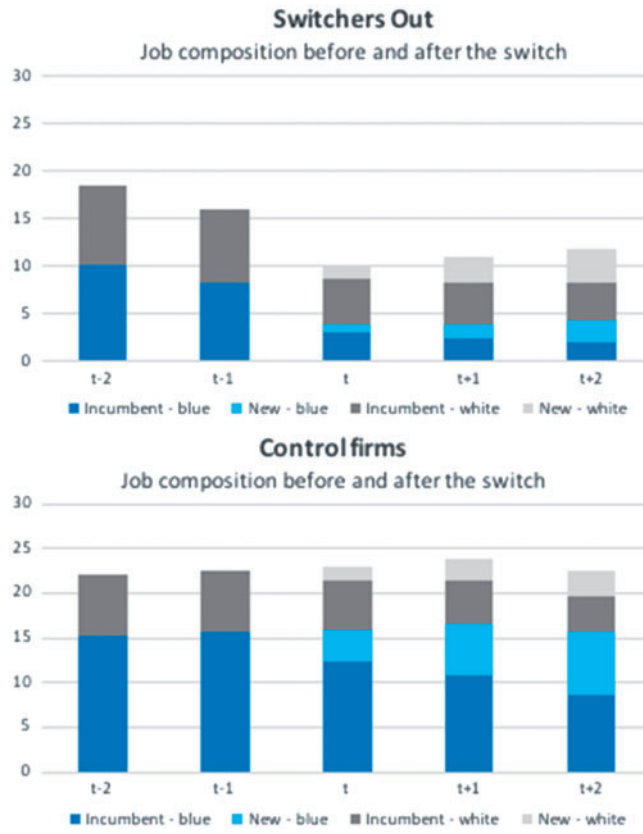

Figure 3. Workforce composition.

Notes: The upper panel reports average employment at switchers for the years before, during, and after leaving manufacturing. Employment is divided into blue-collar and white-collar workers and further separated into continuing workers who stay after the switch and new workers who arrive after the switch. The bottom panel gives the same averages for matched continuing manufacturing firms over comparable five year intervals.

Source: Authors' own calculations.

new at switchers, hired in years t through t + 2. The comparable statistic for non-switchers is under 42%.

The pattern of educational attainment of the workforce at switchers is similar. Low education and medium education workers are reduced before the switch out, and while all categories of workers increase after the transition, the growth is largest for high education workers. The share of high education workers rises from 4.4% to 9.0% of the workforce; at non-switching firms, the share is unchanged.

Figure 4 examines the types of activities performed at switching firms from 1994 to 2007. All firms that will switch out of manufacturing are included in every year, whether or not they have already made the industry change. The decline in overall employment starts with the recession in the early part of the 2000s, but the more noticeable change is in the composition of employment across function. Both types of line workers (production and non-production) contract sharply in levels and as a share of employment at

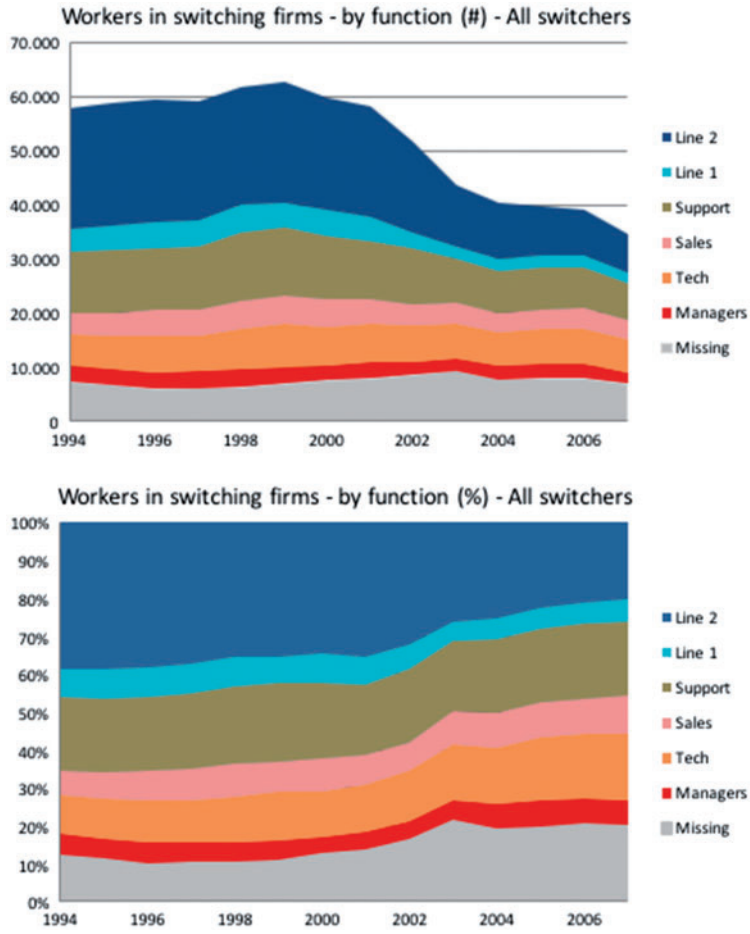

Figure 4. Workforce composition.

