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Abstract

We present novel stylized facts on the cyclicality of labour productivity for large and small firms and contrast them with those at the aggregate level. We find that the large-firm output-labour productivity correlation declines by nearly 0.5 from the pre-1985 to post-1985 period, closely resembling the decline of 0.6 in the aggregate annual data. The lead-lag correlation pattern is also similar to that in the aggregate data. We do not find patterns consistent with these facts for small firms. Our findings are of direct relevance to the growing literature on the role of large firms in driving US business cycles.

Key words: Large Firms, Labour Productivity, Business Cycles
JEL classification: D22, E24, E32

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1 Introduction

The behaviour of aggregate labour productivity has changed substantially since the onset of the Great Moderation in the mid-1980s. Labour productivity used to be strongly procyclical, moving together with output over the business cycle. Since the onset of the Great Moderation, however, this relationship has entirely disappeared. It is now nearly acyclical when labour productivity is defined as output per worker or moderately countercylical when labour productivity is defined as output per hour. Explaining this change in contemporaneous cyclicality – the *labour producitivity puzzle* – has attracted a large amount of research in the business cycle literature (Galí and Gambetti (2009), Stiroh (2009), Barnichon (2010), Garin, Pries and Sims (2018), Galí and van Rens (2020), Mitra (2020)). At the same time labour productivity also lost its positive leading economic indicator property and now negatively lags the business cycle (Brault and Khan 2020). Motivated by recent research on the role of large firms we ask the following question: Does the cyclical behaviour of labour productivity among large firms resemble the cyclicality observed at the aggregate level?

Several recent contributions have studied the role of large firms from a variety of perspectives. Carvalho and Grassi (2019) propose a model of the business cycle in which idiosyncratic shocks can drive the cycle due to the presence of large firms. They find that the largest firms can account for roughly 30% of aggregate fluctuations. Daniele and Stüber (2021) examine local labour markets in Germany and find that higher local concentration is associated with more persistent local employment and higher conditional volatility; facts which are consistent with the large firm model proposed by Carvalho and Grassi (2019). Crouzet and Mehrotra (2020) examine the cyclicality of small and large firms and provide evidence that small firms are more sensitive to movements in GDP than large firms and suggest that small firms likely have a negligible effect on aggregate fluctuations. Autor, Dorn, Katz, Patterson and Van Reenen (2020) provide a new interpretation of the fall in the labour share based on the rise of 'superstar firms'.[1] Gutiérrez and Philippon (2019, 2020) examine the economic footprint of these firms in the US and internationally, and find that contrary to popular wis-

[1]See, for example, Acemoglou (2020) and Vives (2020) on the role of market power of firms such as Google/Alphabet, Apple, Facebook, Amazon, and Microsoft (referred to with the acronym *GAFAM*).

dom superstar firms have not become larger by shares of employees or sales, and that their contribution to productivity growth has fallen by more than 1/3 since 2000.

A separate literature emphasizes the role that sectoral shocks play in aggregate business cycle dynamics. Recently, vom Lehn and Winberry (2019) argue that because the majority of investment goods are produced in what they refer to as 'investment hubs', shocks to these sectors generate large employment effects. They show using a multisector real business cycle model that a rise in sector specific shocks relative to aggregate shocks is capable of explaining the decline in the procyclicality of labour productivity.[2]

Our contribution to the literature is threefolds. First, we present novel stylized facts on the behaviour of labour productivity among large firms over the US business cycle. Second, we document productivity dynamics across firm size and industries, in particular, sectors such as manufacturing, non-manufacturing, and investment hubs. Third, our findings can serve as a useful benchmark to evaluate the properties of theoretical models of business cycles in which large firms play a central role.

From the Computstat database which covers all publicly listed firms, we compute firm specific measures of labour productivity. Using these, we construct a weighted-average of labour productivity conditional on firm size/sectors. We then compare the cyclicality of this measure with aggregate output. This comparison allows us to evaluate the sectors and the part of the firm size distribution for labour productivity that most closely resemble aggregate labour productivity dynamics. Our measure of firm-level productivity as the ratio of real sales and employment and the cut-off of 20,000 employees or more to define 'large firms' are the same as the productivity definition and upper cutoff in Carvalho and Grassi (2019). We label as 'small firms' those with less than the 20,000 employees. Notably, as we show below, the share of employees working in large firms relative to all firms has increased quite dramatically from 62.3% in 1994 to 76.6% in 2018.

