BACKGROUND READING

Supply Stocktake (4/10)

Note title: **The UK Productivity Puzzle: An update on the Sector Story**

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Authors:

BACKGROUND READING

From **&**

THE UK PRODUCTIVITY PUZZLE: AN UPDATE ON THE SECTOR STORY

Main Message: ***The productivity puzzle remains largely the same, even after excluding the largest contributors to the aggregate puzzle. The role of total factor productivity, though, may be overstated by aggregate analysis.***

Key points

- **Though not entirely a sector story, the productivity puzzle does have a sector-specific dimension: a handful of sectors are responsible for nearly half the aggregate puzzle.**
- **Excluding these sectors, however, makes little difference to the size or shape of the puzzle (in terms of per cent deviation from trend).**
- **Weak total factor productivity (TFP) growth is a significant part of the puzzle, but a sector-level approach suggests the role of TFP could be overstated by aggregate analysis.**
- **There appears to be less capital re-allocation and greater use of labour relative to capital, relative to previous recessions.**

Overview of the productivity puzzle

1. UK labour productivity growth since the financial crisis has been exceptionally weak. So much so that, relative to a simple linear pre-crisis trend, output per hour is nearly 15% lower (**Chart 1**). This compares unfavourably to the UK experience in previous recessions (**Chart 2**), although it is not out of line with the international experience in this recession, apart, perhaps, from the United States and Spain (**Chart 3**).[1] While there are a number of different explanations for this productivity puzzle, the key causes, and the extent to which productivity will recover, remains an open question.

Chart 1: Labour productivity relative to pre-crisis trend

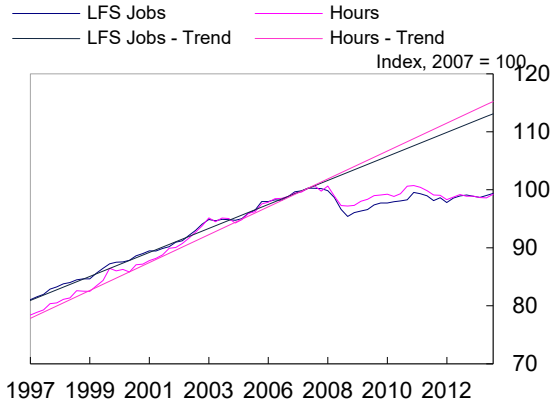
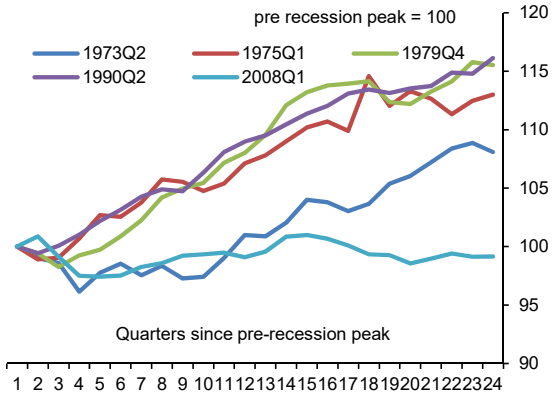


Chart 2: Labour productivity relative to previous recessions (hours)



2. This note takes another look at the UK productivity puzzle from a sectoral perspective. It breaks down the aggregate productivity short-fall into sector contributions, both at the 1-digit and 2-digit level, making use of an improved methodology. It then uses new estimates of capital services, both at the aggregate and at the sector (1-digit) level to look at the contributions of TFP and factor substitution to the aggregate shortfall. We use the most recent official output data (after significant revisions for *Blue Book* 2014), and new capital stock and capital services estimates (preferring to use in-house Bank estimates over the official series from the ONS).

3. While productivity in output-per-hour terms tends to be our preferred measure, the analysis presented here is in terms of labour productivity per head because data on hours are not readily available at the level of disaggregation we prefer. The extent and profile of the productivity puzzle that that arises using the two definitions are compared in **Chart 4**. The magnitude of the productivity puzzle relative to trend is smaller for output per worker since, although the fall in output per hour was smaller, the pre-crisis trend in productivity per hour was greater than that of output per worker[2]. The distinction between jobs and hours could affect the distribution of the productivity puzzle across sectors, although in practice the distribution of hours and workers may not differ sufficiently to do so materially.