Notes: The upper panel reports average employment by occupation at all switching in every year. Line 1 refers to blue-collar workers not involved in production. Line 2 refers to blue-collar workers involved in production. Firms are included before, during and after the year that they switch. The bottom panel reports the same numbers as a share of employment (including misclassified occupations).

Source: Authors' own calculations.

these firms. In contrast, sales and tech workers rise both in levels and shares. These firms are clearly changing their activities away from production.

5.2. Identifying types of switchers

We next try to identify whether some of these firms are still involved in some aspect of the manufacturing process even after switching industry. We adopt two different approaches to distinguish between types of firms. First, we look at the destination

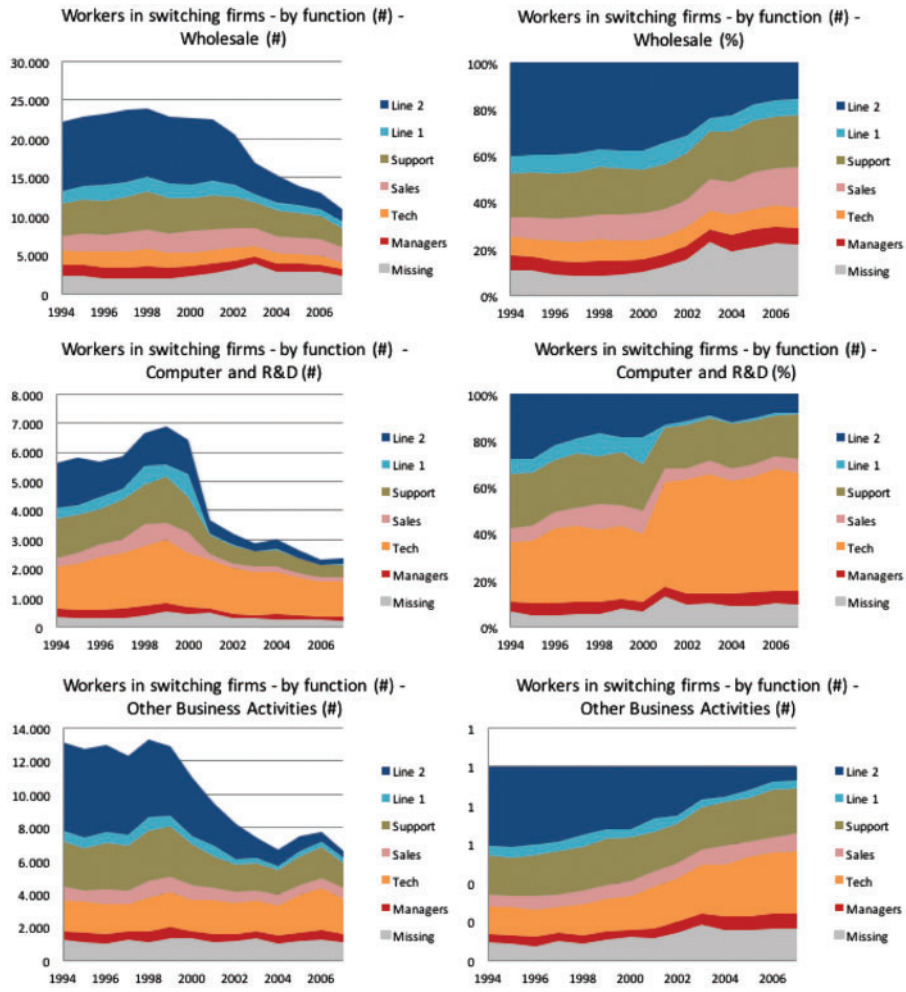

Figure 5. **Workers in switching firms by function.**

Notes: The left-hand panel reports average employment by occupation at all switching firms in every year for firms that switch to specific service industries: Wholesale, Computer and R&D, and Other Business Activities. Firms are included before, during and after the year that they switch. Line 1 refers to blue-collar workers not involved in production. Line 2 refers to blue-collar workers involved in production. The bottom panel reports the same numbers as a share of employment (including misclassified occupations).

Source: Authors' own calculations.

industries of switching firms. Second, we group firms by their pre-switch levels of high-tech employment.

5.2.1. Types by destination. Figure 5 examines whether there are important differences across firms according to their destination industry. There are at least two possible types of firms that leave manufacturing. The first type transits from a set of production-based activities towards pure intermediation. These firms use their knowledge of suppliers and customers to become traditional wholesalers who match buyers and producers.

A second possible category is a firm that no longer undertakes production of the goods but still is involved in design and engineering, supervision of third-party production (inside or outside the country) and branding, marketing and distribution. These FGPFs have many of the same capabilities and activities as traditional manufacturing firms but no longer directly control the assembly and processing activities in-house. Bernard and Fort (2015) document the extent of these types of firms in the wholesale sector in the United States and find that a substantial number of firms and workers are employed at FGPFs.

We do not have data on any pre-production and post-production activities at the switching firms, nor do we know whether they are engaged in hiring contract manufacturing services. Instead, we use indirect ways to identify different types of switchers. We start by dividing the switching firms by destination sector. We assume that firms ending up in the wholesale sector are more likely to be closer to traditional wholesalers, the evidence of Bernard and Fort (2015) notwithstanding, while switching firms that move to Computer and R&D sectors or Other Business Activities are more likely to still be engaged in manufacturing-like activities.