The main results on cyclicality and the lead-lag relationships are as follows: First, during the pre-1985 period, large firm labour productivity was moderately procyclical with a cor-

[2]Both Foerster, Sarte and Watson (2011) and Garin, Pries and Sims (2018) provide evidence in favour of a decline in the importance of aggregate shocks, increasing the relative importance of sectoral shocks.

relation coefficient of 0.25. In the post-1985 period this correlation declined significantly to -0.22. The magnitude of this decline, -0.47, is quite close to the decline in the aggregate contemporaneous cyclicality, which is -0.6. We find that the decline in the contemporaneous cyclicality of large firms occurred primarily in manufacturing/investment hubs industries. In contrast to this result, small firms exhibit an increase in the procyclicality of labour productivity over this period. Second, we find that the lead-lag pattern (i.e. correlations between labour productivity and output at different leads and lags) of large firms matches the aggregate data quite closely. In the pre-1985 period both aggregate and large-firm labour productivity were, respectively, strongly positively correlated with current and future output. In the post-1985 period both aggregate and large-firm labour productivity negatively lag the business cycle. Third, an aspect of the labour productivity puzzle is that its correlation with the labour input declined sharply after the mid-1980s, turning from procyclical to countercyclical (Galí and Gambetti (2009), Stiroh (2009)). We find that a similar dampening in the correlation and its sign-switch has occured only among the large firms. For small firms the correlation has remained strongly procyclical after the mid-1980s.

Based on the patterns of large-firm labour productivity and aggregate labour productivity we have documented, we think that large-firm behaviour prior to and after the Great Moderation can shed light on the labour productivity puzzle and the phase-shift in aggregate labour productivity observed since the mid-1980s.

2 Data & Results

Our analysis is based on annual data. We obtain the aggregate annual data from the Federal Reserve Bank of St. Louis (FRED). Our measure of the aggregate state of the economy is Nonfarm Business Sector: Real Output (FRED code: `OUTNFB`) and our measure of employment is the Nonfarm Business Sector: Employment (FRED code: `PRS85006013`). We define aggregate labour productivity as real output divided by the level of employment. We take logs and detrend output, employment, and productivity using the Hodrick-Prescott (HP) filter with a smoothing parameter of 6.25.[3]

For labour productivity measures conditional on firm size we use the Compustat database which covers all publicly listed firms in the US. The database provides sales and employment information at an annual frequency and we use data from the years 1963 to 2018. Since our measure of the aggregate business cycle is the non-farm business sector, we exclude all firms with NAICS codes below 20 (agriculture, forestry, fishing and hunting) and above 90 (government). We focus exclusively on firms located in the US and drop firms with negative sales.[4]

To compute real sales measures we use the BEA GDP by Industry accounts price indexes. Industry accounts roughly correspond to NAICS 3 digit codes. In cases where we cannot identify a firm based on NAICS 3 digit codes, we use a NAICS 2 digit code.[5] We define labour productivity for firm i in industry j in year t by

$$z_{i,t} \equiv \frac{sales_{i,t}}{p_{j,t} n_{i,t}}, \tag{1}$$

where $sales_{i,t}$ is nominal sales in Compustat, $p_{j,t}$ is industry j's BEA price deflator, and $n_{i,t}$ in the number of employees reported in Compustat. After obtaining firm specific measures of labour productivity we construct an aggregate measure conditional on firm size and sector by

$$\text{Labour Productivity}_{t|size,sector} = \sum_{i=1}^{N} \omega_{i,t} z_{i,t} \tag{2}$$

where N is the number of firms conditional on size and sector(s) and $\omega_{i,t}$ is a firm weighting based on the firms employment size relative to total employment in that size/sector (i.e., $\omega_{i,t} \equiv \frac{n_{i,t}}{\sum_{i=1}^{N} n_{i,t}}$).[6] After computing the above productivity measure, we detrend the log of the time series with the HP filter.