[2] This, in turn, is due to the fact that average weekly hours had been flat or falling prior to the crisis, whereas employment had been rising.

Chart 3: Labour productivity – the international experience

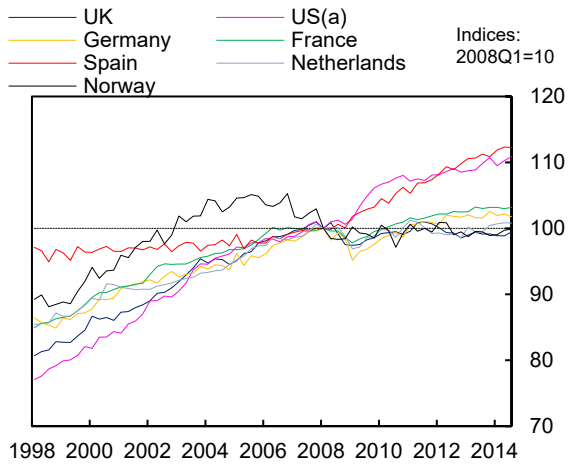
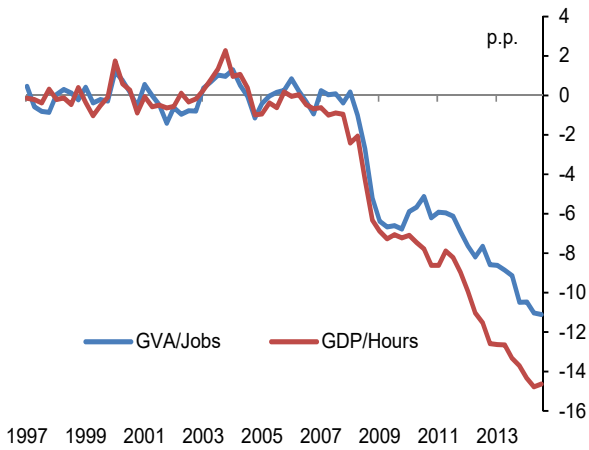


Chart 4: The productivity puzzle in hours and heads



Is the puzzle a sectoral puzzle?

4. Previous work has looked at whether there is a sectoral dimension to the productivity puzzle. This work has not reached a consensus: for example a 2014 speech by Ian McCafferty[3] concluded that there probably was a sectoral dimension to the puzzle. In contrast, other work by Bank staff suggested that there was much more variation within sectors – at the level of the firm – than there was between sectors.[4]

5. This note uses the revised output data and an improved methodology[5] to revisit this analysis. The results suggest that there is some truth to both conclusions: although not entirely a sectoral story, a handful of sectors, worth about 20% of GVA, are responsible for around 40% of the UK's aggregate productivity puzzle. Excluding these 4 largest contributors, however, does not markedly change the size or shape of the puzzle.

6. **Chart 5** illustrates the sectoral breakdown of the productivity puzzle at a fairly aggregated level (groups of 1-digit SIC codes). At this level of disaggregation, and consistent with the conclusions of previous work[6], the puzzle is *within* sectors – i.e. driven by falls in productivity of each sector - rather than by reallocations of resources *between* sectors. **Chart 6** shows the results of a similar exercise, but at a more disaggregated level. The main difference is that the business services bars are smaller, and the between sector bars are larger, suggesting that the *between* effect is largely due to movements in employment shares between business services sub-sectors (which at the 1-digit level are captured as *within* effects).

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[3] See, for example, 'The UK productivity puzzle – A sectoral perspective' by Ian McCafferty. In contrast to that speech, this analysis assesses the productivity puzzle relative to the continuation of a pre-crisis trend rather than the pre-crisis peak. A drawback of our approach is that it requires taking some stance on pre-crisis trends across sectors. An advantage is that it takes into account the differences in productivity growth across sectors pre-crisis.

[4] See, for example, Annex B in Barnett, Chiu, Franklin & Sebastiá-Barriel (2014).

[5] The methodology used here differs from previous sector-based analysis of the productivity puzzle, and so the decompositions and conclusions may differ. For a detailed explanation of this see

[6] Oulton (2013); Martin (2011).

