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Tracing Productivity Growth Channels in the UK[1]

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Abstract

What drove the UK productivity slowdown post-GFC, and how is the post-Covid recovery expected to differ? This paper traces the sources of TFP growth in the UK over the last two decades through the lens of a structural model of innovation, using registry data on the universe of firms. The dominant innovation source in the pre-GFC decade were improvements by incumbent firms on their own products, whereas creation of new varieties by entrants took a leading role post-GFC. In the Covid recovery, survey data suggests that creative destruction (i.e., innovation replacing other firms' products) is expected to gain importance. This emphasizes the need for growth policies that facilitate labor and capital reallocation across firms, in addition to R&D support.

CONTENTS

I. Introduction

UK productivity growth has been lackluster over the decade following the Global Financial Crisis—even more so than in other advanced economies. While part of that is driven by a decline in investment, the supply-side component that has underperformed the most is total factor productivity (Chart 1). Several hypotheses have been advanced for the TFP growth decline, including legacy effects from both the dotcom and global financial crises (GFC), the stagnation of laggard or small-scale firms, the UK's reliance on the service sector, mismeasurement of intangible investment, or diminishing technological opportunities.[1] However, none of these channels seems to provide a holistic explanation; the literature still refers to this period as the "UK's productivity puzzle".

Chart 1. UK: Gross Value Added, Supply-Side Decomposition
(moving average (5) annual growth rate, percent)

Source: ONS (January 2021 vintage).
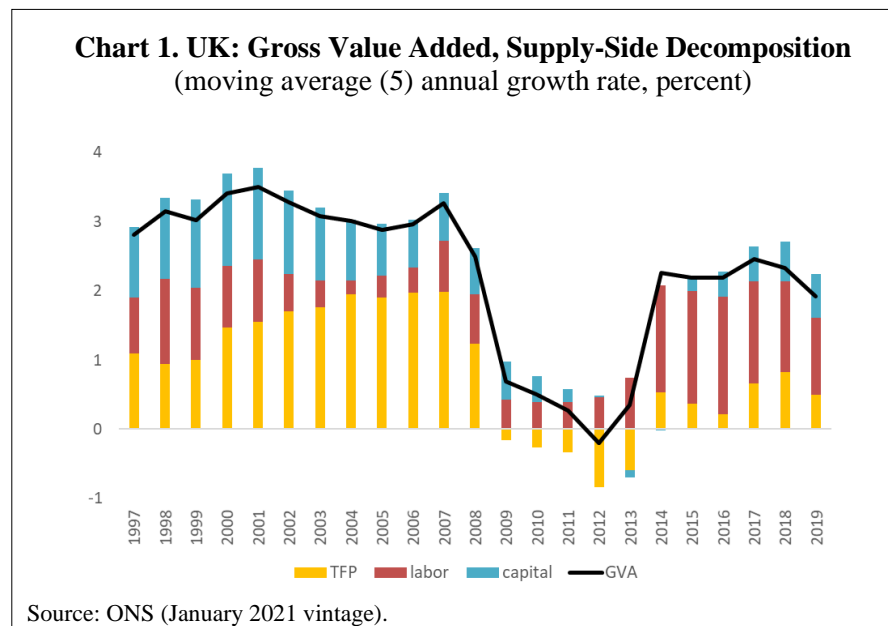
If the pre-Covid period remains a puzzle, the evolution of productivity after the structural shocks caused by Covid and Brexit is even more uncertain. Some analysts view the economy on the edge of a productivity boom, taking the shape of a wave of creative destruction, while others anticipate that depressed innovation will give way to persistent scarring. Optimists point to new sectors with potential to be future sources of growth, such as digital and green, while pessimists emphasize difficulties in reallocating workers from the traditional sectors most affected by the shocks. IMF forecasts continue to identify TFP growth as the weaker component of the UK recovery in the medium run (Chart 2), based on the experience of past recessions in advanced economies, including those caused by epidemics (IMF, 2021a).

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[1] See e.g., Goodridge et al. (2013), Barnett et al (2014), Haldane (2017), Castellani et al. (2018), Goodridge et al. (2018), and OECD (2020).

Chart 2. UK: Real GDP, Supply-Side Decomposition
(growth rate, percent)

Source: IMF staff forecasts, July 2021 WEO vintage.
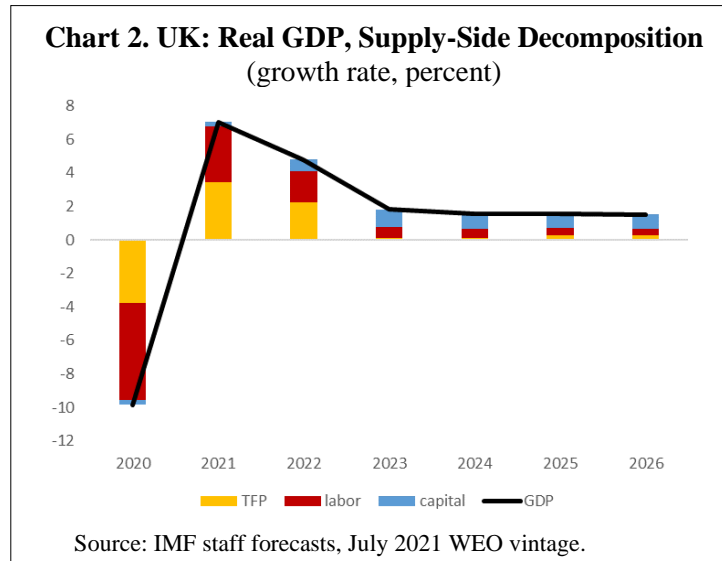
In this context, the government's Plan for Growth (HM Treasury, 2021) and Innovation Strategy (BEIS, 2021) situate innovation as one of the main pillars of the post-Brexit growth strategy. The government has set a target for total R&D investment to reach 2.4 percent of GDP by 2027 (from 1.7 percent in 2019), which will be underpinned by a review of R&D tax reliefs, and commits to increasing annual public R&D investment to £22 billion (about 0.9 percent of GDP).[2] Achieving these targets would contribute to reduce the economic scarring caused by an incomplete TFP recovery. The other two main pillars of the Plan for Growth—infrastructure and skills—would also help to sustain the recovery by facilitating the reallocation of capital and labor towards sectors with better prospects. Notably, the plan also singles out specific sectors with higher growth potential, including digital and clean energy.

Nonetheless, the degree to which the government should intervene to promote private investment, including in R&D, and whether or how the approach should be tailored by sector depend on which channels of productivity growth dominate. For example, the optimal subsidy for innovation in the form of creative destruction is lower than for less disruptive forms of innovation, as creative destruction entails not only positive knowledge spillovers but also a negative "business stealing" externality (see Atkeson and Burstein, 2019). Instead, creative destruction would put the onus on policies to permit a rapid reabsorption of displaced workers and capital, such as enhanced active labor market policies and ample financing for viable firms. Hence, successful policy design relies on an understanding of the role of creative destruction vs other sources of growth across the economy.

This paper aims to inform the debate on the drivers of productivity growth in the UK and the optimal policies to boost it by addressing the following questions:

1.   What sources of innovation account for the decline in UK TFP growth over the last decade, compared with the 2000s?

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[2] https://www.gov.uk/government/consultations/rd-tax-reliefs-consultation.

2.   Do major peers (namely the US) feature similar patterns?

3.   How do the sources of innovation vary by economic sector?

4.   What sources are expected to dominate in the post-Covid era?

5.   What are the implications for optimal innovation and growth policies?

To answer these questions, the paper provides an accounting of the sources of productivity growth in the UK using a state-of-the-art decomposition previously applied to the US (Garcia-Macia, Hsieh and Klenow, 2019). This decomposition reveals how the sources of innovation have evolved, distinguishing between creation of brand-new varieties, creative destruction of other firm's existing varieties, and quality improvements on existing varieties. For each of these three categories, it also identifies the relative contributions of entrant and incumbent firms.

The estimation mainly uses data from the UK's Office of National Statistics (ONS) firm registry covering the past two decades. It finds that own innovation was the dominant source of growth in the pre-GFC period, although creative destruction, especially by incumbents, was relatively more prevalent than in the US. In the post-GFC period, though, it appears that the majority of (the lower) TFP growth came from creation of new varieties by entrants.

The estimation is also done by sector, with an emphasis on large traditional sectors, such as manufacturing and retail, as well as on sectors with growth potential, such as information and communication technologies (ICT). The modest productivity growth seen in manufacturing has been split between own innovation and creative destruction by incumbents, while faster growth in ICT has been due to a relatively larger contribution of new varieties and creative destruction, and in retail to own innovation. Productivity in tradable sectors as a whole grew less than non-tradables, with new variety creation by entrants the only source that was relatively more important for tradables.