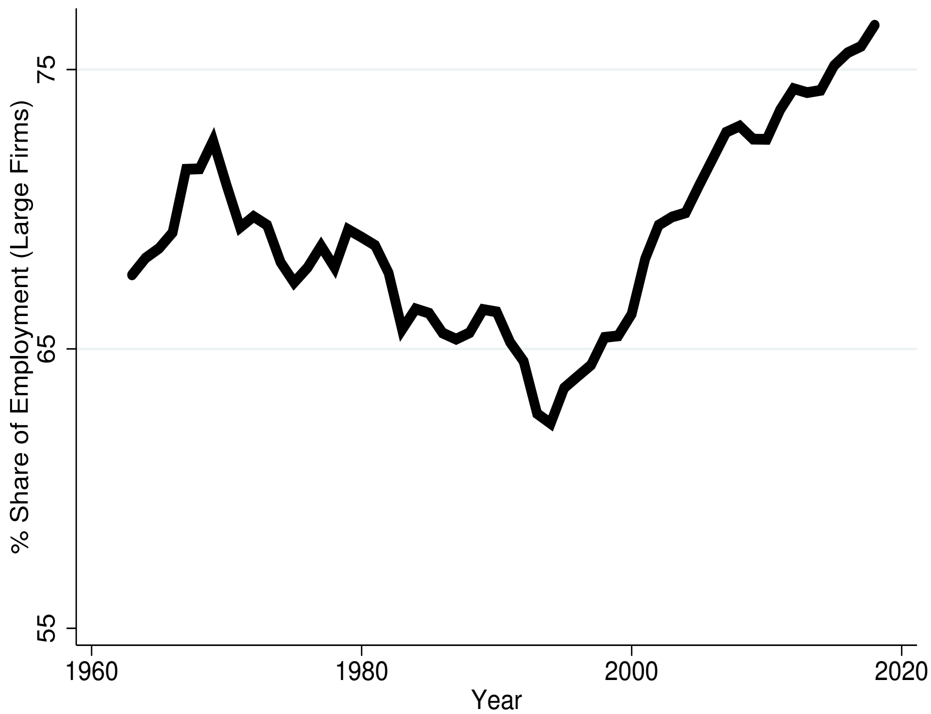
[3]The correlations are similar when using alternative filters, such as the one suggested by Hamilton (2018). These results are available upon request.

[4]Additional details on our Compustat data construction are available in the Appendix.

[5]This case represents a very small sample of our observations, roughly equal to 5% of our firm-year observations. Our NAICS mapping to industries is reported in the Appendix.

[6]For robustness we consider an alternative sales based weighting scheme in Section 3.

Figure 1: THE SHARE OF TOTAL EMPLOYMENT ACCOUNTED BY LARGE FIRMS



Notes: Total employment is defined as the sum of employment in our Compustat database of firms.

The employment share of large firms declined during the 1970s and 1980s, since its peak in 1969. It, however, increased steadily from 62.3% in 1994 to 76.6% in 2018, suggesting the growing importance of large firms in the labour market.

2.1 Cyclicality: Contemporaneous correlations

Table 1 reports the correlations between aggregate output, Y_t^{agg}, and aggregate labour productivity, and between aggregate output and labour productivity for large and small firms. All measures are logged and HP filtered.

We report these correlations for all industries, manufacturing, and non-manufacturing. Additionally, we report measures for investment hubs as described by vom Lehn and Winberry (2019).[7] In the bottom row of each subset of industries we report the number of firm-

[7]Investment hubs are businesses belonging to construction, machinery, manufacturing, motor vehicles man-

year observations used in constructing the labour productivity measure conditional on firm size and industry.

Table 1. CYCLICAL LABOUR PRODUCTIVITY: AGGREGATE, LARGE FIRMS, AND SMALL FIRMS

Panel A		**All Industries**			**Manufacturing**		
		Correlation(Y_t^{agg}, $Prod_t^{size}$)			Correlation(Y_t^{agg}, $Prod_t^{size}$)		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.77	0.48	0.45	0.25	0.34	0.54	0.12
1985-2018	0.17	0.12	0.49	-0.22	-0.11	0.39	-0.29
Firm-year obs.		271,004	253,049	17,955	111,434	103,774	7,660

Panel B		**Investment hubs**			**Non-Manufacturing**		
		Correlation(Y_t^{agg}, $Prod_t^{size}$)			Correlation(Y_t^{agg}, $Prod_t^{size}$)		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.77	0.33	0.52	0.12	0.30	0.34	0.15
1985-2018	0.17	-0.10	0.43	-0.30	0.26	0.35	0.11
Firm-year obs.		125,386	117,060	8,326	159,570	149,275	10,295

Notes: The table reports the correlations between labour productivity and aggregate output (Y^{agg}). The 'Aggregate' column shows the correlation based on aggregate productivity. We have computed standard errors (not reported) for these correlations using the Delta method with a Newey-West estimator and 4 lags and they are statistically significant.

