The UK Productivity Shortfall in an Era of Rising Labour Supply

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Abstract

Labour productivity stagnated in the UK between the financial crisis and the emergence of Covid-19. At the same time, labour supply and employment rose strongly, driven primarily by net inward migration. Although labour productivity should be independent of labour supplied in the long run, this need not be the case in the medium-run while capital-per-worker adjusts. Our evidence suggests that around one-fifth, or 4pp, of the 21 log point fall in productivity from its previous trend can be explained by increased labour supply, with a slowdown in TFP growth accounting for most of the shortfall.

Keywords: Productivity, labour supply, capital deepening

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1 Introduction

The UK's productivity shortfall dominated its economic challenges in the years between the global financial crisis (GFC) of 2008 and the emergence of Covid-19 in 2020. Labour productivity stagnated for over a decade and contributed to the UK's real wage squeeze, prolonged fiscal consolidation, and, arguably, the Brexit vote. The productivity shortfall emerging since 2008 reached 21 log points by 2019 (Figure 1a).[1] While productivity growth in other countries also slowed down after the GFC, the slowdown in the UK was particularly stark (Figure 1b).[2]

In a growth accounting exercise, reduced capital deepening – capital shallowing – accounts for between one-quarter and one-third of the slowdown in the market sector. But what caused such capital shallowing? We present evidence that it was partly due to an increase in labour supply that came at a time when capital markets were impaired. Between 2005 and 2019, the labour force expanded by almost 4 million, or 12.5%. That expansion was partly driven by rising participation rates, especially at older ages, but mostly driven by inward migration.

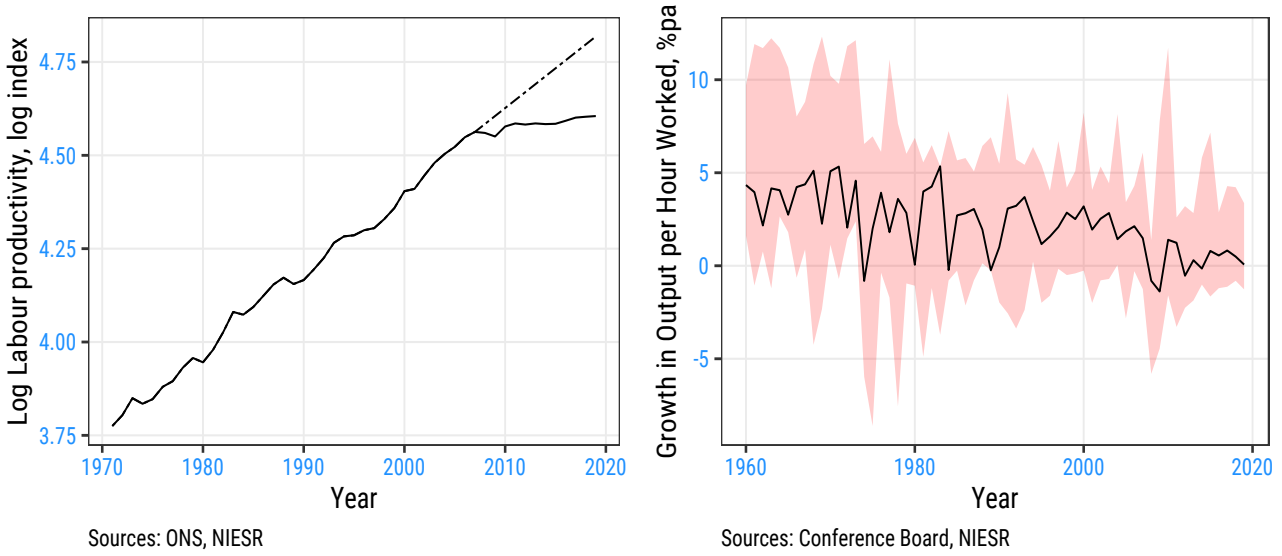
Standard growth models suggest that in the long run labour productivity is independent of the quantity of labour supplied. Nevertheless, it appears likely that increased labour supply weighed on labour productivity growth and real wages during a prolonged adjustment phase from the mid-2000s. Consistent with the micro-economic evidence, this does not imply that labour supplied by older persons or migrants 'undercut' wage-setting, it was just that greater labour supply pushed down on real wages generally.

While Van Reenen and Pessoa (2013) emphasise the role of reduced capital deepening in contributing to the U.K. productivity shortfall up to 2012, they do not emphasise the role of rising labour supply. Most surveys of the productivity slowdown (eg Goldin *et al*, 2021) neither draw attention to, nor quantify, a role for labour supply. Oulton (2018) is a notable exception.

Identifying the effect of economy-wide shocks, such as an expansion of labour supply,

[1]This estimate is relative to an extrapolated linear trend in log labour productivity estimated over 1971-2007.

[2]That said, Fernald and Inklaar (2022) suggest that, for the most part, the productivity puzzle is not primarily a UK-specific issue.



(a) The productivity shortfall

(b) UK productivity growth (line) among advanced economies (swathe)

Figure 1: The UK productivity shortfall

is not straightforward.[3] While there has been a 'revolution of identification' in many applied fields of economics, particularly using panel datasets, this has not been the case in macroeconomics where convincing natural experiments rarely exist. Even with large shocks, such as Brexit for example, it is difficult to provide the clear counterfactuals that can be used when distinct treatment and control groups are available: with macroeconomic shocks all groups are affected by the 'treatment'. Our empirical approach is to show that the macroeconomic and sectoral evidence is consistent with a labour supply expansion that contributed to capital shallowing in all sectors and an associated slowdown in productivity growth.

We reach three main conclusions. First, we quantify the impact of the U.K. labour supply shock in the 15 years to 2019 as having lowered UK labour productivity by around a fifth of the 21 log point shortfall. While this is modest relative to the overall shortfall it is still sizable in absolute terms. Nevertheless, it should be stressed that increased labour supply and capital shallowing is not the main explanation for the post-GFC weakness of labour productivity in the UK. Instead, a shortfall in total factor productivity (TFP) is

[3]See Nakamura and Steinsson (2018) on identification in macroeconomics.

the main factor behind the productivity shortfall during the medium run.

Second, we reconcile our view that a positive labour supply shock contributed to weaker labour productivity growth with standard growth theory by viewing the latter as applying in the long run. Post-crisis, adjustment of the capital stock may have been further slowed down in the UK by credit imperfections and heightened risk aversion. This links the labour supply view with impaired capital adjustment.

Third, we reconcile our view that inward immigration, as a contributor to increased labour supply, weighed on labour productivity with the micro evidence suggesting immigration has had negligible effects on UK real wages or productivity. Most micro-based studies provide estimates that implicitly hold constant the macro-channel of reduced capital deepening that we highlight. Those that do not do this (eg, Ottaviano and Peri, 2012) emphasise an important role for slow capital adjustment to weigh on real wages in the short run, as do we.

The remainder of the paper is organised as follows. Section 2 outlines several facts about the UK labour productivity shortfall from aggregate and sector-level data. Section 3 turns to the key features of the rising labour supply view. Section 4 presents macroeconomic simulation results which help gauge the macroeconomic significance of these views. We include cross-country analysis as supplementary evidence of UK experience. Section 5 concludes.

2 The productivity shortfall: some stylised facts

Our analysis of UK productivity uses estimates from the Office for National Statistics (ONS) for the UK market sector and component industries.[4]

Relative to a simple extrapolative trend from 1970 to 2007, the UK labour productivity shortfall reached 21 log points in 2019. While growth in hourly labour productivity averaged 2.32% p.a. between 1971 and 2007, it slumped to just 0.37% p.a. from 2008 to 2019.[5]

[4]We use ONS data for productivity released on 7 October 2021 consistent with the Productivity Overview release for April – June 2021. These estimates are badged as 'experimental' and are subject to revision.

[5]For a recent review of UK productivity, see Crafts and Mills (2020).

2.1 Reduced capital deepening in a growth accounting exercise

Table 1 summarises a growth accounting exercise for the UK's market sector since 1971. As usual, estimates of total factor productivity (TFP) in such decompositions are derived as a residual and in the short run can reflect labour hoarding and other cyclical influences. We draw attention to the following:

- In each of four cycles before the GFC, average labour productivity growth had been in the region of 2%pa with larger differences in average output growth across the cycles being reflected in differences in labour input growth.
- Figure 2a shows the post-GFC cycle from 2008-19 was unusual in that while output growth was weaker than usual at 1.44%pa its composition was skewed towards growth in labour input (1.07%pa) rather than growth in labour productivity (0.36%pa).
- The 2.22pp fall in labour productivity growth from 2002-07 to 2008-19 is largely accounted for by a fall in TFP growth of 1.38pp. Standard neoclassical economics offers little explanation for long-term movements in TFP beyond attributing it to technical progress.[6]
- Capital deepening was also unusually weak. In the run-up to the GFC capital deepening accounted for 0.5pp of average annual labour productivity growth during 2002-07. By contrast, a declining capital/labour ratio was a drag on labour productivity after 2008 (-0.07pp). Post-GFC, the turn-around in capital deepening between 2002-07 and 2008-19 (0.6pp) accounted for over a quarter of the slowdown in labour productivity growth (2.22pp). Figure 2b shows an annual decomposition of productivity growth.

