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A comment on Sampson (2023)*

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Abstract

In their paper, Sampson (2023) introduces a theoretical framework and conducts empirical testing to elucidate the impact of gaps in countries' innovative efficiencies on income, wages, and trade dynamics. We successfully replicate the paper's findings by running the provided codes, and confirm the absence of any coding errors in the process. We also provide an extensive battery of robustness checks, which confirms the resilience of their results. We then scrutinize two key aspects of their study: the choice of developing countries and the innovation measure employed. The outcomes of this refined analysis partly temper the original paper's message of technology gaps driving inequality, underscoring the need for additional research in this domain.

JEL classifiers: D31, F14, O31, O33, O47.

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1 introduction

Sampson (2023) develops and tests a theory on technology gaps and their implications for inequality. The author compiled a dataset from various sources, covering R&D data, bilateral information, and trade statistics, spanning the years 2010 to 2014. Constructing an endogenous growth model that considers factors at both the industry and country levels, the study explores diverse R&D efficiencies among countries and variations in innovation levels and adoption choices across industries. These factors collectively shape the equilibrium conditions that influence technology gaps, trade dynamics, and income/wage inequality.

Their study reveals that countries with higher R&D efficiency tend to exhibit a greater comparative advantage in industries characterized by a higher degree of innovation dependence. The calibration of country-level R&D efficiency and industry-level innovation dependency is based on extensive datasets, including bilateral trading data, R&D expenditures, and patent statistics. Additionally, they conducted a counterfactual analysis by assuming uniform R&D efficiency across all sample countries. One of their findings is that technological disparities contribute to approximately 25% to 33% of the observed nominal wage variation within the OECD.

Our exploration commences with the replication of Sampson's results, followed by an assessment of their robustness. In the replication process, we executed the provided codes and examined the output, affirming the absence of any coding errors. This successful implementation enhances the robustness of the study"s reproducibility and validates the accuracy of its computational methods.

Then, to scrutinize the resilience of their findings, we conduct four variations: (i) We exclude two market outliers, specifically, the Paper and Paper Products (17) industry and the Agriculture, Forestry, and Fishing (0103) industry. These outliers, identified using information from Figure 4 in Sampson (2023)'s paper, are examined for their impact on the results. (i) We broaden the scope by expanding the number of countries from 26 to 29. This expansion includes country-years with observations for at least 10 industries, relaxing the original requirement of 14 industries. (ii) We broaden the temporal scope by incorporating an additional two years of data into the original four-year dataset. Subsequently, we explore various partitions of time periods to assess their impact. (iii) The original paper includes a robustness check in which the author varies the trade elasticity within the range of 2.5 to 8.5. In our analysis, we extend this examination by adjusting the trade elasticity to a lower value, 1, and a higher value, 10.5, to further assess its robustness. (iv) We exclude two outliers, specifically, the Paper and Paper Products (17) industry and the Agriculture, Forestry, and Fishing (0103) industry. These outliers, identified using information from Figure 4 in Sampson (2023)'s paper, are examined for their impact on the results.

The outcomes of this comprehensive set of robustness checks affirm the reliability and consistency of the results observed in the original paper.

Following this exercise, we undertake an examination of the paper, focusing on the selection of countries and the measure of innovation. We investigate the potential influence on external validity by examining the impact of having fewer impoverished countries, characterized by lower R&D intensity, or wealthier countries, characterized by higher R&D intensity, on the empirical results. In terms of measuring innovation, we advocate for a more comprehensive metric that encompasses not only original innovations but also incorporates imitations and diffusions of existing technologies. Our dual objectives are to enhance our understanding of the impact of data availability on only some developing countries on the paper's core message, and to employ an innovation measure that is more favorable to poorer nations. This is the main contribution of our work to the literature. Both branches of this analysis convey the message that the impact of technology gaps on inequality is diminished, if not dismissed.

2 Computational reproducibility

In the course of replicating the study, we executed the provided codes and thoroughly scrutinized the output, thereby confirming the absence of any coding errors. This successful implementation not only bolsters the robustness of the study's reproducibility but also serves as a validation of the accuracy underlying its computational methods.

3 Critical examination of Sampson's research: Demonstrating robustness and unveiling challenges

This section begins by commending the transparency demonstrated in Sampson (2023)'s code and data sharing practices. The quality of these resources facilitated our replication of the original work.

3.1 Demonstrating robustness

In this section, we subject the original results to various checks to test their robustness. In doing so, we furnish summary statistics for the dependent variable outlined in Equation (33) of the original paper: $\log\left(\frac{EX_{js\tilde{s}}}{EX_{j\tilde{s}\tilde{s}}}\right) - (\sigma - 1)\log\left(\frac{w_{\tilde{s}}}{w_s}\right)$, where j denotes the industry, s represents the exporting country, and $s\widetilde{s}$ signifies trade from country s to $\widetilde{s}$, indicating the destination country. Moreover, we present data on the key independent variable of interest, b_s, specifically in the form of medians aggregated across industries for R&D efficiencies, denoted as $\log\left(\frac{RD_{js}}{RD_{j\tilde{s}}}\right)$.

3.1.1 Refining country inclusion Our initial step involves adjusting the filter set presented in the original paper, which excludes countries with over two-thirds of industries featuring missing values. By extending our analysis to include country-years with observations available for at least 10 industries, we increase the total number of OECD countries from 25 to 29. The supplementary four countries incorporated into the study are Estonia, Iceland, Slovakia, and Sweden. The outcomes closely resemble the original findings and are reported in Appendix A.[1]

3.1.2 Modifying the time frame We begin the comparison by modifying the time period. First, we extend the original time period from 2010-2014 to 2010-2016 and then partition the intervals into two subgroups 2010-2012 and 2014-2016. The results of those three groups are similar to those in the original paper. They are available in Appendix B.

3.1.3 Changing the values of trade elasticity The original paper includes a robustness check in which the author varies the trade elasticity within the range of 2.5 to 8.5. In our analysis, we extend this examination by adjusting the trade elasticity to 1 and 10.5 to further assess its robustness. Overall, the findings closely align with the original results, and the new results are given in Appendix C.

3.1.4 Dropping outlier industries In the original paper, Figure 4, the author mentioned two outliers industries: Agriculture, forestry, and fishing (0103), and Paper and paper products (17). The results excluding these two industries are still similar to the original ones. They are documented in Appendix D.

3.2 Unveiling challenges

3.2.1 Exploring variations in the number of countries In this section, we refine the composition of countries by initially excluding six developing nations identified as outliers in Figure 2 of the original paper, followed by the exclusion of six developed countries that appear on the top north-east side of the Figure. It has to be

[1] In addition to our primary analysis, we conducted further investigations: (i) We refined the sample by excluding any country with more than 1/2 industries with missing values, resulting in a sample of 17 countries (comprising six developing and 11 developed countries). (ii) We applied a more stringent criterion by excluding any country with more than 8/10 industries with missing values, resulting in a sample of 28 countries (six developing and 22 developed countries). (iii) To maintain balance, we kept an equal number of developed and developing countries. Specifically, we randomly selected six developed countries to match the number of six observed developing countries, totaling 12 countries. (iv) We conducted analyses with three countries exhibiting a high level of innovation removed (excluding the US, which serves as the reference country). Importantly, the results remained consistent with the original findings. The codes and detailed results are available upon request.

acknowledged that the exclusion of six developing countries, identified as outliers in Figure 2, has also been carried out in Sampson (2023). However, a key distinction lies in the approach: while Sampson removed the countries after calculating the equilibrium, we take a different approach. Here, we preclude these countries from the dataset before equilibrium calculation, performing the equilibrium calculation without their inclusion.

Our rationale for this choice stems from data limitations, as the list of countries utilized by Sampson is notably an incomplete representation of the 38 OECD countries and of course of the 195 countries in the world. Our objective is to assess the impact of an incomplete representation of countries, spanning from developing to developed nations, on the equilibrium and the overarching message conveyed in the paper. By investigating whether the removal of 6 out of 25 countries, constituting 24% of the dataset, influences the results, we aim to shed light on potential implications for the external validity of the findings. Caution may be warranted if such exclusions significantly impact the outcomes.

In this section, each table is organized to present multiple perspectives on the results. Tables featuring columns (or rows) labeled with a prefix of '1' (model 1) showcase the original findings. Correspondingly, those labeled with a prefix of '2' (model 2) present the results after the exclusion of six developing countries. Finally, tables labeled with a prefix of '3' (model 3) document the outcomes following the removal of six developed countries.

In Table 1, an expanded iteration of Table 1 from the original paper presents the computed estimates of innovation dependence derived from the specified equation (33). Drawing insights from Sampson (2023), the gradual integration of trade cost, productivity level, and comparative advantage, in sequential order, reveals a systematic reduction in the average estimated innovation dependence (reflected in the values of AID in columns 1A-1D).