Under the aggregate column we can see the *labour productivity puzzle* - the sharp drop in the procyclicality productivity after the mid-1980s. In the pre-1985 data, labour productivity was strongly procyclical over the business cycle. In the post-1985 period, however, this correlation fell dramatically to the point where it is only mildly procyclical. Based on all firms in our Compustat data we find a pattern similar to the aggregate, labour productivity was moderately procyclical during pre-1985 period and mildly procyclical afterwards.

The first novel stylized fact is that the decline in the aggregate output labour productivity correlation is quite close to the decline experienced by large firms (-0.6 vs. -0.47). In

ufacturing and professional / technical services industries. We report the corresponding NAICS codes for the hubs classification we use in the Appendix.

sharp contrast, firms with less than 20,000 employees exhibit a slight increase in the cyclicality of labour productivity over this period. Large-firm labour productivity is moderately procyclical in the pre-1985 period and moderately countercyclical in the post-1985 period.

The remaining parts of the table examine average labour productivity based on subsets of industries. It is worth noting that investment hubs emphasized by vom Lehn and Winberry (2019) closely correspond to the manufacturing sector. Manufacturing is included in investment hubs. Comparing the number of firm-year observations under manufacturing and investment hubs, it is quite clear that manufacturing comprises about 90% of investment hubs. Compared to our large-firm all industries results, we find that manufacturing and investment hubs exhibit similar changes in their labour productivity dynamics. Both are mildly procyclical in the pre-1985 period and moderately countercylical in the post-1985 period. Large-firms in non-manufacturing do not exhibit much change in cyclicality over this period.

While countercyclical labour productivity of large firms in the post-1985 period appears at odds with the mildly procyclical correlation in the aggregate data, it is worthwhile to note the following data properties. When labour productivity is defined as output per hour, that is, including both extensive and intensive margin adjustments, large firm labour productivity cyclicality matches close with the aggregate. Table 2 reports aggregate labour productivity cyclicality across the periods when aggregate labour productivity is defined as output per worker and output per hour.[8] Aggregate labour productivity cyclicality is moderately countercyclical in the post-1985 period when it is defined as output per hour with a correlation of -0.26. Our firm level data does not allow for a direct comparison to this result, but reinforces the point that countercyclical labour productivity at the large firm level is not inconsistent with the aggregate data. Regardless of labour productivity measure, the dampening observed in cyclicality at the aggregate level is not observed for small firms.

[8] Our measure of hours worked used in constructing output per hour is the Nonfarm Business Sector: Hours of All Persons (FRED code: `HOANBS`).

Table 2. OUTPUT-LABOUR PRODUCTIVITY CORRELATIONS: AGGREGATE (EMPLOYMENT- AND HOURS-BASED), LARGE FIRMS (ALL INDUSTRIES), AND SMALL FIRMS (ALL INDUSTRIES)

Sample	Output/worker	Output/hour	Large Firms	Small Firms
1963-1984	0.77	0.68	0.25	0.45
1985-2018	0.17	-0.26	-0.22	0.49

Notes: The table reports the correlations between aggregate labour productivity and aggregate output using different definitions of labour productivity. The last two columns is the same as the result reported in Table 1, shown here for convenience. We have computed standard errors (not reported) for these correlations using the Delta method with a Newey-West estimator and 4 lags and they are statistically significant.

2.2 Business cycle lead-lag properties

Figure 2 shows the shifts in lead-lag properties of labour productivity for the aggregate, large, and small firms across all industries. In the first row we observe that during the pre-1985 period aggregate labour productivity (black line) exhibited no lead-lag pattern with the largest absolute cross-correlation equal to $Corr(Y_t^{agg}, Prod_t^{agg}) = 0.77$.[9] Large firm labour productivity in all industries (red line) is positively correlated with future output, but the largest absolute correlation is $Corr(Y_t^{agg}, Prod_{t+2}^{>20k}) = -0.41$. In the second row we observe that small firm labour productivity in all industries during the pre-1985 period exhibits a negative correlation with future output and a positive lagging property with $Corr(Y_t^{agg}, Prod_{t+2}^{<=20k}) = 0.67$.