2.2 A sector-level perspective

More light can be shed on the drivers of the overall productivity slowdown by looking at changes in trends in different parts of the economy.[7]

[6] A recent TFP literature highlights roles for allocation and misallocation of resources as key drivers of TFP (eg. Hsieh and Klenow, 2014).

[7] We do not consider the mainly non-market sectors where there is not a reliable productivity decomposition or the real estate sector that mainly consists of imputed rent.

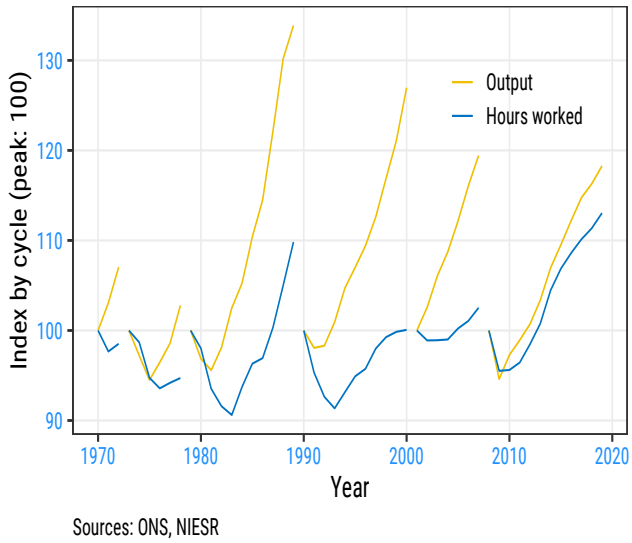
Table 1: A growth accounting exercise

	Output growth (%pa)	TFP growth (%pa)	Labour Productivity growth (%pa)	Contribution of K/L to Productivity growth (pp)	Growth in Capital services, K (%pa)	Growth in Hours worked, L (%pa)
1974-1979	1.07	0.52	1.83	1.14	3.02	-0.76
1980-1990	2.82	1.46	1.94	0.56	2.46	0.89
1991-2001	2.36	0.79	2.25	1.11	2.94	0.12
2002-2007	3.00	1.37	2.58	0.51	1.83	0.42
2008-2019	1.44	-0.01	0.36	-0.07	0.88	1.07
1971-2019	2.30	0.92	1.84	0.63	2.22	0.45

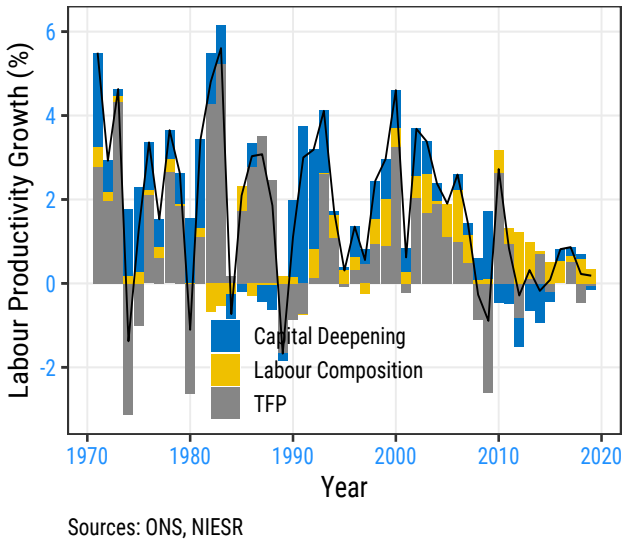
* Note: UK market sector, average annual rates.
† Output growth = Labour productivity growth + Growth in hours worked.
‡ Labour productivity growth = TFP growth + Contribution of K/L to productivity growth + Contribution of labour composition (not shown).
§ Sources: ONS, NIESR

The composition of employment shifted towards sectors of the economy with lower average productivity over this period. Labour input grew in almost all of the market sectors from end-2007 to end-2019. The exceptions were manufacturing (sector C) and financial and insurance activities (K) where the labour input was lower in 2019 than it was in 2007; both of these sectors are relatively high productivity sectors. The largest contributions to the growth in total hours from end-2007 tended to be in sectors where the level of productivity was lower. This shift in the composition of employment contributed to the weakness in aggregate productivity in the post-GFC period.

Productivity growth within sectors varied significantly between the mid-2000s and 2008-19 (Figure 3a). Labour productivity growth fell in nine of the fifteen market sectors under consideration; these are mining and quarrying (B), manufacturing (C), water supply (E), wholesale and retail (G), transport and storage (H), information and communication (J), financial and insurance (K), professional and scientific (M), arts and entertainment (R). This group includes the external-facing trading sectors. Productivity growth rose in agriculture (A), electricity (D), construction (F), accommodation and food (I), administration and support (N), other services (STU). This group includes mainly the internal-facing



(a) Output and Hours worked by Cycle



(b) Composition of the slowdown, annual

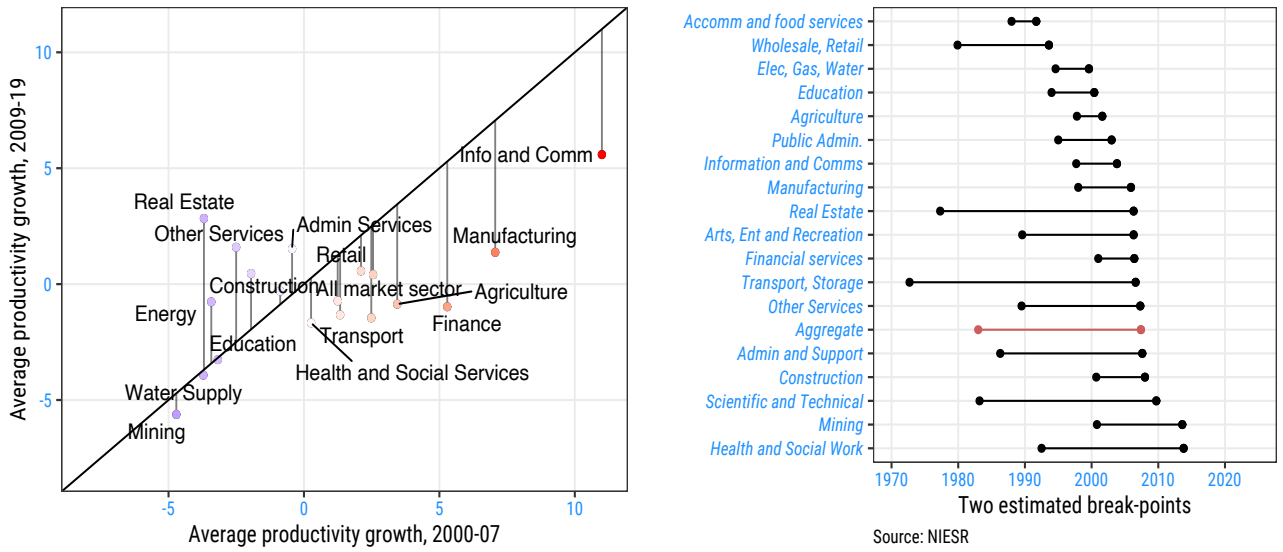
Figure 2: The slowdown and its composition

non-traded sectors. Estimated break-points indicate that only 4 out of 18 sectors have a break-point in the 2007 to 2009 period, notably including the financial services sector (Figure 3b).[8]

There is a strong positive correlation between the change in productivity growth within the different sectors between 2002-7 and 2008-19 and the change in output growth within those sectors. This might suggest that demand weakness contributed to the productivity slowdown, though such an interpretation would have to explain why businesses in these sectors did not restrain employment to a larger extent.

At a sectoral level, the 2.22pp fall in labour productivity growth from 2002-07 to 2008-19 is largely accounted for by the slowdown in productivity growth in manufacturing (contributing -0.6pp), wholesale and retail (-0.37pp), transport and storage (-0.17pp), information and communication (-0.23pp), financial and insurance (-0.41pp), professional and scientific (-0.26pp), and arts and entertainment (-0.14pp). Other sectors made small positive or close-to-zero contributions. It is worth noting that in four of these sectors (B, D, E

[8]Our estimates allow for two break-points per sector at unrestricted dates over the 50-year period since 1970. Cette *et al.* (2016) find that the productivity slowdown in the U.S. and Euro area slightly preceded the great financial crisis.



(a) Pre- and Post-Crisis

(b) Estimated break-points in labour productivity

Figure 3: The slowdown across sectors

and I) productivity growth remained negative in 2008-19.

Variation in labour productivity and its drivers across 18 sectors is shown in Figure 4a, from 1970. Figure 4b shows the equivalent profiles for capital deepening at the sector level and total market sector. Both in aggregate and for most sectors the productivity slowdown coincided with an abrupt end to capital-deepening. Figure 4c shows that total factor productivity stagnated in all sectors from 2010.