Table 1. Innovation dependence by industry

R&D efficiency measure	R&D intensity			R&D intensity			R&D intensity			Patenting intensity		
Industries	(1A)	(2A)	(3A)	(1B)	(2B)	(3B)	(1C)	(2C)	(3C)	(1D)	(2D)	(3D)
0103 (Agriculture)	0.45	0.05	0.44	0.33	0.24	0.32	0.17	0.25	0.09	0.01	-0.04	0.01
	(0.06)	(0.14)	(0.07)	(0.05)	(0.15)	(0.06)	(0.09)	(0.14)	(0.11)	(0.06)	(0.08)	(0.03)
0508 (Mining)	0.37	-0.21	0.41	0.25	-0.01	0.29	-0.11	-0.04	-0.09	-0.14	-0.20	0.00
	(0.09)	(0.25)	(0.11)	(0.07)	(0.21)	(0.08)	(0.13)	(0.18)	(0.2)	(0.08)	(0.06)	(0.05)
1012 (Food)	0.48	0.09	0.48	0.36	0.28	0.36	0.21	0.28	0.15	0.06	0.00	0.03
	(0.05)	(0.12)	(0.06)	(0.04)	(0.14)	(0.05)	(0.08)	(0.1)	(0.1)	(0.06)	(0.07)	(0.03)
13 (Textiles)	0.51	0.05	0.52	0.42	0.24	0.44	0.29	0.33	0.20	0.12	0.10	0.07
	(0.05)	(0.13)	(0.07)	(0.05)	(0.13)	(0.06)	(0.06)	(0.06)	(0.11)	(0.05)	(0.05)	(0.02)
14 (Apparel)	0.47	-0.09	0.47	0.37	0.21	0.40	0.33	0.18	0.35	0.13	0.04	0.09
	(0.06)	(0.11)	(0.07)	(0.06)	(0.14)	(0.06)	(0.05)	(0.15)	(0.08)	(0.04)	(0.05)	(0.02)
15 (Leather)	0.48	-0.19	0.47	0.39	0.01	0.42	0.34	-0.27	0.30	0.12	0.01	0.03
	(0.06)	(0.14)	(0.1)	(0.07)	(0.14)	(0.08)	(0.08)	(0.18)	(0.09)	(0.07)	(0.07)	(0.02)
16 (Wood)	0.52	0.08	0.53	0.40	0.27	0.41	0.20	0.20	0.18	0.03	-0.04	0.05
	(0.06)	(0.09)	(0.07)	(0.04)	(0.1)	(0.05)	(0.07)	(0.09)	(0.09)	(0.05)	(0.05)	(0.03)
17 (Paper)	0.58	0.13	0.58	0.45	0.31	0.45	0.34	0.37	0.28	0.13	0.05	0.07
	(0.05)	(0.09)	(0.07)	(0.04)	(0.11)	(0.05)	(0.07)	(0.09)	(0.1)	(0.05)	(0.07)	(0.02)
18 (Printing)	0.58	0.06	0.61	0.46	0.25	0.49	0.27	0.24	0.27	0.11	0.04	0.09
	(0.06)	(0.11)	(0.07)	(0.04)	(0.13)	(0.04)	(0.06)	(0.06)	(0.08)	(0.04)	(0.04)	(0.02)
19 (Petrol)	0.48	0.17	0.48	0.36	0.32	0.37	0.14	0.15	0.11	0.05	0.08	0.07
	(0.05)	(0.11)	(0.06)	(0.04)	(0.1)	(0.05)	(0.08)	(0.08)	(0.11)	(0.04)	(0.04)	(0.02)
20 (Chemicals)	0.59	0.15	0.61	0.47	0.33	0.51	0.38	0.28	0.43	0.19	0.08	0.10
	(0.05)	(0.1)	(0.07)	(0.05)	(0.12)	(0.06)	(0.09)	(0.1)	(0.14)	(0.06)	(0.04)	(0.03)
21 (Pharma)	0.62	-0.16	0.68	0.50	0.05	0.56	0.22	0.09	0.43	0.17	0.05	0.10
	(0.07)	(0.21)	(0.11)	(0.06)	(0.22)	(0.08)	(0.14)	(0.22)	(0.21)	(0.1)	(0.09)	(0.03)
22 (Plastics)	0.60	0.13	0.60	0.48	0.29	0.48	0.38	0.36	0.32	0.18	0.13	0.09
	(0.05)	(0.1)	(0.07)	(0.04)	(0.13)	(0.04)	(0.05)	(0.08)	(0.07)	(0.04)	(0.05)	(0.02)
23 (Minerals)	0.57	0.07	0.58	0.45	0.25	0.46	0.30	0.23	0.26	0.12	0.05	0.09
	(0.05)	(0.09)	(0.06)	(0.04)	(0.11)	(0.04)	(0.06)	(0.06)	(0.07)	(0.04)	(0.05)	(0.02)
24 (Basic metals)	0.58	0.14	0.57	0.43	0.29	0.42	0.27	0.30	0.16	0.18	0.19	0.09
	(0.05)	(0.13)	(0.07)	(0.05)	(0.14)	(0.06)	(0.07)	(0.09)	(0.11)	(0.03)	(0.03)	(0.05)
25 (Fabric. metals)	0.60	0.10	0.60	0.48	0.28	0.48	0.33	0.28	0.29	0.14	0.06	0.09
	(0.05)	(0.08)	(0.06)	(0.04)	(0.11)	(0.04)	(0.06)	(0.06)	(0.07)	(0.04)	(0.04)	(0.02)
26 (Computers)	0.65	0.31	0.64	0.49	0.49	0.50	0.60	0.73	0.44	0.30	0.27	0.19
	(0.06)	(0.14)	(0.08)	(0.04)	(0.13)	(0.05)	(0.12)	(0.16)	(0.18)	(0.05)	(0.06)	(0.05)
27 (Electrical)	0.61	0.08	0.65	0.53	0.25	0.58	0.37	0.29	0.40	0.19	0.13	0.21
	(0.09)	(0.11)	(0.08)	(0.07)	(0.15)	(0.06)	(0.1)	(0.11)	(0.11)	(0.04)	(0.04)	(0.05)
28 (Machinery)	0.71	0.10	0.75	0.60	0.29	0.64	0.38	0.26	0.38	0.21	0.13	0.10
	(0.08)	(0.12)	(0.08)	(0.05)	(0.15)	(0.05)	(0.11)	(0.13)	(0.12)	(0.06)	(0.05)	(0.03)
29 (Vehicles)	0.55	0.15	0.55	0.39	0.36	0.38	0.27	0.37	0.15	0.19	0.24	0.15
	(0.05)	(0.11)	(0.07)	(0.04)	(0.12)	(0.05)	(0.08)	(0.08)	(0.15)	(0.03)	(0.06)	(0.04)
30 (Other trans.)	0.56	0.00	0.67	0.38	0.24	0.45	0.26	0.21	0.61	0.00	-0.10	-0.01
	(0.1)	(0.13)	(0.11)	(0.06)	(0.17)	(0.08)	(0.13)	(0.13)	(0.22)	(0.05)	(0.06)	(0.07)
3133 (Furniture)	0.55	-0.06	0.56	0.42	0.14	0.44	0.25	0.22	0.23	0.10	0.03	0.08
	(0.07)	(0.15)	(0.09)	(0.04)	(0.17)	(0.05)	(0.07)	(0.08)	(0.09)	(0.05)	(0.06)	(0.03)
Observations	171K	137K	129K	171K	137K	129K	171K	137K	129K	171K	137K	129K
R-squared	0.52	0.11	0.51	0.65	0.34	0.65	0.70	0.43	0.71	0.69	0.43	0.71
TCC†	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PLC†	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CAC†	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
AID†	0.55	0.05	0.57	0.43	0.24	0.45	0.28	0.24	0.27	0.12	0.06	0.08
F test	0.13	0.82	0.32	0.00	0.93	0.00	0.07	0.08	0.35	0.00	0.00	0.01

Notes: †TCC=Trade-cost controls; PLC=Productivity-level controls; CAC=Comparative advantage controls; AID=Average innovation-dependence. The F-test assesses whether innovation-dependence exhibits equal levels of significance across various industries. Columns 1A-1D present the original results from Table 1, page 498. Columns 2A-2D showcase results after excluding the six low-income countries before calculating the equilibrium; in the original results, these countries were excluded after equilibrium calculations. In columns 3A-3D, we exclude the five high-income countries, identified using Figure 2 in the original paper. The standard errors are clustered by importer-industry, and they are presented within brackets. We incorporate exporter-industry fixed effects, industry dummy variable interactions with six bilateral distance intervals, and with a dummy variable indicating whether the nations share a border, a common language, or a free trade agreement—all examples of trade cost restrictions. Productivity is significantly influenced by rule of law, corruption prevention, political stability, regulatory quality, voice and accountability, ease of doing business, and private credit as a percentage of GDP. Comparative advantage controls conclude interactions of industry dummy variables with the importer's rule of law, log private credit as a proportion of GDP, log physical capital per employee, and human capital. The F-test equalizes innovation-dependence across industries (p-value reported).

A noteworthy observation emerges when we exclude the developing countries from the analysis. In column 2A, where only a trade cost control is considered, the mean estimated innovation dependence sharply diminishes to 0.05, a substantial reduction from the original figure of 0.55. This suggests a minimal impact of innovation when solely incorporating trade cost controls. However, with the subsequent introduction of controls for productivity level and comparative advantage (columns 2B-2D), the estimated innovation dependence aligns more closely with the original result, although still slightly lower in most scenarios. This indicates that trade cost plays a pivotal role in influencing the estimation, particularly when focusing solely on developed countries in the dataset.

Columns 3A to 3D exhibit similar mean innovation dependence estimates to the original results when the top six developed countries are excluded from the analysis. The variation pattern remains consistent even after the inclusion of additional control variables. Although columns 3A-3D exhibit quite similar results, suggesting minimal changes when developed countries are excluded, they imply that the presence or absence of developed countries in the dataset may not significantly alter the outcomes.

The observations above hint at the robustness of the results when a cluster comprising both developed and developing countries is present in the data sample. The similarity in results suggests that the dynamics within this mixed cluster contribute to consistent findings. Conversely, when the data sample exclusively encompasses developed countries, a distinct and homogeneous development pattern emerges. This pattern, shared among developed nations, can potentially exert a notable influence on the results. In essence, the observed similarity in outcomes may be attributed to the shared development trajectories among developed countries within the dataset.

Upon reviewing the results using a median innovation dependence, rather than a mean value, in Table 2, we note that in case of removal of developing countries the value is -0.295. This figure is, in absolute value, considerably lower than the original value of −0.689, whereas the value with the exclusion of developed countries, −0.838, is higher than the original. The rationale behind this discrepancy lies in the characteristics of model 2, where the data sample exclusively comprises high-income countries. These high-income countries exhibit a relatively similar level of innovation, contributing to a more uniform innovation landscape. According to the definition of innovation dependence, represented by $\log\left(\frac{RD_{js}}{RD_{j\bar{s}}}\right)$, it is reasonable for the median level of innovation dependence to be closer to zero than the original result. This pattern aligns with the findings in Table 1, where rows 2A-2D illustrate values noticeably lower than the original figures.

Table 2. Median Innovation dependence summary statistics

b_s	obs	Mean	Std. dev	Min	Max
Model 1	25	-0.69	0.81	-2.61	0.30
Model 2	19	-0.30	0.33	-0.84	0.30
Model 3	20	-0.84	0.83	-2.61	0.27

Notes: Model 1 displays the original results derived from Table 1 on page 498 of the original paper. Model 2 presents results after excluding the six low-income countries before calculating the equilibrium—a departure from the original methodology where these countries were excluded after equilibrium calculations. Finally, in Model 3, we omit the five high-income countries, as identified in Figure 2 of the original paper.

In model 2, the presence of exclusively developed countries leads to a convergence in R&D efficiency, measured by nominal wage and real income. This convergence in R&D efficiency among developed countries contributes to the observed decrease in innovation dependence values, as reflected in both Table 2 and Table 1.

This trend is mirrored in Table 3, where the values in rows 2A-2D also indicate a relatively low magnitude in inequality compared to the original results. The coherence arises from the homogeneity in R&D efficiency among developed nations in model 2, emphasizing the impact of the exclusive inclusion of developed countries on innovation dependence metrics. The results obtained through calibrations of the generalized model are particularly striking, as they indicate a near-complete disappearance of inequality.