As a forward-looking complement to the ONS data, the BoE's Decision Maker Panel (DMP) survey data is also employed to shed light on how the sources of productivity growth may shape up in the immediate post-Covid future. Firm expectations point to an incoming wave of creative destruction, consistent with the view that Covid will lead to a period of intense factor reallocation across firms.

The rest of the paper is organized as follows. Section II summarizes the model. Section III presents the data and identification method. Section IV discusses the results of the estimation. Section V concludes with policy implications.

II. MODEL

The paper uses the growth model developed by Garcia-Macia, Hsieh and Klenow (2019), henceforth GHK. In the model, productivity growth can occur from three sources: 1) creation of new varieties (a la Romer, 1990); 2) creative destruction of a firm's existing varieties by

another firm (as in the models of Aghion and Howitt, 1992, and Klette and Kortum, 2004); and 3) improvement in the productivity of a firm's own varieties. Sources 1) and 2) can be further decomposed into the contributions of entrant and incumbent firms, while source 3) is only available to incumbent firms.

For intuition, new varieties (source 1) capture products that become newly available in a given market; for example, an Indian restaurant opening in a town where there was none. Creative destruction (source 2) occurs when a firm innovates by improving upon the quality or efficiency of an existing product produced by another firm, and by doing so takes over the market from the original firm. An example would be a new Tesco store that drives out of business the local grocery store. Finally, own improvements (source 3) encompass any increase in the quality or efficiency of the products produced by an incumbent firm. Examples could be a new Land Rover model, or a streamlined production line.

The main model ingredients are as follows (see Appendix I for the full set of equilibrium equations). Firms are defined as a collection of varieties (or products) with heterogenous quality levels. Innovation of different types occurs randomly with a given probability per existing variety. As shown in Table 1, each existing variety can only experience at most one type of innovation per period: it can either be improved by its owner (with probability λ_i), creatively destroyed by another incumbent (probability $(1-\lambda_i)*\delta_i$), or creatively destroyed by an entrant ($(1-\lambda_i)*(1-\delta_i)*\delta_e$). The creative destruction probabilities δ_i and δ_e are defined as conditional on own innovation not taking place, hence the term $(1-\lambda_i)$ in the unconditional probability. The underlying assumption is that own innovation protects a variety from creative destruction. The arrival rate of brand-new varieties created by entrants (κ_e) or incumbents (κ_i) is also proportional to the number of existing varieties.

All types of innovation imply an increase in the quality of the innovated variety. "Quality" should be broadly understood as the amount of utility generated by a given product per unit of input. Thus, quality increases also encompass process or efficiency improvements. The quality step size of innovations on existing qualities is drawn from a Pareto distribution with shape parameter θ and scale parameter equal to 1 (so the minimum possible net improvement is zero). The quality of brand-new varieties is drawn from the existing quality distribution and multiplied by parameter $s_\kappa \leq 1$.

Table 1. Innovation Sources

Source	Unconditional probability per existing variety	Quality step size
Own-variety improvements by incumbents	λ_i	Pareto(1,θ)
Creative destruction by incumbents	$(1-\lambda_i)*\delta_i$	Pareto(1,θ)
Creative destruction by entrants	$(1-\lambda_i)*(1-\delta_i)*\delta_e$	Pareto(1,θ)
New varieties from incumbents	κ_i	s_κ
New varieties from entrants	κ_e	s_κ

The only factor of production in the model is labor, so output per variety is equal to the variety's quality times labor. Firms are also subject to overhead production costs in terms of labor, implying that a minimum level of profitability (and thus quality) is required for production of a variety. The parameter ψ indicates the relative quality of the break-even variety, i.e., the quality that makes the net present value of a variety's profits equal to zero. The labor supply grows at a constant rate. Households consume a CES aggregator of all varieties produced in the economy, with elasticity of substitution σ.

Entrant firms start with one variety, either newly created or obtained by creative destruction of an existing variety. Over time, firms grow (in both output and employment) if they creatively destroy more varieties, and/or if they improve the quality of their varieties. Firms exit if they either lose all their varieties due to creative destruction by other firms, or if the relative quality of their varieties drifts below the break-even threshold. The latter may happen as the aggregate wage grows over time, raising overhead costs.

Profit maximization implies that firms that increase their number of varieties and/or their quality will also increase their employment.[3] The novelty of the model is that it describes how the different sources of innovation, undertaken by entrant and incumbent firms, have distinct implications for the distribution and dynamics of employment across firms.[4] Hence, the contributions of each source can be inferred using a representative panel dataset with information on employment across firms and firm population dynamics.

For example, a higher rate of creative destruction will lead to an increased frequency of large employment changes at the firm level, as innovating firms capture the market share of other individual firms, whereas own-variety improvements will tend to cause smaller labor inflows for the innovating firm and a more dispersed employment loss for other firms. Higher firm exit rates (if sustained over time) are also a sign of more creative destruction, as creative destruction puts incumbents at a higher risk of losing their varieties. Instead, creation of new varieties will manifest in a growing number of firms in the economy (assuming a stationary distribution of varieties per firm) and growing employment (as average employment per firm is constant over time). Regarding the relative contributions of entrants vs incumbents, a larger share of employment by entrants signals a higher rate of entrant innovation, while higher average growth of firms over their lifetime signals a greater importance of incumbents.

Focusing on firm and employment dynamics in the model allows the estimation to cover the universe of firms. Other relevant variables such as R&D spending or patents would not be available for all firms, and would not cover all types of innovation, especially by young and small firms. Similarly, the capital stock is measured with more noise for smaller firms. GHK

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[3] Productivity growth is also followed by employment growth in the data (see, e.g., Moral-Benito, 2018).

[4] While this is a closed-economy model, firm-level innovation can be interpreted more generally as adoption of technologies, including those invented or developed abroad.

show that results are robust to using output, which includes capital returns, instead of employment shares (using data from the US, an economy with broadly comparable product and factor market flexibility). This implies that labor-substituting innovation, which would tend to move output and employment in opposite directions, does not play a substantial role on aggregate.

The model equilibrium is simulated numerically. The simulation tracks the lifetimes of overlapping cohorts of firms as they are created, grow over time, and, if they lose all their varieties, die. Such simulation will permit to compare key moments in the model vs the data.

III. DATA AND ESTIMATION

A. ONS Business Structure Database

The main estimation uses data from the ONS's Business Structure Database (BSD), which covers about 99 percent of UK firms over 1997–2019. Our sample excludes publicly-owned firms, not-for-profit firms, and product categories dominated by publicly-owned firms, since employment changes in those firms are not necessarily driven by profit maximization. This also avoids capturing the effects of privatizations or nationalizations. Appendix II describes the sample in further detail.

The full list of moments needed to estimate the model is displayed in Table 2.[5] Multifactor productivity (or TFP) annual growth rates for the total market economy and by sector are publicly available at the ONS website (this paper uses the January 2021 vintage).[6] All other moments are calculated from the BSD firm-level data. The job creation (destruction) rate is defined as the total change in employment in firms with growing (declining) employment, divided by the average of current and past employment. Firm-level employment changes are calculated netting out sector-level (5-digit SIC categories) employment changes, in order to avoid capturing shocks not related to firm-level innovation such as changes in sector-level demand.[7]

A key assumption of the model is that employment evolves in proportion to productivity (or quality) growth, which is a consequence of profit maximization by firms facing a downward-sloping demand. To avoid bias due to temporary frictions in labor reallocation, which would cause an underestimation of the role of creative destruction, the paper focuses on the medium run, defining a period as 5 years.

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[5] The only moment in the list that is not targeted is total employment. The simulated sample features less total employment than the data, as this allows to reduce computational time.

[6] Since the only production factor in the model is labor, the model is silent on whether the empirical productivity target should be multi-factor or labor productivity. The empirical strategy targets multi-factor productivity because it is a less volatile statistic and less subject to transitional dynamics after aggregate shocks.

[7] Since some firms switch sectors over time, sectors are kept fixed at their initial-year values.

Specifically, moments are calculated for four 5-year periods[8], which are then averaged into two 10-year blocks: pre-GFC (1998–2007) and post-GFC (2010–2019). The GFC years—2008 and 2009—are excluded, since they feature strongly negative TFP growth (see Chart 3). The model cannot fit negative TFP growth as it is not meant to describe short-run aggregate fluctuations.