Chart 5: Sectoral decomposition of the productivity puzzle (heads)

1-digit SIC codes

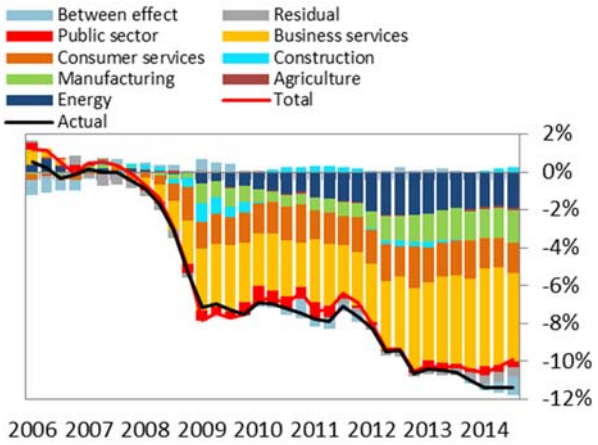
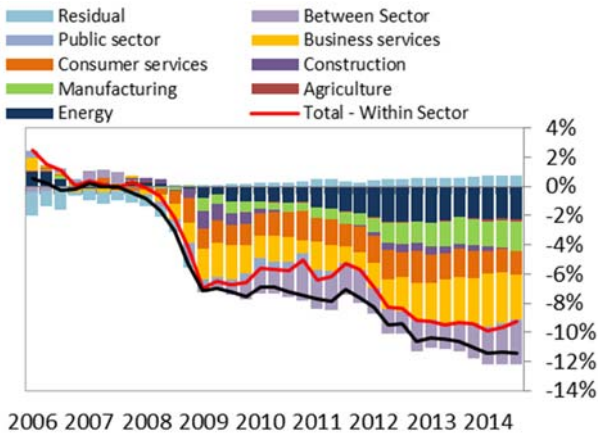


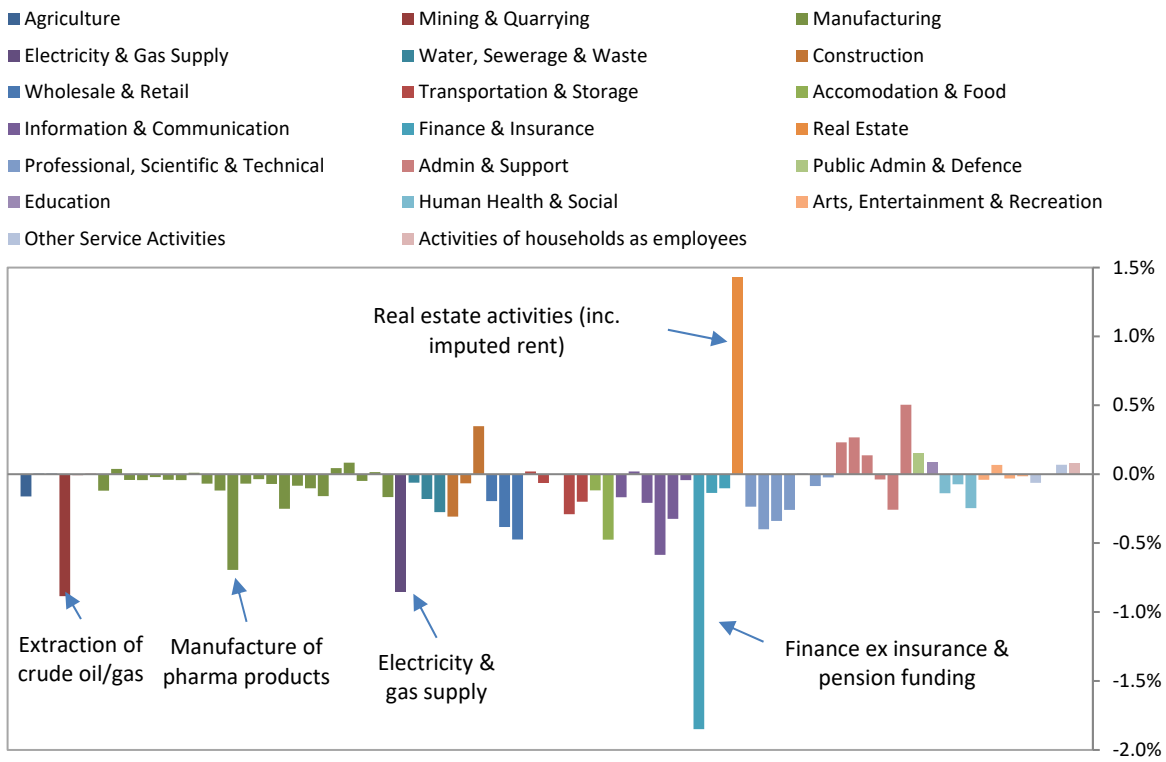
Chart 6: Sectoral decomposition of the productivity puzzle (heads)