Table 3. Counterfactual Results

R & D efficiency measure (1)	Outcome (2)	R & D intensity (3)	Patenting intensity (4)	R & D intensity generalized model (5)
1A Nominal wage	Average change relative to US	0.18	0.14	0.18
2A Nominal wage	Average change relative to US	0.09	0.05	0.03
3A Nominal wage	Average change relative to US	0.20	0.14	0.22
1B Nominal wage	Dispersion ratio	0.32	0.27	0.31
2B Nominal wage	Dispersion ratio	0.24	0.22	0.07
3B Nominal wage	Dispersion ratio	0.27	0.30	0.27
1C Real income	Average change relative to US	0.06	0.04	0.06
2C Real income	Average change relative to US	0.02	0.01	0.01
3C Real income	Average change relative to US	0.06	0.04	0.07
1D Real income	Dispersion ratio	0.17	0.13	0.16
2D Real income	Dispersion ratio	0.09	0.07	0.03
3D Real income	Dispersion ratio	0.13	0.14	0.14

Notes: For detailed descriptions of Models 1-3, refer to the notes in Table 2. The up panel one and two are the average log wage change and its standard deviation ratio relative to the United States, comparing the counterfactual economy with the calibrated model. Moving to the bottom panel three and four, similar statistics are presented for real GDP per capita, denoting the GDP per working-age individual. The model is calibrated using R&D data for Column 3, while the calibration for Column 4 utilizes patent data. Column 5 features the calibration of the generalized model from Section IVA using R&D data.

3.2.2 Using an alternative measure of innovation Sampson investigates R&D intensity and efficiency utilizing two distinct data sources. The first is the OECD's Analysis of Business and Economic Research and Development (ANBERD) database, offering aggregated business R&D expenditure data by industry and country (OECD 2023b). The second source involves counts of 'triadic patent applications' by technology class, also from the OECD (2023a). These counts are then mapped to industries using a widely-accepted correspondence (Lybbert and Zolas 2014). While both sources are widely employed in the literature, they have limitations in fully capturing innovative R&D efforts.

In Section I.A of his article, Sampson defines R&D as an investment 'to create new ideas and technologies through innovation'. Alternatively, firms can pursue an 'adoption' strategy, which is oriented towards 'learning about and implementing existing production techniques' (p. 477) —often referred to in other contexts as imitation or diffusion of existing technology. However, the OECD's R&D expenditure ANBERD data, collected following the definitions in the Frascati Manual (OECD 2015), encompasses activities that could be appropriately categorized as adoption efforts. This includes tasks such as identifying discrepancies when replicating existing results and incorporating additional material into the maintenance manual of a complex system.

In contrast, triadic patent applications are widely acknowledged as proxies for valuable technologies (Criscuolo 2006, Nagaoka et al. 2010, van Zeebroeck 2011, De Rassenfosse et al. 2013). While these proxies are relevant in various research contexts, their application is constrained in studies like Sampson's one, which specifically focuses on technological progress rather than the commercial outcomes of R&D (Shankar et al. 1998, Hoppe 2000). Moreover, the 'home advantage' of firms from countries hosting triadic patent offices, along with their financial capacity to file foreign patents, can introduce biases in international comparisons, potentially disadvantaging emerging economies. Recognizing these considerations is vital for studies that aim to compare countries at diverse developmental stages.

We employ a third R&D metric by quantifying *all* patent application families, regardless of the patent offices where they were submitted. To achieve this, we rely on the European Patent Office (EPO)'s Patent Statistics (PATSTAT) database (version autumn 2021), which consolidates data from 90 global patent offices and enjoys widespread use in research (Kang and Tarasconi 2016). Notably, the OECD relies on this database for their triadic patent counts as well.[2] This dataset alleviates 'geographic bias' and refrains from imposing a 'filter on patent value' (De Rassenfosse et al. 2013).

We advocate for the use of *patent families*—defined by OECD (2009) as sets of related patents filed in multiple countries to protect the same invention—rather than a raw count of patent applications. This preference aims to facilitate international comparisons across diverse national patent systems (Nagaoka et al. 2010, De Rassenfosse et al. 2013). Notably, different countries, such as Japan, may traditionally necessitate more patent applications for the same invention compared

[2]For further details, refer to the OECD Triadic Patent Families database usage instructions, July 2020, available at https://www.oecd.org/sti/intellectual-property-statistics-and-analysis.htm#ip-data.

to the US and Europe. Adopting the concept of patent families, each linked to a unique International Patent Documentation (INPADOC) patent family ID (`INPADOC_FAMILY_ID`) in PATSTAT table 201, effectively addresses and mitigates this issue (Park and Hingley 2009).

For each `INPADOC_FAMILY_ID`, we determine the earliest filing date to assign a unique invention year. Inventor countries are extracted from PATSTAT tables 206 and 207. However, owing to significant missing data in these tables (De Rassenfosse et al. 2013, 2019), we additionally utilize imputation methods proposed by De Rassenfosse and Seliger (2021). Patent families are linked to countries based on the relative share of each country among all inventor countries within the family (Dernis and Khan 2004). For example, if a family has 'Italy' assigned twice, 'Germany' once, and 'United Kingdom' once as the inventor countries, the family is accounted for as 0.5 patent families for Italy, and 0.25 for both Germany and the UK, respectively.[3] Only inventor countries from the original sample and patent families filed between 2010-2014 are considered.

Table 4. Summary statistics of different R&D measures, by patent technology class (IPC)

R&D measure:	R&D exp. (bn.)	patent application families					
Data source:	OECD	OECD	OECD	PATSTAT	PATSTAT	PATSTAT	PATSTAT
Patent family definition:		triadic	triadic	triadic	triadic	INPADOC	INPADOC
Imputed location data:					yes		yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
across all observations							
mean	112	91	282	76	39	1304	1676
SD	1100	367	1118	318	219	4908	7135
median	0.184	4.8	17	5	1	124	101
mean/SD	*0.10*	*0.25*	*0.25*	*0.24*	*0.18*	*0.27*	*0.23*
mean/median	*608.70*	*18.96*	*16.59*	*15.20*	*39.00*	*10.52*	*16.59*
across countries							
mean	97.6	90	282	76	39	1300	1663
SD	383	209	644	177	117	2609	3999
median	0.398	13.3	41	11.8	3.3	205	188
mean/SD	*0.25*	*0.43*	*0.44*	*0.43*	*0.33*	*0.50*	*0.42*
mean/median	*245.23*	*6.77*	*6.88*	*6.44*	*11.82*	*6.34*	*8.85*
across industries							
mean	109	91	282	76	39	1308	1682
SD	247	120	370	104	63	1831	2354
median	26.5	56	171	50	26	853	1027
mean/SD	*0.44*	*0.76*	*0.76*	*0.73*	*0.62*	*0.71*	*0.71*
mean/median	*4.11*	*1.63*	*1.65*	*1.52*	*1.50*	*1.53*	*1.64*

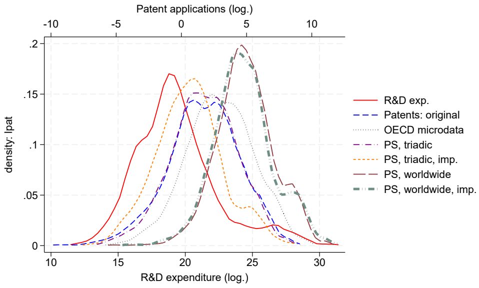
Notes: One observation is a country-year-IPC tuple, where IPC is one of 634 different 'technology classes'. Columns (1) and (2) report the results from the original paper and are identical to columns (3) and (4), respectively, in Sampson's Table 1. Column (3) replicates the results of column (2) using microdata obtained from the OECD to validate our self-written code. Columns (4)–(7) use patent data independently obtained from PATSTAT but differ in the level of aggregation and selection of patent applications: (4) and (5) use the OECD's triadic patent family definition but inventor country locations obtained from all available patent applications (in contrast to the OECD's approach using only information from patent applications filed in the US), while (6) and (7) use the `INPADOC` patent family definition that comes with PATSTAT to additionally count patent applications not filed in all top-3 patent offices. While (4) and (6) only use inventor location data included in PATSTAT, (5) and (7) additionally use inventor location data from De Rassenfosse and Seliger (2021). The rest of the data used and all computations are identical to those used in the original article, hence any difference stems entirely from differences in the measurement of R&D.

[3] While the OECD, relying solely on US patent office data, counts each inventor only once per patent family, our data does not allow tracking the same inventor across different applications. Consequently, we count an inventor country as many times as it occurs within the same patent family. The impact of this difference in approach on national patent counts is minimal, as demonstrated in Table 4. Unreported robustness checks, involving averaging country shares first at the application level before aggregating them at the family level, yield nearly identical results.

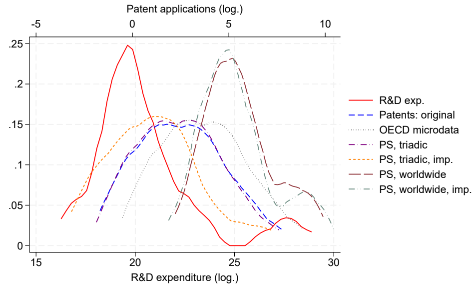
Table 4 provides summary statistics for various patent application counts analyzed in our replication. We systematically investigate the influence of different patent family definitions on the results. In addition to the author's R&D counts (Columns 1 and 2), we replicate the OECD's triadic patent measure using OECD Science, Technology, and Innovation (STI) department microdata (Column 3). We then employ the EPO's PATSTAT database, both without (Column 4) and with (Column 5) imputed inventor locations. Subsequently, we construct our R&D measure using the EPO's INPADOC patent family definition, without (Column 6) and with (Column 7) imputed inventor locations.

Despite unexpectedly higher values from the OECD microdata, the PATSTAT-based replication yields overall comparable albeit slightly lower values, likely attributed to our utilization of a broader range of inventor location sources. Panels a-c in Figure 1 reveal comparable distribution shapes across R&D measures, with R&D expenditures exhibiting a notably longer right tail. The utilization of imputed inventor locations and the worldwide patent family definition slightly extends the right tail of the patent count distribution. Particularly when considering country averages (Figure 1b), the distribution of INPADOC family counts (labeled 'worldwide') aligns more closely with the R&D expenditure distribution than the triadic patent counts.

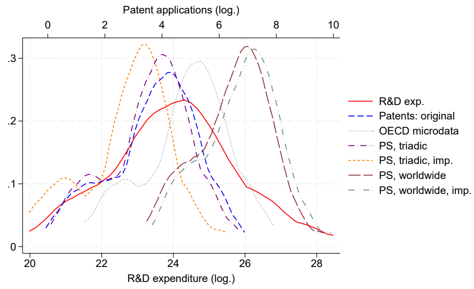
Figure 1d presents the estimation results of countries' R&D efficiency. The distributions obtained using R&D expenditure and INPADOC patent counts exhibit similar shapes, contrasting with the flatter distribution observed when using triadic patent counts. The distribution based on expenditures features a longer left tail, while the INPADOC-based distribution includes an upper outlier. Details on the underlying values for the density curves are provided in Table 5.