Chart 3. UK: Multi-Factor Productivity
(growth rate, percent)

average 1998-2007: 1.7%

average 2010-2019: 0.5%

Source: ONS.
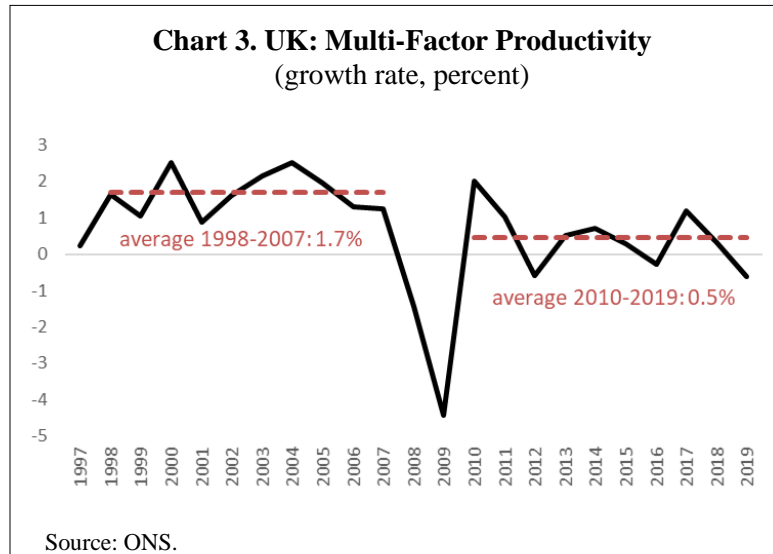
The paper estimates the sources of innovation for the aggregate market economy as well as for select large sectors. It also compares the results in tradable vs non-tradable sectors, where tradable 2-digit SIC sectors are defined as those where more than 10 percent of total demand was traded on average for 1997–2015, following Broadbent et al. (2019). This threshold roughly splits the sample in half.

The estimation employs the Simulated Method of Moments. This is, it finds the set of parameters that minimizes the sum of squared distances between statistical moments calculated for a model-simulated population of firms and their values in the data.

B. Present and Forward-Looking Data

To predict how the sources of innovation may evolve after Covid, the paper also uses data from the Decision Makers Panel (DMP). The DMP surveys both the realized and 1-year-ahead expected flows of employment by firm at a quarterly frequency, from 2016Q4 to 2021Q2, among other variables. The sample consists of about 9,400 firms and is designed to be representative of the firm population.

Given that the DMP only includes incumbent firms, it is combined with ONS quarterly data on entrant and exiting firms, publicly available up to 2021Q1. While these two datasets do

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[8] These are 1998–2002, 2003–2007, 2010–2014, and 2015–2019.

not provide all the moments required for a full estimation of the model, they do contain some suggestive information that is analyzed in Section IV.E.

IV. RESULTS

This section discusses the values of the empirical moments used for estimation, the estimated model parameters, and the implications for the contribution of innovation sources.

A. Empirical Moments

Table 2 displays the values of the set of moments used to estimate the model in the pre- and post-GFC periods in the UK. It also compares it with the corresponding values in the US, calculated in GHK for partially overlapping time periods.

A few patterns stand out. First, both in the UK and the US, the employment share of young firms and the job creation and destruction rates have all been trending down. The literature has interpreted this as a decline in business dynamism (Decker et al., 2016). However, the UK data features some distinct traits. First, TFP growth has dropped to a strikingly low level post-GFC, whereas employment growth has increased significantly in the same period. Second, firms tend to be on average half the size as in the US, and the employment distribution across firms is less disperse, reflecting the relative scarcity of giant firms in the UK. Exit rates are lower than in the US, which would suggest less dynamism through cleansing of low-productivity firms, but job creation and destruction rates are larger, pointing to greater labor churn across firms.[9] The latter is confirmed by the bigger share of labor flows which are large in the UK. To make sense of these patterns, the empirical moments will be read through the lens of the model in the following subsections.

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[9] A potential concern is that merger and acquisition (M&A) activity would tend to inflate recorded job reallocation and firm exit rates, and thus the role of creative destruction. This is not obvious, since creative destruction can also be carried through the acquisition of the "creatively destroyed" firm. In any case, Appendix III shows that the key moments are broadly invariant to excluding firms that undergo M&As.

Table 2. UK vs. US: Moments over Time
(period averages)

Moment	UK 1998–2007	US 1993–2003	UK 2010–19	US 2003–13
Total employment (millions)	18.6	112.0	19.9	125.0
Employment per firm	10.2	23	9.3	24
Employment share young firms (<5y)	13.5%	18.3%	12.0%	15.5%
Average employment young firms	3	11	3	10
Average employment old firms	15	31	13	32
Std. dev. log employment by firm	1.04	1.27	1.04	1.28
Job creation rate	44.3%	41.5%	37.7%	32.5%
Job destruction rate	40.7%	33.2%	32.3%	30.0%
Share of small job creation (<3x)	33.5%	36.6%	33.0%	36.3%
TFP growth rate	1.69%	2.30%	0.46%	1.32%
Employment growth rate	0.7%	1.6%	1.1%	0.5%
Exit rate small firms	6.4%	7.2%	6.2%	7.5%
Exit rate large firms	3.7%	5.3%	3.4%	4.9%

Source: ONS and authors' calculations.

Notes: Young firms are defined as less than 5 years old, and old firms are the rest. Job creation and destruction rates are defined as DHS growth rates over 5 years. The share of small job creation includes firms whose employment grows by less than 300 percent in 5 years. Growth rates and exit rates are annualized. Small firms are those with below-average employment, and large firms the rest. Minimum employment is equal to 1 in all samples.

Before turning to the inference, though, it is useful to describe the data also by sector. Table 3 contains the moments in the most recent time period (2010–2019) for manufacturing and services, as well as a few select subsectors within services: information and communications technologies (ICT), retail and wholesale trade, and professional services. The data for the overall service sector is close to the aggregate—naturally, as services account for about 4/5 of employment in the sample—but features slightly higher TFP and employment growth rates. The manufacturing sector is more particular. In the UK it is a sector in stagnation, with marginally negative employment growth, a very small share of young firms, relatively small labor flows, and low exit rates. It also features a wide dispersion of employment across firms, and steep growth in employment by firm age.

Within services, ICT is one of the sectors with the fastest TFP growth, and also features high levels of job reallocation (i.e., job creation and destruction rates) and a relatively high entrant share. The professional services sector shows similar employment dynamics to ICT, but a considerably lower TFP growth rate. Finally, the retail sector is also a prominent driver of growth, but with more stable employment dynamics, including slow employment growth, relatively little job reallocation, a low share of entrants, and low firm exit rates.

Table 3. Moments by Sector, 2010–2019
(period averages)

Moment	Manuf.	Services	ICT	Retail	Prof. Serv.
Total employment (millions)	2.8	15.9	0.9	4.8	2.0
Employment per firm	18.1	9.4	5.5	12.5	4.8
Employment share young firms (<5y)	6.0%	12.5%	15.5%	7.0%	19.0%
Average employment young firms	4	3	2	3	2
Average employment old firms	23	13	9	17	7
Std. dev. log employment by firm	1.36	1.03	0.85	1.04	0.87
Job creation rate	30.5%	40.3%	47.6%	27.6%	51.5%
Job destruction rate	31.0%	32.7%	35.9%	25.9%	39.6%
Share of small job creation (<3x)	42.9%	31.4%	27.2%	39.8%	22.2%
TFP growth rate	0.39%	0.73%	1.72%	1.65%	1.15%
Employment growth rate	-0.1%	1.5%	2.2%	0.3%	2.3%
Exit rate small firms	5.1%	6.1%	6.3%	5.5%	6.0%
Exit rate large firms	1.9%	3.3%	2.8%	2.3%	3.1%

Source: ONS and authors' calculations.

Note: data for manufacturing are for the period 2011–2019—dropping 2010 avoids more negative employment growth, which the model cannot fit.

Given the relatively high trade openness of the UK and the large external shocks over the past decade, including the Brexit referendum and associated depreciation of the pound, the estimation is also conducted for tradable and non-tradable sectors separately. Table 4 shows that the majority of moments related to firm employment dynamics are not too dissimilar across the two groups, with slightly more disruptive dynamics for tradables (more job reallocation and exit rates, a larger entrant share, and a wider employment dispersion). However, TFP growth rate is about 3 times faster for non-tradables. This is mostly driven by retail and wholesale trade, which accounts for half of nontradable employment and features fast TFP growth, on the one hand, and by the hospitality and financial sectors, which are important tradeable sectors and experienced substantially negative TFP growth, on the other. Surprisingly, though, employment growth has been faster for tradables.