There is clear evidence of a common shock that reduced capital deepening in all sectors. The Annex reports labour productivity growth and its decomposition into TFP change and capital deepening over the pre- and post-GFC economic cycles, at the sector-level. The decompositions highlight two factors about the productivity slowdown: 1) With the exception of arts and entertainment, all of the sectors that made a material negative contribution to the change in labour productivity growth between 2001-7 and 2008-19 (C, G, H, J, K, M, R) experienced both lower TFP growth and a lower contribution from capital deepening. 2) While all other sectors benefitted from higher TFP growth in the post-GFC cycle, with the exception of electricity they all also experienced a lower contribution from capital deepening. This suggests to us that while certain key sectors experienced a negative TFP shock

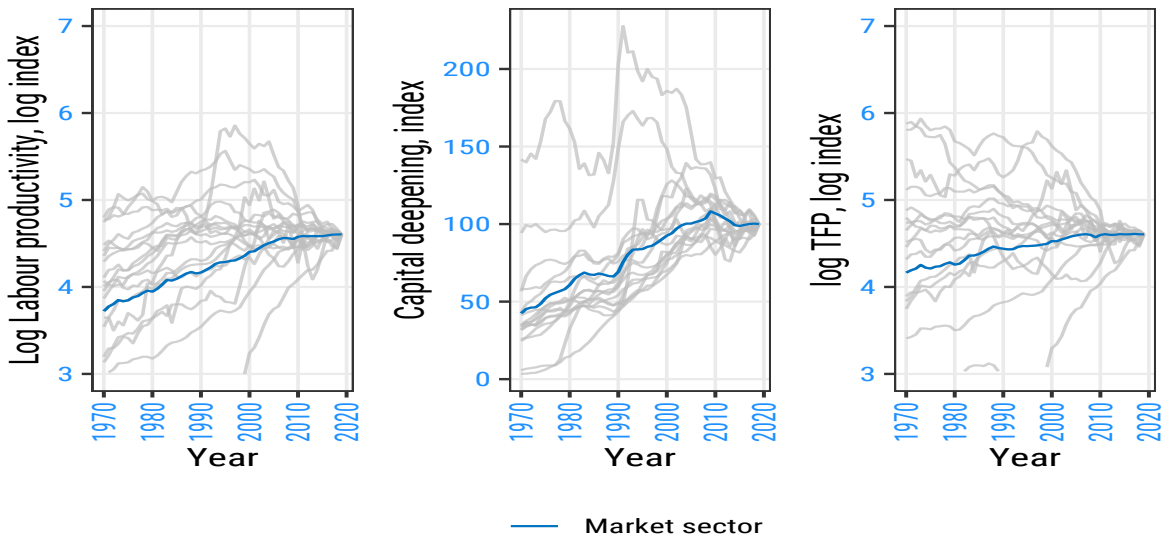


Figure 4: Labour productivity, capital deepening and TFP across sectors

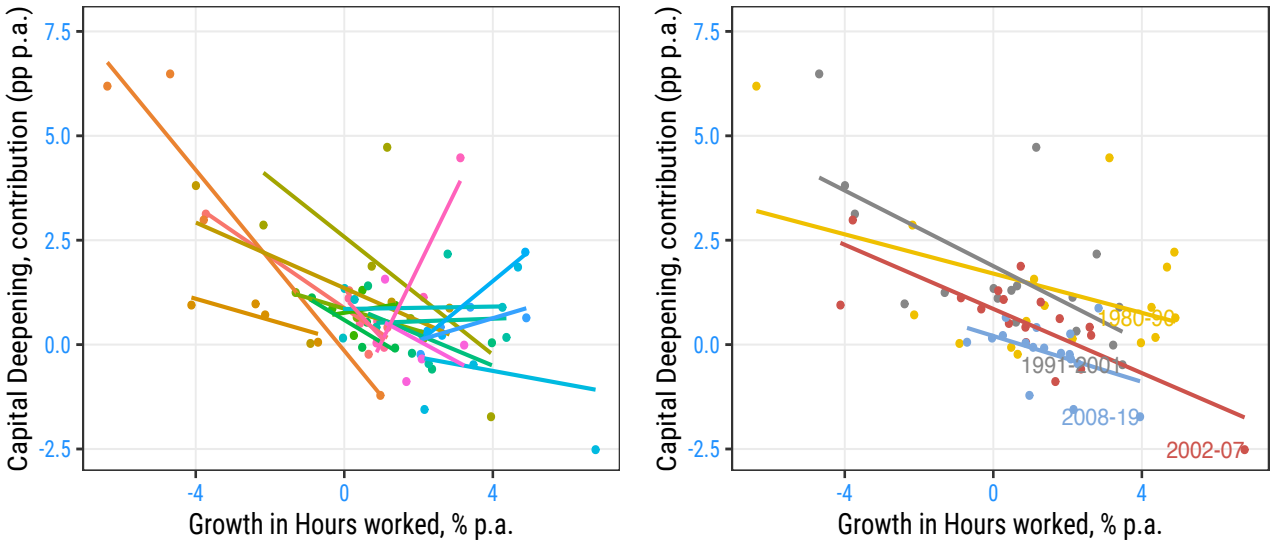
there was a common shock that caused the contribution of capital deepening to decline throughout the economy. A positive labour supply shock would help explain such capital shallowing.

Typically there is a negative correlation between a sector's labour expansion and capital deepening that we attribute to slow adjustment of capital to shocks.

We compare average growth in hours worked and in the capital deepening contribution, within five distinct business cycles since 1971 for each sector. Figure 5 suggests those sector/period averages with larger labour expansions were associated with a significantly lower capital deepening contribution. Plotting the relationship separately for each business cycle, suggests a broadly similar relationship in each period. At a descriptive level, larger labour input expansions are associated with a lower contribution from capital per worker to productivity growth.

2.3 Capital/labour substitution

The aggregate capital/labour ratio declined from the mid-2000s and, especially, post-crisis. This coincided with a fall in the relative price of labour (Figure 6), as well as the weaker TFP trend.



(a) By sector, across cycles

(b) By cycle, across sectors

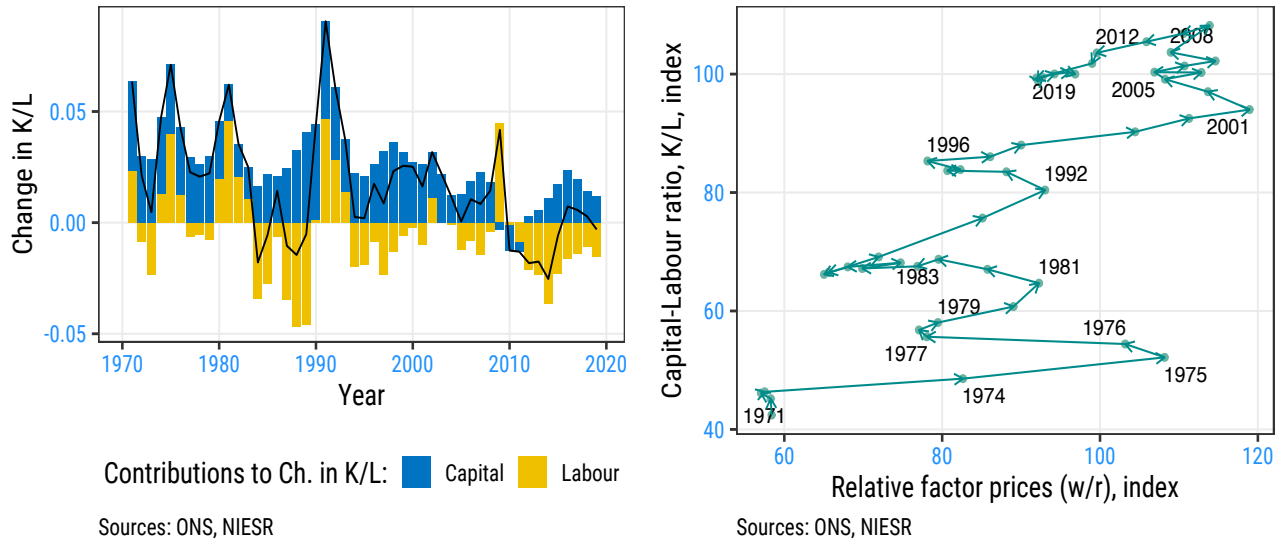
Figure 5: Reduced capital deepening and labour expansions

On a neo-classical view, greater abundance of labour would go hand in hand with a fall in its relative price. ONS data suggest that the relative price of labour fell quite substantially, by around 20%, in the 2009-15 period (Figure 7). [9]

If capital and labour are gross complements (and the elasticity of substitution $\sigma < 1$), an increase in the supply of labour raises the demand for capital. While there is no consensus about the precise value of σ, published estimates in the CES framework using aggregate US or sector-level data suggest $\sigma < 1$. Evidence on the elasticity of substitution implies K/L responds to relative prices, consistent with Figure 6.

Labour and capital are also likely 'q-complements' meaning that an increase in labour input raises the marginal product of capital. This assumption is widely employed in the immigration and labour market literature. It implies that an increase in labour will ultimately raise wages when the capital stock has adjusted, assuming a competitive labour market (Amior and Manning, 2021). We return to the adjustment of the capital stock in

[9] As measured by the ONS, the price of capital is the implied average price of capital services from the existing stock. This is measured as gross operating surplus divided by the capital services index. The factor price of labour is calculated as compensation of employees divided by the quantity of labour index. Pessoa and Van Reenen (2014) argued that capital/labour substitution owed partly to increased wage flexibility and this contributed to a large role for reduced capital deepening in accounting for the UK productivity shortfall up to 2012.



(a) Aggregate factor contributions

(b) Capital/Labour and relative factor prices

Figure 6: Reduced capital deepening and relative prices

response to stronger labour supply below.