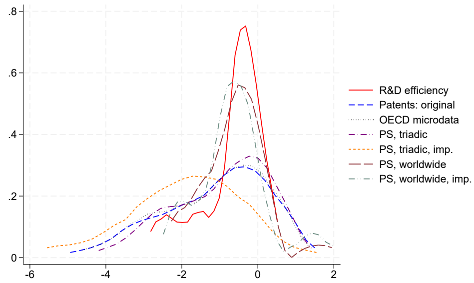
(a) Raw R&D measures



(b) R&D country averages



(c) R&D industry averages



(d) Estimated country R&D efficiency

Figure 1. Density plots comparing different R&D measures

Table 5. Estimated R&D efficiency by country

R&D efficiency measure:	R&D intensity	Patenting intensity					
Data source:	OECD	OECD	OECD	PATSTAT	PATSTAT	PATSTAT	PATSTAT
Patent family definition:		triadic	triadic	triadic	triadic	INPADOC	INPADOC
Imputed location data:					yes		yes
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Australia (AUS)	-0.25	-0.99	-1.00	-0.71	-2.01	-1.15	-0.49
Austria (AUT)	0.00	-0.15	-0.24	-0.16	-0.95	-0.34	-0.60
Belgium (BEL)	0.27	-0.08	-0.13	0.04	-0.44	-0.76	-1.14
Canada (CAN)	-0.57	-1.10	-1.00	-0.74	-1.46	-0.49	-0.70
Chile (CHL)	-2.50	-3.00	-2.94	-2.55	-3.07	-1.92	-2.21
Czechia (CZE)	-1.30	-2.55	-2.36	-2.46	-2.79	-1.06	-1.02
Germany (DEU)	-0.31	0.05	-0.07	-0.03	-0.96	0.14	0.09
Denmark (DNK)	-0.38	-0.02	-0.12	0.06	-0.63	-0.19	-0.62
Spain (ESP)	-0.84	-1.79	-1.87	-1.62	-2.43	-1.03	-1.06
Finland (FIN)	-0.09	-0.30	-0.22	0.02	-1.03	-0.17	-0.16
France (FRA)	0.30	0.11	0.09	0.16	-1.39	-0.12	-0.05
United Kingdom (GBR)	-0.45	-0.15	-0.29	-0.18	-1.21	-0.38	-0.69
Hungary (HUN)	-1.38	-2.29	-2.44	-2.01	-2.89	-0.86	-0.87
Ireland (IRL)	-0.72	-0.85	-0.24	-0.48	-0.61	-0.11	-0.26
Italy (ITA)	-0.66	-0.97	-1.09	-0.90	-2.15	-1.16	-1.23
Japan (JPN)	0.14	0.91	0.74	0.84	0.91	-0.08	1.19
Korea (KOR)	-0.24	-0.50	-0.55	-0.38	-2.64	1.62	1.70
Mexico (MEX)	-2.61	-4.30	-4.01	-3.62	-4.82	-1.95	-1.98
Netherlands (NLD)	-0.52	0.51	0.43	0.48	-0.84	0.03	-0.38
Norway (NOR)	-0.43	-0.87	-0.92	-0.69	-2.07	-0.72	-0.97
Poland (POL)	-2.05	-2.60	-2.73	-2.16	-3.14	-0.55	-0.43
Portugal (PRT)	-0.52	-2.52	-2.33	-2.13	-3.52	-1.85	-1.92
Slovenia (SVN)	-0.31	-1.41	-1.79	-1.71	-1.98	-0.61	-0.54
Turkey (TUR)	-1.78	-3.39	-3.48	-3.04	-4.91	-1.86	-1.95
USA	0.00	0.00	0.00	0.00	0.00	0.00	0.00
mean	-0.72	-1.18	-1.19	-1.00	-1.96	-0.65	-0.68
SD	0.81	1.35	1.31	1.21	1.38	0.80	0.91

Notes: Columns (1) and (2) report the results from the original paper and are identical to columns (3) and (4), respectively, in Sampson's Table 1. Column (3) replicates the results of column (2) using microdata obtained from the OECD to validate our self-written code. Columns (4)–(7) use patent data independently obtained from PATSTAT but differ in the level of aggregation and selection of patent applications: (4) and (5) use the OECD's triadic patent family definition but inventor country locations obtained from all available patent applications (in contrast to the OECD's approach using only information from patent applications filed in the US), while (6) and (7) use the `INPADOC` patent family definition that comes with PATSTAT to additionally count patent applications not filed in all top-3 patent offices. While (4) and (6) only use inventor location data included in PATSTAT, (5) and (7) additionally use inventor location data from De Rassenfosse and Seliger (2021). The rest of the data used and all computations are identical to those used in the original article, hence any difference stems entirely from differences in the measurement of R&D.

When employing worldwide patent counts, notable shifts in efficiency estimates are observed for certain countries. Belgium and France experience a decrease, while Japan and Korea witness an increase. Particularly, countries at the lower end (Chile, Czechia, Hungary, Mexico, Poland, and Turkey) show an enhanced estimated R&D efficiency relative to the US when comparing worldwide to triadic patent counts. Ireland and Poland also demonstrate improvement compared to expenditure-based estimates. Across all columns, worldwide patent counts yield the highest mean estimates, aligning with the objective of mitigating the 'disadvantaging' of less-developed economies in the patent-based measure.

Table 6 and Table 7 mirror tables 1 and 3 from the original paper. In Table 6, columns (5) and (6) depict a slightly reduced estimated average innovation dependence. Notably, 'Computer, electronic, and optical products (26)' is no longer a pronounced outlier among industries with the highest innovation dependence. Meanwhile, 'Mining and quarrying' maintains its position as the industry with the lowest innovation dependence. The null hypothesis of equal innovation dependence across industries is now rejected below the 5% level, as opposed to the previous 1% level.

Table 6. Innovation dependence by industry — alternative patent counts

R&D efficiency measure:	R&D intensity	Patenting intensity				
Data source:	OECD	OECD	OECD	PATSTAT	PATSTAT	PATSTAT
Patent family definition:		triadic	triadic	triadic	INPADOC	INPADOC
Imputed location data:				yes		yes
	(1)	(2)	(3)	(4)	(5)	(6)
Agriculture, forestry and fishing (0103)	0.17	0.01	0.02	0.01	0.02	0.06
	(0.09)	(0.06)	(0.06)	(0.05)	(0.07)	(0.05)
Mining and quarrying (0508)	-0.11	-0.14	-0.14	-0.05	-0.21	-0.22
	(0.13)	(0.08)	(0.08)	(0.1)	(0.07)	(0.07)
Food products, beverages and tobacco (1012)	0.21	0.06	0.07	0.06	0.04	0.07
	(0.08)	(0.06)	(0.06)	(0.04)	(0.06)	(0.05)
Textiles (13)	0.29	0.12	0.12	0.03	0.11	0.12
	(0.06)	(0.05)	(0.05)	(0.03)	(0.05)	(0.03)
Wearing apparel (14)	0.33	0.13	0.13	0.01	0.09	0.11
	(0.05)	(0.04)	(0.04)	(0.02)	(0.03)	(0.02)
Leather and related products (15)	0.34	0.12	0.11	0.02	0.07	0.13
	(0.08)	(0.07)	(0.06)	(0.04)	(0.05)	(0.04)
Wood and products of wood and cork, except furniture (16)	0.20	0.03	0.03	0.01	0.02	0.06
	(0.07)	(0.05)	(0.05)	(0.03)	(0.05)	(0.04)
Paper and paper products (17)	0.34	0.13	0.14	0.09	0.10	0.13
	(0.07)	(0.05)	(0.06)	(0.04)	(0.06)	(0.05)
Printing and reproduction of recorded media (18)	0.27	0.11	0.12	0.10	0.09	0.10
	(0.06)	(0.04)	(0.04)	(0.03)	(0.06)	(0.05)
Coke and refined petroleum products (19)	0.14	0.05	0.05	0.06	0.02	0.05
	(0.08)	(0.04)	(0.04)	(0.04)	(0.07)	(0.06)
Chemicals and chemical products (20)	0.38	0.19	0.20	0.14	0.14	0.15
	(0.09)	(0.06)	(0.06)	(0.06)	(0.08)	(0.05)
Basic pharmaceutical products and pharmaceutical preparations (21)	0.22	0.17	0.19	0.13	0.13	0.14
	(0.14)	(0.1)	(0.1)	(0.08)	(0.09)	(0.07)
Rubber and plastics products (22)	0.38	0.18	0.19	0.11	0.15	0.17
	(0.05)	(0.04)	(0.04)	(0.03)	(0.06)	(0.04)
Other non-metallic mineral products (23)	0.30	0.12	0.12	0.07	0.12	0.14
	(0.06)	(0.04)	(0.04)	(0.03)	(0.05)	(0.04)
Basic metals (24)	0.27	0.18	0.19	0.14	0.09	0.12
	(0.07)	(0.03)	(0.04)	(0.04)	(0.06)	(0.05)
Fabricated metal products, except machinery and equipment (25)	0.33	0.14	0.14	0.10	0.12	0.14
	(0.06)	(0.04)	(0.04)	(0.03)	(0.06)	(0.05)
Computer, electronic and optical products (26)	0.60	0.30	0.26	0.13	0.12	0.17
	(0.12)	(0.05)	(0.05)	(0.03)	(0.05)	(0.06)
Electrical equipment (27)	0.37	0.19	0.18	0.12	0.10	0.15
	(0.1)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)
Machinery and equipment n.e.c. (28)	0.38	0.21	0.22	0.16	0.14	0.18
	(0.11)	(0.06)	(0.07)	(0.05)	(0.07)	(0.06)
Motor vehicles, trailers and semi-trailers (29)	0.27	0.19	0.21	0.17	0.11	0.15
	(0.08)	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)
Other transport equipment (30)	0.26	0.00	0.01	0.01	-0.01	0.05
	(0.13)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)
Furniture, other manufacturing (3133)	0.25	0.10	0.11	0.07	0.11	0.12
	(0.07)	(0.05)	(0.05)	(0.04)	(0.06)	(0.04)
Observations	171K	171K	171K	171K	171K	171K
R-squared	0.70	0.69	0.69	0.69	0.68	0.69
TCC†	Yes	Yes	Yes	Yes	Yes	Yes
PLC†	Yes	Yes	Yes	Yes	Yes	Yes
CAC†	Yes	Yes	Yes	Yes	Yes	Yes
AID†	0.28	0.12	0.12	0.08	0.08	0.10
F test	0.07	0.00	0.00	0.00	0.08	0.02

Notes: Row definitions are equivalent to those in Table 1. The standard errors are clustered by importer-industry, and they are presented within brackets. Columns (1) and (2) report the results from the original paper and are identical to columns (3) and (4), respectively, in Sampson's table 1. Column (3) replicates the results of column (2) using microdata obtained from the OECD to validate our self-written code. Column (4)–(6) use patent data independently obtained from PATSTAT but differ in the level of aggregation and selection of patent applications: (4) uses the OECD's triadic patent family definition but inventor country locations obtained from all available patent applications (in contrast to the OECD's approach using only information from patent applications filed in the US), while (5) and (6) use the `INPADOC` patent family definition that comes with PATSTAT to additionally count patent applications not filed in all top-3 patent offices. While (5) only uses inventor location data included in PATSTAT, (6) additionally uses inventor location data from De Rassenfosse and Seliger (2021). The rest of the data used and all computations are identical to those used in the original article, hence any difference stems entirely from differences in the measurement of R&D.