Table 4. Moments by Sector Tradability, 2010–2019 (period averages)		
Moment	**Tradables**	**Non-tradables**
Total employment (millions)	11.7	8.2
Employment per firm	9.7	8.6
Employment share young firms (<5y)	13.0%	11.0%
Average employment young firms	3	3
Average employment old firms	14	12
Std. dev. log employment by firm	1.09	0.97
Job creation rate	41.4%	36.0%
Job destruction rate	34.8%	32.2%
Share of small job creation (<3x)	30.7%	31.3%
TFP growth rate	0.42%	1.27%
Employment growth rate	1.3%	0.8%
Exit rate small firms	6.3%	5.6%
Exit rate large firms	3.2%	3.2%

Source: ONS and authors' calculations.

Note: tradable sectors are those where more than 10 percent of demand is traded, as in Broadbent et al. (2019).

B. Inferred Parameters

Table 5 displays the estimated model parameters for the UK's aggregate market economy. Taking the post-GFC period as reference, the estimation obtains that about half of varieties are improved by their owners each period (5 years). Among the other half, 4/5 are creatively destroyed by another incumbent, and the rest by an entrant. This implies that all varieties experience some type of innovation. Such corner solution helps to keep the quality step size low for a given aggregate TFP growth rate, and thus to avoid (counterfactual) excessive dispersion in the employment distribution.

New varieties arrive at a 6 percent rate, and are exclusively created by entrants—another corner solution. This helps to keep young firms small as in the data, as the quality of new varieties tends to be about half the quality of existing ones, and so firms entering with a new variety tend to be smaller. The shape parameter of the Pareto distribution of quality improvements is substantially larger in the post-GFC than in the pre-GFC period, implying a smaller quality step size of innovation on average. This is consistent with a smaller TFP growth coupled with higher employment growth post-GFC, which assigns most productivity growth to expanding varieties and leaves little "room" for quality growth.

The parameter ψ is estimated at 0.17, meaning that varieties whose relative quality falls below 17 percent of the average do not generate enough profits to cover for the overhead cost, and thus are discontinued. The moment tying down this parameter most directly is the minimum size of a firm, equal to one employee. The only parameter that is calibrated is the elasticity of substitution across varieties σ, which is set equal to 4 following the estimate of Broda and Weinstein (2006).

Table 5. Inferred Parameters over Time		
Parameter	1998–2007	2010–2019
Own-variety improvements by incumbents λ_i	0.56	0.51
Creative destruction by incumbents δ_i	0.79	0.82
Creative destruction by entrants δ_e	1.00	1.00
New varieties from incumbents κ_i	0.00	0.00
New varieties from entrants κ_e	0.04	0.06
Pareto shape of quality draws θ	14.5	84.3
Relative quality of new varieties s_κ	0.64	0.55
Average quality of exiting varieties ψ	0.15	0.17

Note: The first five parameters indicate the arrival rate of different sources of innovation per existing variety. The rate of own-variety improvements by incumbents is expressed unconditionally. The rate of creative destruction by incumbents is conditional on the variety not experiencing an own improvement. The rate of creative destruction by entrants is conditional on the variety not being creatively destroyed by an incumbent. Note $\delta_e=1$ in the two sets of estimated parameters, implying that all varieties experience some type of innovation in each period.

Table 6 shows the fit between simulated and data moments for the post-GFC period. To reiterate, parameters are chosen to minimize the sum of squared distances between data and model moments. Overall, the fit is quite good. The greatest tension points are growth in firm employment by age, and firm exit rates, both of which are too low in the model. Intuitively, generating more firm growth would require even smaller/low-quality entrants, but that would tend to make the employment distribution too disperse. Higher exit rates could be obtained with higher creative destruction rates, but that would lead to excessive job creation and destruction, and a smaller share of small job creation.

Table 6. Model Fit, Market Economy, 2010–2019		
(period averages)		
Moment	Data	Model
Employment per firm	9.3	9.3
Minimum employment	1	1
Employment share young firms (<5y)	12.0%	11.7%
Average employment young firms	3.1	4.4
Average employment old firms	12.7	10.9
Std. dev. log employment by firm	1.04	1.06
Job creation rate	37.7%	38.4%
Job destruction rate	32.3%	32.5%
Share of small job creation (<3x)	33.0%	32.5%
TFP growth rate	0.46%	0.46%
Employment growth rate	1.07%	1.15%
Exit rate small firms	6.2%	4.8%
Exit rate large firms	3.4%	2.0%

Note: parameters are chosen to minimize the squared distance between data and model moments.

C. Innovation Sources

Once the parameters are estimated, the contribution of each source of innovation to TFP growth can be calculated analytically (see equations (1) and (2) in Appendix I). Table 7 shows these contributions in absolute terms for the pre- and post-GFC periods. In the pre-

crisis period, own innovation (available only to incumbents) and creative destruction by incumbents were the main sources of growth, accounting for 50 and 32 percent of TFP growth respectively. These two sources declined markedly in the post-crisis period, while creation of new varieties by entrants grew in both relative and absolute importance, accounting for almost half of all growth in the period. The larger contribution of new varieties by entrants is a direct consequence of the increase in employment growth coupled with the overall decline in productivity growth, which the model interprets as a growing inflow of low-quality new varieties.[10]

Table 7. UK Market Economy: Sources of Innovation over Time
(contribution to TFP growth, percentage points)

	1998–2007	2010–2019
Total TFP growth	1.69	0.46
Creative destruction	0.68	0.12
o/w entrants	*0.14*	*0.02*
o/w incumbents	*0.54*	*0.10*
New varieties	0.16	0.22
o/w entrants	*0.16*	*0.22*
o/w incumbents	*0.00*	*0.00*
Own innovation	0.85	0.12

Compared with the US, the UK features a higher creative destruction rate in the pre-GFC period (although the periods available for each country do not fully overlap), and a substantially higher share of new-variety creation thereafter, as seen in Table 8. Own innovation is lower in the UK throughout the periods, but especially post-GFC. Whereas the US has experienced a growing contribution of incumbents over time, the opposite has happened in the UK. Section IV.D discusses structural drivers that could potentially be behind these trends.

These results are obtained by indirect inference, using information on firm demographics and employment dynamics. However, more direct survey data from the Global Entrepreneurship Monitor on product innovation by start-ups in 2002–2015 (which capture primarily new varieties and, perhaps to some extent, creative destruction) point to similar patterns. Chart 4 shows that product innovation has declined substantially in the US, whereas it stayed

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[10] Using the latest (July 2021) vintage of the ONS multi-factor productivity estimates (not yet available at the time of the estimation) would imply higher TFP growth in the post-GFC period. While the qualitative changes in the sources of innovation from pre- to post-GFC should remain, higher TFP growth would tend to increase the estimated quality step of innovation on existing varieties, leading to a larger absolute contribution of creative destruction and own innovation.

generally stable in the UK, which roughly matches the evolution in the *absolute* contributions to TFP of new varieties (falling to less than half in the US and increasing slightly in the UK).

Table 8. UK vs. US: Sources of Innovation over Time
(share of TFP growth, percent)

Source:	UK 1998–2007	US 1993–2003	UK 2010–19	US 2003–13
Creative destruction	40.3	27.8	25.7	21.9
o/w entrants	*8.5*	*14.2*	*4.6*	*15.6*
o/w incumbents	*31.8*	*13.6*	*21.1*	*6.2*
New varieties	9.4	8.3	47.5	4.2
o/w entrants	*9.4*	*8.3*	*47.5*	*4.2*
o/w incumbents	*0.0*	*0.0*	*0.0*	*0.0*
Own innovation	50.3	63.9	26.8	74.0

Chart 4. Product Innovation Reported by Start-Ups
(Percent reporting product innovation annually)

