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How globalization is changing digital technology adoption: An international perspective

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ABSTRACT

This paper examines how globalization influences the adoption of digital technologies. The purpose of the paper is to explain how globalization affects new technology adoptions. We use country-level data from the globalization index (KOF), digital adoption index (DAI), global competitiveness index (GDI), and total factor productivity (TFP) on 183 countries and using advanced panel data modeling. Empirical findings show globalization can significantly affect technology adoption in all countries. The study's findings show globalization positively affects technology transfers and spillovers; here, using digital technology. Countries undergoing significant technological changes achieve ever-growing digital technology adoption convergence. In our study, the evidence comes from an international perspective, with an extensive sample of 183 countries that explain about 80 percent of the transfer process.

Introduction

The nature of economic development has continuously changed and shifted fundamental factors across the timeline. After World War II, industrialization, modernization, and economic growth drove development. Labor productivity growth within structural transformation under technology improvement marked the development until the 1970s. Oil crises and the transformation of developing economies (liberalization) initiated a catching up with developed economies. Low inflation and growth volatility from the 1980s-2000s inspired policymakers to believe in the Washington Consensus's great moderation. At the turn of the millennium, with the dot.com bust and industry 4.0 (fourth industrial revolution), the crisis of 2008 forced us to rethink development policies towards becoming more goal based. Digital technology was the primary force behind industry 4.0, guiding economic development in the 21st century.

This study investigates the impact of globalization on the international digital adoption rate. We study the main determinants of digital technology transmission to reveal the importance of globalization as a spillover factor. To isolate the globalization impact, we use country-level data on the (KOF) globalization index, digital adoption index, global competitiveness index, and total factor productivity on a sample of 183 countries using panel data modeling. The globalization process induces innovation and accelerates technology transmission. We use a random panel model due to data availability on digital technology adoption.

Fatima (2017) uses firm-level data from 30 developed and emerging economies, studying the relationship between openness and technology adoption. Particularly in process innovation, foreign direct investment (FDI) is less inclined to innovate than their domestic counterparts.

Globalization offers a new opportunity to disseminate information, but that does not guarantee that all nations and organizations can benefit. Developing countries are not specifically exempt (Archibugi & Pietrobelli, 2003).

Miranda, Farias, de Araújo Schwartz and de Almeida (2016) showed that the decision to adopt or reject specific technological solutions or innovations is a diffuse and nonlinear one. Straub (2009) considered adoption and diffusion theory, finding several factors that influence whether or not a person chooses a technology.

Technology adoption models change quickly because of the complex nature of modern information technology. As Straub (2009) noticed, technology adoption is a complex social and developmental process dependent on individual construct. Globalization improves technology adoption through the transfer of foreign knowledge, enhancing international competition.

The role of globalization in the technology adoption process remains unanswered and is missing international empirical evidence.

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How vital is globalization for digital technology adoption? How does it relate to other technology adoption processes?

Our study aims to answer just how vital globalization is for digital technology transfer and adoption. A previous study offered insight into single countries and a group of countries while providing evidence on an international scale using 183 countries' data. We study the impact of globalization on digital technology adoption rates worldwide using a random panel data model. Differences in economic, social, and political dimensions of globalization across countries impact the level of technology adoption. This provides a rationale behind the use of the random effects model in our study.

The goal of the paper is to examine the empirical link between digital adoption and globalization in order to establish causal relationships between them.

The study's results show that globalization is a necessary (but not sufficient) precondition for digital technology adoption. Digital technology adoption rates increase with the level of globalization.

Policies to speed up the digital technology adoption rate for an economy must rely on increasing the globalization index which drives knowledge and competition spillover.

The remainder of this paper is as follows. Section 2 provides a literature review identifying theories and factors of technology adoption. Section 3 outlines the hypotheses, data, and method used to address the research question, and section 4 outlines the research results. Section 5 discusses these results and identifies the implications for future research in the conclusion.

Review on globalization and technology adoption

Differences in technology adoption result in divergences of productivity (International monetary fund 2018) and economic growth. There is a significant body of literature study models and determinants of technology adoption. Acemoglu, Antràs and Helpman (2007) developed a tractable framework for analyzing the impact of contractual incompleteness and technological complementarities on the equilibrium technology choice. The authors found that, in those sectors with more complementary intermediate inputs, the effect of contractual incompleteness on technology adoption is more significant. Dastidar (2015) analyzed companies' incentives for using cost-cutting technologies in a horizontally separate industry under two alternative commodity market competitors, Cournot and Bertrand. The authors stated that the cost of buying new technology and its quality are not exogenous, but depend on the scoring auction's equilibrium outcome.