Figure 5 shows big differences in the levels and shares of different functions across switching firms in these destination sectors. Firms that move to Wholesale see drops in blue-collar workers (Line 1 and Line 2) but increasing shares of sales and support staff, with little change in the share of tech workers. On the other hand, firms that move either to Computer and R&D or to Other Business Activities show large increases in the share of tech workers. This evidence suggests that the narrative about firms that leave manufacturing includes at least two different stories. In one, the manufacturing-related capabilities are indeed declining as the firms become more like traditional wholesale firms. The other path is one of continuing activity related to manufacturing in spite of the absence of the manufacturing processes themselves.

5.2.2. Types by initial conditions in workforce composition. Another way to distinguish between firm types is to look at their initial stock of knowledge workers, i.e. technical and R&D workers. We focus on the subset of surviving switchers at the end of our period of analysis. We then define high-tech firms as those firms that have a share of high-tech workers above the 75th percentile two years before switching (the cutoff is above 8%). Those firms represent about a quarter of our sample, but they also employ about half of the workers (see Figure 6). We can also see that these firms experience a large increase in the number and share of high-tech workers. Figure 7 shows the composition of the workforce by type of firm. We observe that high-tech switchers are much larger than low-tech firms. Both types have a large decline in employment the year before and during the industry change (especially getting rid of blue-collar production workers), but start growing again afterwards. However, for high-tech firms, the share of tech workers increases (the stock remains constant) dramatically, from 19% to 27%; while sales and support activities gain in relative terms for low-tech firms.

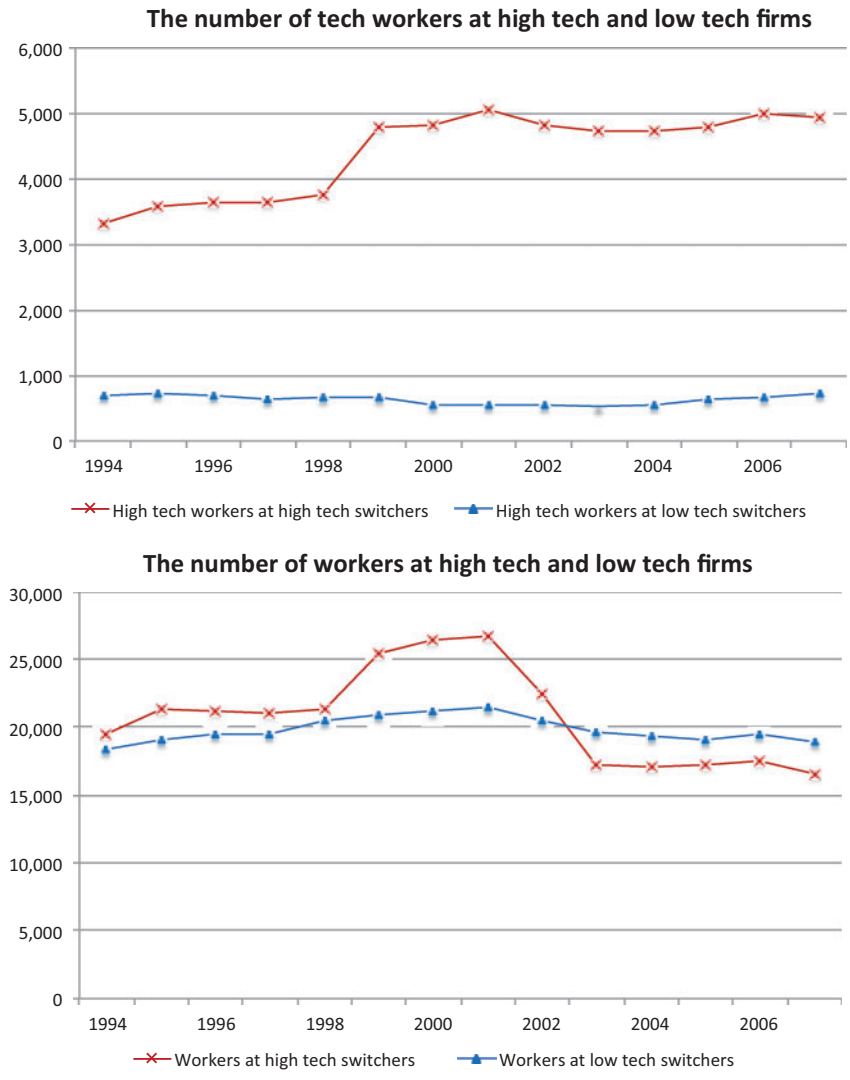

Figure 6. Evolution of the number of workers in switching firms.

Notes: The upper panel reports total employment at high tech switchers (top quartile of R&D/tech employment shares among switchers) and low-tech switchers (remaining firms) for all years before, during, and after leaving manufacturing. The bottom panel gives the total R&D/tech workers at the same two groups of firms.

Source: Authors' own calculations.

