Productivity, competition and downsizing*

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Introduction

The PBR/Budget view of productivity growth has been consistent since 1997. It is that productivity growth comes from (a) improving inputs; and (b) using inputs more efficiently. But what does "using inputs more efficiently" mean? Some take this to be a polite code for downsizing which they associate with productivity growth. Others, looking at productivity in the 1970s UK car industry, would say improving the use of capital and labour at individual plants (abolishing overmanning, demarcation etc.). Still others, looking at productivity improvements in the 1980s UK steel industry, would take this to mean the exit of poorly performing plants. The purpose of this paper is therefore to advance evidence on the contributions of all these factors.

2. The variation in productivity between plants

2a. The productivity spread

If all plants had the same level of productivity there would be no gain from entry and exit of different plant types. So the first issue is to document the productivity differences between plants.

To calculate plant-level data on productivity we use data drawn from the Office for National Statistics (ONS) most recent Annual Respondents Database (ARD) data set (more details are in the appendix). Data are drawn from the ONS *Interdepartmental Business Register* (IDBR) which makes use of VAT records, PAYE, other surveys and historical information to compile plant data. The IDBR is considered to be very comprehensive. We have calculated productivity for each enterprise, which for convenience we call a plant. Each plant has a unique reference number and so we can identify entry, exit and survival. We define productivity as

$$prod_{it} = \frac{real\ GVA_{it}}{emp_{it}} \qquad \textbf{(1)}$$

where i denotes the establishment and t denotes the year. The numerator is gross value added (GVA) at factor cost deflated by a 5-digit industry price deflator (and so measured in 1995 prices). The denominator is the employment in the plant, defined as year average total employment.[1]

Table 1 shows the number of plants, employment and average productivity per year. In 1994 we have usable data on 12,802 plants, which have an average employment of 228 and productivity of £26,188 per head at 1995 prices.

Table 1: ARD Data 1994-1997: Plants, employment and productivity in manufacturing

Year	Number of plants	Average Plant Employment	Average Plant Productivity
1994	12,802	228	26,188
1995	12,352	221	27,555
1996	13,147	215	28,589
1997	12,963	218	29,686
Ave: 1994-97	12,816	221	28,005

Source: Authors' calculations using the ARD.
Note: Selected data for 1994 to 1997. Average plant productivity is measured in £ (1995) per worker.

To get some idea of the spread lying behind these averages, figure 1 shows the distribution of productivity in UK manufacturing. The figure shows average productivity for each occurrence of a reporting unit. The figure also shows the 10th and 90th percentiles of the productivity distribution, respectively, the point where productivity is 10 per cent above the worst performing plant and 10 per cent below the best performing plant. The 90/10 differential is 5.5 i.e. the plant at the top of the distribution is over 5 times more productive than the plant at the bottom.

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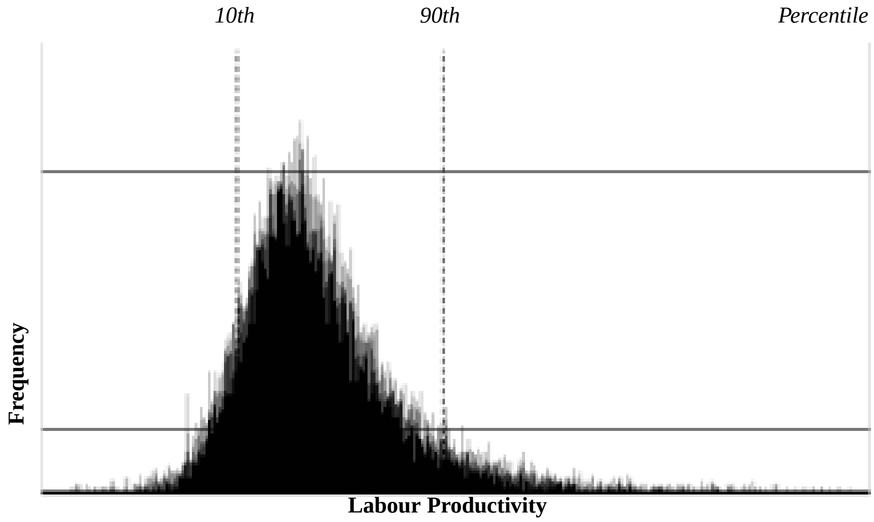
1 Some plants have negative GVA. On average this was only 2% of all plants each year.