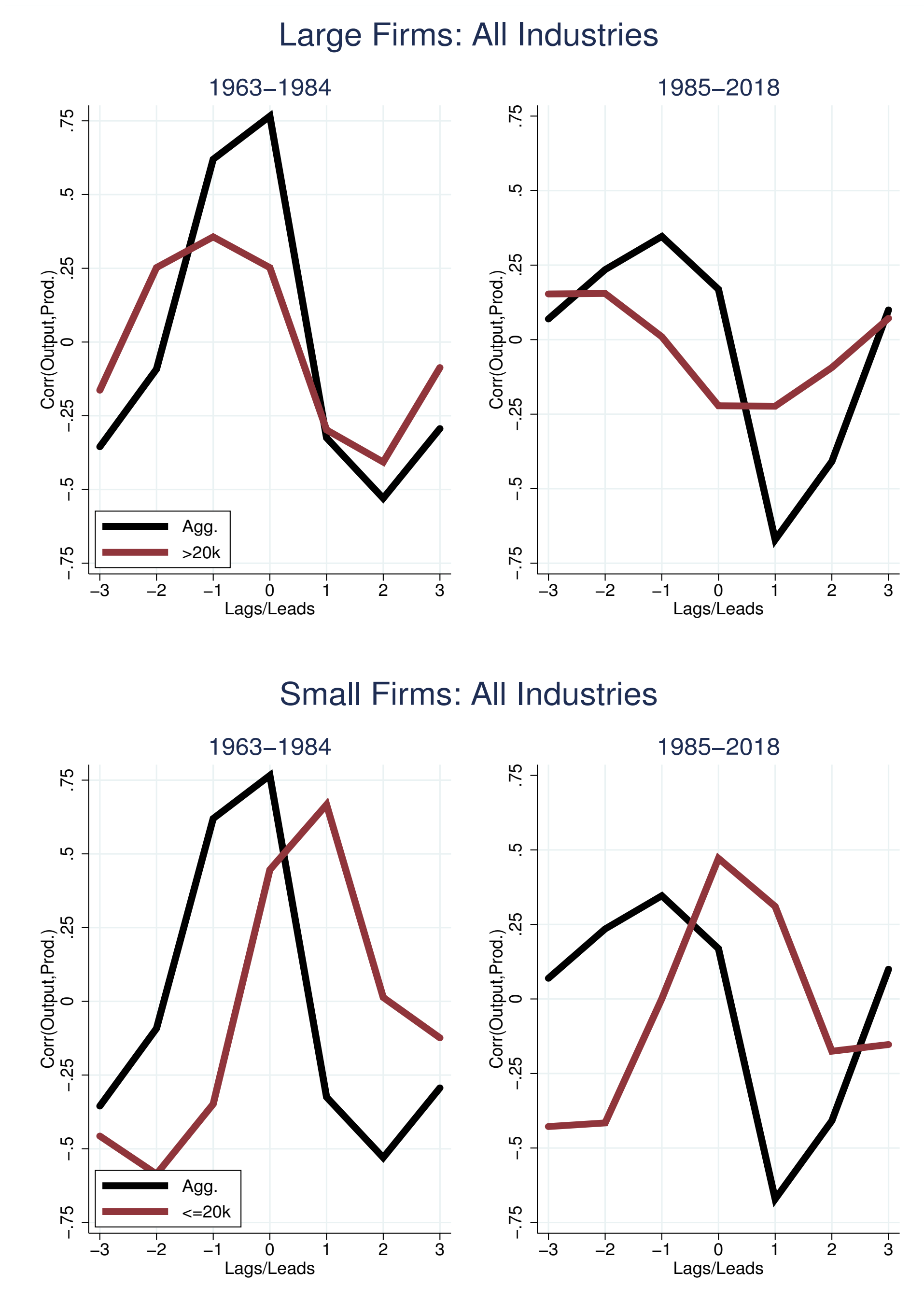
In the post-1985 period, aggregate labour productivity experiences a substantial change in its lead-lag pattern and strongly negatively lags the business cycle with the largest absolute correlation given by $Corr(Y_t^{agg}, Prod_{t+1}^{agg}) = -0.67$ (Brault and Khan (2020)).

The second novel stylized fact is that large-firm labour productivity has a negatively lagging pattern in the post-1985 period, consistent with the aggregate, with the largest absolute correlation of $Corr(Y_t^{agg}, Prod_{t+1}^{>20k}) = -0.22$. More generally, the correlations at different leads and lags for large firms in both periods are broadly consistent with those in the aggregate data. By contrast, the largest correlation for small firms is contemporaneous with $Corr(Y_t^{agg}, Prod_t^{<=20k}) = 0.47$, which is at odds with the aggregate data.

