Research vs Development:
differential returns and the measured decline of research productivity

Extended Abstract

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Abstract

The standard measure of research productivity divides TFP growth by total R&D input, treating *research* and *development* as a single activity. This paper shows that distinguishing between these components changes both the measurement and the interpretation of the productivity slowdown. Using NSF BERD data from 1953 to 2023, I document that the development share of business R&D has risen from 64 to 78 percent, a shift that is pervasive across industries and the firm size distribution. This compositional change alone accounts for 31 percent of the measured decline in research productivity. Estimated industry-level elasticities confirm that research is positively and significantly correlated with TFP growth, while development is not. Development instead achieves new product introduction, contributing to growth through variety expansion rather than through the knowledge spillovers that TFP captures. Standard measures of research productivity therefore simultaneously overstate the decline in research productivity and understate the breadth of innovation-driven growth: the effective input to frontier-pushing research is a shrinking fraction of total R&D effort, and the reallocation toward development is itself growth-enhancing through a separate channel.

Keywords: R&D, TFP, endogenous growth, innovation

JEL classification: O47, O31, O32, D24, E23

1. Introduction

Real investment in research and development (R&D) has grown by a factor of approximately 20 since the early 1950s in the United States, a sustained increase driven overwhelmingly by private-sector spending. Over the same period, US productivity growth has slowed from an average of 1.92% to 0.8%, raising concerns over the sustainability of idea-driven growth and motivating a large body of work seeking to understand whether the frontier of knowledge is becoming harder to push and posing concerns about the durability of balanced growth with decreasing returns to research.

Yet not all R&D is aimed at the kind of productivity gains these comparisons presuppose, and the composition of R&D has changed dramatically over the period in question. The empirical literature evaluates the returns to research effort through the lens of research productivity, defined as marginal returns to research effort

$$RP \equiv \frac{\dot{A}/A}{S} \tag{1}$$

typically measured as the growth rate of total factor productivty (TFP) generated per unit of R&D input. The formulation originatng in Romer (1990) has subsequently been refined by a long literature on semi-endogenous growth that sought to reconcile the framework with mounting evidence against constant returns to research.Bloom et al. (2020) document the decline of research productivity most systematically, showing at the aggregate, sectoral, and technology-case level that U.S. research productivity has fallen by a factor of 41 since the 1930s. Their finding has become a central stylised fact in the growth literature, but one that rests on treating research effort as a homogeneous input.

However R&D investments conflate activities aimed towards distinct outcomes. The relevant distinction for this paper is between *research* and *development*. Research, in both its basic and applied forms, is directed at generating new knowledge and pushing the technological frontier, with partially non-appropriable returns that flow to the wider economy as knowledge spillovers.performing firm. Development is instead directed at translating existing knowledge towards commercialisation , with predominantly internal returns seizable by the innovating firm through product introduction. The distinction is not merely one of intensity but of kind: they differ in their objectives, their spillover properties, and in their relationship to aggregate productivity. If research drives growth through positive TFP externalities while development drives growth through the expansion of product variety, then conflating the two components in a TFP-based productivity measure that pools them is contaminated by inputs directed at a channel it does not capture.

This paper investigates the extent to which the measured decline in research productivity reflects the rising share of development in total R&D, and whether development contributes to growth through a channel that is invisible to TFP-based measures. When standard research productivity measures treat these as a single input, estimates are biased downwards and the different channels through which each

component contributes to growth are disregarded. With a shifting composition towards development, the measured decline is overstated, and the standard diagnostic conflates two activities whose contributions to economic growth operate through fundamentally different channels.

I exploit the decomposition of business R&D expenditures into basic research, applied research, and experimental development available from the National Science Foundation (NSF) to document a dramatic shift in the composition of R&D toward development in the past seven decades, quantifying the resulting bias in the standard research productivity measure, and providing direct evidence that research and development lead to distinct growth outcomes. The development share of business R&D rose by 14 percentage points over this period, from approximately 0.64 to 0.78. The trend is pervasive: it is present across industries and throughout the firm size distribution, and a shift-share decomposition confirms that it reflects within-industry reallocation rather than a between-sector composition effect. Correcting the standard measure in (1) for this compositional shift reduces the measured cumulative decline by a factor of 1.44, with approximately 31% of the measured decline is attributable to the contamination alone.

The theoretical anchor is Young (1998), who develops a first model for macroeconomic growth formalising the distinction between quality and variety channels, and proving that scale effects are not necessary for growth. This places the present argument between the epistemic and allocative accounts of the slowdown: rather than a harder frontier (Jones, 2009) or a deterioration in how research effort is allocated across firms (Akcigit and Ates, 2023; De Ridder, 2024), the decline reflects a shift in the composition of what the R&D aggregate contains, with implications for the channel through which innovation enters measured growth.

2. Methodology

The empirical analysis uses the decomposition of business R&D into basic research, applied research, and experimental development from the NSF Business R&D Survey (1953–2023), merged with industry-level TFP from BLS KLEMS and the BEA-BLS Integrated Industry-Level Production Account at the NAICS industry level. Three TFP measures enter the analysis: official BLS major-sector TFP, the spillover-adjusted variant of Bloom et al. (2020), and the integrated industry-level measure.