Overall, this suggests we should expect the capital/labour ratio to fall less than proportionately with the fall in the relative price of labour. That applies in the long-run and especially in the short-run. Adjustment of the aggregate capital stock plays a key role in transmitting the benefits of a larger labour force through the economy, but this takes time. More generally, a slower adjustment of capital will weigh on the capital/labour ratio (and productivity) in response to a rise in labour supply.

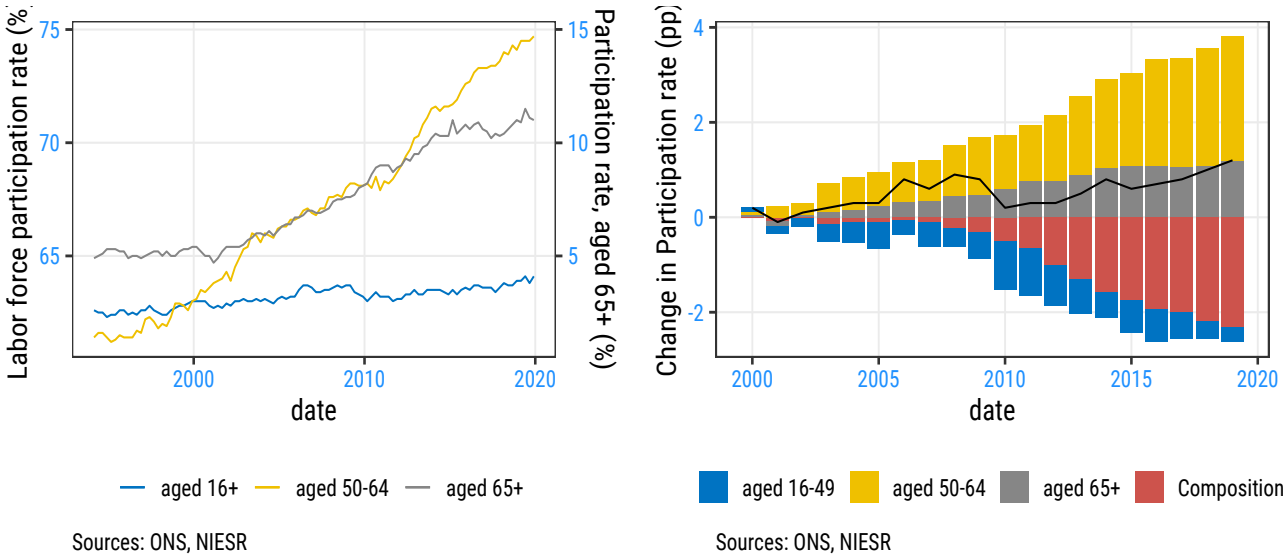
3 Rising Labour Supply

We now describe key features of the UK's rising labour supply, amid reduced capital deepening and the productivity shortfall.

3.1 Domestic labour supply

From 2005 to 2019, the UK labour force expanded by 3.8 million, or 12.5%.

We discuss population changes below, alongside net migration. In tandem, the 16+



(a) Participation rates

(b) Contributions to changing participation

Figure 7: Older persons' participation rates and rising aggregate participation

labour force participation rate rose by around 1pp from 2005 and similarly from its 2010 low (Figure 7). That is equivalent to a rise of around 310,000 in the labour force. While that aggregate change may make the rise in participation appear modest, it masks the profound changes in participation at older ages. It also understates the underlying shift in labour supply at a time when real wages had stagnated or fallen.

The rising participation rate is significant for three reasons. First, it is a symptom of a positive labour supply shock as it coincided with a historically large squeeze in real wages. With a positively-sloped labour supply curve, only a labour supply curve shifting 'to the right' can reconcile falling real wages with a higher participation rate.

Second, a rising participation rate is historically unusual after a downturn. The participation rate fell quite notably following the recessions of the early-1980s and early-1990s. There is evidence that increased labour supply is a household response to financial pressures. Benito and Saleheen (2013) find that negative financial shocks are followed by an increased incidence of participating in the labour market and increased desired working hours. Blundell *et al* (2016) find that families self-insure adverse shocks through increased labour supply. They find that families do this much more often than they use credit mar-

kets, the traditional means of adjustment emphasised in models of household behaviour that take labour supply as given.

Third, the rise in participation rate has occurred despite the drag from a rising incidence of older persons with below-average participation rates. This compositional effect was a drag on participation, especially from 2010. A large behavioural effect (from higher participation rate at a specific age, especially among older persons) more than offset the increased incidence of older persons to result in the higher participation rate.[10] Figure 7 illustrates this point. The behavioural effect among those aged 50-64 contributed +3pp to a rise in participation, with an additional 1pp contribution from those aged 65+.[11]

High immigration was another source of labour force expansion, including from Central and Eastern Europe as the A8 countries joined the EU from 2004 (Portes, 2016; Oulton, 2018). Unlike most of the EU, the UK chose not to apply transitional controls on migration from the A8 accession countries. In much of Western Europe these transitional controls did not end completely until May 2011.

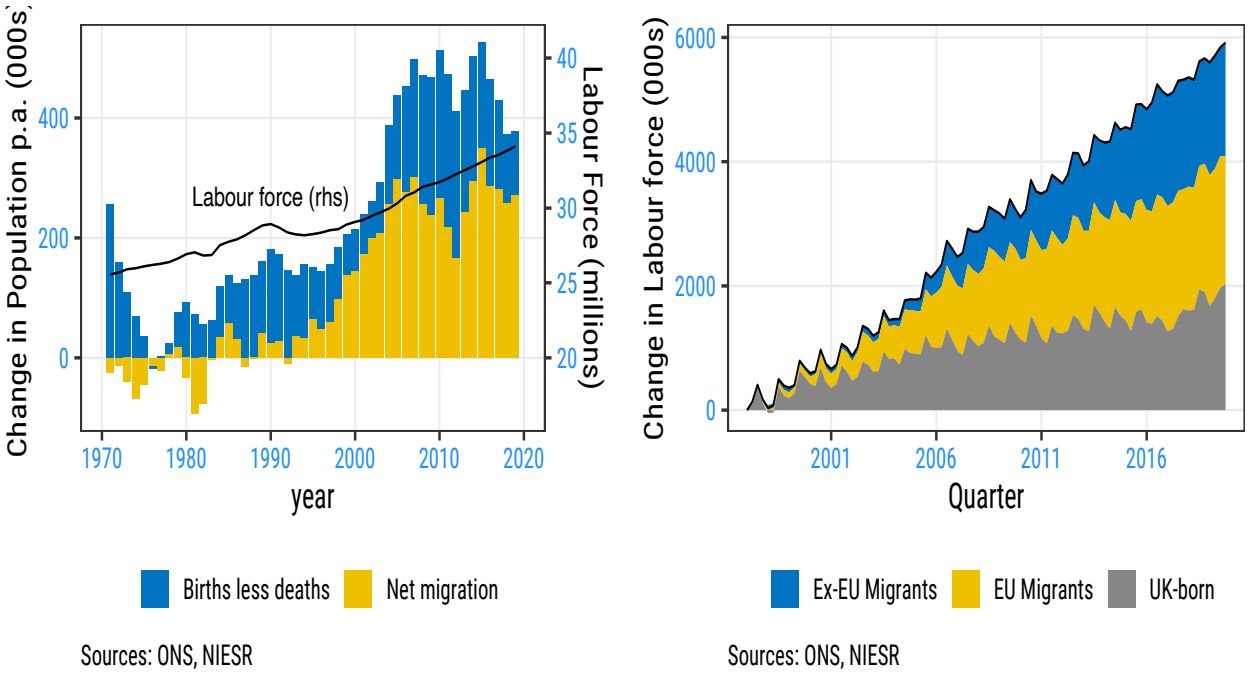
3.2 Net migration and older persons' participation rates

Net inward migration has been historically high since the mid-1990s. From 2005 to 2019, net inward migration totalled 3.8 million based on the International Passenger Survey. This compares with the contribution to population growth coming from births less deaths that totalled 2.7 million.

Around one-half of migrants (both inbound and outbound) participate in the labour force. Expansion in the labour force since the mid-2000s owed predominantly to migrants (Figure 8, based on the Labour Force Survey from 1997Q1 to 2019Q4). From 2005, migrants contributed 3.2mn to the expansion in the labour force and those UK-born contributed 1.1mn. Since the 2016 Brexit vote, the proportions of inward migration that has been of

[10] Benito and Bunn (2011).

[11] The state retirement age for women increased gradually from 60 to 65 between 2010 and late-2018, putting it in-line with men's state pension age. From March 2019, the state pension age rose (for both women and men) by a further year to 66 in September 2020. Micro evidence suggests raising women's retirement age also raises men's retirement ages, and participation rates overall, as older couples time their retirement decisions jointly.



(a) Population growth and migration

(b) Labour force and migration, cumulative

Figure 8: Population growth, the labour force and migration

EU citizens has fallen.

The increase in labour force that one can attribute to older persons is about one-third as large as that resulting from net inward migration. The rise in the participation rate since 2005 of those aged 50+, which pushed up on the aggregate participation rate by almost 4pp, implied a 1.1 million rise in labour force.