2-digit SIC codes



7. **Chart 7** shows the distribution of contributions to the productivity puzzle at the 2-digit SIC code level of disaggregation.[7] Two things stand out. First, the majority of sectors have contributed to the productivity shortfall. And this is primarily because most sectors have seen small productivity shortfalls, rather than small sectors suffering disproportionately large shortfalls. Second, the distribution is negatively skewed and contains more weight in the left hand tales: in fact, just four sectors explain around 40% of the productivity puzzle.

Chart 7: The distribution of contributions to the productivity puzzle in 2014 Q3



[7] There may be limits to what insights sectoral data can provide, especially given that, at lower levels of aggregate, the data become less reliable.

8. Calculating productivity excluding the five outliers and the four largest contributors to the puzzle[8], however, gives quite a similar picture to the aggregate. The shape and magnitude (as a proportion of the trend) – of the puzzle is little changed, although the gap has not increased as much since 2009 (**Chart 8** and **Chart 9**). So, although a small number of sectors stand out in terms of their contribution to the overall puzzle, the characteristics of the puzzle would remain even without them.

Chart 8: Productivity, with and without the largest contributors to the puzzle

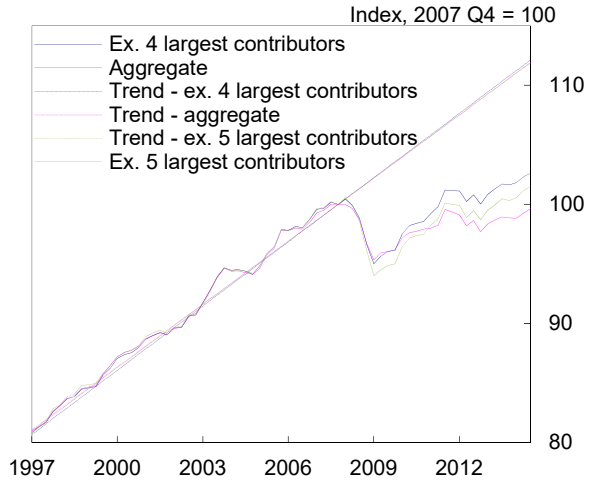
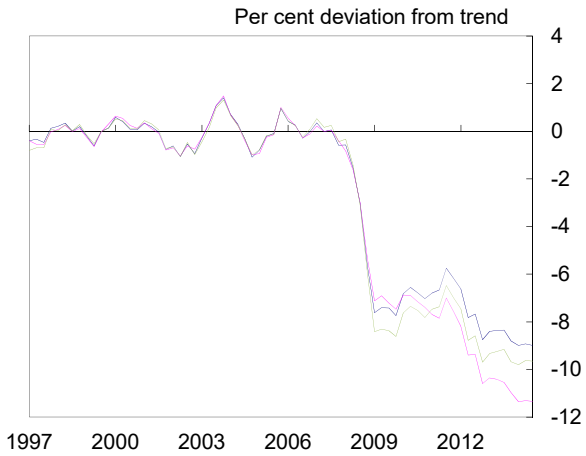


Chart 9: Deviation from trend productivity, with and without the largest contributors to the puzzle



Total Factor Productivity, or greater reliance on labour as an input?