Figure 1: Distribution of Productivity in UK Manufacturing



Source: Authors' calculations using the ARD.
Note: Selected data for 1994 to 1997. Distribution is number of enterprises at each value of average productivity, where the values are rounded to the nearest 100.

Table 2 shows some more information for different sectors. Large variations in productivity persist. In most sectors, the best plants are between 3.4 and 9.0 times as productive as the worst plants in most manufacturing sectors.[2]

Table 2 The spread of productivity

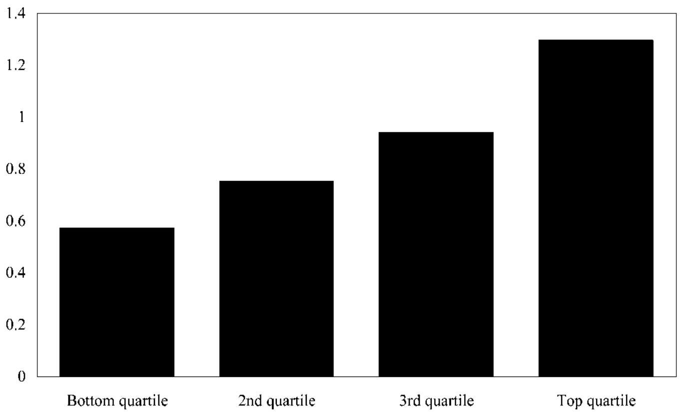
UK SIC 92	Sector	Average Productivity (£ 1995 per worker)	Dispersion (p90/p10)
15-37	All Manufacturing	28,005	5.5
15	Food & beverages	28,797	9.0
17	Textiles	20,736	4.0
18	Wearing apparel	15,302	4.9
19	Leather	17,528	4.2
20	Wood & wood products	21,651	5.8
21	Pulp, paper & paper products	31,611	4.9
22	Publishing, printing & reproduction of recorded media	30,078	5.8
24	Chemicals & chemical products	49,004	8.1
25	Rubber & plastic products	25,782	3.9
26	Other non-metallic mineral products	27,818	5.8
27	Basic metals	31,486	4.1
28	Fabricated metals	23,334	3.6
29	Machinery and equipment nec	27,422	3.9
30	Office machinery and computers	32,964	6.0
31	Electrical machinery and apparatus nec	26,316	4.1
32	Radio, television & communication equipment and apparatus	30,388	5.1
33	Medical, precision & optical instruments, watches & clocks	27,228	4.5
34	Motor vehicles, trailers & semi-trailers	26,998	3.4
35	Other transport equipment	25,258	6.1
36	Furniture, manufacturing nec	20,818	5.1
37	Recycling	41,207	15.1

Source: Authors' calculations using the ARD.
Note: Selected data for 1994 to 1997. Productivity and dispersion measures are averaged by sector and over time. We exclude SIC 16 (tobacco) and SIC 23 (coke, refined petroleum & nuclear fuel) where tax problems make measurement problems acute.

Some of this dispersion is explained by different inputs. As figure 2 shows, for example, plants at the higher quintiles of the distribution have a more skilled workforce and so it is not surprising that there should be a spread of labour productivity.

2 Disney et al (2000) find slightly narrower spreads for 1980-1992, but this reflects improved sampling in the more recent data.

Figure 2 Skill mix, by productivity quartile, 1994-1995



Source: Authors' calculations using the ARD.
Note: Selected data for 1994 to 1995. These questions were not asked after 1995. Average of two years observations. Skill mix is given by the ratio of administrative workers to operatives; these occupational measures are correlated with educational attainment (Haskel and Heden, 1999).

2b. How do plants move in the productivity distribution?