4 The macroeconomic impact of labour supply shocks

4.1 The long-run

One interpretation of our aggregate growth accounting exercise is that the observed reduced rate of capital deepening is a *response* to the slowdown in TFP growth associated with the financial crisis. This is a natural interpretation in a standard growth model in which the capital stock is determined by the usual first order condition requiring the marginal product of capital to equal the real interest rate. Under constant returns to scale, both productivity

and the capital/labour ratio are independent of the size of the labour force.[12]

To illustrate this point, consider a Cobb-Douglas production function which implies the following for labour productivity (y-l).

$$y - l = a + b(k - l) \tag{1}$$

where y = log output, l = log labour force, k = log capital stock, a = log TFP, b = capital share. This has the following first-order condition:

$$(1 - b)(l - k) = log(r/b) - a \tag{2}$$

with r = discount rate. This leads to:

$$y - l = a + [b/(1 - b)][a - log(r/b)] = a/(1 - b) - [b/(1 - b)].log(r/b) \tag{3}$$

implying that labour productivity $(y - l)$ is independent of the quantity of labour supplied (l). In the long-run, and given diminishing marginal returns to labour (and capital), rises in the size of the labour force do not affect labour productivity as the optimum capital stock will increase in line with labour supply in equilibrium.

From (2), a negative TFP shock (a) also implies reduced capital deepening. This means that in the long run, the labour productivity shortfall no longer results from reduced capital deepening and a labour supply shock. Instead, the evolution of total factor productivity alone determines the productivity shortfall. In the long run, as Prescott (1998, p.526) puts it, "Total factor productivity determines labor productivity, not only directly, but also indirectly by determining capital per worker."

Our interpretation is that this only applies after the economy and labour market have fully adjusted to higher labour supply. The role of stronger domestic labour supply is, therefore, best seen as a view of the 'medium-run'.[13] But this is important because adjust-

[12] Our simulation exercise avoids this interpretation since it explicitly considers the economy's response to a labour supply shock.

[13] As an example of capital deepening affecting labour productivity during an extensive period, Oulton (2020) cites the case of post-War reconstruction. Post-war reconstruction raised labour productivity during an extensive, post-war period. We think of the role of the labour force expansion since the mid-2000s as

ment does not occur instantaneously. Moreover, the evidence in Section 2 suggests that while some sectors experienced both lower TFP growth and capital shallowing, consistent with a TFP shock, others experienced higher TFP growth and capital shallowing, a combination that is not consistent with a TFP shock alone. We suggest that this was due to a common positive labour supply shock that overlay a more heterogeneous, but primarily negative, TFP shock.

In standard macroeconomic analysis, a positive labour supply shock shifts the long-run aggregate supply curve 'to the right' and causes actual output to rise in line with increased potential. In the short run, greater availability of labour pushes down on real wages and, by reducing marginal costs, encourages imperfectly competitive firms to lower prices and thereby stimulate demand, output and employment. With capital tending to be slow to adjust, higher employment is associated initially with reduced capital deepening and lower labour productivity. Yet, with a lower capital/labour ratio pushing up the marginal product of capital, firms have an incentive to increase investment until the capital/labour ratio rises back to its original level and the economy returns to its balanced growth path.

In the new, long-run equilibrium, output and the capital stock will have risen proportionately to increased labour supply and labour productivity will ultimately be unaffected by the labour supply shock (e.g. Borjas, 2019).

The key practical question is how long this adjustment process takes to complete and relatedly its impact on labour productivity in the meantime. In an influential analysis of immigration in the US, Ottaviano and Peri (2012) explicitly take capital adjustments into account. They note that 'the recent growth literature usually estimates a 10% speed of convergence of capital to the own balanced growth path for advanced (OECD) economies (Islam, 1995; Caselli *et al* 1996)'. They estimate a similar rate of convergence based on US data, 1960-2004.

According to Dustmann *et al* (2008), "this adjustment speed means that, instead of reducing the capital/labour ratio by 11% and consequently average real wages by 3.6%, the immigrant inflows to the US between 1990 and 2004 only reduced the capital/labour ratio by 3.4%, which in turn implies a much smaller negative effect of only 1.1% on average

being the mirror image of that post-war capital deepening.

wages in the economy. Basically, the faster capital is able to adjust, the smaller will be the effect on average wages in the economy."[14]

Our own assessment is that adjustment could be considerably slower than this in the UK context, resulting in an extended period of weak productivity. This largely reflects the apparent slow adjustment of fixed investment to its determinants. Some of the key channels of adjustment may have been especially impaired in the aftermath of the financial crisis.

We employ an empirically-based macroeconomic model that has been calibrated to recent UK quarterly national accounts data.[15] The model highlights the possibility of an extended period of weak productivity growth following an increase in labour supply, and illustrates the key channels involved. We also show the simulated impact of a reduction in TFP growth for an extended period. Together these shocks can account for the stylised facts of the UK experience following the GFC.

4.2 Simulation results

We use the model (outlined in an Annex) to simulate the effects of a 12.5% increase in the population of working age, corresponding roughly to the increase in UK labour supply that occurred between the GFC that began in 2007 and 2019. In the main case we allow for an increase that occurs smoothly over a twelve-year period (labelled "staggered labour supply"). We contrast this with a variant where the increase occurs smoothly over three years ("frontloaded labour supply").

Employment increases quickly in response to the rise in labour supply (Figure 9). This owes to the extra labour supply pushing down initially on wages and domestic prices leading to increased demand for UK output, and hence employment via the production function. The demand increase is driven by the internationally traded sectors, manufacturing, financial services and other private traded services, where exports rise sharply in response to

[14] See also Furlanetto and Robstad (2019).

[15] The Dynamic Sectoral Model is a prototype sectoral model that has been developed at NIESR. It is an open-economy New Keynesian model where output is largely demand determined in the short run and supply determined in the long run. The sectoral model has now been fully integrated into the National Institute Global Econometric Model (NiGEM), see Lenoel and Young (2021).

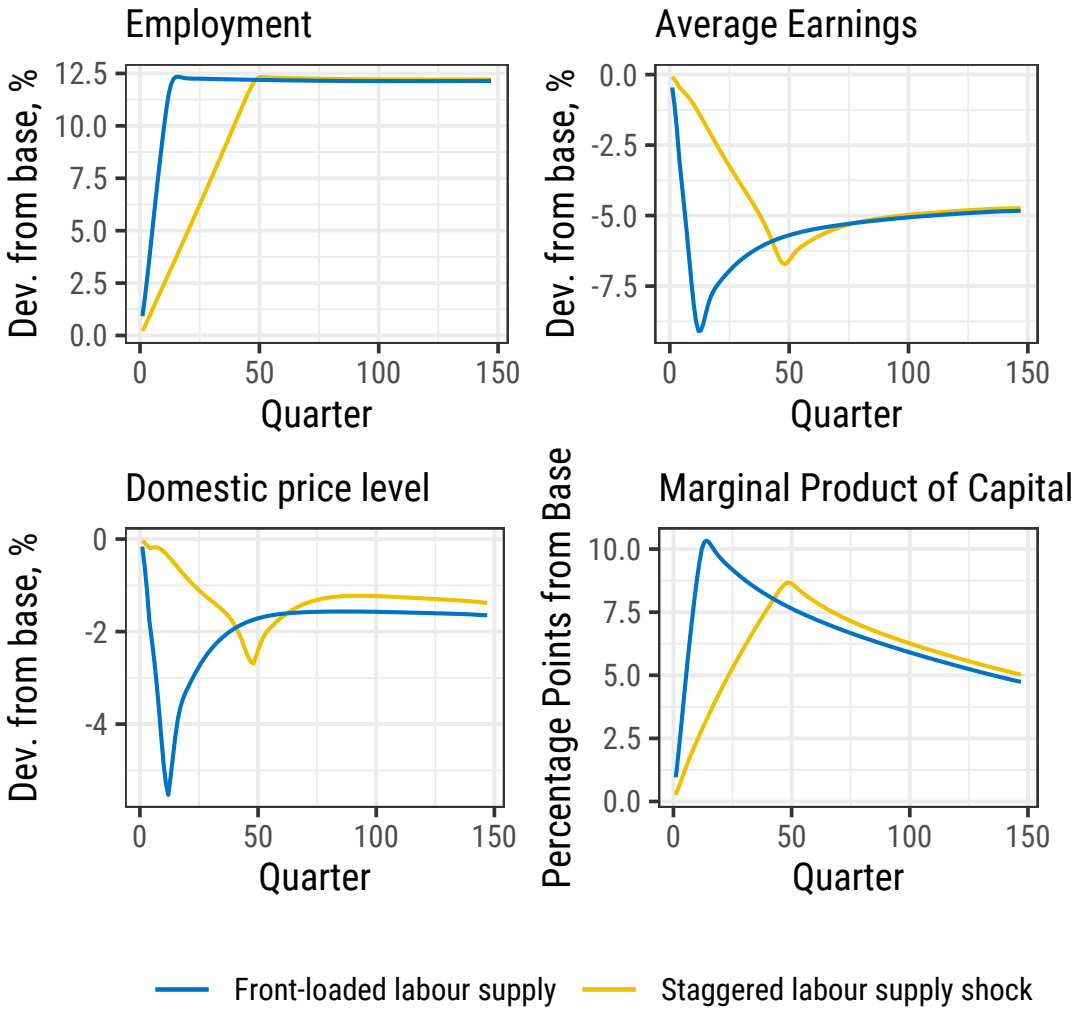


Figure 9: The simulated macroeconomic effects of increased labour supply

increased competitiveness. It spills over to other sectors via greater demand for intermediate outputs and as domestic output expands. But domestic demand rises quite sluggishly in comparison. This is partly because of short-term yet persistent weakness in real household income reflecting lower real wages weighing on consumers' expenditure.