Source: Global Entrepreneurship Monitor.
Note: The chart shows the average annual share of start-ups who answered 'All' to the question on whether 'All, some or none customers consider the product or service as new'.
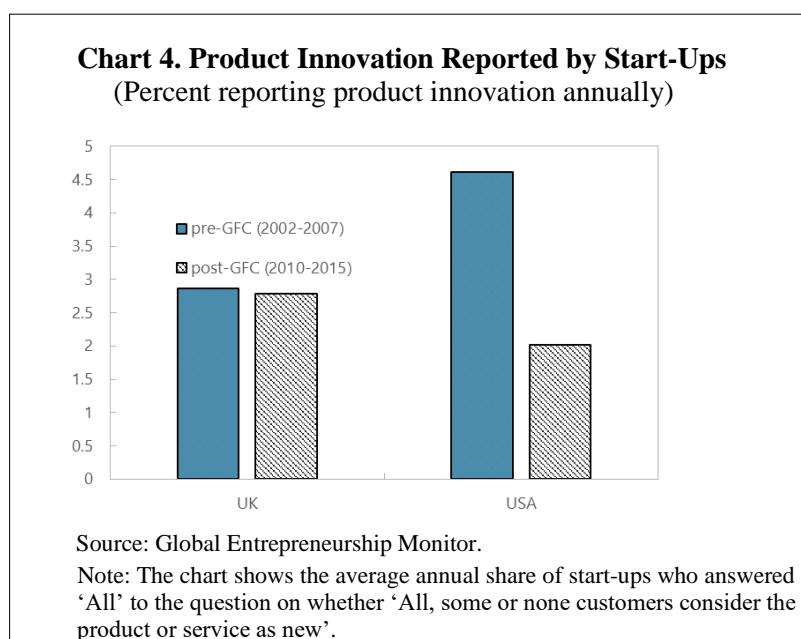
Table 9 estimates the sources of innovation for a few sectors with specific relevance or characteristics: manufacturing—a sector in stagnation, ICT—an emerging sector with potential spillovers as an input to other sectors, and retail—a growth driver with smooth labor dynamics. The little TFP growth that the manufacturing sector enjoyed was split between own innovation and creative destruction by incumbents, with creative destruction by entrants having a small contribution, and new varieties virtually irrelevant. The latter is inferred from the lack of employment growth in the sector—in fact, the estimation period for manufacturing excludes year 2010 to avoid having to target significantly negative job growth, which the model cannot replicate.

The overall service sector features very similar moments to the aggregate economy and so is not estimated separately. Within services, though, the comparison between ICT and retail is

remarkable. Both sectors enjoyed fast TFP growth, but for ICT this was the consequence of more disruptive forces, as seen in the greater importance of creative destruction and new varieties by entrants. Instead, retail benefited from an important inflow of own innovation by incumbents. If ICT, or the digital economy more broadly, is to continue expanding along the same pattern, policymakers should prepare for potentially high business and job dislocation ahead.

Table 9. Sources of Innovation by Sector, 2010–2019
(Share of TFP growth, percent)

Source:	Manufacturing	ICT	Retail
Creative destruction	47.1	39.5	28.9
o/w entrants	*6.2*	*6.4*	*3.4*
o/w incumbents	*40.9*	*33.1*	*25.6*
New varieties	0.0	26.7	7.9
o/w entrants	*0.0*	*26.7*	*7.9*
o/w incumbents	*0*	*0*	*0*
Own innovation	52.9	33.8	63.2

Note: the time period for manufacturing is 2011–2019—dropping 2010 avoids more negative employment growth, which the model cannot fit.

Table 10 compares the sources of innovation between tradable and non-tradable sectors. Recall that the tradable sector features low TFP growth coupled with fast employment growth. This leads to the inference that the main source of growth are new varieties by entrants, to an even larger extent than for the aggregate economy in the same period. For non-tradables, own innovation and creative destruction are more important, both in relative and absolute terms. Incidentally, this illustrates that job reallocation rates are not a sufficient statistic for the contribution of creative destruction: creative destruction is more relevant for non-tradables despite the lower job creation and destruction rates in those sectors.

Table 10. Sources of Innovation by Tradability, 2010–2019
(Share of TFP growth, percent)

| Source:	Tradables	Non-tradables
Creative destruction	21.5	39.6
o/w entrants	*4.1*	*6.7*
o/w incumbents	*17.4*	*32.9*
New varieties	56.1	13.5
o/w entrants	*56.1*	*13.5*
o/w incumbents	*0.0*	*0.0*
Own innovation	22.4	46.9

Note: tradable sectors are those where more than 10 percent of demand is traded, as in Broadbent et al. (2019).

D. Discussion of Structural Drivers

The shift in the sources of innovation over time may be driven by a number of structural and policy factors. This subsection discusses and provides suggestive evidence for the potential relevance of some of these underlying factors. Pinpointing these factors should also help to better understand how innovation sources might evolve post-Covid, and thus how policy would need to react.

Overall, the result in Table 7 that the absolute contributions of incumbents through all sources have sharply declined post-GFC in the UK, while those of entrants have slightly increased, would suggest the presence of incumbent-specific constraints. These could be related to legacy effects for the firms that were alive during the GFC, including through a need to deleverage, but also to changes in the policy environment in some sectors (e.g., financial sector regulation).

Higher creative destruction in the UK than in the US (Table 8), especially in the pre-GFC period, may reflect the flexibility of UK markets, as this form of innovation involves more drastic changes in firm market shares and higher firm exit rates.[11] Indeed, OECD indicators of product market regulation show the UK as one of the countries with the least stringent regulation, but with a shrinking advantage over time relative to the average country (Chart 5).

Chart 5. Product Market Regulation Stringency Index

Source: OECD.
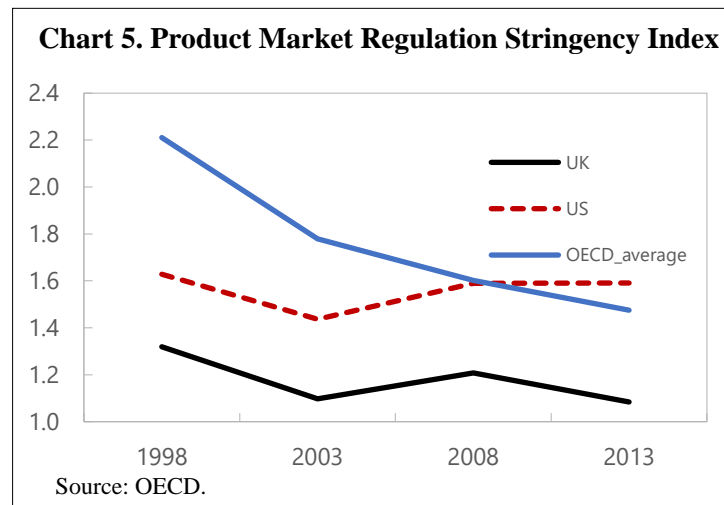
Higher new variety creation by entrants in the post-GFC period could signal lower barriers to entry—the time and procedures required to open a new business declined after 2013 in the UK—, as well as the contribution of the inflow of immigrants—immigrants create businesses

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[11] Bassanini and Ernst (2002) show that the OECD product market regulation index is more strongly associated with innovation than the labor market regulation index.

at a much higher per capita rate than natives.[12] On the other hand, it could also reflect that some of the competitive forces that tend to prevent the survival of low-quality varieties in other countries are missing in the UK. In fact, the productivity gap between firms is much higher in the UK than in other European countries, and the difference has grown post-GFC (Chart 6). This may also be partly related to the increasing trend of self-employment, facilitated by the spread of the gig economy and preferences for more labor flexibility—the employment share of one-employee firms in the sample has widened from 3.6 percent pre-GFC to 4.5 percent post-GFC.

Chart 6. Productivity Gap between Firms, Services
(Ratio of 90th to 25th percentile in TFP, logs)

Source: OECD, 2020.
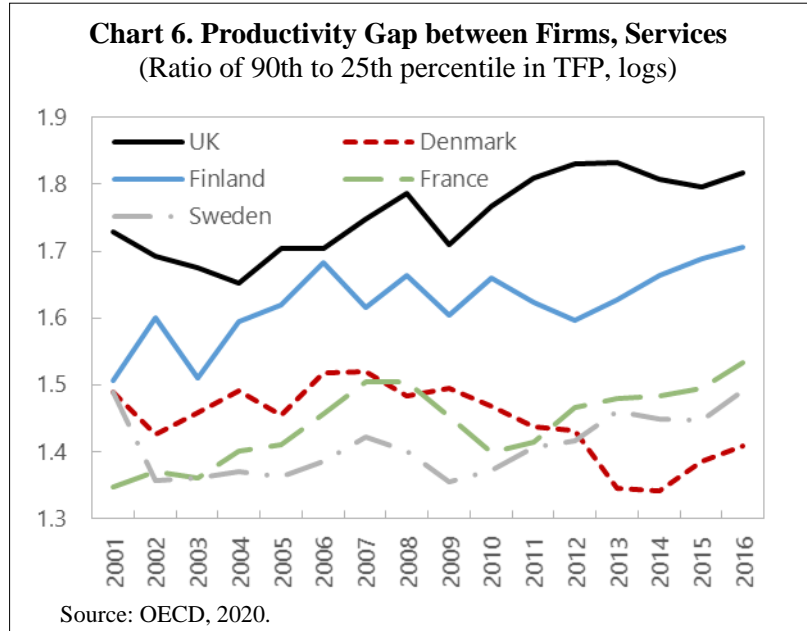
Lower own-variety innovation than in the US could be a consequence of barriers to firm growth, including the prevalence of sole-proprietor firms that do not seek to expand their business (although as mentioned above they constitute a minor share of the sample), or simply of a smaller internal market in the UK limiting the potential scale of incumbent firms and preventing the advent of giant firms. The relative decline of this source of innovation in the UK in the 2010–2019 period could in part pick up some of the negative effects of Brexit on investment (including in intangibles) by incumbent firms (Bloom et al., 2019), on top of the broader factors mentioned above.