6. WORKER OUTCOMES

Deindustrialization by definition involves a decline in the size and relative importance of the manufacturing sector. We have shown that this process of declining manufacturing is not simply about the shrinking or shutdown of manufacturing firms but also includes an important component of reorganization of activities in firms that leave

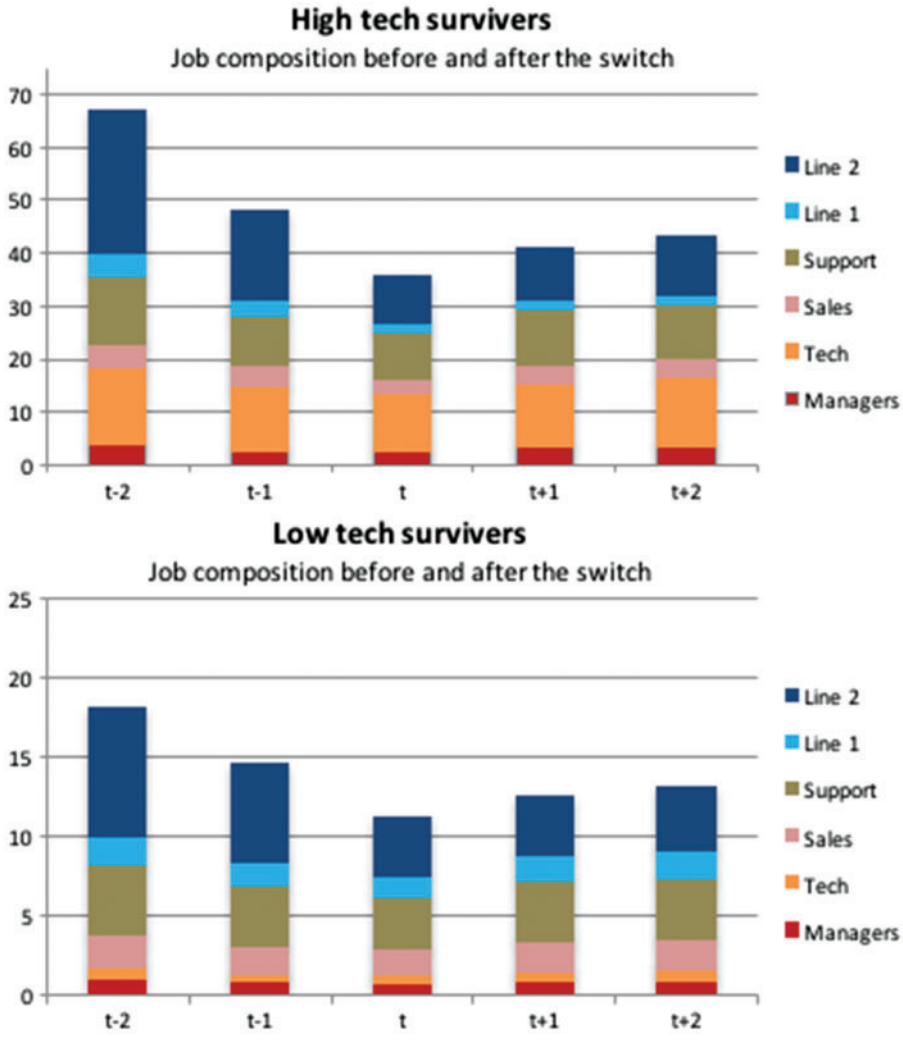

Figure 7. Evolution of the occupational composition of the workforce.

Notes: The upper panel reports average employment at high-tech switchers (top quartile of R&D/tech employment shares among switchers) for the years before, during, and after leaving manufacturing. Employment is divided into six occupation categories. The bottom panel gives the same averages for low-tech switchers.

Source: Authors' own calculations.

manufacturing for service sectors. A question remains what happens to the labour market outcomes of the workers themselves.

In this section, we focus on outcomes for individual workers, in particular, workers that are separated from employment at manufacturing firms that switch and at firms that exit manufacturing entirely. We consider outcomes for the five years after the job separation for workers that leave switchers just before the sectoral transition as well as for workers that are laid off from manufacturing plants that shut down entirely. There is

a well-known potential problem in comparing employment paths of workers laid off in a mass firing (exiting manufacturing) with those individuals laid off from continuing firms (switchers), see Gibbons and Katz (1991). A priori we might expect workers separated from switchers to have worse post-layoff employment outcomes as they could be perceived by the market to be lower quality workers at those firms.[22]

The first year after separation yields very different results for layoffs from switchers and exits largely in line with expectations. Laid-off workers from switchers are much more likely to be unemployed or out of the labour market (17.5%) than are workers from exiting manufacturers (12.0%) (see Table A3 in the Supplementary Online Appendix).

The situation five years after separation is dramatically different. Five years out, fewer than one third of these workers are employed in manufacturing. They are also much more likely be employed in the service sector and less likely to be employed in manufacturing. This suggests that workers losing their jobs from switchers already had skills (or were performing tasks) more adapted to the changing nature of the economic environment, characterized by the increased relative share of services.

For the wage evolution, rather than look at the absolute evolution over time, we analyse the relative wage change of individuals losing their jobs during a switch-out or an exit compared with a control group of workers not losing their jobs in firms that remain in manufacturing. This is a similar approach to what is typically done in the literature on mass layoffs (e.g. Jacobson *et al.*, 1993 and Davis and von Wachter 2011). To identify this control group, we use workers employed in the firm-level control groups for switchers and exiters discussed previously and consider workers who remain employed in these firms.

Note that in our analysis, we only consider the annual labour income for workers who are employed in November of the following years. Our variable for labour income is the total wages received over the year, so if one type of workers takes longer to find a new job, it will be reflected in our measure of wages.