Previous studies have highlighted the difference between consumers' adoption and that of firms (Forman, Goldfarb & Greenstein, 2018). They see technology adoption as the act of a person, business, or another agent's first use of new technology. Technology can point to revolutionary new products, services, or management in this environment. Using examples from IT adoption, the authors emphasized the role of costs, advantages, communication networks, and complex factors to implement new technology. A study by Sadik (2008) showed that healthy institutions that reduce adoption costs correlate with high per capita income. The model shows that the total costs, that is, transport and institutional costs of technology introduction, determine whether a region is industrialized or not.

The links between technology adoption and globalization refer to the country open to foreign investments, firms' entry, technology, and knowledge transfer. Straub (2009) examined the adoption and diffusion theory and found several factors that influence whether or not a person chooses a technology. Miranda et al. (2016) revealed that the decision to adopt or reject specific technological solutions or innovations is diffuse and nonlinear. Fatima (2017) used company data from 30 developed and emerging economies to investigate the relationship between openness and technology adoption. Particularly in terms of process innovation, foreign direct investment (FDI) is less prone to innovation than its domestic counterparts. Globalization offers a new opportunity to disseminate information, but that does not guarantee that all nations and organizations can benefit from it. Developing countries are not explicitly excluded (Archibugi & Pietrobelli, 2003). Khanna and Palepu (2010) determined that family-run businesses in this environment rely on six main elements of organizational resilience to guide them toward sustainability. However, this advantage is not always reflected in developed markets, where trust is greater, institutions are more robust, and competition is more challenging. Technology adoption readiness differs between family and non-family-run businesses. Son and Han's (2011) study provides a theoretical contribution by showing that the willingness to use technology influences users' behavior after adoption. The empirical results suggest each dimension of technology readiness has a significantly different influence on user behavior. Personality strongly impacts technology adoption, but social influence appears to be a dominant factor, too. Oleschewski, Renken and Mueller (2018) examined technology readiness and social influence in the acceptance of collaboration technologies. The authors examined the impact of these factors on the adoption of technology and their re-orientation beyond traditional adoption research, which focused on the initial acceptance of the technology. They noted that social influence is a dominant factor in the context of personal acceptance of collaboration technologies, surpassing technological readiness and traditional adoption measures. Foster and Rosenzweig (2010) studied factors that influence decisions regarding technology selection and input allocation. They included financial and non-financial returns from adoption, learning and social learning, technological externalities, economies of scale, education, credit constraints, risks and incomplete insurance, and deviations from codes of conduct implied by simple rationality models. The authors found the introduction and efficient use of new technologies to be essential features of the development process, with education playing a pivotal role.

Other studies have looked at the link between entry barriers and technology adoption (Fang, 2017). The author found that reducing the entry cost from the average level in the world's lowest 30 percent to the US level led to a 12 percent increase in total factor productivity and a 27 percent increase in total non-agricultural factor productivity. Bridgman, Livshits and MacGee (2007) integrated the asymmetric capacity of different interest groups to exclude non-members and full advantages and diffused costs into a political economy model of vested interests and adoption of technology, which included several features highlighted in the recent literature. Protection and interest lobbying create barriers to technology adoption, negatively impacting labor productivity and economic growth. Kwon and Chun (2015) examined the role of the strategic adoption of multinationals' technology by local companies in regards of technology's transfer effects. Under local content requirements, local companies may not adopt the widespread technology to avoid competition with multinationals on the local market. The digital adoption process in family businesses require a clear digital entrepreneurship model to speed up the adoption process in small and medium firms (Basly & Hammouda, 2020). Late adoption of innovation demands attitudes toward technology, brand image, consumer innovativeness, and lead-user profile (Jahanmir & Cavadas, 2018). The main drivers of digital adoption in small and medium enterprises are sales, marketing, process innovation, and product development (Lee, Falahat & Sia, 2020).

We find there is a significant gap in the literature on globalization and technology adoption in other research on technology adoption. Fatima (2017) found that globalization can have discouraging effects on local firms' innovation efforts. Local firms are forced to innovate to stay on the market by product or process innovation. The main open innovation determinants are digital technologies and globalization (Sag, Sezen & Alpkan, 2019). University-industry networks are important determinants of open innovation (Huggins, Prokop & Thompson, 2020). Globalization-induced innovation appears to be more productoriented than process-oriented. Technology and knowledge spillover effects are higher in high- and middle-income to low-income countries. Developing countries lack the full potential benefits from IT technology adoption. Ejiaku (2014) analyzed the challenges associated with the adoption of information technology in developing nations. Poor government policies, inadequate infrastructure, and inadequate training and qualifications contribute to the creation of challenges in transferring and adopting information technology. Meschi, Taymaz and Vivarelli (2011) researched the relationship between openness, technology adoption, and the relative need for skilled labor in the Turkish manufacturing sector. Technology adoption shifts the demand for human capital to a higher skill level. Different research use data on trade, FDI, and openness. However, we lack studies using direct indicators on globalization and its impact on digital technology adoption. It has been our effort in this article to fill the gap in the literature on globalization. We have observed it directly using (KOF) index (see Dreher, 2006; Gygli, Haelg, Potrafke & Sturm, 2019; and Potrafke, 2015) and levels of technology adoption.