Since large firms appear to closely match the aggregate, we examine large firms by sec-

[9] The positive leading indicator property highlighted by the literature during this period is based on quarterly data, so this result is not necessarily inconsistent with that literature since we are working with annual data.

Figure 2: CORRELATIONS AT DIFFERENT LEADS AND LAGS



tors. When we consider large firms in manufacturing and non-manufacturing sectors (not shown), we find that neither is consistent with the lead-lag patterns in the aggregate data. In the pre-1985 period labour productivity in large manufacturing firms exhibits a positive leading indicator property with $Corr(Y_t^{agg}, Prod_{t-2}^{>20k}) = 0.49$. In the post-1985 period it again leads the aggregate business cycle with $Corr(Y_t^{agg}, Prod_{t-3}^{>20k}) = 0.37$. In the non-manufacturing sectors labour productivity negatively leads the business cycle in both periods, with $Corr(Y_t^{agg}, Prod_{t-2}^{>20k}) = -0.53$ in the pre-1985 period and $Corr(Y_t^{agg}, Prod_{t-3}^{>20k}) = -0.51$ in the post-1985.

2.3 Labour productivity and labour input correlations

One aspect of aggregate labour productivity puzzle as noted by Galí and Gambetti (2009) and Stiroh (2009) is that its correlation with the labour input declined sharply after the mid-1980s, turning from procyclical to countercyclical.

The third novel fact is that only large firms exhibit the dampening and the sign-switch in this labour productivity-labour input correlation similar to that observed at the aggregate level. For small firms the correlation has remained strongly procyclical.

Table 3. LABOUR PRODUCTIVITY AND AGGREGATE EMPLOYMENT OVER THE CYCLE

Panel A		**All Industries**			**Manufacturing**		
		Correlation($Prod_t^{size}$, E_t^{agg})			Correlation($Prod_t^{size}$, E_t^{agg})		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.28	0.44	0.61	0.11	0.21	0.43	0.00
1985-2018	-0.37	0.14	0.47	-0.16	0.00	0.29	-0.14
Firm-year obs.		271,004	253,049	17,955	111,434	103,774	7,660

Panel B		**Investment hubs**			**Non-Manufacturing**		
		Correlation($Prod_t^{size}$, E_t^{agg})			Correlation($Prod_t^{size}$, E_t^{agg})		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.28	0.20	0.40	0.00	0.45	0.60	0.20
1985-2018	-0.37	-0.01	0.33	-0.16	0.21	0.42	0.03
Firm-year obs.		125,386	117,060	8,326	159,570	149,275	10,295

Notes: The table reports the correlations between labour productivity and aggregate employment (E^{agg}). The 'Aggregate' column shows the correlation based on aggregate productivity and aggregate employment. We have computed standard errors (not reported) for these correlations using the Delta method with a Newey-West estimator and 4 lags.

3 Some additional considerations

In the following sections we consider two additional considerations relative to our baseline results in Section 2.

3.1 End of year filing date

One potential concern with labour productivity measures based on the annual Compustat data is that filing dates for some firms does not necessarily coincide with year end measures of our aggregate output variable. For example, some firms consider their fiscal year end in the month of June. This may have the unintended effect of distorting our cyclicality measures. To check whether this issue matters, we restrict our Compustat database to only those firms which file on the last day of December. Table 4 reports the cyclicality of labour productivity based on this restriction. The number of year-firm observations on large firms decreases from 17,955 in the baseline case (Table 1) to 12,269.

Comparing the results in Table 4 to Table 1, we find little difference. This suggests that the timing of filing dates is not an important factor in any of the results presented in Section 2.