9. Various papers have argued that the UK productivity puzzle is a Total Factor Productivity (TFP) puzzle.[9] That is, by assuming an aggregate production function they decompose the deviation of labour productivity from its pre-crisis trend into the contribution from changes in capital per worker and TFP. They generally find most of the deviation in productivity from trend is a result of weaker TFP growth, rather than a change in the amount of capital each worker can use. **Chart 10** illustrates our results from this exercise, which produces similar results.

10. New in-house estimates of capital services allow us to analyse labour productivity, and its components, at a 1-digit SIC code level. Bank estimates of sectoral capital services differ significantly to the latest ONS estimates released on 23rd January (**Chart 12**). We are in contact with the ONS about these differences; however our initial view is that the in-house estimates are more accurate, particularly in the earlier years of the series where the new ONS data appear implausibly strong.

11. Building the aggregate picture up from a sector level makes the picture looks a bit different (**Chart 11**).[10] With this approach, the productivity puzzle is still, in large part, a TFP puzzle, but the

[8] The chained volume measures series were re-chain-linked excluding the value-added for these four/five sectors, and then this new aggregate output series is divided by employment excluding those four/five sectors.
[9] See, for example, Goodridge, Haskell & Wallis (2014). For a contrasting view, see Pessoa and Van Reenen (2013), although this has been criticised by Oulton (2013).
[10] As with the top-down version, we use Tornqvist weights, but at the sector level (in this case, 1-digit SIC code), using sector specific labour and capital shares in income. Then we aggregate using the same weights we use to weight the contributions of sector labour productivity to the aggregate – i.e. the product of the growth

significance of factor substitution is markedly larger; being responsible for nearly half the total shortfall in labour productivity by the end of 2014. Which one of these decompositions one places more weight on depends to some extent on one's beliefs about the level at which it is most appropriate to assume a production function.

12. The two measures differ to the extent that there are differing returns to scale across sectors, or heterogeneity across sectors in the marginal products of factor inputs.[11] It is therefore preferable to use the bottom-up approach to account for these effects. This suggests, however, that the degree to which the UK's productivity puzzle is a TFP puzzle may be slightly smaller – by around 2pp – than implied from a top-down estimation.

Chart 10: Aggregate decomposition of labour productivity

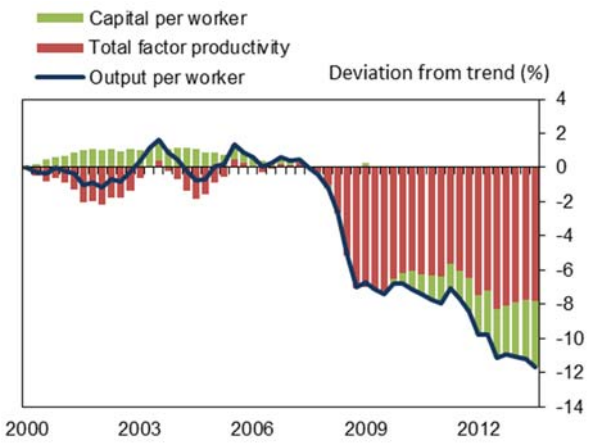
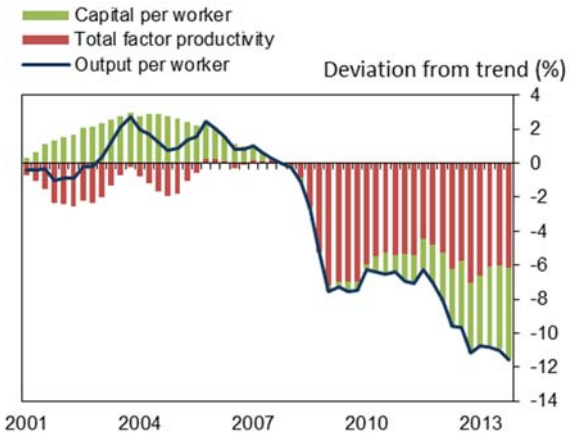


Chart 11: Sector decomposition of labour productivity



13. Using our preferred (sector-level) decomposition, **Chart 13** breaks down the contributions from the bottom-up approach in **Chart 11** into the contributions from each sector. Weak TFP growth is significant and the larger factor in nearly all sectors that have seen lower rates of productivity growth since 2008. But, lower capital per worker is an important factor in some sectors, and particularly in two – Gas Steam and Air conditioning Supply (D) and Water Supply and Sewerage (E) – that are very capital intensive.

rate in the sectors employment share and its weight in nominal value-added in the last period. Strictly, one would want to use total output and include intermediate inputs in the production function (as in Groth, Gutierrez-Domenech & Srinivasan (2004)). However, as the necessary data is only available annually and up to 2012 we don't show this here, but the resulting estimates of TFP look broadly similar.