Table 7. Counterfactual results — alternative patent counts

		R&D efficiency measure:	R&D intensity	Patenting intensity				
		Data source:	OECD	OECD	OECD	PATSTAT	PATSTAT	PATSTAT
		Patent family definition:		triadic	triadic	triadic	INPADOC	INPADOC
		Imputed location data:				yes		yes
			(1)	(2)	(3)	(4)	(5)	(6)
1.	Nominal wage	Average change relative to US	0.18	0.14	0.14	0.15	0.05	0.06
		Dispersion ratio	0.32	0.27	0.27	0.2	0.11	0.17
2.	Real income per capita	Average change relative to US	0.06	0.04	0.05	0.05	0.02	0.02
		Dispersion ratio	0.17	0.13	0.13	0.1	0.05	0.08

Notes: Column definitions are equivalent to those in Table 6.

In Table 7, countries exhibit increased similarity when our alternative patent count is employed. The model now accounts for only 17% of nominal wage dispersion, roughly half of the explanatory power achieved by the author's R&D measures.

Similarly, it diminishes the model's ability to explain real income dispersion. The anticipated average change in both outcomes, when eliminating differences in R&D efficiency between countries, is now reduced to approximately one-third of the original estimates

While we acknowledge that R&D expenditure likely overcounts true R&D efforts and triadic patent applications likely undercount them, both measures may introduce bias in the same direction when comparing country pairs. Imagine a scenario where each country's total R&D effort includes (1) highly valuable new inventions, (2) less commercially valuable new inventions, and (3) imitation efforts (still novel enough to be considered R&D by the OECD's definition). Triadic patent counts would approximate (1), while R&D expenditure proxies the sum of all three parts. Our proposed measure aims to proxy the sum of (1) and (2). If a reference country exhibits both higher R&D expenditure and a larger share of triadic patent applications from all patentable inventions, countries will appear more disparate using the author's R&D measures than with our measure. Section 6 of De Rassenfosse et al. (2013) suggests the presence of differences between patent indicators across countries, but a more in-depth investigation would necessitate additional data, surpassing the scope of this replication report.

4 Conclusions

Sampson's work has laid the foundation for a new strand of literature. We successfully replicated the original paper's results and subjected it to various robustness checks, all of which it withstood. Our contribution lies in questioning the selection of developing countries and the choice of innovation measure. Our findings nuance the message conveyed in the original paper. However, it is essential to clarify that our intent is not to criticize the original work but to advocate for additional research, ensuring a comprehensive understanding of the role of innovation in driving inequality.

While the group of countries under examination constitutes a relatively homogeneous subset, representing only a fraction of the 195 countries globally, it remains noteworthy that within this narrowed scope, a discernible ranking becomes evident (see Figure 6 in the original article). The inherent challenge in comparing these countries lies in their diverse industry structures and varying levels of economic development, a complexity further compounded by limitations in available data.

Moreover, no single innovation indicator is flawless. Therefore, results should be cross-verified using a range of innovation indicators that capture different facets of innovation measurement De Rassenfosse et al. (2013). The triadic patent count favors countries with affiliated patent offices and economically prosperous firms. Introducing a more technologically oriented indicator may help mitigate some of this bias. Another unexplored alternative could involve additionally weighting worldwide patent families by the number of citations received, thereby incorporating further aspects of technological importance into the calculations.

Given the crucial policy implications of this paper, further research is warranted, potentially employing a more comprehensive list of developing countries and utilizing more extensive patent data.

References

Criscuolo, P.: 2006, The 'home advantage' effect and patent families. A comparison of OECD triadic patents, the USPTO and the EPO, *Scientometrics* **66**(1), 23–41.

De Rassenfosse, G., Dernis, H., Guellec, D., Picci, L. and van Pottelsberghe de la Potterie, B.: 2013, The worldwide count of priority patents: A new indicator of inventive activity, *Research Policy* **42**(3), 720–737.

De Rassenfosse, G., Kozak, J. and Seliger, F.: 2019, Geocoding of worldwide patent data, *Scientific Data* **6**(1), 260.

De Rassenfosse, G. and Seliger, F.: 2021, Imputation of missing information in worldwide patent data, *Data in Brief* **34**, 106615.

Dernis, H. and Khan, M.: 2004, *Triadic Patent Families Methodology*, OECD Science, Technology and Industry Working Papers, No. 2004/02, OECD Publishing, Paris.

Hoppe, H. C.: 2000, Second-mover advantages in the strategic adoption of new technology under uncertainty, *International Journal of Industrial Organization* **18**(2), 315–338.

Kang, B. and Tarasconi, G.: 2016, PATSTAT revisited: Suggestions for better usage, *World Patent Information* **46**, 56–63.

Lybbert, T. J. and Zolas, N. J.: 2014, Getting patents and economic data to speak to each other: An 'Algorithmic Links with Probabilities' approach for joint analyses of patenting and economic activity, *Research Policy* **43**(3), 530–542.

Nagaoka, S., Motohashi, K. and Goto, A.: 2010, Chapter 25 - patent statistics as an innovation indicator, *in* B. H. Hall and N. Rosenberg (eds), *Handbook of the Economics of Innovation*, Vol. 2 of *Handbook of the Economics of Innovation*, North-Holland, pp. 1083–1127.

OECD: 2009, *OECD Patent Statistics Manual*, OECD Publishing, Paris.

OECD: 2015, *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris.

OECD: 2023a, Patents by main technology and by International Patent Classification (IPC), OECD Patent Statistics (database), doi: 10.1787/data-00508-en. Last accessed 2023-07-31.

OECD: 2023b, The OECD Analytical Business Enterprise Research and Development (ANBERD) Database, url: `http://oe.cd/anberd`. Last accessed 2023-07-31.

Park, W. G. and Hingley, P.: 2009, Patent family data and statistics at the European Patent Office, *American University Department of Economics Working Paper Series, No. 2009-08* .

Sampson, T.: 2023, Technology gaps, trade, and income, *American Economic Review* **113**(2), 472–513.

Shankar, V., Carpenter, G. S. and Krishnamurthi, L.: 1998, Late Mover Advantage: How Innovative Late Entrants Outsell Pioneers, *Journal of Marketing Research* **35**(1), 54–70.

van Zeebroeck, N.: 2011, The puzzle of patent value indicators, *Economics of Innovation and New Technology* **20**(1), 33–62.

Appendices

A Refining country inclusion

Table A1. Innovation dependence by industry

R&D efficiency measure	R&D intensity		R&D intensity		R&D intensity		Patenting intensity	
Industries	(1A)	(2A)	(1B)	(2B)	(1C)	(2C)	(1D)	(2D)
0103 (Agriculture)	0.45	0.46	0.33	0.33	0.17	0.16	0.01	0.01
	(0.06)	(0.05)	(0.05)	(0.04)	(0.09)	(0.09)	(0.06)	(0.06)
0508 (Mining)	0.37	0.39	0.25	0.25	-0.11	-0.11	-0.14	-0.14
	(0.09)	(0.08)	(0.07)	(0.06)	(0.13)	(0.13)	(0.08)	(0.08)
1012 (Food)	0.48	0.51	0.36	0.37	0.21	0.23	0.06	0.07
	(0.05)	(0.04)	(0.04)	(0.05)	(0.08)	(0.08)	(0.06)	(0.05)
13 (Textiles)	0.51	0.50	0.42	0.38	0.29	0.22	0.12	0.08
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.07)	(0.05)	(0.05)
14 (Apparel)	0.47	0.47	0.37	0.35	0.33	0.29	0.13	0.11
	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)	(0.04)	(0.04)
15 (Leather)	0.48	0.48	0.39	0.37	0.34	0.30	0.12	0.11
	(0.06)	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)	(0.07)
16 (Wood)	0.52	0.51	0.40	0.37	0.20	0.16	0.03	0.02
	(0.06)	(0.06)	(0.04)	(0.04)	(0.07)	(0.07)	(0.05)	(0.05)
17 (Paper)	0.58	0.58	0.45	0.43	0.34	0.30	0.13	0.12
	(0.05)	(0.05)	(0.04)	(0.03)	(0.07)	(0.06)	(0.05)	(0.05)
18 (Printing)	0.58	0.58	0.46	0.44	0.27	0.24	0.11	0.10
	(0.06)	(0.05)	(0.04)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)
19 (Petrol)	0.48	0.46	0.36	0.32	0.14	0.09	0.05	0.03
	(0.05)	(0.05)	(0.04)	(0.04)	(0.08)	(0.08)	(0.04)	(0.04)
20 (Chemicals)	0.59	0.58	0.47	0.44	0.38	0.33	0.19	0.16
	(0.05)	(0.05)	(0.05)	(0.05)	(0.09)	(0.09)	(0.06)	(0.06)
21 (Pharma)	0.62	0.65	0.50	0.50	0.22	0.23	0.17	0.18
	(0.07)	(0.07)	(0.06)	(0.06)	(0.14)	(0.13)	(0.1)	(0.09)
22 (Plastics)	0.60	0.59	0.48	0.44	0.38	0.31	0.18	0.16
	(0.05)	(0.05)	(0.04)	(0.04)	(0.05)	(0.06)	(0.04)	(0.04)
23 (Minerals)	0.57	0.57	0.45	0.44	0.30	0.27	0.12	0.11
	(0.05)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)
24 (Basic metals)	0.58	0.59	0.43	0.41	0.27	0.24	0.18	0.17
	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.07)	(0.03)	(0.04)
25 (Fabric. metals)	0.60	0.59	0.48	0.45	0.33	0.30	0.14	0.13
	(0.05)	(0.05)	(0.04)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)
26 (Computers)	0.65	0.65	0.49	0.45	0.60	0.51	0.30	0.23
	(0.06)	(0.06)	(0.04)	(0.06)	(0.12)	(0.13)	(0.05)	(0.06)
27 (Electrical)	0.61	0.59	0.53	0.48	0.37	0.31	0.19	0.14
	(0.09)	(0.09)	(0.07)	(0.08)	(0.1)	(0.09)	(0.04)	(0.05)
28 (Machinery)	0.71	0.71	0.60	0.57	0.38	0.33	0.21	0.19
	(0.08)	(0.07)	(0.05)	(0.05)	(0.11)	(0.1)	(0.06)	(0.06)
29 (Vehicles)	0.55	0.54	0.39	0.35	0.27	0.21	0.19	0.16
	(0.05)	(0.05)	(0.04)	(0.04)	(0.08)	(0.09)	(0.03)	(0.03)
30 (Other trans.)	0.56	0.58	0.38	0.38	0.26	0.24	0.00	0.00
	(0.1)	(0.08)	(0.06)	(0.05)	(0.13)	(0.12)	(0.05)	(0.06)
3133 (Furniture)	0.55	0.55	0.42	0.41	0.25	0.21	0.10	0.09
	(0.07)	(0.06)	(0.04)	(0.04)	(0.07)	(0.07)	(0.05)	(0.05)
Observations	171K	185K	171K	185K	171K	185K	171K	185K
R-squared	0.52	0.54	0.65	0.65	0.70	0.70	0.69	0.69
TCC†	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PLC†	No	No	Yes	Yes	Yes	Yes	Yes	Yes
CAC†	No	No	No	No	Yes	Yes	Yes	Yes
AID†	0.55	0.55	0.43	0.41	0.28	0.24	0.12	0.10
F test	0.13	0.09	0.00	0.01	0.07	0.24	0.00	0.01