Domestic-facing, non-traded sectors such as construction and private non-traded services thereby respond more weakly than the internationally traded sectors. The marginal product of capital increases as output rises ahead of the capital stock and this leads to higher fixed investment (Figure 10). But fixed investment increases only moderately lead-

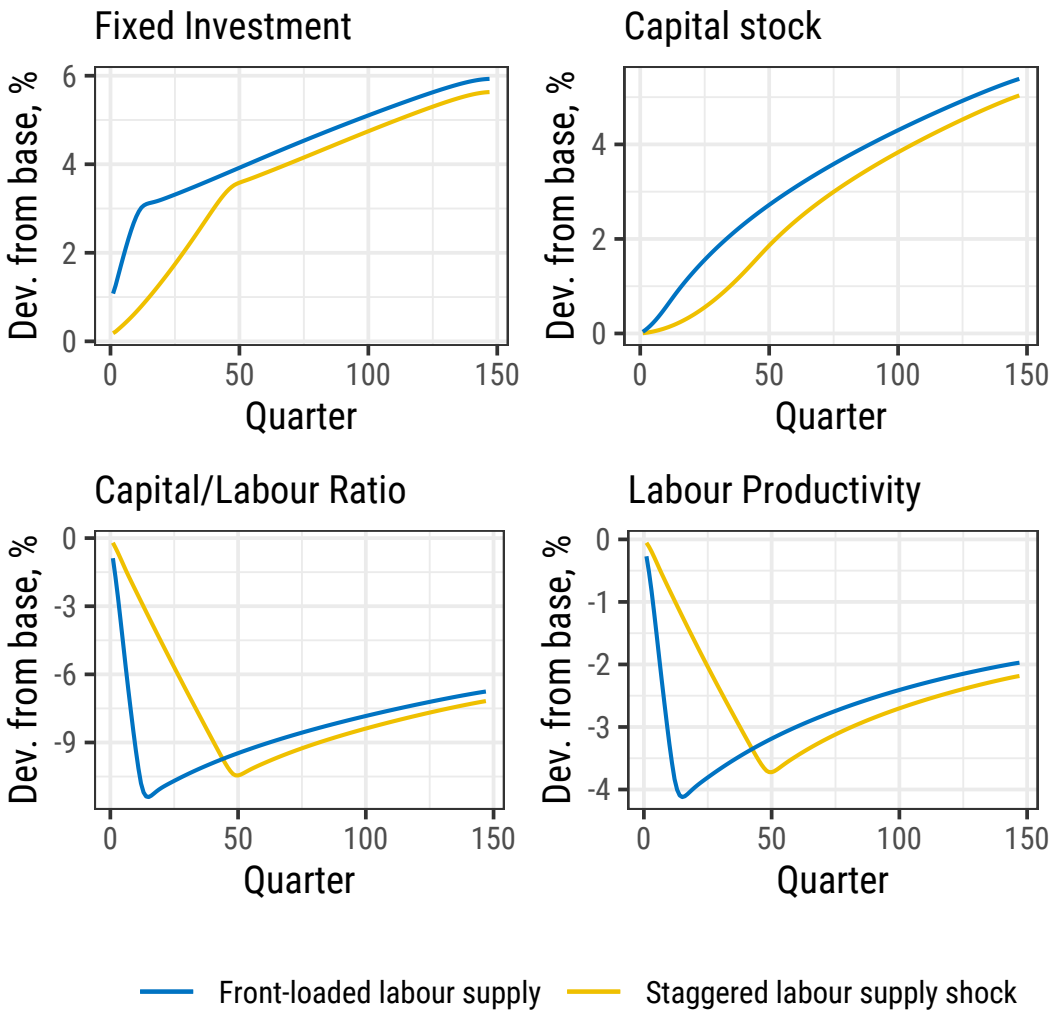


Figure 10: The simulated macroeconomic effects of increased labour supply

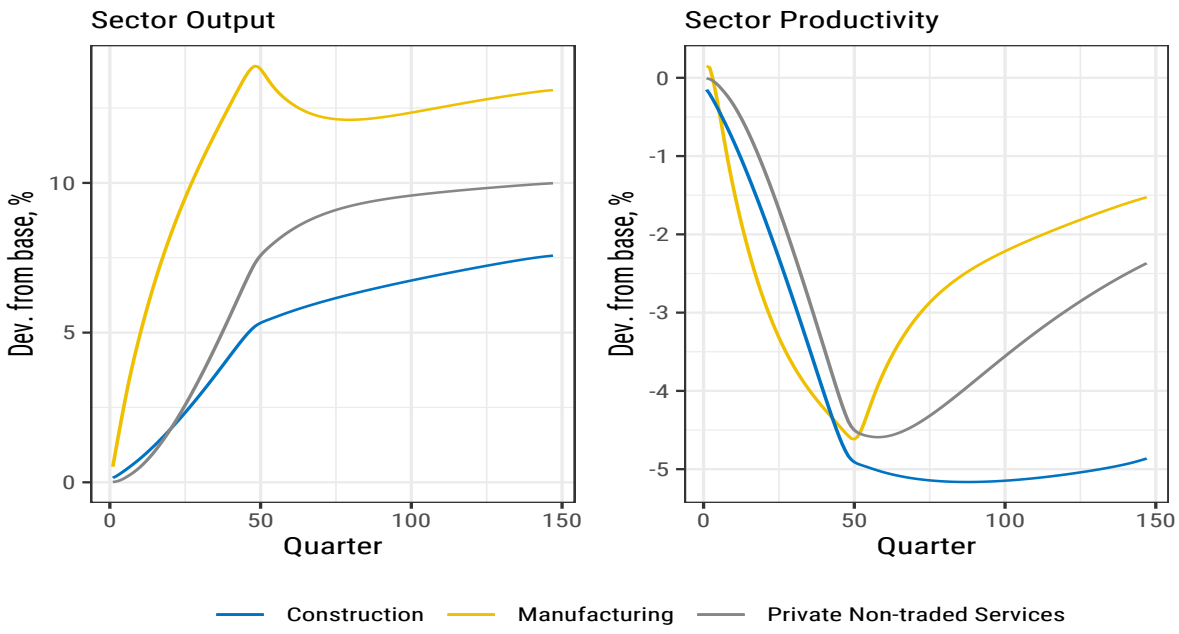


Figure 11: The simulated macroeconomic effects of increased labour supply

ing to a slow expansion in the capital stock. The net effect is that the capital-labour ratio declines and labour productivity is lowered by around 4% at its peak effect (Figure 10). Even after 30 years, labour productivity remains around 2% lower than otherwise, absent the increase in labour supply.

The model simulations show that the faster the labour supply shock occurs the larger the short-run adjustment will be, particularly for wages and prices, but the ultimate adjustment is broadly the same.

In summary, the simulation evidence suggests that a labour supply shock of a similar size to the labour supply increase observed in the UK between 2007 and 2019 could reduce the level of labour productivity temporarily by around 4%. This effect is close to the size of the reduced contribution of capital deepening to the productivity slowdown over that period.

As highlighted earlier in this paper, the evidence suggests that the major part of the productivity slowdown was due to a reduction in TFP. Figure 12 compares the effect on key macroeconomic aggregates of the labour supply shock with a reduction in TFP that is sufficient to reduce labour productivity by 16 log points over 50 quarters. This is achieved

in the model by reducing the growth rate of technical progress in the different sectors by 0.5pp for 6 years.

Figure 12a shows that the negative effect on GDP of the TFP shock would dominate the positive effect of the labour supply shock so that GDP would be reduced by a combination of these shocks, consistent with the evidence of a lower average growth rate over this period.

Figure 12b shows a similar pattern for fixed investment with the negative effect of the TFP shock dominating the positive effect of the labour supply shock, again consistent with the evidence of weak investment over this period.

Figure 12c shows that the positive labour supply shock is required to account for higher employment after the GFC. In this case the positive effect of the labour supply shock dominates the negligible effect of the TFP shock on employment, consistent with the strong pick-up in employment after the GFC.

Figure 12d shows that the positive labour supply shock and the negative TFP shock reinforce each other in their negative effect on the capital/labour ratio. The most significant impact in the short run is that of the positive labour supply shock in bringing about capital shallowing. As discussed earlier this negative effect should wear off in time, but the negative effect of the TFP shock will then become more dominant.

Figure 12e shows the reinforcing effects of the two shocks on labour productivity. At its peak the positive labour supply shock would reduce labour productivity by about 4 log points, accounting for around one-fifth of the decline.