The data above describe a snapshot of the UK economy. How does the productivity distribution change? To examine this, Table 3 maps the productivity progress of all plants between 1980 and 1990 and between 1994 and 1997. Consider the top left cell in panel (a). This shows that 31.5% of (employment-weighted) plants that were in the top quintile of productivity in 1980 were still in the top quintile a decade later. Working along the row, the next cell shows that 12.9% of plants in the top quintile in 1980 were in the second quintile in 1990. Only 4.6% of plants descended into the third quintile. The final column shows the data for exit and shows that 49.8% of plants from the top quintile in fact exited.

Similarly the equivalent cells in panel (b) show that 33.7% of (employment-weighted) plants that started in the top quintile of productivity in 1994 were still in the top quintile in 1997 and 13.9% of plants who started in the top quintile in 1994 were in the second quintile in 1997. Additionally, 2.0 of starters at the top in 1994 were in the bottom in 1997. As before the final column shows that 43.0% of top 1994 plants exited at some point between 1994 and 1997.

Table 3 Labour productivity transition matrix, all plants

a. 1980-1990

		Quintiles in 1990: Top	2nd	3rd	4th	Bottom	Exit from 1980 quintile:
Quintiles in 1980	Top	31.5	12.9	4.6	0.9	0.4	49.8
	2nd	8.1	17.6	14.1	7.2	1.1	51.9
	3rd	2.2	8.7	14.1	14.8	6.3	54.0
	4th	0.8	3.0	8.9	15.1	13.8	58.4
	Bottom	0.4	0.8	1.4	5.1	21.5	70.8
	Entry to 1990 quintile	58.7	56.4	57.8	61.3	63.2	

b. 1994-1997

		Quintiles in 1990: Top	2nd	3rd	4th	Bottom	Exit from 1994 quintile:
Quintiles in 1994	Top	33.7	13.9	4.8	2.6	2.0	43.0
	2nd	7.5	19.1	16.1	7.5	4.1	45.8
	3rd	3.4	8.9	14.7	15.4	7.5	50.1
	4th	1.6	3.5	8.2	15.5	14.1	57.1
	Bottom	1.0	1.7	3.5	6.3	19.6	68.0
	Entry to 1997 quintile	47.0	49.9	51.6	56.0	65.3	

Source: Authors' calculations using the ARD.
Notes: The top left cell shows the employment-weighted fraction of plants beginning in the top labour productivity quintile in 1980 for panel (a) and 1994 for panel (b) who remained in the top productivity quintile in 1990 for panel (a) and 1997 for panel (b). The second cell on the top row shows the employment-weighted fraction of plants beginning in the top labour productivity quintile in 1980 for panel (a) and 1994 for panel (b) who were in the second productivity quintile in 1990 for panel (a) and 1997 for panel (b). The rest of the body of the table reads analogously. The top cell of the last column shows the employment-weighted fraction of plants beginning in the top labour productivity quintile in 1980 (1994) who exited at some point between 1980 (1994) and 1990 (1997). The bottom left hand cell shows the employment-weighted fraction of plants ending up in the top labour productivity quintile in 1990 (1997) who entered at some point between 1980 (1994) and 1990 (1997).

Consider now the bottom quintile in 1980 (bottom row of main body of panel (a)). The bottom left cell shows the fraction of plants in the bottom quintile in 1980 who made it to the top quintile in 1990. This is very small, 0.4%. Working along this row, the final cell shows that 21.5% of plants in the bottom quintile in 1980 were still there in 1990. The exit column is revealing: 70.8% of plants in the bottom quintile in 1980 exited by 1990.

The bottom row in panel (b) shows that 1.0 per cent of plants starting in the bottom quintile of plant productivity in 1994 ended up in the top quintile in 1997. Looking across the row, 19.6 ended up still at the bottom quintile and 68% exited. This is a similar pattern to that for the 1980 to 1990 period.