Notes: Row and column definitions are equivalent to those in Table 1. Columns 1A-1D encompass the original findings as established in the paper. Expanding our analysis to encompass country-years with data available for a minimum of 10 industries in columns 2A-2D has resulted in an augmentation of the overall country count to 29. The standard errors are clustered by importer-industry, and they are presented within brackets.

Table A2. Median Innovation dependence summary statistics

b_s	obs	Mean	Std. dev	Min	Max
Model 1	25	-0.69	0.81	-2.61	0.30
Model 2	29	-0.74	0.82	-2.61	0.30

Notes: Model 1 encompasses the original findings as established in the paper. Expanding our analysis to encompass country-years with data available for a minimum of 10 industries in model 2 has resulted in an augmentation of the overall country count to 29.

Table A3. Counterfactual Results

R & D efficiency measure (1)	Outcome (2)	R & D intensity (3)	Patenting intensity (4)	R & D intensity generalized model (5)
1A Nominal wage	Average change relative to US	0.18	0.14	0.18
2A Nominal wage	Average change relative to US	0.18	0.13	0.17
1B Nominal wage	Dispersion ratio	0.32	0.27	0.31
2B Nominal wage	Dispersion ratio	0.33	0.25	0.29
1C Real income	Average change relative to US	0.06	0.04	0.06
2C Real income	Average change relative to US	0.06	0.04	0.05
1D Real income	Dispersion ratio	0.17	0.13	0.16
2D Real income	Dispersion ratio	0.16	0.11	0.14

Notes: For detailed descriptions of Models 1-3, refer to the notes in Table A2. For detailed descriptions of row and column definitions, refer to the notes in Table 3.

B Modifying time frame

Table B1. Innovation dependence by industry

R&D efficiency measure	R&D intensity				R&D intensity				R&D intensity				Patenting intensity			
	2010-2014	2010-2016	2010-2012	2014-2016	2010-2014	2010-2016	2010-2012	2014-2016	2010-2014	2010-2016	2010-2012	2014-2016	2010-2014	2010-2016	2010-2012	2014-2016
Industries	(1A)	(2A)	(3A)	(4A)	(1B)	(2B)	(3B)	(4B)	(1C)	(2C)	(3C)	(4C)	(1D)	(2D)	(3D)	(4D)
0103 (Agriculture)	0.45	0.43	0.47	0.39	0.33	0.31	0.31	0.2	0.17	0.09	0.16	0.15	0.01	-0.02	0	-0.02
	(0.06)	(0.06)	(0.06)	(0.07)	(0.05)	(0.05)	(0.05)	(0.06)	(0.09)	(0.06)	(0.09)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
0508 (Mining)	0.37	0.33	0.38	0.33	0.25	0.23	0.2	0.14	-0.11	-0.25	-0.27	-0.18	-0.14	-0.17	-0.19	-0.18
	(0.09)	(0.09)	(0.1)	(0.1)	(0.07)	(0.07)	(0.07)	(0.09)	(0.13)	(0.13)	(0.14)	(0.15)	(0.08)	(0.08)	(0.08)	(0.08)
1012 (Food)	0.48	0.45	0.5	0.43	0.36	0.33	0.33	0.24	0.21	0.12	0.19	0.17	0.06	0.03	0.05	0.01
	(0.05)	(0.06)	(0.05)	(0.07)	(0.04)	(0.05)	(0.05)	(0.07)	(0.08)	(0.06)	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
13 (Textiles)	0.51	0.47	0.51	0.45	0.42	0.39	0.34	0.3	0.29	0.18	0.23	0.22	0.12	0.06	0.09	0.07
	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.07)	(0.06)	(0.04)	(0.07)	(0.05)	(0.05)	(0.04)	(0.05)	(0.04)
14 (Apparel)	0.47	0.4	0.49	0.37	0.37	0.33	0.25	0.23	0.33	0.27	0.31	0.37	0.13	0.07	0.13	0.11
	(0.06)	(0.04)	(0.09)	(0.03)	(0.06)	(0.06)	(0.07)	(0.06)	(0.05)	(0.08)	(0.09)	(0.06)	(0.04)	(0.03)	(0.05)	(0.03)
15 (Leather)	0.48	0.43	0.49	0.41	0.39	0.36	0.3	0.3	0.34	0.26	0.31	0.17	0.12	0.06	0.12	0.01
	(0.06)	(0.04)	(0.05)	(0.06)	(0.07)	(0.06)	(0.07)	(0.09)	(0.08)	(0.08)	(0.1)	(0.07)	(0.07)	(0.08)	(0.07)	(0.03)
16 (Wood)	0.52	0.5	0.53	0.47	0.4	0.39	0.37	0.28	0.2	0.19	0.17	0.25	0.03	-0.01	0.01	-0.03
	(0.06)	(0.06)	(0.07)	(0.07)	(0.04)	(0.04)	(0.04)	(0.05)	(0.07)	(0.05)	(0.07)	(0.06)	(0.05)	(0.04)	(0.05)	(0.05)
17 (Paper)	0.58	0.55	0.6	0.55	0.45	0.44	0.41	0.34	0.34	0.3	0.32	0.34	0.13	0.09	0.1	0.09
	(0.05)	(0.05)	(0.06)	(0.07)	(0.04)	(0.04)	(0.04)	(0.06)	(0.07)	(0.05)	(0.08)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)
18 (Printing)	0.58	0.55	0.59	0.53	0.46	0.43	0.43	0.33	0.27	0.23	0.23	0.26	0.11	0.08	0.09	0.04
	(0.06)	(0.06)	(0.07)	(0.06)	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.04)	(0.04)	(0.04)	(0.05)
19 (Petrol)	0.48	0.49	0.49	0.45	0.36	0.38	0.33	0.26	0.14	0.15	0.04	0.17	0.05	0.04	0.04	0.05
	(0.05)	(0.05)	(0.06)	(0.07)	(0.04)	(0.04)	(0.05)	(0.06)	(0.08)	(0.06)	(0.08)	(0.07)	(0.04)	(0.03)	(0.03)	(0.04)
20 (Chemicals)	0.59	0.56	0.6	0.55	0.47	0.46	0.42	0.38	0.38	0.25	0.3	0.28	0.19	0.13	0.14	0.16
	(0.05)	(0.05)	(0.05)	(0.07)	(0.05)	(0.06)	(0.05)	(0.08)	(0.09)	(0.1)	(0.1)	(0.09)	(0.06)	(0.07)	(0.06)	(0.08)
21 (Pharma)	0.62	0.53	0.63	0.46	0.5	0.44	0.42	0.31	0.22	0.12	0.06	0.21	0.17	0.12	0.11	0.09
	(0.07)	(0.06)	(0.08)	(0.08)	(0.06)	(0.06)	(0.07)	(0.08)	(0.14)	(0.12)	(0.14)	(0.15)	(0.1)	(0.06)	(0.1)	(0.04)
22 (Plastics)	0.6	0.56	0.61	0.55	0.48	0.45	0.42	0.36	0.38	0.28	0.36	0.33	0.18	0.14	0.15	0.15
	(0.05)	(0.04)	(0.07)	(0.05)	(0.04)	(0.03)	(0.04)	(0.04)	(0.05)	(0.06)	(0.07)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)
23 (Minerals)	0.57	0.54	0.57	0.53	0.45	0.43	0.4	0.33	0.3	0.24	0.26	0.28	0.12	0.08	0.1	0.05
	(0.05)	(0.05)	(0.07)	(0.06)	(0.04)	(0.04)	(0.04)	(0.05)	(0.06)	(0.05)	(0.06)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
24 (Basic metals)	0.58	0.54	0.6	0.5	0.43	0.39	0.42	0.28	0.27	0.19	0.31	0.18	0.18	0.13	0.16	0.15
	(0.05)	(0.06)	(0.04)	(0.07)	(0.05)	(0.05)	(0.05)	(0.07)	(0.07)	(0.06)	(0.08)	(0.05)	(0.03)	(0.02)	(0.04)	(0.03)
25 (Fabric. metals)	0.6	0.58	0.6	0.57	0.48	0.47	0.43	0.36	0.33	0.31	0.31	0.33	0.14	0.12	0.12	0.1
	(0.05)	(0.05)	(0.07)	(0.06)	(0.04)	(0.05)	(0.04)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)	(0.04)	(0.04)	(0.04)	(0.05)
26 (Computers)	0.65	0.54	0.68	0.47	0.49	0.44	0.45	0.29	0.6	0.41	0.66	0.37	0.3	0.29	0.31	0.26
	(0.06)	(0.06)	(0.06)	(0.07)	(0.04)	(0.05)	(0.05)	(0.06)	(0.12)	(0.11)	(0.16)	(0.09)	(0.05)	(0.05)	(0.06)	(0.11)
27 (Electrical)	0.61	0.57	0.63	0.6	0.53	0.53	0.49	0.52	0.37	0.35	0.34	0.32	0.19	0.16	0.17	0.2
	(0.09)	(0.05)	(0.09)	(0.12)	(0.07)	(0.03)	(0.06)	(0.09)	(0.1)	(0.06)	(0.1)	(0.09)	(0.04)	(0.03)	(0.05)	(0.03)
28 (Machinery)	0.71	0.66	0.68	0.7	0.6	0.57	0.51	0.55	0.38	0.31	0.29	0.37	0.21	0.15	0.16	0.15
	(0.08)	(0.06)	(0.1)	(0.12)	(0.05)	(0.04)	(0.06)	(0.07)	(0.11)	(0.05)	(0.12)	(0.07)	(0.06)	(0.04)	(0.07)	(0.04)
29 (Vehicles)	0.55	0.53	0.55	0.51	0.39	0.41	0.36	0.29	0.27	0.27	0.27	0.2	0.19	0.17	0.19	0.1
	(0.05)	(0.04)	(0.06)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.08)	(0.09)	(0.1)	(0.04)	(0.03)	(0.03)	(0.04)	(0.03)
30 (Other trans.)	0.56	0.57	0.59	0.54	0.38	0.47	0.35	0.37	0.26	0.24	0.25	0.3	0	0.05	-0.02	0.01
	(0.1)	(0.07)	(0.12)	(0.08)	(0.06)	(0.08)	(0.09)	(0.08)	(0.13)	(0.09)	(0.19)	(0.07)	(0.05)	(0.05)	(0.06)	(0.05)
3133 (Furniture)	0.55	0.5	0.56	0.51	0.42	0.4	0.37	0.32	0.25	0.18	0.2	0.26	0.1	0.06	0.08	0.03
	(0.07)	(0.07)	(0.08)	(0.07)	(0.04)	(0.04)	(0.05)	(0.06)	(0.07)	(0.07)	(0.07)	(0.06)	(0.05)	(0.06)	(0.05)	(0.06)
Observations	171K	235K	99K	31K	171K	235K	99K	31K	171K	235K	99K	31K	171K	235K	99K	31K
R-squared	0.52	0.54	0.50	0.53	0.65	0.66	0.65	0.67	0.70	0.71	0.70	0.75	0.69	0.71	0.70	0.74
TCC†	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PLC†	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CAC†	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AID†	0.55	0.51	0.56	0.49	0.43	0.41	0.38	0.32	0.28	0.21	0.24	0.24	0.12	0.08	0.10	0.07
F test	0.13	0.04	0.36	0.03	0.00	0.00	0.01	0.02	0.07	0.00	0.01	0.01	0.00	0.00	0.00	0.00