We use a log difference in wages over several time periods (between 1 and 5 years) and identify the wage changes of individuals losing their jobs at switchers and in exiting firms relative to those for stayers in the control groups.

Specifically, we estimate a simple regression in first differences:

$$\Delta \log W_{i,t=0\rightarrow t=j} = \alpha^{SO} SO_{i,t=1} + \varepsilon_{it}$$

for $j = 1, \ldots, 4$ and where $SO_{i,t=1}$ indicates a dummy for whether the individual works in $t = 0$ for a firm that switches out in $t = 1$ and the individual no longer works for the firm in $t = 1$. Workers leaving switching firms are compared to workers who remain at firms from the control group of continuing manufacturers.

22 See Frederiksen and Westergaard-Nielsen (2007) and Frederiksen *et al.* (2013).

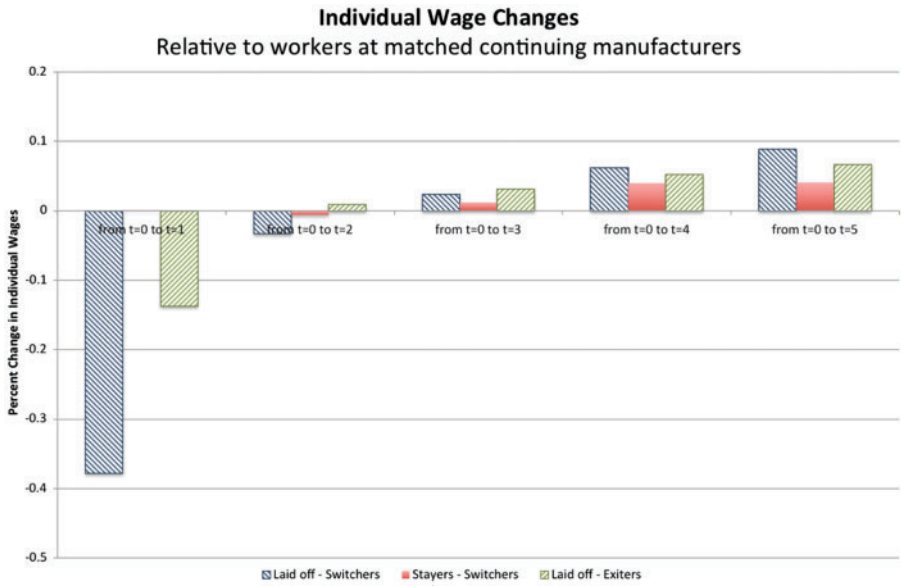

Figure 8. Worker wages after switching or exiting.

Notes: The columns represent the cumulative change in wages for (i) workers that leave switching firms, (ii) workers that stay at switching firms, and (iii) workers that leave manufacturing firms that shut down. All the wage changes are relative to control groups as defined in Section 4.2.

We estimate a similar regression for workers at exiting firms

$$\Delta \log W_{i,t=0\to t=j} = \alpha^{E} \text{Exit}_{i,t=1} + \varepsilon_{it}$$

and compare their wage trajectories to those for workers at control group of continuing manufacturing firms. Both specifications also include year dummies and a second-degree polynomial in age.

Results are shown in Figure 8. Individuals losing their job at switchers have a big relative loss one year after the switch, equivalent to 38% of the previous wage. However, the wages quickly recover and end up catching up outperforming stayers in the longer run. Individuals losing their job because of firm exit see substantial but lower wage declines in the first year after the shutdown (14%). Finally, we also look at individuals who keep their jobs at switchers relative to those who keep their jobs at the control group of continuing manufacturers. While they do not differ in terms of wage trajectory in the short run, individuals who remain on the job at switchers experience a faster wage growth over longer horizons. This may reflect the better overall performance of switching firms.

7. CONCLUSIONS

This paper has documented a new set of facts about the process of deindustrialization in advanced economies. The well-documented decline in manufacturing employment is

not simply a story of disappearing industries and failing firms. An important piece of the evolution of modern advanced economies involves the transition of some firms from manufacturing to services, as well as the evolution of continuing manufacturing firms towards more service-like enterprises. This part of the deindustrialization story raises important questions for several dimensions of economic policy.

Manufacturing has a long history as a driver of economic growth and aggregate economic performance. As a sector with relatively high productivity growth rates over many decades, manufacturing is perceived by policymakers to be the engine of the modern economy and as a result essential to prospects for long-run real growth and rising welfare. In turn, the focus of industrial policy is usually an attempt to retain or bring back the manufacturing sector.

Examples of this type of policy are widespread. Presidential politics in the United States often focuses on the depth of support for manufacturing and policy areas from direct subsidies to trade to taxes are often designed to enhance opportunities for manufacturing firms. In 2012, France went so far as to create a position titled 'le ministère du redressement productif', or Minister of Industrial Recovery. In Denmark, the government launched a Strategy for Denmark as a Production Country, with the aim of ensuring that Denmark will continue to be an attractive location for production. This strategy involves targeting the adoption of advanced production technologies and ensuring that workers have the right skills to match with this technology (Danish Government, 2014). In every case, these policies have focused on manufacturing itself.