Finally the last row in each panel considers entry rates. The first column shows the fraction of plants in the top quintile in 1990 (1997) who entered at some point over the period (58.7% in 1990, 47.0% in 1997). The fractions are rather evenly spread between 1980 and 1990, with plants that enter spread over many parts of the productivity distribution. However this is not the case for the more recent data shown in panel (b). This shows that entry is more important in the lower quintiles in 1997.

The picture is then clearest for plants at the bottom of the distribution. They either stay low productivity, or they exit. Very few of these plants grow to be high productivity; approximately 70% of them exit. At the top of the distribution there is a fair amount of persistence. Equally, a number of firms at the top do seem to exit a number of years later. Finally, the distribution of entrants seems to have changed between the earlier and the more recent periods.

3. How much does sorting contribute to productivity growth?

All this suggests that the sorting role of the market may be very important in raising productivity growth. A number of papers have tried to quantify this for the UK (see e.g. Oulton, 2000, Disney, Haskel and Heden, 2000 and Barnes and Haskel, 2000b). The method here is to decompose productivity growth into that accounted for by stayers, entrants and exitors. Stayers raise productivity growth if they grow, or if market shares move to higher productivity stayers. Entrants raise productivity growth if they enter the market with above average productivity. Likewise exitors raise productivity growth if below average productivity units leave the market. For 1994-97, Barnes and Haskel (2000b) calculate that 55% of productivity growth is accounted for by entry and exit.

As well as sorting, one would also expect competition to raise productivity in incumbent firms. It encourages firms to innovate by reducing slack, putting downward pressure on costs and providing incentives for the efficient organisation of production. Nickell (1996) finds that various measures of competitive pressures in a sector have a positive impact on productivity levels and growth rates. Disney et al (2000) confirm these results controlling for the possible biases to the relation arising from the selection of plants.[3]

In sum, the main conclusions of this work on the contribution of sorting to productivity growth are:

1. In all periods and all economies the entry and exit process tends to raise productivity growth as poor firms exit and good firms enter.
2. The rearrangement of market shares among incumbents, whereby good firms gain market shares and poor firms lose them, contributes positively to productivity growth in almost all periods and countries.
3. In the UK over the 1980s, around half of productivity growth was due to market selection and half due to productivity growth within plants. The recession period was where plant growth ceased and entry and exit were the main contributors and the boom was when plant growth was the main contributor (Disney et al, 2000).
4. Whilst the contribution of entry and exit varies from study to study and time period to time period, since competition raises incumbent productivity growth, the contribution of reallocation here should be regarded as a lower bound on the importance of competition for productivity growth.

4. How much does downsizing contribute to productivity growth?

To develop policies to raise productivity growth we have to understand the causes of productivity growth in survivors. One possible cause of the former is downsizing. Between 1980 and 1994 UK manufacturing productivity grew by around 4.5% pa.[4] Between 1994 and 1998 it fell by around 0.4% pa. Between 1980 and 1994, manufacturing employment fell by 2.5m, a fall of 46%. Between 1994 and 1999 employment rose, from 4.3m to 4.5m. It has therefore been suggested that the lack of downsizing explains the late 1990s standstill.

As we have seen however, substantial heterogeneity in enterprise performance suggests that using aggregate data might be misleading. We therefore use establishment-level data to track surviving establishments over time and analyse their performance (this method is that used by Baily, Bartelsman and Haltiwanger, 1996, for the US and Oulton, 2000, for the UK in the 1970s and 1980s). Table 4 sets out our results.

Table 4: Downsizing and Productivity Growth in the UK

	1980-92	1994-97
% of plants downsizing	62	42
+ productivity rising	52	25
+ productivity falling	10	17
% of plants upsizing	38	58
+ productivity rising	29	32
+ productivity falling	9	26

Source: Authors' calculations using the ARD.
Note: Figures show % of plants in the base year. Data are establishments, called plants here for convenience.

The table uses plant-level data for 1980-92 and 1994-1998 (the missing years are due to data problems). Over any period a plant can downsize or upsize, and can raise or lower productivity. The table shows the fraction of plants falling into each category. Column 1 shows that 62% of plants between 1980 and 1992 downsized and 38% upsized. It also shows that 52% of plants in 1980 downsized and raised productivity growth, whilst 10% downsized and lowered productivity growth. Column 3 shows that between 1994 and 1998 42% of plants downsized and 58% upsized. 25% of plants downsized and raised productivity growth whilst 17% of plants downsized and lowered productivity growth.