Notes: Row and column definitions are equivalent to those in Table 1. Columns 1A-1D present the original results from Table 1, page 498. In columns 2A-2D, we extend the period by two years, spanning from 2010-2014 to 2010-2016 (following Sampson's Readme file). In columns 3A-3D, we divide the timeframe into 2010-2012. In column 4A-4D, we focus on the interval from 2014-2016. The standard errors are clustered by importer-industry, and they are presented within brackets.

Table B2. Median Innovation dependence summary statistics

b_s	obs	Mean	Std. dev	Min	Max
Model 1	25	-0.69	0.81	-2.61	0.30
Model 2	25	-0.69	0.85	-2.93	0.33
Model 3	24	-0.60	0.73	-2.47	0.33
Model 4	25	-0.74	0.88	-3.20	0.13

Notes: Model 1 incorporates the initial discoveries outlined in the paper. Model 2 extends the original timeframe from 2010-2014 to 2010-2016. Model 3 divides the timeframe into 2010-2012, while Model 4 focuses on the interval from 2014-2016.

Table B3. Counterfactual Results

R & D efficiency measure (1)	Outcome (2)	R & D intensity (3)	Patenting intensity (4)	R & D intensity generalized model (5)
1A Nominal wage	Average change relative to US	0.18	0.14	0.18
2A Nominal wage	Average change relative to US	0.16	0.15	0.18
3A Nominal wage	Average change relative to US	0.14	0.10	0.09
4A Nominal wage	Average change relative to US	0.10	0.05	0.14
1B Nominal wage	Dispersion ratio	0.32	0.27	0.31
2B Nominal wage	Dispersion ratio	0.31	0.27	0.32
3B Nominal wage	Dispersion ratio	0.28	0.24	0.21
4B Nominal wage	Dispersion ratio	0.33	0.26	0.35
1C Real income	Average change relative to US	0.06	0.04	0.06
2C Real income	Average change relative to US	0.05	0.04	0.06
3C Real income	Average change relative to US	0.05	0.03	0.03
4C Real income	Average change relative to US	0.03	0.02	0.04
1D Real income	Dispersion ratio	0.17	0.13	0.16
2D Real income	Dispersion ratio	0.15	0.12	0.16
3D Real income	Dispersion ratio	0.14	0.10	0.09
4D Real income	Dispersion ratio	0.15	0.10	0.16

Notes: For detailed descriptions of Models 1-3, refer to the notes in Table B2. For detailed descriptions of row and column definitions, refer to the notes in Table 3.

C Changing values of trade elasticity

Table C1. Innovation dependence by industry

R&D efficiency measure	R&D intensity			R&D intensity			R&D intensity			Patenting intensity		
	6.53	1	10.5	6.53	1	10.5	6.53	1	10.5	6.53	1	10.5
Industries	(1A)	(2A)	(3A)	(1B)	(2B)	(3B)	(1C)	(2C)	(3C)	(1D)	(2D)	(3D)
0103 (Agriculture)	0.45	-0.09	0.50	0.33	-0.24	0.38	0.17	-0.41	0.22	0.01	-0.48	0.05
	(0.06)	(0.18)	(0.05)	(0.05)	(0.19)	(0.04)	(0.09)	(0.37)	(0.07)	(0.06)	(0.23)	(0.05)
0508 (Mining)	0.37	-0.53	0.45	0.25	-0.69	0.33	-0.11	-2.07	0.06	-0.14	-1.30	-0.04
	(0.09)	(0.27)	(0.07)	(0.07)	(0.29)	(0.05)	(0.13)	(0.61)	(0.1)	(0.08)	(0.32)	(0.06)
1012 (Food)	0.48	0.06	0.52	0.36	-0.08	0.40	0.21	-0.18	0.24	0.06	-0.16	0.08
	(0.05)	(0.11)	(0.05)	(0.04)	(0.12)	(0.04)	(0.08)	(0.25)	(0.07)	(0.06)	(0.19)	(0.05)
13 (Textiles)	0.51	0.43	0.51	0.42	0.29	0.43	0.29	0.47	0.27	0.12	0.25	0.11
	(0.05)	(0.12)	(0.05)	(0.05)	(0.13)	(0.05)	(0.06)	(0.22)	(0.06)	(0.05)	(0.17)	(0.04)
14 (Apparel)	0.47	0.18	0.50	0.37	-0.02	0.40	0.33	0.79	0.30	0.13	0.50	0.10
	(0.06)	(0.19)	(0.06)	(0.06)	(0.2)	(0.05)	(0.05)	(0.31)	(0.06)	(0.04)	(0.18)	(0.04)
15 (Leather)	0.48	0.35	0.49	0.39	0.15	0.41	0.34	0.94	0.29	0.12	0.23	0.11
	(0.06)	(0.27)	(0.06)	(0.07)	(0.27)	(0.06)	(0.08)	(0.53)	(0.07)	(0.07)	(0.43)	(0.05)
16 (Wood)	0.52	0.29	0.54	0.40	0.15	0.42	0.20	-0.25	0.24	0.03	-0.35	0.06
	(0.06)	(0.17)	(0.06)	(0.04)	(0.18)	(0.03)	(0.07)	(0.24)	(0.06)	(0.05)	(0.12)	(0.04)
17 (Paper)	0.58	0.59	0.58	0.45	0.44	0.45	0.34	0.54	0.32	0.13	0.22	0.12
	(0.05)	(0.14)	(0.05)	(0.04)	(0.14)	(0.04)	(0.07)	(0.23)	(0.06)	(0.05)	(0.16)	(0.05)
18 (Printing)	0.58	0.63	0.58	0.46	0.50	0.46	0.27	0.19	0.28	0.11	0.15	0.11
	(0.06)	(0.13)	(0.06)	(0.04)	(0.13)	(0.04)	(0.06)	(0.17)	(0.06)	(0.04)	(0.09)	(0.04)
19 (Petrol)	0.48	0.05	0.52	0.36	-0.08	0.40	0.14	-0.84	0.23	0.05	-0.37	0.09
	(0.05)	(0.17)	(0.04)	(0.04)	(0.19)	(0.04)	(0.08)	(0.28)	(0.07)	(0.04)	(0.18)	(0.03)
20 (Chemicals)	0.59	0.71	0.58	0.47	0.56	0.47	0.38	0.63	0.36	0.19	0.48	0.16
	(0.05)	(0.18)	(0.05)	(0.05)	(0.17)	(0.04)	(0.09)	(0.36)	(0.08)	(0.06)	(0.23)	(0.05)
21 (Pharma)	0.62	0.84	0.60	0.50	0.64	0.48	0.22	-0.07	0.25	0.17	0.44	0.15
	(0.07)	(0.21)	(0.07)	(0.06)	(0.2)	(0.05)	(0.14)	(0.63)	(0.11)	(0.1)	(0.45)	(0.07)
22 (Plastics)	0.60	0.75	0.59	0.48	0.59	0.47	0.38	0.74	0.35	0.18	0.44	0.16
	(0.05)	(0.15)	(0.05)	(0.04)	(0.16)	(0.03)	(0.05)	(0.19)	(0.05)	(0.04)	(0.15)	(0.03)
23 (Minerals)	0.57	0.55	0.57	0.45	0.42	0.45	0.30	0.29	0.30	0.12	0.16	0.11
	(0.05)	(0.13)	(0.05)	(0.04)	(0.14)	(0.04)	(0.06)	(0.17)	(0.05)	(0.04)	(0.09)	(0.04)
24 (Basic metals)	0.58	0.56	0.58	0.43	0.41	0.43	0.27	0.48	0.25	0.18	0.55	0.15
	(0.05)	(0.17)	(0.05)	(0.05)	(0.19)	(0.04)	(0.07)	(0.34)	(0.06)	(0.03)	(0.17)	(0.03)
25 (Fabric. metals)	0.60	0.73	0.59	0.48	0.59	0.47	0.33	0.53	0.32	0.14	0.28	0.13
	(0.05)	(0.14)	(0.05)	(0.04)	(0.15)	(0.03)	(0.06)	(0.15)	(0.05)	(0.04)	(0.09)	(0.04)
26 (Computers)	0.65	1.16	0.61	0.49	0.98	0.45	0.60	3.28	0.37	0.30	1.74	0.17
	(0.06)	(0.21)	(0.07)	(0.04)	(0.21)	(0.04)	(0.12)	(0.67)	(0.08)	(0.05)	(0.31)	(0.04)
27 (Electrical)	0.61	1.09	0.57	0.53	0.98	0.49	0.37	1.12	0.31	0.19	0.79	0.13
	(0.09)	(0.31)	(0.07)	(0.07)	(0.28)	(0.05)	(0.1)	(0.51)	(0.07)	(0.04)	(0.27)	(0.03)
28 (Machinery)	0.71	1.43	0.65	0.60	1.30	0.54	0.38	0.81	0.34	0.21	0.76	0.17
	(0.08)	(0.28)	(0.07)	(0.05)	(0.26)	(0.04)	(0.11)	(0.52)	(0.08)	(0.06)	(0.35)	(0.04)
29 (Vehicles)	0.55	0.41	0.57	0.39	0.25	0.40	0.27	0.50	0.26	0.19	0.60	0.15
	(0.05)	(0.17)	(0.05)	(0.04)	(0.17)	(0.03)	(0.08)	(0.46)	(0.06)	(0.03)	(0.27)	(0.02)
30 (Other trans.)	0.56	0.41	0.58	0.38	0.25	0.39	0.26	0.05	0.27	0.00	-0.25	0.02
	(0.1)	(0.34)	(0.09)	(0.06)	(0.31)	(0.05)	(0.13)	(0.66)	(0.09)	(0.05)	(0.21)	(0.05)
3133 (Furniture)	0.55	0.44	0.56	0.42	0.28	0.44	0.25	0.01	0.28	0.10	0.09	0.10
	(0.07)	(0.17)	(0.06)	(0.04)	(0.18)	(0.04)	(0.07)	(0.2)	(0.06)	(0.05)	(0.14)	(0.05)
Observations	171K	171K	171K	171K	171K	171K	171K	171K	171K	171K	171K	171K
R-squared	0.52	0.28	0.60	0.65	0.28	0.78	0.70	0.32	0.82	0.69	0.33	0.81
TCC†	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PLC†	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CAC†	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
AID†	0.55	0.50	0.56	0.43	0.35	0.43	0.28	0.34	0.28	0.12	0.22	0.11
F test	0.13	0.00	0.93	0.00	0.00	0.18	0.07	0.00	0.86	0.00	0.00	0.17