Regarding the differences across sectors (Table 9), the higher contribution of new varieties by entrants in ICT than in manufacturing or retail probably owes to the sector being less mature, with a higher fraction of newly developed products, but could also relate to higher barriers to competition in the other sectors.

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[12] See the World Bank's World Development Indicators for barriers to firm entry, and the Global Entrepreneurship Monitor for immigrant entrepreneurship in the UK.

E.   Present and Forward-Looking Analysis

As a complement to the estimation with ONS data, which ends in 2019, survey data from the DMP are analyzed to derive implications for the sources of productivity in the present and near f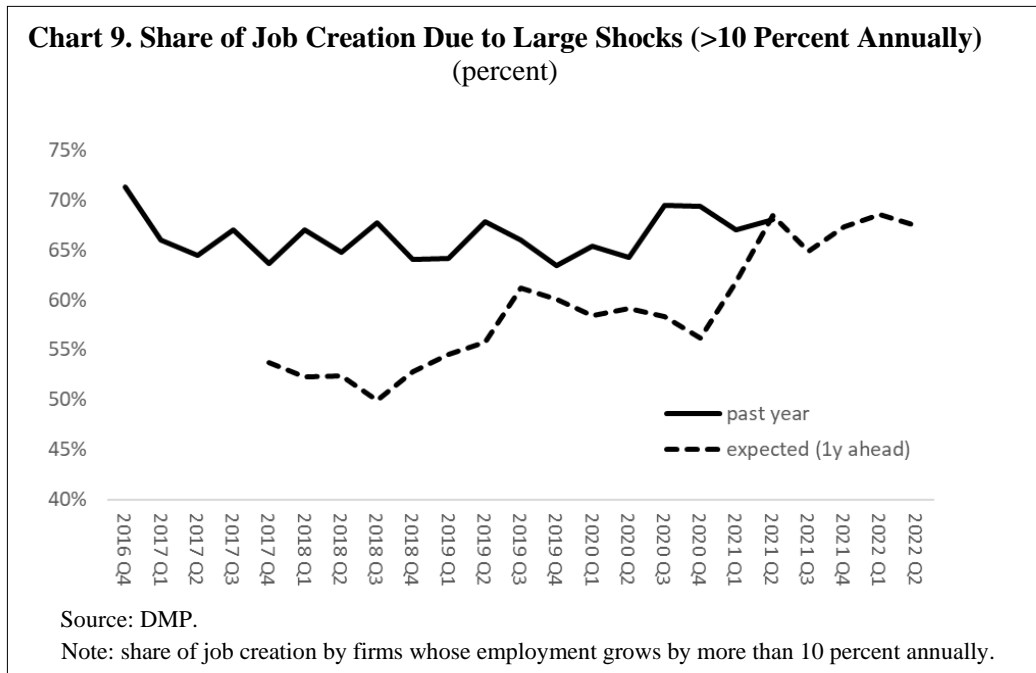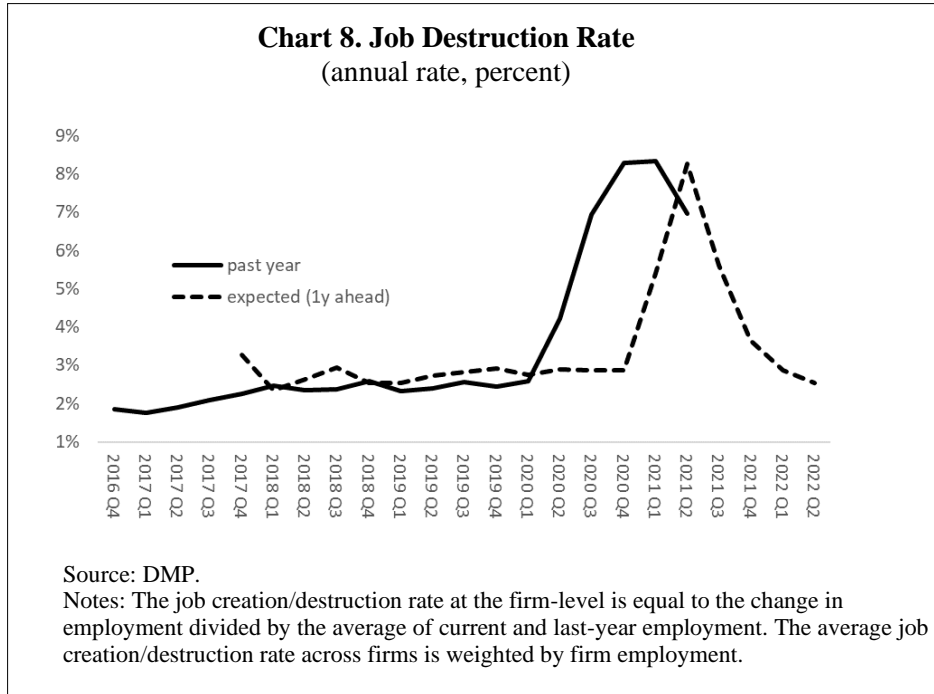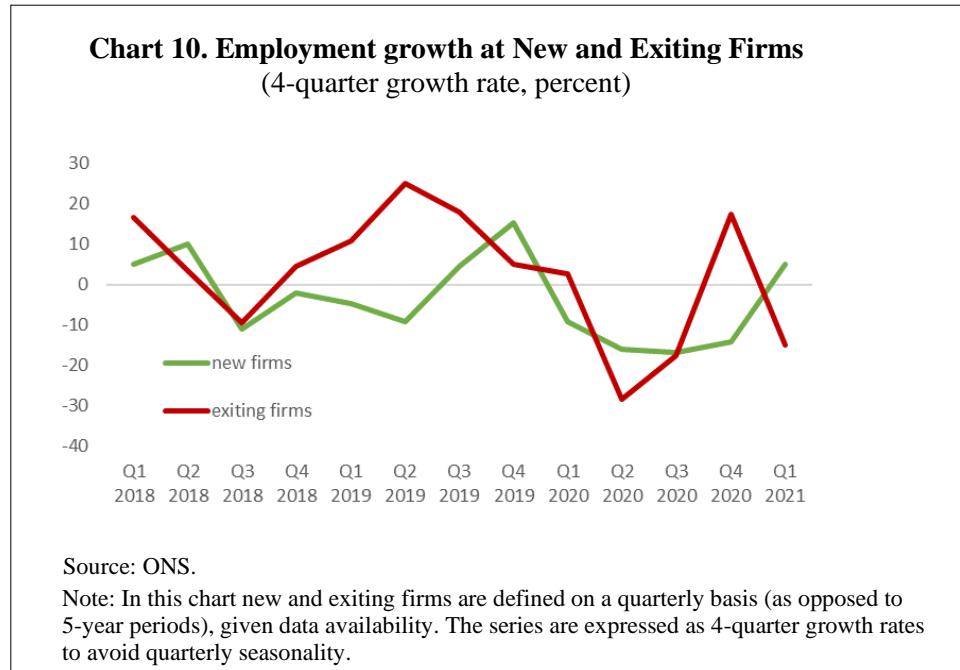uture. Focusing on the impact of the Covid shock, the DMP data show that incumbent firms experienced a drop in job creation (Chart 7) together with soaring job destruction (Chart 8). Interestingly, though, the pattern is slightly different for the extensive margin (Chart 10). While the employment share of new firms fell since 2020Q1, the share of exiting firms did not pick up until 2020Q4, and was actually below normal levels in 2020Q2–Q3 and in 2021Q1, probably reflecting the large impact of corporate support policies.[13]

Turning to the prospects for the recovery, the DMP viewed through the lens of the model would suggest that firms expect innovation to take primarily the form of creative destruction after Covid. This conclusion is based on the large expected increase in job creation (Chart 8) after a period of intense job destruction (Chart 9) and, more crucially, on the increase in the share of firms expecting large positive employment shocks (Chart10). Despite this potential wave of creative destruction, though, overall TFP is expected to stay below its pre-crisis level in the coming years. The low levels of firm entry during Covid may forebode a weaker contribution of new varieties going forward, whereas the decline in R&D investment reported in national accounts data and the DMP itself (Bloom et al., 2020) could translate into less own-variety improvements.