It is therefore true that in the 1990s fewer plants downsized. But as the table shows, it is not necessarily the case that if plants downsize their productivity grows. Looking at column 2 for example, a bit over half the plants who upsized (32/58) raised their productivity. Hence the productivity slowdown in the 1990s might equally be ascribed to a problem of insufficient upsizing. Barnes and Haskel (2000b) contains more analysis and data but the point is that productivity growth and employment size are two endogenous variables and hence the ultimate causes of slow productivity growth depend on what drives these two variables.

5. Conclusions and policy implications.

The policy conclusions are necessarily tentative since a fuller evaluation of policy requires a cost-benefit analysis, clarification of

3 Our data shows a negative correlation between the dispersion of productivity and productivity growth of the industry (correlation coefficient -0.11)
4 Data from the OCED.

precise market failures involved and the like. But our conclusions can be stated as follows.

1. Growth accounting, typically conducted at the aggregate level, shows that technology, capital and labour all raise productivity growth. But it does not tell us the mechanism by which this occurs. We do not know from growth accounting whether, for example, productivity growth due to increased capital intensity is driven by more capital in existing firms, or the disappearance of old replacement capital due to exit, or the appearance of new capital from entry. Hence plant-level studies are vital for understanding productivity growth.

2. The major insight from plant-level evidence is that at least half of productivity growth over a decade is due to changes in the market fortunes of good and bad firms, with entry and exit particularly important in this reallocation process. Thus policy has to let the market work. Hindrance of free entry, propping up firms who would otherwise exit and stopping firms from competing will all slow the reallocation process down that is crucial for raising productivity. Of course, a number of market interventions might be well justified on other grounds, e.g. planning rules might prevent entry but be beneficial for the environment. This suggests that detailed policy initiatives have to be looked at for their possible conflicting effects on productivity.

3. Finally, the broader policy picture. Encouraging a faster pace of reallocation is likely to raise productivity, but also raises job insecurity, bankruptcies and riskiness in the economy. For citizens to accept such an economy the state would probably have to provide insurance where individuals cannot. This may take the form of unemployment insurance but also ensuring that the social safety net is sufficient for citizens to accept the new, more disruptive, social contract.

Data Appendix

In this paper we derive results using micro-level data for the UK. It is necessary to use such data as aggregation causes much of the heterogeneity in the real world to be averaged out. The ONS has however recently provided contracted researchers (who are subject to ONS data security agreements) access to extensive micro-data as part of a Business Data Linking Project.

Data for the 1980s are described in more detail in Disney et al (2000). This appendix describes the 1990s data although much of the description also applies to the earlier period. The data we use are the raw micro data from the UK *Annual Census of Production* (ACOP) (now the *Annual Business Inquiry* (ABI)) and so are a representative longitudinal database similar in design to the LRD in the US. These data have at least three advantages relative to macro-data. First, since they are Census data they are more representative than other studies. Second, we have arranged the data at plant level and hence it is compatible with other work.[5] Third, we can identify entry, exit and survival and so can follow plants through time and calculate the productivity of an individual plant.[6]

The data set being used is known as the *Annual Respondents Database* (ARD). Data are drawn from the CSO business register. The ARD until 1994 was based on the ACOP drawn from a register maintained by the Office for National Statistics (ONS). In 1994 this register was re-organised and combined with others to become the *Inter Departmental Business Register* (IDBR).[7] Both stages of the register make use of VAT records, PAYE, other surveys and historical information. The IDBR was the result of combining the registers held by different government departments. It makes use of all available information, including commercial data (such as Dunn and Bradstreet), and is considered to be very comprehensive and reliable.

Observations are at the level of the smallest autonomous unit within each firm. These are termed establishments pre-1994 and are now called enterprise reporting units. In this paper we work at this level and refer to them as plants.