Our findings do nothing to diminish the role and importance of manufacturing. However, they raise questions about the evolution of the advanced economies and the nature of activities done by firms in a modern economy. We find that there exist service sector firms that still perform many of the high value-added activities of a typical traditional manufacturing firm. The dominant focus on manufacturing misses an important part of the production economy.

It is universally agreed that economic policies that promote long-run productivity growth are in the national interest. What is less well understood is what exact form those policies should take and which industries and firms they should target. In this paper, we argue that there is a set of firms in the service sector that have the capabilities to produce innovation and productivity growth. Policies that favor 'production', i.e. manufacturing, are going to miss this growing and important set of firms and may bias firms towards retaining less efficient production activities.

Analysing the evolution of these switching firms provides insight into a broader set of trends in advanced economies. Comparative advantage in assembly and production has shifted abroad due to the increased integration of Eastern Europe, China and India into the global economy as well as the advent of advanced low-cost communication technologies. However, the movement of these firms out of manufacturing does not signal the end of their ability to innovate and increase value-added. Design, R&D and post-production activities in many cases remain in the home country and these firms grow and prosper after making the transition out of manufacturing.

Turning our attention to the workers themselves, we find important results that can inform policy. As has been documented in many other countries, workers separated from either exiting firms or from switchers, have relatively bad short-term labour market outcomes: their wages are lower and they are more likely to be unemployed or out of the labour force. However, we find that the long-term prospects, especially for workers separated from switchers, are relatively good. Wages have recovered and labour force engagement has rebounded. The positive longer term outcomes are in contrast to recent research on the United States and elsewhere, see Autor *et al.* (2014). One possible reason lies in the contrasting support given to Danish workers relative to that in other countries. As opposed to countries like France, Italy or Spain where firms find it costly to adapt their labour force to a changing environment, a key feature of the Danish labour market is its so-called flexicurity, the coexistence of flexibility, low adjustment costs for both employers and employees, and security, owing to a developed social safety net with high coverage and high replacement ratios, see Eriksson (2012). This system has been associated with very high mobility rates between jobs. The Danish government also spends a significant amount of resources in active labour market policy and retraining of workers, both during unemployment spells and on the job. These policies may provide a template for other countries who are facing similar transitions in their industrial and firm structure. More research is needed to compare and contrast the outcomes for workers in Denmark with those in other countries.

Discussion

Mikhail Drugov

New Economic School

This is an interesting and encouraging paper which will be welcomed by policymakers and workers alike. It shows that the loss of manufacturing in Denmark, as seen in statistical data, is in some sense exaggerated. A significant number of firms that stop production activity continue to exist, and perform many related activities they had been doing before, such as design, engineering, accounting, marketing and distribution. In particular, the paper finds that there are two types of switching firms. Some firms completely stop any involvement in manufacturing and act as wholesalers. These firms mostly employ a relatively low-skilled workforce. Other switching firms focus on design and distribution and hence are still involved in some manufacturing activities. These firms employ a more skilled workforce than an average firm in manufacturing. While they do formally switch sectors – from manufacturing to services – this switch is less important than could otherwise be thought. Also, the consequences for the workers who lose their jobs in the switching firms are milder than for those losing their jobs at manufacturing firms which stop existing.

It is, of course, well known that many firms reorganize and reinvent themselves. Nokia started as a paper mill, while Hasbro (one of the largest toy manufacturers in the world) started selling textile remnants. So, it is not too surprising that nowadays the reorganization sometimes crosses the manufacturing/services (official) boundary. It is probably more surprising that this phenomenon has not been studied in detail earlier, particularly given the widespread concern about the loss of manufacturing in developed countries. A possible reason might be the lack of appropriate data. Few, if any, other countries have such detailed data as Denmark. Hence, replicating this analysis beyond Denmark does not seem feasible. It is then important to understand some features of the switching process that might help to extrapolate the results of the paper to other countries. Let me focus here on two points.

First, it would be useful to understand firms in industries which are more prone to switching. If industry-specific 'switching rates' are known, it is then straightforward to obtain a rough estimate of switching for other countries. The more similar a particular industry is to its Danish counterpart, the more reliable this switching rate is. Second, it is important to know whether, and how much, switching is bolstered by firm location in a big city or in a densely populated area more generally. In footnote 19 the authors say that switching firms are slightly more likely to be located in Copenhagen, but otherwise the location does not seem to matter. I wonder if this is a consequence of Denmark being a small country, but it is definitely something to keep in mind for policymakers in larger countries. Related to this, there might be spillovers from other firms nearby in the same industry. For example, if there are other similar firms still in manufacturing, it might be easier to switch and specialize in services to them.

Policymakers should welcome this paper not only because it shows that many firms are still 'close' to manufacturing, even if they are formally classified in the service sector, but also because workers laid off in the switching firms do better than in firms that close. As the authors discuss in the concluding section, this seems to hinge on the particular Danish feature of the labour market, 'flexicurity', which is 'the coexistence of flexibility, low adjustment costs for both employers and employees, and security, owing to a developed social safety net with high coverage and high replacement ratios'. Hence, the encouraging finding for the workers may not apply to other countries, particularly Southern European ones which have very different labour markets. A more detailed analysis in this area will definitely be welcomed.

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Over the past decades, many high-income countries have seen a sharp decline in manufacturing related output. This 'deindustrialization' is considered a threat to the current standard of living and to future income levels. In 'Rethinking Deindustrialization' the authors (Bernard, Smeets and Warzynski) raise a provocative question – namely, have we been measuring deindustrialization properly?