[11] In this we follow Groth, Gutierrez-Domenech & Srinivasan (2004); who in turn rely on Basu, Fernald and Shapiro (2001) and Bosworth & Triplett (2003).

Chart 12: Capital services estimates

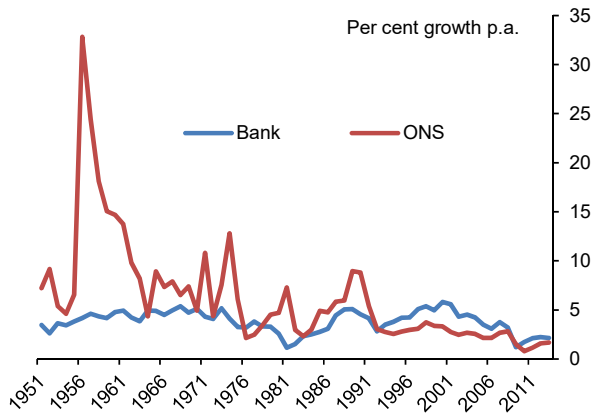
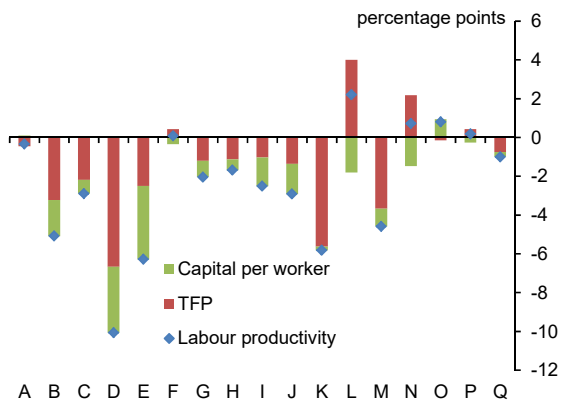


Chart 13: Labour productivity relative to a pre-crisis trend[12]



Capital in previous recessions: How does this time compare?

14. One of the hypotheses for explaining some of the shortfall in productivity growth relative to a pre-crisis trend is a move towards using more labour relative to capital, which would pull down on labour productivity. Indeed, the sector-level analysis above suggested that this might be a more important factor than previous aggregate level analysis has concluded. In order to investigate this hypothesis further, we can look at dispersion in rates of return and changes in capital to labour ratios in the aftermath of the 2008 recession compared to previous recessions.

15. **Chart 14** replicates some work from an earlier SPT[13] on capital allocation using the latest sector-level capital data. The solid lines are the findings from that SPT, and the dashed line is the results using new data. The dispersion in rates of return indicates that capital across the economy may be misallocated, and to a greater extent than usual.

16. An efficient economy in equilibrium should exhibit roughly equal ex-ante, risk-adjusted rates of return across industries. This is because an efficient financial system should allocate capital to where it will be most productive, and therefore earn the highest risk-adjusted return. Diminishing returns to capital, means the returns in each industry should fall as more capital is employed. And the combination of these two factors implies that investors, intermediated by the financial system, will continue to allocate their capital until returns across industries have been equalised.

17. There are a number of reasons why this may not happen. First, there may be barriers to enter certain industries (e.g. due to high start-up costs) that ensure rates of return in these sectors remain elevated. And second, activity in some sectors may be inherently more risky, and the return in these sectors will be required to reflect this risk premium. Finally, and perhaps most importantly for the current economic climate the financial sector may be impaired so that it cannot efficiently allocate capital.

[12] Both capital per worker and TFP are calculated relative to their individual trends in each sector. Given the assumption of the underlying production function these, by construction, are equal to the shortfall in labour productivity.