How plausible is this simulation evidence? Inevitably, the modelled effect is sensitive to the various assumptions underlying the empirical relationships in the model. Of key importance are the investment relationships that lie behind the small adjustment of fixed investment and the capital stock to an increase in the marginal product of capital. Greater investment sensitivity would reduce the estimated effect on labour productivity, but there is little empirical evidence of such an effect. In fact, as documented in Section 2, recent trends at the aggregate level and in individual sectors support a reduction in capital intensity since the financial crisis, consistent with the simulation evidence. Impaired capital markets following the financial crisis could have made capital adjustment more difficult than implied

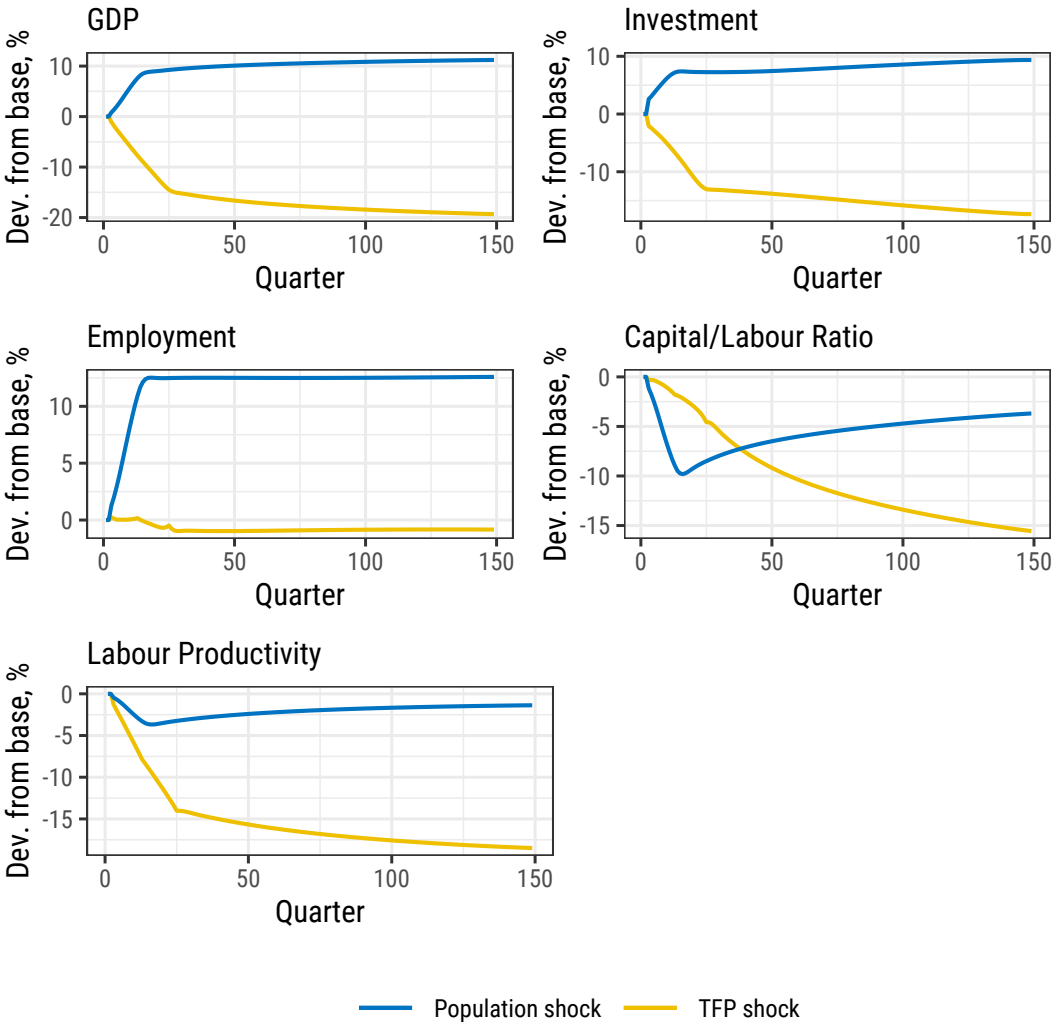
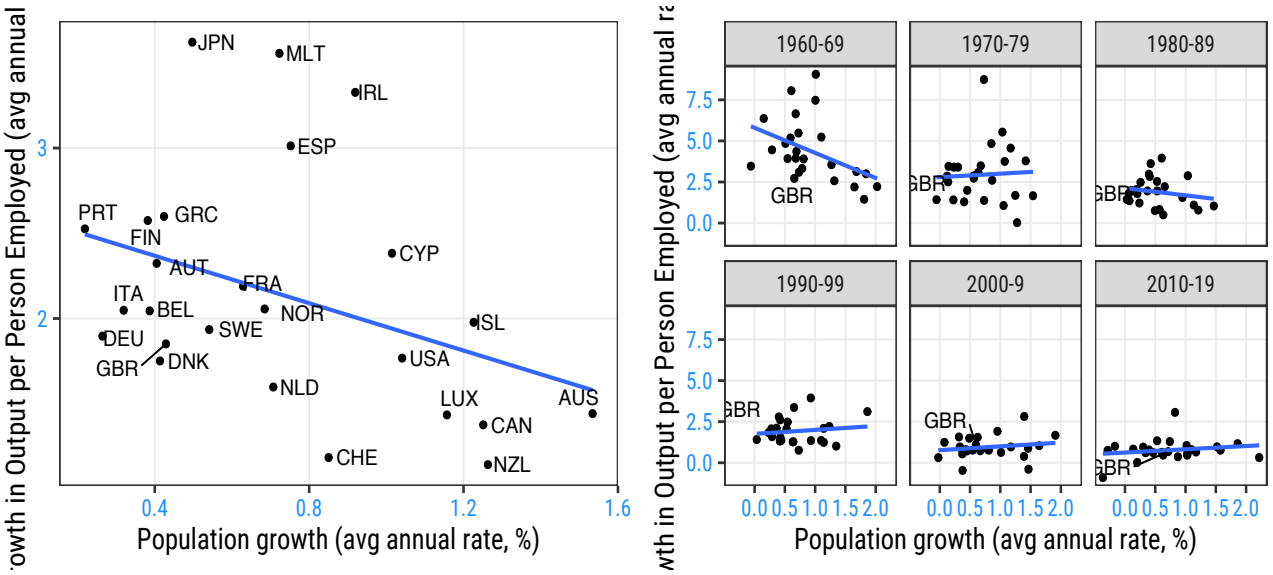


Figure 12: The simulated macroeconomic effects of increased labour supply (front-loaded) and reduced TFP



(a) Averages 1960-2019

(b) By Decade

Figure 13: Cross-country evidence: Productivity and Population growth

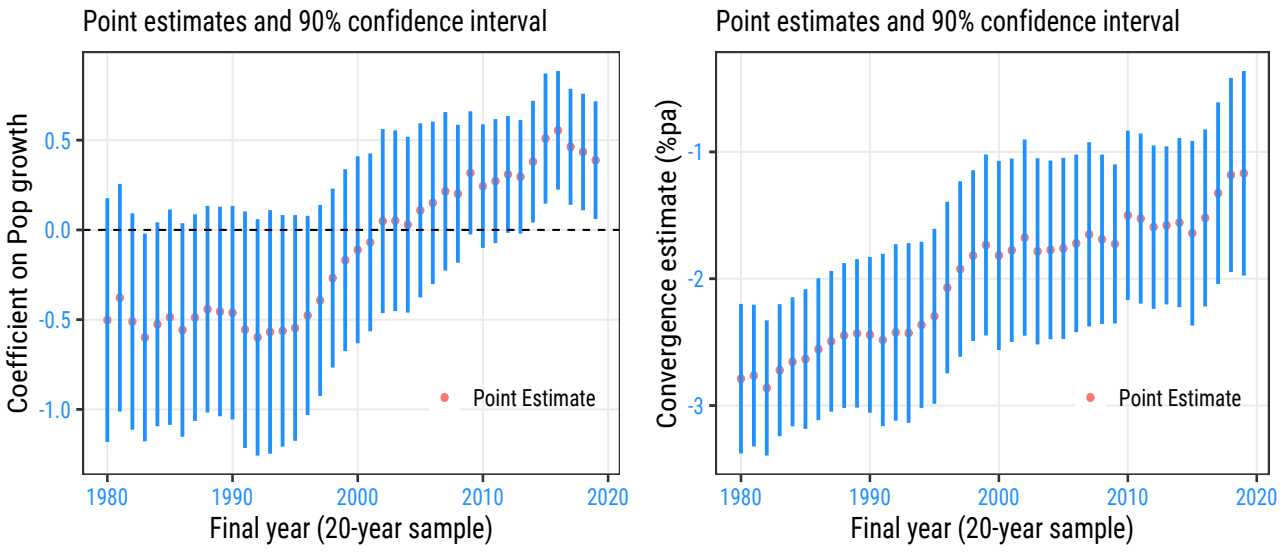
by the model.

4.3 Cross-country evidence

We complement our earlier analysis with some cross-country evidence on productivity growth. We use The Conference Board's Total Economy Database to explore cross-country links between labour productivity growth and population (or labour force) growth. From the database, we select its 25 countries in Western Europe, North America, Oceania and Japan for the period from 1960.

Average annual productivity growth correlates inversely with (average annual) population growth in the 60-year period (Figure 13). High productivity growth economies over this extended period have tended to have lower population growth. This is similar to the cross-country relationship highlighted by Beaudry and Collard (2002) up to 1997. Dividing the sample period by decade indicates that the cross-country relation is strongest in, and largely driven by, the 1960s experience. A generalised productivity slowdown across industrialised countries over time is also apparent.