The novel insight, and the starting point of their paper, is the idea that manufacturers do more than simply manufacture. To this end, instead of focusing on the decline of manufacturing firms, they dig deeper into firms classified (or previously classified) as manufacturing to examine what activities are performed by those firms. They focus their analysis on five important occupations associated with both manufacturing and service activities including managing, technology (i.e., R&D workers and technicians), support activities, sales activities and line work.

While the decline in manufacturing is global they focus on manufacturing activities in Denmark (between 1980 and 2013) to take advantage of a detailed longitudinal survey (the Integreret Database for Arbejdsmarkedsforskning, IDA) which links workers to plants over time. These data contain a vast amount of information on both workers (including age, gender, tenure, average hourly wage, socioeconomic status, occupation and education) and the type of economic activity conducted at the plant.

They begin their analysis with an examination of which types of firms are most likely to switch out of manufacturing. To do so they must decide the time window around the switching date – they decide on two years. In Table 2, they provide results from regressions of log firm characteristics on a variable that takes on the value of one if the firm will switch in next two years and another binary variable for the firm will exit in two years. They also present estimates of a model of the probability of switching to non-manufacturing services, exiting or continuing to produce (in Table 4).

One natural concern comes to mind, namely that the decision to switch is a dynamic one and the firm will make the choice to switch or not by weighing the discounted value of continuing in manufacturing to the value of changing or exiting altogether. These decisions are unlikely to be made in the same time period for all firms. The issue regarding how important is the choice of the two-year window for the findings can be alleviated by conducting alternative robustness checks. However, a harder problem to address is how to deal with firm heterogeneity in changing decisions and the dynamic nature of the choice and to what extent would the findings remain.

The paper also distinguishes between types of switching firms – those who become traditional wholesalers and those who retain most of their manufacturing capabilities. They find that the focus on employment in manufacturing firms overstates the loss in manufacturing-related capabilities that are retained by firms that simply switch industries. They also note that firms which switch have a lower share of blue-collar workers, while shares of managers, sales and technology workers are higher. They conclude that the switchers have a comparative advantage to switch. However, one concern regards the endogenous nature of the firm composition. Was it indeed that firms were already structured this way and hence they decided to switch (in support of the paper's conclusions)? Or was this composition planned, that is the firm decided they wanted to switch and hence started to fire blue-collar workers earlier than the non-switchers. This is of course related to the two-year window around which they examine switching activities, as it may be difficult to determine deliberate choices in occupation composition in such a tight time frame. One interesting way to get an insight into the potential importance

of this endogenous choice (that also could address the dynamic concerns a bit), is to redefine the time window to examine how far back in the past must the window be extended before the differences in occupational composition disappear, if ever.

A related concern applies to their conclusions regarding the finding that higher production in the last period is correlated with the firm switching in the current period. It may not be a comparative advantage of the switchers, but rather that the increase in production in the period prior to switching is driven by the switching decision. That is, the firm decides they will switch in period t, so they use up their resources in period $t - 1$ and hence production increases. It is hard to be certain whether this result would be persistent if the switchers continued to produce instead of switching in period t.

An intriguing result of the paper is that they can use the IDA data to follow individuals after they lose their jobs to examine both relocation decisions as well as individual wage dynamics. They find that individuals who lose their job at a firm that decides to switch have a big relative loss in earnings one year after the switch, equivalent to 38% of the previous wage. However, the wages quickly recover and outperform stayers in the longer run, which suggests there is something special about these workers that leaves further room for examination.

In summary, the paper provides a way to look at the manufacturing industry from a different direction. In doing so, the authors have added to our understanding of what is driving changes in manufacturing. Their paper has raised questions for further research and helped us to better understand a global phenomenon that is not likely to dissipate in the coming years.

Panel discussion

Ugo Panizza asked what happens to workers a few years after the firm has exited. He maintained that there can be a selection issue given that the authors show an increase in wages together with very high exit rates. He also raised some concerns about whether the results are generalizable given that the study is focused on as small a country as Denmark. Consistent with the latter point, Kevin O'Rourke wanted to know more about the size distribution of Danish manufacturing firms when compared to other countries, as well as their sectoral and regional concentration.

Charles Bean argued that the distinction between manufacturing and services firms may no longer apply in practice since many do both already. He claimed that this paper is only looking at the tip of an iceberg and suggested examining manufacturing firms that are still manufacturing in more detail. Following this point, Shang-Jin Wei also recommended giving a more complete characterization of the rise of the services sector.

Volker Nitsch asked to what extent firm structure matters, i.e., whether changes are driven by internal reorganization within a firm or if, instead, they are due to external forces, for instance. He also inquired why the number of jobs lost due to switchers seems

to be unrelated to business cycle factors. From a policy perspective, Andrea Ichino wondered whether we should be worried if goods are produced in a certain country or, instead, if jobs are located in that country. Finally, Andreas Madestam observed that besides wages, education outcomes of workers can be a potential explanation for the variances across different types of firms.