Data and method

To study the impact of globalization on digital technology adoption, we use international data for 183 countries (see Table 1).

Countries were selected according to data availability on digital adoption and globalization from below databases.

List of variables we used in the study is a follows:

- (DAI) = digital adoption index measuring a country's digital adoption across three dimensions Group (2020). The index covers 180 countries in a composite of DAI (Economy) = DAI (Business) + DAI (People) + DAI (Governments), see World Bank Group (2016).
- (KOF) = globalization index measuring economic, social, and political dimensions of globalization (Dreher, 2006; Gygli et al., 2019; Potrafke, 2015). (KOF) globalization index covers 43 underlying variables (economic, financial, social, cultural, and political globalization aspects) for 203 countries from 1970 to 2016.
- (GCI) = global competitiveness index measuring the country's gap from the competitiveness frontier (Schwab, 2020). The index covers 141 countries, ranking 103 indicators on the scale from 0 to 100, including institutions, infrastructure, ICT adoption, macroeconomic stability, health, skills, product market, labor market, the financial system, market size, business dynamism, and innovation capability.
- (TFP) at Constant National Prices (2011=1) total factor productivity (TFP) levels at constant prices against the reference year, 2011. TFP is the portion of output not explained by the amount of inputs used in production (Feenstra, Inklaar & Timmer, 2015). Total factor productivity derivation methodology is available in the appendix of Feenstra et al. (2015).

Data availability for the digital technology adoption rate at present is for years 2014 and 2016.

Fig. 1 shows digital technology adoption dynamics for EU firms 2009–2018.

From Fig. 1, we can see the digital adoption dynamics across firms in the EU differ by size of firms and type of technology. Large firms in the EU quickly adopt big data analysis in their business, while medium and small firms lag significantly behind. On average, large firms' digital technology adoption rates rise for enterprise resource planning (ERP) software by 16.5%, customer relationship management (CRM) software by 12.3%, and websites allowing online booking/purchase by 7.9%.

Medium-sized firms in Europe catch up (and surpass for ERP software) the digital technology adoption dynamics of large firms. On average, the digital technology adoption rate in medium-sized firms rises for enterprise resource planning (ERP) software by 22.2%,

Table 1
List of countries in the sample.

		country
Afghanistan	Ecuador	Macedonia, FYR
Albania	Egypt, Arab Rep.	Madagascar
Algeria	El Salvador	Malawi
Andorra	Equatorial Guinea	Malaysia
Angola	Estonia	Maldives
Antigua and Barbuda	Ethiopia	Mali
Argentina	Fiji	Malta
Armenia	Finland	Marshall Islands
Australia	France	Mauritania
Austria	Gabon	Mauritius
Azerbaijan	Gambia, The	Mexico
Bahamas, The	Georgia	Moldova
Bahrain	Germany	Mongolia
Bangladesh	Ghana	Montenegro
Barbados	Greece	Morocco
Belarus	Grenada	Mozambique
Belgium	Guatemala	Myanmar
Belize	Guinea	Namibia
Benin	Guinea-Bissau	Nepal
Bhutan	Guyana	Netherlands
Bolivia	Haiti	New Zealand
Bosnia and Herzegovina	Honduras	Nicaragua
Botswana	Hong Kong SAR, China	Niger
Brazil	Hungary	Nigeria
Brunei Darussalam	Iceland	Norway
Bulgaria	India	Oman
Burkina Faso	Indonesia	Pakistan
Burundi	Iran, Islamic Rep.	Panama
Cabo Verde	Iraq	Papua New Guinea
Cambodia	Ireland	Paraguay
Cameroon	Israel	Peru
Canada	Italy	Philippines
Central African Republic	Jamaica	Poland
Chad	Japan	Portugal
Chile	Jordan	Qatar
China	Kazakhstan	Romania
Colombia	Kenya	Russian Federation
Comoros	Kiribati	Rwanda
Congo, Dem. Rep.	Korea, Rep.	Samoa
Congo, Rep.	Kuwait	Saudi Arabia
Costa Rica	Kyrgyz Republic	Senegal
Croatia	Lao PDR	Serbia
Cuba	Latvia	Seychelles
Cyprus	Lebanon	Sierra Leone
Czech Republic	Lesotho	Singapore
Denmark	Liberia	Slovak Republic
Djibouti	Lithuania	Slovenia
Dominica	Luxembourg	Solomon Islands
Dominican Republic	Macao SAR, China	South Africa
Spain		
Sri Lanka		
St. Kitts and Nevis		
St. Lucia		
St. Vincent and the Grenadines		
Sudan		
Suriname		
Swaziland		
Sweden		
Switzerland		
Syrian Arab Republic		
Tajikistan		
Tanzania		
Thailand		
Timor-Leste		
Togo		
Tonga		
Trinidad and Tobago		
Tunisia		
Turkey		
Turkmenistan		
Tuvalu		
Uganda		
Ukraine		
United Arab Emirates		