[13] For a summary of this work

18. If capital is not being efficiently allocated across the economy then firms can also adjust their labour input. It is striking that, compared to previous recessions, firms have increased capital inputs by less, and increased labour by significantly more, resulting in a much smaller increase in the capital-labour ratio (**Chart 15**). This may be because in the current economic climate with higher uncertainty and lower real wages firms find it easier to adjust labour rather than capital. And, even if this is most profitable and efficient for each individual firm, it is likely to reduce aggregate labour productivity.

Chart 14: Dispersion of rates of return

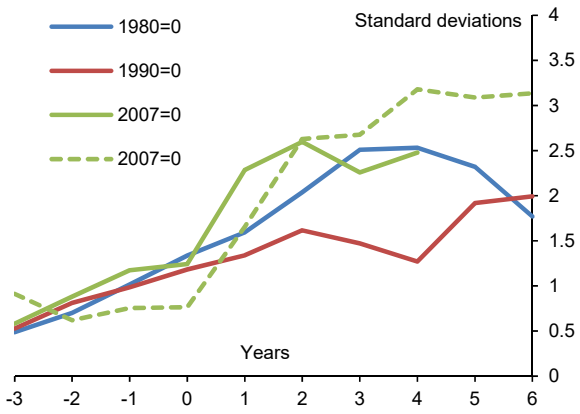
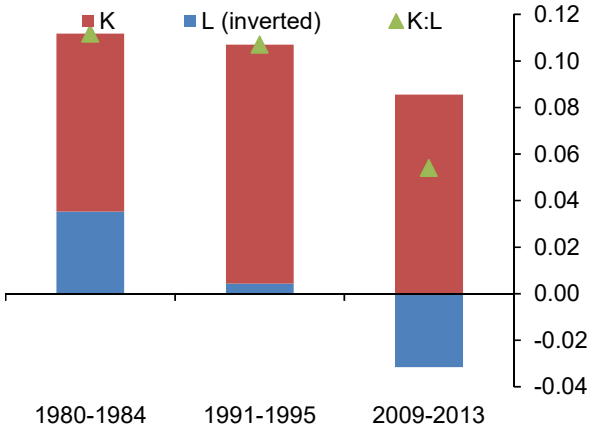


Chart 15: Log Capital labour ratios



Conclusion

19. This note revisits and updates analysis of the productivity puzzle from a sector perspective, and draws three main conclusions. First, 40% of the productivity shortfall is concentrated in just four sectors. However, excluding these sectors from the productivity calculation does not change the character – size or profile – of the puzzle by very much at all. Second, from an aggregate perspective, the productivity puzzle is significantly a TFP puzzle; but a sectoral approach suggests that capital shallowing could be more important than previously thought. Finally, there is some evidence that capital to labour substitution and capital misallocation are more significant after the Great Recession than previous recessions, which may partly explain the weakness in labour productivity growth this time around.

References

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Appendix

Table 1: Sectors (One digit SIC code level)

Sector	Label	Average weight in output (1995-2012)	Grouping in Chart 4
AGRICULTURE, FORESTRY AND FISHING	A	0.9%	Agriculture
MINING AND QUARRYING	B	2.3%	Energy
MANUFACTURING	C	13.6%	Manufacturing
ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	D	1.4%	Energy
WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	E	1.1%	Energy
CONSTRUCTION	F	6.4%	Construction
WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	G	11.4%	Consumer Services
TRANSPORTATION AND STORAGE	H	4.9%	Business Services
ACCOMMODATION AND FOOD SERVICE ACTIVITIES	I	2.8%	Consumer Services
INFORMATION AND COMMUNICATION	J	6.4%	Business Services
FINANCIAL AND INSURANCE ACTIVITIES	K	7.9%	Business Services
REAL ESTATE ACTIVITIES	L	8.7%	Business Services
PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	M	6.6%	Business Services
ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	N	4.4%	Business Services
PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	O	5.2%	Public Sector
EDUCATION	P	5.8%	Public Sector
HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	Q	6.9%	Public Sector
ARTS, ENTERTAINMENT AND RECREATION	R	1.5%	Consumer Services
OTHER SERVICE ACTIVITIES	S	1.3%	Consumer Services