We exploit the cross-country variation in each year by regressing country-level average



(a) Population growth

(b) Estimated Convergence

Figure 14: Estimated Effects from Population Growth and Speed of Convergence

productivity growth (in a 20-year window) on its population growth and initial level of productivity, allowing also for convergence.[16]

As in Beaudry and Collard (2002), we show the evolution of the rolling coefficients on population growth and that capturing convergence. This allows us to assess how the cross-country link between productivity growth and population growth varies over time, while controlling for convergence effects.

Our estimates confirm that an inverse cross-country relation between productivity growth and population existed up to the 1980s and mid-1990s. In that era, higher growth economies tended to have lower average rates of population growth. Yet, this estimated relationship has since changed sign. More recently, in our sample of 25 countries higher productivity growth economies have tended to have higher population growth, also controlling for productivity convergence.

While our estimates also provide evidence of convergence in our sample of advanced

[16] As an exercise in cross-country data description, this involves estimating:

$$\Delta log(Y_{it}/L_{it}) = \alpha_{0,t} + \alpha_{1,t} log(Y_{i0}/L_{i0}) + \alpha_{2,t} \Delta Pop_{it} + \epsilon_{it}$$

where *'i'* indexes countries i = 1,2..35 and *'t'* indexes years, t = 1980,1981...2019.

economies, the estimated rate of productivity convergence has slowed notably since the early-2000s and in the post-crisis period. Compared with an estimated 2.5%pa annual speed of convergence up to the 1980s, this has slowed to a little over 1%pa by 2019.

Beaudry and Collard (2002) argue that productivity growth in the 1970s was slower in economies where labour force growth was high, specifically, after the adoption of a general purpose technology and this owed to reduced capital deepening. They also suggest that this relationship was changing by the end of their sample period which ran to 1997. Our evidence is consistent with, and extends, that view.

What of the more recent UK experience in its era of rising labour supply and productivity slowdown? The cross-country evidence suggests that in the post-GFC period, it was not population growth per se that was the drag on productivity growth but rather the slower pace of cross-country convergence that followed the financial crisis. That feature could have owed to impaired capital markets slowing adjustment of the capital stock to an increase in labour force. While the UK was a laggard in terms of its initial level of labour productivity, by international standards its rate of population growth was not unusually high in this period. The cross-sectional evidence emphasises a reduced speed of international convergence rather than the direct impact of population growth as being important after the financial crisis.[17]

5 Conclusions

Reduced capital deepening accounts for between one-quarter and one-third (or 6 log points) of the UK's large productivity shortfall since 2008. We estimate that around 4 log points of the 21 log point shortfall in labour productivity that has emerged since 2008 is due to increased labour supply. The evidence we have presented suggests that the slow adjustment of the economy to a pronounced increase in labour supply weighed on capital shallowing for a prolonged period.

Our perspective has been both sectoral and aggregate (including cross-country). The

[17] The cross-country evidence (based on rolling 20-year samples for each country) is also likely to capture long-run effects of population which we expect to be more neutral for productivity as capital intensity adjusts.

macro perspective suggests that while micro-based evidence of the impact of immigration on local labour markets points to small long-run effects, this may understate macro effects in the medium-run that owe to reduced capital deepening. Our macroeconomic simulation evidence suggests that 4 log points of the productivity shortfall could be attributed to stronger labour supply, and we speculate that this effect could be even stronger in a period of impaired capital markets and weak international demand.

How quickly the capital stock adjusts becomes critical for this macro channel. It is plausible to believe that this pace of adjustment was slowed down since the financial crisis – and the aggregate impact on productivity of stronger labour supply increased – through credit market imperfections and heightened risk aversion.[18]

At the sector level, our analysis suggests that the impact on sector-level productivity is more similar across sectors than the impact on sector output. This is consistent with sector-level data suggesting broad-based reductions in capital-deepening and labour productivity across sectors.

Nonetheless, other shocks have clearly been central to the productivity slowdown accounting quantitatively for most of the shortfall. Some idiosyncratic shocks have applied in the finance and energy sectors.[19] In manufacturing, weak international demand may have also played a role. To some extent these show up in total factor productivity. We leave for future research to address whether some of these factors are reversed or intensified by Covid-19 and the policy responses to it.

Annex A: Sectoral productivity decompositions

The Table summarises sector-level productivity growth decompositions into capital-deepening and TFP contributions for the 2002-07 and 2008-19 periods and how these changed.

[18] Barnett *at al* (2014) and Hsieh and Klenow (2014).
[19] Tenreyro (2018)

	2002-07			2008-19			Difference		
sector[†]	Productivity growth	TFP	Capital deepening	Productivity growth	TFP	Capital deepening	Productivity growth	TFP	Capital deepening
A	0.84	-0.78	1.29	2.14	1.77	0.41	1.3	2.54	-0.88
B	-3.86	-7.14	2.98	-4.39	-3.54	-1.22	-0.53	3.59	-4.2
C	7.21	5.69	0.95	1.52	1.14	0.06	-5.69	-4.55	-0.89
D	-4.87	-6.07	1.02	-0.71	-1.83	0.87	4.16	4.24	-0.14
E	-2.57	-4.27	1.88	-3.6	-2.15	-1.73	-1.03	2.12	-3.6
F	-2.13	-2.62	0.62	0.13	-0.82	0.65	2.26	1.8	0.03
G	2.49	1.26	0.85	0.24	-0.39	0.22	-2.24	-1.65	-0.64
H	1.96	0.82	1.12	-0.58	-0.74	-0.08	-2.53	-1.56	-1.2
I	-0.83	-1.23	-0.59	-0.23	-0.59	-0.21	0.59	0.64	0.38
J	10.19	9.06	0.42	6.3	6.5	-0.46	-3.9	-2.56	-0.87
K	8.28	6	1.08	-1.04	-1.74	0.16	-9.32	-7.74	-0.92
M	1.96	1.41	0.22	-0.38	-0.9	0.26	-2.35	-2.31	0.03
N	-0.14	-0.85	0.42	1.25	1.16	-0.24	1.39	2.01	-0.65
R	3.95	6.15	-0.88	-0.88	-0.7	-0.34	-4.83	-6.85	0.54
STU	-2.6	-3.08	0.05	1.61	0.73	0.04	4.21	3.82	-0.01
Market sector	2.58	1.78	0.51	0.36	0.13	-0.07	-2.22	-1.65	-0.57

[†] Sectors defined as follows: Agriculture (A), mining and quarrying (B), manufacturing (C), electricity (D), water supply (E), construction (F), wholesale and retail (G), transport and storage (H), accommodation and food (I), information and communication (J), financial and insurance (K), professional and scientific (M), administration and support (N), arts and entertainment (R) and other services (STU).

Figure 15: Sectoral Productivity Decompositions

Annex B: Model simulations

The underlying macroeconomic structure for our model simulations is a standard (but non-DSGE) open-economy, New Keynesian model based around an IS curve, a Phillips curve and a description of monetary policy behaviour. The model includes the following features:

- A well-specified production function linking factor demands and aggregate potential output to the net capital stock, labour supply and labour augmenting technical progress. The model disaggregates production into eight industrial sectors. [20] Each sector has its own production function and differs in terms of the estimated factor shares, underlying productivity trends, exposure to international competition and its use and consumption of intermediate goods.
- A forward-looking investment function that relates the investment rate to the difference between the marginal product of capital (determined by the production function) and the cost of capital. The equation used in each sector is:

$$I_{it}/K_{it-1} = \beta_{i0} + \beta_{i1}(\partial Y_i^V/\partial K_i - u_{it} - \phi_{it}) + \beta_{i2} I_{it+1}/K_{it}$$

In theory, β_{i1} is determined by the cost of adjusting the capital stock — the larger the adjustment cost the smaller is β_{i1} — and $\beta_{i2} \approx 1-\delta_i$, the proportion of the capital stock that survives from one period to the next. The term $\partial Y_i^V/\partial K_i - u_{it} - \phi_{it}$ is the marginal product of capital less the user cost adjusted for a time-varying premium reflecting uncertainty and borrowing restrictions not already included in the user cost. The values $\beta_{i1} = 0.013$ and $\beta_{i2} = 0.9$ are imposed in each sector. These values are based on estimation results for the manufacturing sector.

- A forward-looking consumption function that relates spending to expected permanent non-property income, net financial wealth and real interest rates. Expected permanent non-property income is determined by the discounted value of expected future non-property income adjusted for population growth.

[20] The 8 sectors are: mining and quarrying, manufacturing, construction, private traded services, private non-traded services, financial services, public sector and an energy sector comprising agriculture, electricity and water. Imputed rent is also treated as a separate industry.

- A wage and price system that ensures that unemployment and the output gap settle at equilibrium values in the medium term. Domestic prices (the GDP deflator) are determined in the long run by unit labour costs, average earnings are determined by productivity and expected producer prices (GDP deflator). Consumer prices are determined by producer prices and import prices, with lagged pass-through.
- Exports and imports are determined by international and domestic demand and by prices in the UK relative to other countries. The nominal exchange rate is determined by uncovered interest parity.
- Monetary policy determines the nominal interest rate which is set to follow a backward-looking feedback rule that targets consumer price inflation.
- Balance sheet equilibrium is ensured by feedback within different sectors. In particular, excess government debt leads to higher household taxes, excess company debt leads to lower dividend distributions and so lower household receipts, lower household net wealth leads to lower consumption.

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