Chart 7. Job Creation Rate
(annual rate, percent)

Source: DMP.

Notes: The job creation/destruction rate at the firm-level is equal to the change in employment divided by the average of current and last-year employment. The average job creation/destruction rate across firms is weighted by firm employment.

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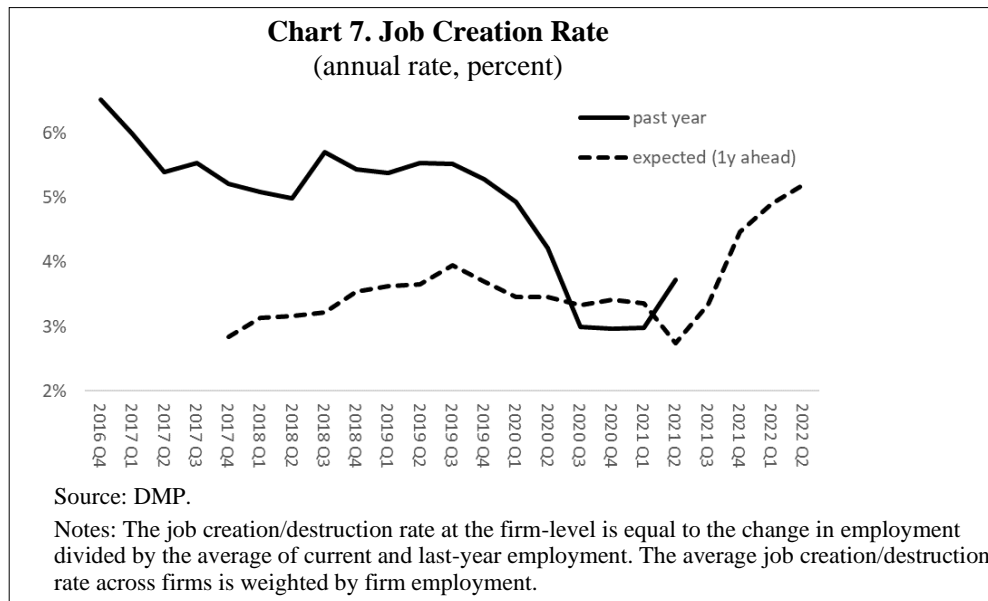
[13] Note the variable definitions are slightly different from Section IV due to data availability.

Chart 8. Job Destruction Rate
(annual rate, percent)

Source: DMP.
Notes: The job creation/destruction rate at the firm-level is equal to the change in employment divided by the average of current and last-year employment. The average job creation/destruction rate across firms is weighted by firm employment.

Chart 9. Share of Job Creation Due to Large Shocks (>10 Percent Annually)
(percent)

Source: DMP.
Note: share of job creation by firms whose employment grows by more than 10 percent annually.

Chart 10. Employment growth at New and Exiting Firms
(4-quarter growth rate, percent)

Source: ONS.
Note: In this chart new and exiting firms are defined on a quarterly basis (as opposed to 5-year periods), given data availability. The series are expressed as 4-quarter growth rates to avoid quarterly seasonality.

V. CONCLUSIONS AND POLICY IMPLICATIONS

This paper has found that the sources driving TFP growth in the UK have shifted substantially over time. In the pre-GFC period, own innovation was the main source of growth, followed by creative destruction by incumbents. These two sources declined markedly post-GFC, while creation of new varieties by entrants grew in both relative and absolute importance, becoming the top source. Going forward, initial evidence points to a key role for creative destruction.

The approach employed to classify the sources of productivity growth is largely complementary to the earlier literature on the drivers of the UK productivity puzzle. Yet, the results here resonate with some of the observations in the literature. For example, the increasing role of laggard firms seems consistent with growth coming progressively more from low-quality new varieties by entrants rather than improvements on (higher-quality) existing varieties, and legacy effects from previous crises may have a disproportionate impact on incumbents. However, further work is needed to formally link how other hypotheses, such as mismeasurement of intangibles or diminishing technological opportunities, would distinctly impact the sources of innovation. Moreover, ONS productivity estimates for recent years remain subject to revisions, so it will be important to reevaluate this paper's findings with forthcoming data.

Disentangling the sources of productivity growth also matters for designing optimal policy. Firm innovation tends to generate positive knowledge spillovers to other firms, as those firms can build upon existing knowledge to develop better products and services and increase their profits. This is a common rationale for public support to R&D, without which innovation

would be too low in a free-market equilibrium. However, certain types of innovation, such as creative destruction, also generate negative externalities in the form of "business stealing". When a firm succeeds in displacing another producer by making a marginal improvement upon that producer's product, it may be earning a disproportionate economic reward relative to its contribution to the stock of knowledge in the economy. This is even more so if reemploying the labor and capital of the displaced firm(s) is subject to frictions and takes time.

Atkeson and Burstein (2019) derive the welfare impact of innovation policy as a function of the shares of each type of innovation, using the same decomposition as in this paper, and modelling innovation decisions endogenously. They show that the welfare gains from innovation subsidies are larger when creation of new varieties or own innovation dominate, and smaller (but still positive on net) when creative destruction is widespread, as the latter source entails more business stealing.

Thus, drawing the map of the sources of innovation in the UK can guide the strategy to spur productivity growth in the post-Covid recovery. Given firm expectations pointing to creative destruction becoming the norm, as suggested by Section IV.E, policymakers should put a special emphasis on easing the reallocation of factors from firms and sectors that lose market share, without prejudice to R&D support. Measures to accelerate reallocation would encompass enhanced active labor market policies (with an emphasis on in-demand skills, such as digital), fast-tracked insolvency proceedings, and making financing available, including by providing seed and venture capital to entrant firms (Parker, 2018) and recapitalizing viable firms where appropriate.

If instead less disruptive forms of innovation were to prevail, as Section IV.C estimates was the case in previous decades, the government should concentrate efforts on stepping up public R&D spending and subsidies to private R&D. To the extent possible, public support should be targeted towards basic research (i.e., undirected, theoretical, or experimental work), which generates larger positive spillovers per unit of public investment (IMF, 2021b). Spillovers could be further amplified by strengthening collaboration between private and public researchers, and ensuring individual firms cannot register excessively broad patents that unduly slow down the diffusion of basic knowledge to other firms.

This paper has also estimated that the sources of innovation exhibit substantial variation across sectors. Given the asymmetric nature of the Covid shock, this may even intensify in the near future. Therefore, a sector-specific approach to innovation policy is warranted. This should not mean picking "winner" or "favored" sectors, but addressing the specific inefficiencies hamstringing productivity growth in each sector.

For example, if the digital sector—viewed as a potential growth driver in the post-Brexit era—continues to generate substantial creative destruction as in the previous decade, reallocation policies will be particularly crucial in that sector to minimize disruption from displaced businesses and jobs. Moreover, to the extent it relies on a large contribution of

entrants, efforts are also needed to ensure that entry barriers are low, including to make the most of new business models based on remote work. Fast-tracking permits and safety regulation procedures for new products and services would be a step in that direction. In sectors with smoother forms of innovation, such as manufacturing and retail, R&D support and investment incentives more broadly would be relatively more beneficial.

All these policy interventions will also be key to improve external competitiveness as the UK economy adapts to the exit from the European Single Market and Customs Union. Whereas the analysis by sector tradability has identified creation of new varieties as the main source of innovation within the tradables sector, the two largest tradable sectors—manufacturing and professional services—feature substantially different patterns, pointing to the relevance of a growth policy package that supports all forms of innovation.

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APPENDIX I. MODEL EQUATIONS

Static Equilibrium

Aggregate output is a CES combination of quality-weighted varieties:

$$Y = \left[\sum_{j=1}^{M} \left(q_j y_j \right)^{1-\frac{1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where y_j denotes the quantity and q_j the quality of variety j. M is the number of varieties in the economy and σ the elasticity of substitution across varieties.

Output of variety j is given by $y_j = l_j$, where l_j is labor used to produce variety j.

The profit maximizing quantity of labor employed in producing variety j is

$$l_j = \left(\frac{\sigma-1}{\sigma} \right)^{\sigma-1} LW^{1-\sigma} q_j^{\sigma-1},$$

where L is the total labor supply and W the real wage.