Replying to the comments and questions, Valerie Smeets agreed with the tip of the iceberg argument raised by Charles Bean and said that the authors had focused more on getting a clean identification in this particular paper. She also acknowledged that there may be a selection issue when looking at wage growth because they only consider workers that do have a job. She explained that Danish manufacturing firms show a wide distribution in terms of sector, size and location. She also clarified that changes were mostly driven by internal reorganizations at the firm level. Finally, she stressed the important policy implications of their results.

SUPPLEMENTARY DATA

Supplementary data are available at *Economic Policy* online.

REFERENCES

Anderson, P. M. and B. D. Meyer (1994). 'The extent and consequences of job turnover', *Brookings Papers on Economic Activity: Microeconomics*, 177–248.

Antràs, P. and D. Chor (2013). 'Organizing the global value chain', *Econometrica*, 81, 2127–204.

Antràs, P. and E. Helpman (2004). 'Global sourcing', *Journal of Political Economy*, 112, 552–80.

Autor, D. H., D. Dorn and G. H. Hanson (2013). 'The China Syndrome: local labor market effects of import competition in the United States', *American Economic Review*, 103, 2121–68.

Autor, D. H., D. Dorn, G. H. Hanson and J. Song (2014). 'Trade adjustment: worker level evidence', *Quarterly Journal of Economics*, 129, 1799–860.

Autor, D. H., F. Levy and R. J. Murnane (2003). 'The skill content of recent technological change: an empirical exploration', *Quarterly Journal of Economics*, 58, 1279–333.

Bernard, A. B. and T. C. Fort (2015). 'Factoryless goods producers in the US', *American Economic Review Papers and Proceedings*, 105, 518–523.

Buera, F. J. and J. P. Kaboski (2009). 'Can traditional theories of structural change fit the data?', *Journal of the European Economic Association*, 7, 469–77.

Crozet, M. and E. Millet (2013). 'Is everybody in service? The servitization of French manufacturing firms', CEPII.

——. (forthcoming). 'The servitization of French manufacturing firms', in L. Fontagné and A Harrison, *The Factory-Free Economy*, Oxford University Press, Oxford UK, pp. 111–138.

Danish Government, The (2014). *Report on Growth and Competitiveness*, OECD Social, Employment and Migration Working Paper No. 139.

Davis, S. and T. von Wachter (2011). 'Recessions and the Cost of Job Loss', *Brookings Papers on Economic Activity*, Fall, 1–72.

Decker, R., J. Haltiwanger, R. Jarmin and J. Miranda (2014). *The Secular Decline in Business Dynamism in the U.S.*, University of Maryland.

Eriksson, T. (2012). *Flexicurity and the Economic Crisis 2008-2009 Evidence from Denmark*, OECD. OECD Social, Employment and Migration Working Paper No. 139.

Davis, S. and T. von Wachter (2011). 'Recessions and the cost of job loss', *Brookings Papers on Economic Activity*.

Eriksson, T. and N. Westergaard-Nielsen (2009). 'Wage and labor mobility in Denmark, 1980-2000', in Edward P. Lazear and Kathryn L. Shaw (eds.), *The Structure of Wages: An International Comparison*, University of Chicago Press, pp. 101–23, University of Chicago Press: Chicago, IL.

Falvey, R., D. Greenaway and J. Silva (2010). 'Trade liberalization and human capital adjustment', *Journal of International Economics*, 82, 230–9.
Fort, T. C. (forthcoming). 'Technology and production fragmentation: domestic versus foreign sourcing', *Review of Economic Studies*.
Frederiksen, A., R. Falkner Ibsen, M. Rosholm, and N. Westergaard-Nielsen (2013). 'Labour market signalling and unemployment duration: an empirical analysis using employer-employee data', *Economics Letters*, 118, 84–86.
Frederiksen, A. and N. Westergaard-Nielsen (2007). 'Where did they go? Modelling transitions out of jobs', *Labour Economics*, 14, 811–28.
Gibbons, R. and L. F. Katz (1991). 'Layoffs and lemons', *Journal of Labor Economics*, 9, 351–80.
Goos, M. and A. Manning (2007). 'Lousy and lovely jobs: the rising polarization of work in Britain', *Review of Economics and Statistics*, 89, 118–33.
Goos, M., A. Manning and A. Salomons (2014). 'Explaining job polarization: routine-biased technological change and offshoring', *American Economic Review*, 104, 2509–26.
Jacobson, L. S., R. J. LaLonde and D. G. Sullivan (1993). 'Earnings losses of displaced workers', *American Economic Review*, 83, 685–709.
Matsuyama, K. (2009). 'Structural change in an interdependent world: a global view of manufacturing decline', *Journal of the European Economic Association*, 7, 478–86.
Nickell, S., S. Redding and J. Swaffield (2008). 'The uneven pace of deindustrialisation in the OECD', *World Economy*, 31, 1154–84.
OECD (2004). *Understanding Economic Growth*, OECD Publishing, Paris.
Pierce, J. R. and P. K. Schott (2016). 'The surprisingly swift decline of U.S. manufacturing employment', *American Economic Review*, 106, 1632–1662.
Rodrik, D. (2016). 'Premature deindustrialization', *Journal of Economic Growth*, 21, 1–33.
Rowthorn, R. and R. Ramaswamy (1999). 'Growth, trade, and deindustrialization', *International Monetary Fund Staff Papers*, 46, 18–41.
Statistics, Denmark (2012). *Statistical Yearbook*, Statistics Denmark. Copenhagen, Denmark.