The details of the ARD are as follows. The ARD is the micro-data underlying the industry-level aggregates published annually in the *UK Census of Production, Summary Volume.* Census results have been published since 1907, but we have usable micro data since 1980.[8] The micro data is based on a register of business addresses.

This study is the first to make use of the data up to 1997. The 1990s results are based on an early release of the data which consists only of the survey answers and has been cleaned by ONS to deal with outliers and data errors. Ordinarily we would make use of the rest of the business register to enable grossing up for the whole economy. Until very recently we have not been able to do this for these data, however experience shows us that this does not dramatically alter the results of the type of analysis undertaken in this paper. We are now in the process of preparing the full set of data for use with the assistance of ONS. In due course we will repeat this analysis to check the results do not change significantly.

References

Baily, M. N., Bartelsman, E. J., and Haltiwanger, J., (1996), "Downsizing and productivity growth: myth or reality?", in Mayes, D. G., (ed.), *Sources of Productivity Growth,* Cambridge, Cambridge University Press.

Barnes, M., and Haskel, J., (2000a), "Did Lack of Downsizing Slow Down 1990s UK Manufacturing Productivity Growth?", *Queen Mary, University of London Draft Paper.* available at <www.qmw.ac.uk/~ugte153>.

Barnes, M. and Haskel, J., (2000b), "Productivity Growth in the 1990s: Evidence from British Plants", *Queen Mary, University of London Draft Paper,* available at <www.qmw.ac.uk/~ugte193>.

Barnes, M. and Haskel, J., (2000c), "Job creation, Job Destruction and Small Firms: Evidence for the UK", *Queen Mary, University of London Draft Paper,* available at <www.qmw.ac.uk/~ugte193>.

Disney, R., Haskel, J., and Heden, Y. (1999), "Exit, entry and establishment survival in UK manufacturing, Centre for Research on Globalisation and Labour Markets", *Research Paper 99/9,* University of Nottingham.

Disney, R., Haskel, J., and Heden, Y. (2000), "Restructuring and Productivity Growth in UK Manufacturing", *Queen Mary, University of London Research Paper,* available at <www.qmw.ac.uk/~ugte153>.

Foster, L., Haltiwanger, J., and Krizan, C., (1998), "Aggregate productivity growth: Lessons from Microeconomic Evidence", *NBER Working Paper 6803.*

Griffith, R., (1999), "Using the ARD establishment Level Data to look at Foreign ownership and Productivity in the UK", *Economic Journal,* 109, 456, F416-F442.

Harris, R. I. D., and Drinkwater, S., (1999), "Productive efficiency in UK manufacturing 1974-94", *mimeo, University of Portsmouth.*

5 Plant level means reporting unit level for the UK. See later text for details.
6 Other work using the ARD has looked at productivity, (Disney et al (2000), Griffith (1999), Harris and Drinkwater (1999), and Oulton (1997, 2000)), entry and exit (Disney et al, 1999), skill upgrading (Haskel and Heden (1999)), and job creation and destruction (Barnes and Haskel (2000c)). For a more detailed description of the data please refer to these papers.
7 The register change effectively means that there is a new database starting in 1994. Attempts to link comprehensively from one register to another are proceeding.
8 The pre-1972 paper records were destroyed. Employment for the 1970s non-selected data (see below) is missing and hence we cannot weight these data satisfactorily.

Haskel, J., (2000), "What raises productivity? The microeconomics of UK productivity growth", *Queen Mary, University of London Research Paper* draft paper, available at <www.qmw.ac.uk/~ugte153>.

Haskel, J., and Heden, Y., (1999), "Computers and the demand for labour: Industry and establishment-level evidence for the UK", *Economic Journal,* 109, 454, C68-C79.

Oulton, N., (1997), "The ABI Respondents Database: A new resource for industrial economics research" *Economic Trends,* 528, November, 46-57.

Oulton, N., (2000), "A tale of two cycles: closure downsizing and productivity growth in manufacturing, 1973-89" *National Institute Economic Review,* 173, July 2000.