Employment of a firm L_f is then given by:

$$L_f \equiv \sum_{j=1}^{M_f} l_j = \left(\frac{\sigma-1}{\sigma} \right)^{\sigma-1} LW^{1-\sigma} \sum_{j=1}^{M_f} q_j^{\sigma-1},$$

where M_f denotes the set of varieties produced by firm f.

After imposing the labor market clearing condition, the real wage is proportional to aggregate labor productivity:

$$W \propto Y / L = M^{\frac{1}{\sigma-1}} \left[\sum_{j=1}^{M} \frac{q_j^{\sigma-1}}{M} \right]^{\frac{1}{\sigma-1}}.$$

Innovation

If a firm innovates on an existing variety, the average proportional improvement in quality weighted by employment is

$$s_q = \left(\frac{\theta}{\theta - (\sigma-1)} \right)^{1/(\sigma-1)} > 1,$$

where the formal definition of s_q is:

$$s_q \equiv \left(\mathbb{E} \tilde{q}^{\sigma-1} \right)^{1/(\sigma-1)} ,$$

and $\tilde{q}$ is the proportional step size of innovation on a given variety.

The expected aggregate productivity growth rate g as a function of innovation arrival rates and their relative quality step size is given by:

$$\mathbb{E}\left[(1+g)^{\sigma-1} \right] = 1 + \underbrace{s_\kappa \left(\kappa_e + \kappa_i \right)}_{new\ varieties} + \underbrace{\left(s_q^{\sigma-1} - 1 \right) \lambda_i}_{own\ innovation} + \underbrace{\left(s_q^{\sigma-1} - 1 \right) \left(1 - \lambda_i \right) \left(\left(1 - \delta_i \right) \delta_e + \delta_i \right)}_{creative\ destruction} - \delta_o \psi . \quad (1)$$

All parameters above are defined in Section II (Table 1) except for δ_o, which denotes the (endogenous) rate at which varieties fall below the break-even quality threshold ψ.

The terms in equation (1) are grouped into the contributions from each of the three innovation sources. Alternatively, they can be grouped into the contributions of entrants and incumbents as follows:

$$\mathbb{E}\left[(1+g)^{\sigma-1} \right] = 1 + \underbrace{s_\kappa \kappa_e + \left(s_q^{\sigma-1} - 1 \right) \left(1 - \lambda_i \right) \left(1 - \delta_i \right) \delta_e}_{entrants} + \underbrace{s_\kappa \kappa_i + \left(s_q^{\sigma-1} - 1 \right) \left(\lambda_i + \left(1 - \lambda_i \right) \delta_i \right)}_{incumbents} - \delta_o \psi . \quad (2)$$

APPENDIX II. SAMPLE DESCRIPTION

The primary data source of the moments used for inference is the UK Business Structure Database (BSD), provided by the UK Office for National Statistics (ONS). The BSD is a snapshot in time of the Inter-Departmental Business Register (IDBR).[1] The IDBR is a life register of firms which are registered for Value Added Tax (VAT) and/or Pay As You Earn (PAYE) in the UK, and it covers approximately 99 percent of economic activity. The BSD snapshots contain unique IDBR reference values at the enterprise level underlying the overall business organization. The ONS uses these enterprise unique identifiers to create the longitudinal panel (LBSD) of firms for the period of 1997–2019 used in this work. The LBSD contains data on employment, turnover, year of birth (company start-up date), year of death (termination date), and industrial activity based on the UK Standard Industrial Classification (SIC 2003 and 2007, with the latter only available from 2007). Firm employment is defined by the current number of employees, including business proprietors.

The LBSD is cleaned to eliminate the entire time series for firms that in at least one year declare their legal status as public firms (i.e., 'Central Government body', 'Local authority', 'Non-profit making body' and 'Public corporation'); sectors dominated by public enterprises (D 'Electricity and gas'; E 'Water supply, sewerage and waste management'; O 'Public administration and defense' , P 'Education', Q 'Human Work and Social Care Activities); T 'Activities of households as employers'; U 'Activities of extra-territorial organizations and bodies'[2]; and 5-digit sectors containing less than five firms per SIC 5-digit-year cell[3]. Dropping sectors with few firms is necessary when netting out sector-level employment changes.

The model requires to define 'alive' and 'exited' firms. The sample of 'alive' firms comprises firm-year observations reported as 'active' with employment greater than zero, and 'reactivated' firms with positive employment and turnover, while the remaining observations are 'exited'. 'Active' firms denote enterprises which have at least one reporting (legal entity) unit, normally associated with a local (plant-level) unit. 'Reactivated' firms are defined as reported active in a subsequent year following the one when they declared as 'dead'. For reactivated firms the whole time series is kept, including in-between years when they show as dormant. Firms are declared 'dead' administratively after two years without any trading, following the BSD methodology paper[4]. The UK market economy final sample contains

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[1] For further discussion of the BSD see https://www.enterpriseresearch.ac.uk/dataset/business-structure-database/.

[2] The letters denote sectoral sections using the SIC 2007 classification (https://www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007). The rationale for excluding those sectors is that they are dominated by non-private firms. Employment changes in non-private companies may reflect considerations other than profit-maximization, which would make the model's inference invalid.

[3] Excluding sectors with less than five firms per SIC 5-digit-year cell leads to losing only 8,553 observations.

[4] Evans and Welpton, 2009.

46 million firm-year observations of 'alive' firms (about 2 million per year) and 14 million firm-year observations of 'exited' firms.[5]

The construction of sectoral sub-samples uses information on both SIC 2003 and 2007 classifications, extending SIC 2007 data availability to the period prior 2007. Relying just on SIC 2003 would lead to an imprecise sectoral classification of some firms given that a single SIC 2003 code could correspond to different SIC 2007 codes, and vice versa.

The manufacturing sector is comprised of all 5-digit-sectors falling within SIC2007 2-digit divisions 10–33. The services sector includes the following SIC2007 sections: G 'Wholesale and retail trade', I 'Accommodation & food services activities, H 'Transport & storage', J 'Information and communication', K 'Financial & insurance activities', L 'Real estate', M 'Professional scientific and technical activities', N 'Administrative and support services', R 'Arts, entertainment and recreation', S 'Other service activities'.

Within services, the 'Information and Communication' (J) sector section is comprised of the following 2-digit divisions according to the SIC 2007 classification: 58 'Publishing activities'; 59 'Motion picture, video and television programme production'; 60 'Programming and broadcasting activities'; 61 'Telecommunications'; 62 'Computer programming, consultancy and related activities'; 63 'Information service activities'. For a closer representation of the digital economy, sectors 58–60 are excluded, but 5-digit sectors 58210 'Publishing of computer games' and 58290 'Other software publishing' are included. The Wholesale and Retail Trade sector includes SIC2007 2-digit categories 45 'Wholesale and retail trade and repair of motor vehicles and motorcycles', 46 'Wholesale trade, except of motor vehicles and motorcycles', and 47 'Retail trade, except of motor vehicles and motorcycles'. The Professional Services sector includes SIC2007 2-digit categories ranging from 69 'Legal services' to 75 'Veterinary activities'.

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[5] Lui et al. (2020) develop an alternative method to refine BSD entry and exit statistics, leveraging access to IDBR quarterly data. The trends in business dynamism they describe are consistent with the ones reported herein.

APPENDIX III. THE ROLE OF MERGERS AND ACQUISITIONS

Table 11 shows key empirical moments for a sample where the entire time series for firms undergoing M&As is excluded, compared with the full sample. The definition of M&As follows the ONS guidelines: an acquisition takes place when all enterprises within a given enterprise reference group change to another common enterprise reference group, and the latter group already existed. A merger occurs when enterprises coming from two or more reference groups move to a new common group.

Excluding M&A firms reduces employment in the sample by about 2 million (or 10 percent). However, key moments are largely invariant. In fact, in the sample without M&As, job creation and exit rates tend to be higher, likely reflecting that M&A firms are on average larger and older, and this more-than-compensates for any disruption effects attributable to M&As. The exception is job destruction, which is lower without M&As. This is not surprising, since M&As tend to lead to redundancies, and the UK does not provide M&A-related employment protection.

Table 1. Moments Excluding M&As, 2010–2019
(period averages)

Moment	Full Sample	Excluding M&A Firms
Total employment (millions)	19.9	17.0
Job creation rate	37.7%	39.5%
Job destruction rate	32.3%	31.9%
Share of small job creation (<3x)	33.0%	31.2%
Exit rate small firms	6.2%	6.3%
Exit rate large firms	3.4%	3.5%

Source: ONS and authors' calculations.