Table 4. ROBUSTNESS: FIRMS WITH FILE DATES OF 12/31

Panel A		**All Industries**			**Manufacturing**		
		Correlation(Y_t^{agg}, $Prod_t^{size}$)			Correlation(Y_t^{agg}, $Prod_t^{size}$)		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.77	0.47	0.50	0.24	0.31	0.56	0.11
1985-2018	0.17	0.04	0.42	-0.28	-0.12	0.35	-0.28
Firm-year obs.		174,291	161,599	12,692	64,077	58,237	5,840

Panel B		**Investment hubs**			**Non-Manufacturing**		
		Correlation(Y_t^{agg}, $Prod_t^{size}$)			Correlation(Y_t^{agg}, $Prod_t^{size}$)		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.77	0.31	0.55	0.12	0.36	0.39	0.19
1985-2018	0.17	-0.14	0.38	-0.31	0.17	0.26	-0.01
Firm-year obs.		72,397	66,153	6,244	110,214	103,362	6,852

Notes: The table reports the correlations between labour productivity and aggregate output (Y^{agg}). The 'Aggregate' column shows the correlation based on aggregate productivity. We have computed standard errors (not reported) for these correlations using the Delta method with a Newey-West estimator and 4 lags and they are statistically significant, except for non-manufacturing in the post-1985 period which is statistically insignificant.

3.2 Alternative aggregation scheme

After computing firm level labour productivity measures in our baseline, we aggregate based on a firm's employment size relative to total employment conditional on size/sector. Below we consider an alternative aggregation based on real sales weights. In this case a firm's weight is given by

$$\omega_{i,t} = \frac{\frac{sales_{i,t}}{p_{j,t}}}{\sum_{i=1}^{N} \frac{sales_{i,t}}{p_{j,t}}}. \tag{3}$$

Table 5 presents results based on this aggregation method.

Table 5. ROBUSTNESS: SALES WEIGHTED AGGREGATION

Panel A		**All Industries**			**Manufacturing**		
		Correlation(Y_t^{agg}, $Prod_t^{size}$)			Correlation(Y_t^{agg}, $Prod_t^{size}$)		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.77	0.22	0.18	0.19	0.11	0.25	0.09
1985-2018	0.17	-0.26	-0.02	-0.38	-0.31	0.08	-0.40
Firm-year obs.		271,004	253,049	17,955	111,434	103,774	7,660

Panel B		**Investment hubs**			**Non-Manufacturing**		
		Correlation(Y_t^{agg}, $Prod_t^{size}$)			Correlation(Y_t^{agg}, $Prod_t^{size}$)		
Sample	**Aggregate**	All firms	$<= 20k$	$> 20k$	All firms	$<= 20k$	$> 20k$
1963-1984	0.77	0.12	0.26	0.09	0.20	0.17	0.47
1985-2018	0.17	-0.31	0.10	-0.40	0.07	0.02	0.05
Firm-year obs.		125,386	117,060	8,326	159,570	149,275	10,295

Notes: The table reports the correlations between labour productivity and aggregate output (Y^{agg}). The 'Aggregate' column shows the correlation based on aggregate productivity. We have computed standard errors (not reported) for these correlations using the Delta method with a Newey-West estimator and 4 lags.

In this case we find some differences with our baseline results. When we consider all firms in all industries, manufacturing, or investment hubs, the pre-1985 period is characterized by mild/moderate procyclicality. In the post-1985 these correlations all switch to moderately countercyclical. In the baseline, all industries fell to a mild procyclicality, but were not countercyclical. Another difference is found when we compare non-manufacturing. In the baseline large firms in non-manufacturing had mildly procyclical labour productivity in both the pre-1985 and post-1985 period. In the real sales weighted scheme, non-manufacturing labour productivity is moderately procyclical in the pre-1985 period and declines to roughly acyclical in the post-1985 period.

However when we focus exclusively on large firms, our baseline results appear quite robust. Large firm labour productivity in all industries, manufacturing, and investment hubs is mildly procyclical during the pre-1985 period and moderately countercyclical in the post-1985 period. The decline in the cyclicality is quite close to the aggregate, ranging from -0.57 to -0.42 (compared to -0.6 in the aggregate).

4 Conclusion

A significant research effort has gone into understanding the decline in the cyclicality of labour productivity in the US since the mid-1980s. At the same time, a major phase shift also occurred in that aggregate labour productivity negatively lags the business cycle. We studied whether large-firm labour productivity dynamics also display the cyclical properties of aggregate labour productivity and presented a set of novel stylized facts. Cyclical changes in large-firm labour productivity are broadly consistent with changes observed in the aggregate data. Large firm contemporaneous cyclicality declined significantly from the pre-1985 to post-1985 period, and the correlations at different leads and lags are close to the aggregate. The correlation of large-firm labour productivity with aggregate employment also matches the switch from procyclical to countercyclical behaviour. By contrast, labour productivity dynamics of small firms do not resemble the aggregate patterns. Changes in large-firm dynamics can, therefore, be a potential candidate to explain the *labour productivity puzzle*. More generally, our findings can serve as a useful benchmark to evaluate the properties of theoretical models of business cycles in which large firms play a central role.