Notes: Row and column definitions are equivalent to those in Table 1. Model 1 encompasses the original findings as established in the paper. Columns 1A-1D encompass the original findings as established in the paper. In Columns 2A-2D, we have adjusted the preferred trade elasticity to 1.12, deviating from the original value of 6.53. In Columns 3A-3D, we have adjusted the preferred trade elasticity to 11.10, deviating from the original value of 6.53. The standard errors are clustered by importer-industry, and they are presented within brackets.

Table C2. Median Innovation dependence summary statistics

b_s	obs	Mean	Std. dev	Min	Max
Model 1	25	-0.69	0.81	-2.61	0.30
Model 2	25	-0.69	0.81	-2.61	0.30
Model 3	25	-0.69	0.81	-2.61	0.30

Notes: Model 1 encompasses the original findings as established in the paper. In Model 2, we have adjusted the preferred trade elasticity to 1, deviating from the original value of 6.53. In Model 3, we have adjusted the preferred trade elasticity to 10.5, deviating from the original value of 6.53.

Table C3. Counterfactual Results

R & D efficiency measure (1)	Outcome (2)	R & D intensity (3)	Patenting intensity (4)	R & D intensity generalized model (5)
1A Nominal wage	Average change relative to US	0.18	0.14	0.18
2A Nominal wage	Average change relative to US	0.33	0.35	0.36
3A Nominal wage	Average change relative to US	0.17	0.12	0.17
1B Nominal wage	Dispersion ratio	0.32	0.27	0.31
2B Nominal wage	Dispersion ratio	0.50	0.65	0.52
3B Nominal wage	Dispersion ratio	0.32	0.23	0.30
1C Real income	Average change relative to US	0.06	0.04	0.06
2C Real income	Average change relative to US	0.09	0.10	0.09
3C Real income	Average change relative to US	0.06	0.04	0.06
1D Real income	Dispersion ratio	0.17	0.13	0.16
2D Real income	Dispersion ratio	0.15	0.12	0.16
3D Real income	Dispersion ratio	0.18	0.12	0.17

Notes: For detailed descriptions of Models 1-3, refer to the notes in Table C2. For detailed descriptions of row and column definitions, refer to the notes in Table 3.

D Dropping outlier industries

Table D1. Innovation dependence by industry

R&D efficiency measure	R&D intensity		R&D intensity		R&D intensity		Patenting intensity	
Industries	(1A)	(2A)	(1B)	(2B)	(1C)	(2C)	(1D)	(2D)
0103 (Agriculture)	0.45		0.33		0.17		0.01	
	(0.06)		(0.05)		(0.09)		(0.06)	
0508 (Mining)	0.37	0.34	0.25	0.23	-0.11	-0.15	-0.14	-0.15
	(0.09)	(0.08)	(0.07)	(0.06)	(0.13)	(0.14)	(0.08)	(0.08)
1012 (Food)	0.48	0.44	0.36	0.33	0.21	0.18	0.06	0.05
	(0.05)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.06)	(0.06)
13 (Textiles)	0.51	0.48	0.42	0.39	0.29	0.27	0.12	0.11
	(0.05)	(0.04)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)	(0.05)
14 (Apparel)	0.47	0.44	0.37	0.35	0.33	0.32	0.13	0.13
	(0.06)	(0.05)	(0.06)	(0.05)	(0.05)	(0.06)	(0.04)	(0.04)
15 (Leather)	0.48	0.45	0.39	0.36	0.34	0.32	0.12	0.12
	(0.06)	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)	(0.07)
16 (Wood)	0.52	0.49	0.40	0.37	0.20	0.18	0.03	0.03
	(0.06)	(0.05)	(0.04)	(0.04)	(0.07)	(0.07)	(0.05)	(0.04)
17 (Paper)	0.58		0.45		0.34		0.13	
	(0.05)		(0.04)		(0.07)		(0.05)	
18 (Printing)	0.58	0.54	0.46	0.43	0.27	0.26	0.11	0.10
	(0.06)	(0.05)	(0.04)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)
19 (Petrol)	0.48	0.45	0.36	0.34	0.14	0.12	0.05	0.05
	(0.05)	(0.04)	(0.04)	(0.04)	(0.08)	(0.08)	(0.04)	(0.04)
20 (Chemicals)	0.59	0.54	0.47	0.44	0.38	0.34	0.19	0.18
	(0.05)	(0.05)	(0.05)	(0.05)	(0.09)	(0.09)	(0.06)	(0.06)
21 (Pharma)	0.62	0.57	0.50	0.45	0.22	0.15	0.17	0.15
	(0.07)	(0.07)	(0.06)	(0.06)	(0.14)	(0.13)	(0.1)	(0.1)
22 (Plastics)	0.60	0.57	0.48	0.45	0.38	0.37	0.18	0.18
	(0.05)	(0.04)	(0.04)	(0.03)	(0.05)	(0.05)	(0.04)	(0.04)
23 (Minerals)	0.57	0.53	0.45	0.42	0.30	0.28	0.12	0.11
	(0.05)	(0.04)	(0.04)	(0.04)	(0.06)	(0.06)	(0.04)	(0.04)
24 (Basic metals)	0.58	0.53	0.43	0.39	0.27	0.23	0.18	0.17
	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.07)	(0.03)	(0.03)
25 (Fabric. metals)	0.60	0.56	0.48	0.44	0.33	0.31	0.14	0.14
	(0.05)	(0.04)	(0.04)	(0.03)	(0.06)	(0.06)	(0.04)	(0.04)
26 (Computers)	0.65	0.59	0.49	0.45	0.60	0.54	0.30	0.30
	(0.06)	(0.04)	(0.04)	(0.03)	(0.12)	(0.1)	(0.05)	(0.05)
27 (Electrical)	0.61	0.58	0.53	0.51	0.37	0.36	0.19	0.19
	(0.09)	(0.08)	(0.07)	(0.07)	(0.1)	(0.09)	(0.04)	(0.04)
28 (Machinery)	0.71	0.66	0.60	0.56	0.38	0.34	0.21	0.21
	(0.08)	(0.07)	(0.05)	(0.05)	(0.11)	(0.09)	(0.06)	(0.06)
29 (Vehicles)	0.55	0.51	0.39	0.36	0.27	0.27	0.19	0.19
	(0.05)	(0.04)	(0.04)	(0.03)	(0.08)	(0.08)	(0.03)	(0.03)
30 (Other trans.)	0.56	0.50	0.38	0.34	0.26	0.19	0.00	0.00
	(0.1)	(0.08)	(0.06)	(0.06)	(0.13)	(0.11)	(0.05)	(0.05)
3133 (Furniture)	0.55	0.51	0.42	0.40	0.25	0.24	0.10	0.10
	(0.07)	(0.06)	(0.04)	(0.04)	(0.07)	(0.06)	(0.05)	(0.05)
Observations	171K	151K	171K	151K	171K	151K	171K	151K
R-squared	0.52	0.52	0.65	0.65	0.70	0.70	0.69	0.70
TCC†	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
PLC†	No	No	Yes	Yes	Yes	Yes	Yes	Yes
CAC†	No	No	No	No	Yes	Yes	Yes	Yes
AID†	0.55	0.51	0.43	0.40	0.28	0.26	0.12	0.12
F test	0.13	0.08	0.00	0.00	0.07	0.03	0.00	0.00

Notes: Row and column definitions are equivalent to those in Table 1. Columns 1A-1D encompass the original findings as established in the paper. In columns 2A-2D, we have excluded two outliers, namely the Paper and Paper Products (17) industry and the Agriculture, Forestry, and Fishing (0103) industry. These outliers were identified based on information from Figure 4 in Sampson (2023). The standard errors are clustered by importer-industry, and they are presented within brackets.

Table D2. Median Innovation dependence summary statistics

b_s	obs	Mean	Std. dev	Min	Max
Model 1	25	-0.69	0.81	-2.61	0.30
Model 2	25	-0.69	0.85	-2.93	0.33

Notes: Model 1 encompasses the original findings as established in the paper. In Model 2, we have excluded two outliers, namely the Paper and Paper Products (17) industry and the Agriculture, Forestry, and Fishing (0103) industry. These outliers were identified based on information from Figure 4 in Sampson (2023).

Table D3. Counterfactual Results

R & D efficiency measure (1)	Outcome (2)	R & D intensity (3)	Patenting intensity (4)	R & D intensity generalized model (5)
1A Nominal wage	Average change relative to US	0.18	0.14	0.18
2A Nominal wage	Average change relative to US	0.16	0.15	0.18
1B Nominal wage	Dispersion ratio	0.32	0.27	0.31
2B Nominal wage	Dispersion ratio	0.31	0.27	0.32
1C Real income	Average change relative to US	0.06	0.04	0.06
2C Real income	Average change relative to US	0.05	0.04	0.06
1D Real income	Dispersion ratio	0.17	0.13	0.16
2D Real income	Dispersion ratio	0.15	0.12	0.16

Notes: For detailed descriptions of Models 1-3, refer to the notes in Table D2. For detailed descriptions of row and column definitions, refer to the notes in Table 3.