The empirical strategy proceeds in three stages.

1. Fact documentation: the trajectory of σ_D by industry and firm size, with a shift-share decomposition isolating within-industry from between-sector reallocation.

2. Bias quantification: the Bloom et al. (2020) aggregate exercise is replicated on the BERD-covered overlap recovering both the correction factor on the cumulative decline and the corrected β.

3. Differential returns: indutry panel estimation of elasticity and semi-elasticity of returns to R&D confirming that the components operate through different channels. Local projections à la (**?**) are also included to trace cumulative and delayed effects. The empirical strategy considers four firm-level innovation outcomes, each mapping to a distinct prediction of the framework.

    - ***TFP growth*** captures the spillover-producing component of R&D and is the central object of the research-productivity literature. Under the proposed framework, only research should predict it.
    - ***Successful innovation*** (whether a firm reported new or significantly improved products or processes) captures the variety-expansion channel and should be predicted by development rather than by research.[1]
    - ***Patent applications*** and ***patent grants***, which both types of R&D produce, contributes to ruling out the interpretation that development inputs are simply unproductive.
    - ***Patent licensing revenue*** captures the appropriable component of R&D returns and provides a direct check on the appropriability margin that distinguishes the two activities.

The results are consistent with the interpretation that research generates knowledge spillovers that raise productivity across the economy, while development is aimed at expanding the set of products and processes available to the innovating firm, confirming its role as the driver of variety expansion rather than frontier advancement.

The reallocation of innovative effort from research toward development documented in Section **??** then speaks to firms' choice to direct resources toward activities whose returns they can capture. This reallocation is itself growth-enhancing through the variety margin, but is invisible to TFP-based measures of research productivity. The pattern is not merely consistent with the paper's hypothesis, but it confirms the specific channels implied by the post-revision measurement framework.

3. Results

Compositional shift. The development share of business R&D rose by 14 percentage points between 1955 and 2023, from approximately 0.64 to 0.78. Real development expenditure grew by a factor of ~ 349 (compound rate $\sim 8.6\%$ per year), substantially outpacing both basic and applied research. The shift is present across all industries with consistent decomposition, more pronounced in non-manufacturing, and visible across the firm size distribution. A shift-share decomposition confirms that the increase reflects within-industry reallocation rather than between-sector composition.

[1] Due to data restrictions the successful-innovation outcome is observed only over 2008–2016, the period during which the BRDIS innovation module was fielded, while the patent and licensing outcomes are available throughout the sample.

Correction to measured research productivity. The Bloom et al. (2020) aggregate exercise replicated on the BERD-covered overlap recovers their headline statistics, including a cumulative decline in RP by a factor of 12.35 on this restricted sample. Corrected for the compositional shift through (**??**), the cumulative decline falls to a factor of 8.55. The correction factor of 1.44 implies that approximately 31% of the measured cumulative decline reflects denominator contamination alone, before any genuine change in the productivity of research effort. The semi-endogenous research elasticity is biased downwards in parallel: the measured β of 3.52 falls to a corrected β of 3.01, which remains well above unity.

Differential returns. Industry-level panel regressions display a sharp asymmetry between the two components of R&D. Research, particularly basic research, predicts TFP growth with a positive and statistically significant coefficient across all three TFP measures. Development carries a point estimate that is small, negative, and statistically indistinguishable from zero. A Wald test rejects equality of the two coefficients. The pattern is most pronounced under the BEA-BLS integrated measure, which incorporates the post-2013 capitalisation framework in which TFP is computed net of R&D capital services and captures the spillover component most cleanly. Development, by contrast, predicts product introduction with a positive and significant coefficient on the BRDIS innovation module, while research carries a smaller coefficient on the same outcome. The two components are correlated with distinct growth outcomes through distinct channels, consistent with the conjectured division between the quality and variety margins.

Cumulative and delayed effects. The local projections trace the divergence between research and development over horizons up to ten years. The research impulse response is positive and rises with the horizon, peaking between four and seven years out, consistent with the gestation lags documented in the spillover literature (Akcigit et al., 2021). The development impulse response remains close to zero or turns negative at longer horizons. The divergence between the two paths widens monotonically with h, providing dynamic confirmation of the cross-sectional asymmetry recovered from the panel.

4. Conclusion

The measured cumulative decline in research productivity overstates the true decline by a factor of 1.44: approximately 31% reflects the compositional shift within R&D toward development, an activity whose contribution to growth operates through variety expansion rather than TFP. The residual decline is real but reflects a weakening of the spillover channel rather than an exhaustion of the broader idea production function, consistent with both the firm-level micro evidence in Bloom et al. (2020)

and the creative-destruction reconciliation through which firm-level decline coexists with sustained aggregate growth in Schumpeterian frameworks (Aghion et al., 2019). The findings bear directly on the allocative-versus-epistemic debate over the slowdown's deeper causes (Jones, 2009): a non-trivial share of the measured decline is neither a harder frontier nor a misallocation of research effort but a shift in what the R&D aggregate contains.

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