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A Data Construction

A.1 Compustat Firm Level Data

Our firm level data is comprised of the universe of Compustat firms. We use firm level data from 1963 to 2018. We screen the Compustat data using $consol = "C"$, $indfmt = "INDL"$, $datafmt = "STD"$, $popsrc = "D"$, and $curcd = "USD"$. We only focus on firms located within the United States ($loc = "USA"$). We exclude all firms with NAICS codes less than 20 and greater than or equal to 90. Additionally we drop firms with negative sales and missing values for sales, employment, or the price index.

We deflate firms nominal sales using BEA industries price indices. These indices roughly correspond to 3 digit NAICS codes. In cases where 3 digit codes are not matched, we use two digit matching.

To compute cyclicality measures for investment hubs with use firms with the following NAICS codes: 236, 237, 238, 31, 32, 33, 321, 327, 331, 332, 333, 334, 335, 336, 337, 339, 311, 312, 313, 314, 315, 316, 322, 323, 324, 325, 326, 441, 54, 541.

BEA Industry NAICS Classification

	Assigned NAICS Code
All industries	
Private Industries	
Agriculture, forestry, fishing and hunting	11
Farms	111,112
Forestry, fishing and related activities	113,114,115
Mining	21
Oil and gas extraction	211
Mining, except oil and gas	212
Support activities for mining	213
Utilities	221
Construction	236,237,238
Manufacturing	31,32,33
Durable goods	
Wood products	321
Nonmetallic mineral products	327
Primary metals	331
Fabricated metal products	332
Machinery	333
Computer and electronic products	334
Electrical equipment, appliances, and components	335
Motor vehicles, bodies and trailers, and parts	336
Other transportation equipment	336
Furniture and related products	337
Miscellaneous manufacturing	339
Nondurable goods	
Food and beverage and tobacco products	311,312
Textile mills and textile product mills	313,314
Apparel and leather and allied products	315,316
Paper products	322
Printing and related support activities	323
Petroleum and coal products	324
Chemical products	325
Plastics and rubber products	326
Wholesale trade	423,424,425
Retail trade	44,45
Motor vehicle and parts dealers	441
Food and beverage stores	445
General merchandise stores	452
Other retail	453

BEA Industry NAICS Classification

	Assigned NAICS Code
Transportation and warehousing	48, 49
Air transportation	481
Rail transportation	482
Water transportation	483
Truck transportation	484
Transit and ground passenger transportation	485
Pipeline transportation	486
Other transportation and support activities	487,488,492
Warehousing and storage	493
Information	51
Publishing industries, except internet (includes software)	511
Motion picture and sound recording industries	512
Broadcasting and telecommunications	515
Data processing, internet publishing, and other information services	518,519
Finance, insurance, real estate, rental and leasing	
Finance and insurance	52
Federal Reserve banks, credit intermediation, and related activities	522
Securities, commodity contracts, and investments	523
Insurance carriers and related activities	524
Funds, trusts, and other financial vehicles	525
Real estate and rental and leasing	53
Real estate	531
Housing	
Other real estate	
Rental and leasing services and lessors of intangible assets	532
Professional and business services	
Professional, scientific, and technical services	54
Legal services	541
Computer systems design and related services	541
Miscellaneous professional, scientific, and technical services	541
Management of companies and enterprises	551
Administrative and waste management services	56
Administrative and support services	561
Waste management and remediation services	562
Educational services, health care, and social assistance	
Education services	611
Health care and social assistance	62
Ambulatory health care services	621
Hospitals and nursing and residential care facilities	623

BEA INDUSTRY NAICS CLASSIFICATION

	Assigned NAICS Code
Hospitals	622
Nursing and residential care facilities	623
Social assistance	624
Arts, entertainment, recreation, accommodation, and food services	
Arts, entertainment, and recreation	71
Performing arts, spectator, sports, museums, and related activities	711,712
Amusements, gambling, and recreation industries	713
Accommodation and food services	72
Accommodation	721
Food services and drinking places	722
Other services, except government	81
Government	92

Notes: Our classification is based on the industry code guide provided by the BEA available at https://www.bea.gov/sites/default/files/2018-04/2017-industry-code-guide.pdf.