(*continued*)

Table 1 (*Continued*)

country
United Kingdom
United States
Uruguay
Uzbekistan
Vanuatu
Venezuela, RB
Vietnam
West Bank and Gaza
Yemen, Rep.
Zambia
Zimbabwe

Source: Authors.

customer relationship management (CRM) software by 10.9%, and websites allowing online booking/purchase by 7.2%. Small firms lag behind both large- and medium-sized firms in adoption dynamics, but not by much. On average, the digital technology adoption rate in small firms rises for enterprise resource planning (ERP) software by 16.6%, customer relationship management (CRM) software by 7.2%, and websites allowing online booking/purchase by 4.8%.

Using panel data modeling techniques enabled us to explore the relationship between globalization and digital adoption across countries. This eliminates the potential bias of a time series approach resulting from individual countries or case study selection. The limitations of using panel data modeling lie in the fact that models require a large amount of data, thus limiting the selection of countries based on data availability of digital adoption alone.

A completely different story holds true for cloud computing and big data analysis technology. Large firms successfully adapt to new and complex digital technology with an average increase in the adoption rate of 10.1% for cloud computing and 7.8% for big data analysis. Medium-sized firms lag significantly in adoption dynamics for this type of technology. The average increase in the adoption rate for medium-sized firms is 4.8% for cloud computing and 4.2% for big data analysis. Small firms fall behind large and medium-sized firms dramatically. On average, their increase in the adoption rate for cloud computing is just 1.6% and 1.8% for big data analysis.

Digital technology adoption varies significantly across countries (see Fig. 2). Digitally advanced economies lead the way in digital technology with average adoption rates for selected digital technologies among firms as follows: Netherlands (47.9%), Finland (47.5%), Japan (46.9%), Belgium (45.8%), Denmark (43.9%), Australia (42.5%), and Sweden (41.3%). Countries at the rear are Latvia (18.9%), Korea (18.9%), Hungary (15.5%), Turkey (14.3%).

From Fig. 3, we can see that countries with low digital technology penetration, such as Lithuania and Estonia, have a high demand for digital jobs. The reason lies in the high potential for automatization, especially in CEE countries (Novak et al., 2018). For digitally advanced countries, the share of digital jobs in total employment remains low since digital technology penetration in the finance and banking industry does not present high automation potentials.

Cloud computing is strongly linked to productivity, so that we can see from Fig. 4 annual gain in multifactor productivity due to technology adoption was 0.45%. Associated gain in productivity (2017) from CRM adoption was 0.21%, ERP 0.18%, and high-speed internet 0.19%. Multifactor productivity depends on the type of technology penetration in firms with cloud computing being a winner.

Fig. 5 shows a type of elasticity coefficient for an increase in the digital technology adoption rate by 10%. We can see that the associated increase in multifactor productivity for most productive firms is 1.91% for high-speed internet, 2.02% for CRP, 0.89% for cloud computing, and 1.09% for ERP. However, we can also see that for at least an average productive firm, elasticity coefficients for digital technology adoption is close to unity. Consequently, an increase in digital technology adoption benefits all firms, the most productive as number one.

Barriers to digital technology penetration are numerous and vary significantly across countries (large cross-country differences in barriers to digital adoption). Cross-country differences and barriers affecting digital technology adoption is visible in Fig. 6 (for methodology on digital services trade and restrictiveness index see Ferencz, 2019).

We can observe significant cross-country differences in digital technology penetration barriers. Barriers are a significant limiting factor to digital technology adoption in Argentina, Brazil, Colombia, India, Indonesia, Russia, and Saudi Arabia. The barriers are mainly present in electronic transactions (human capital and regulations), infrastructure and connectivity (high-speed internet), intellectual property rights (lack of protection and absent institutional regulation), and payment systems (highly regulated and high-risk financial systems). Barriers to digital technology adoption are higher in emerging economies like Brazil, India, and Indonesia, with future high growth potentials.

We have learned that digital technology adoption significantly differs across certain types of digital technology, countries, and barriers, and is tightly linked to multifactor productivity.

In this study, we wanted to explore its link to globalization by using the data described earlier. For this purpose, we used panel data modeling techniques.

Table 2 shows the statistical summary of the sample.

Due to limited data availability across time for the digital technology adoption rate (years) and the cross-sectional differences in the panel (difference in the globalization level) the random effects panel data model seems to be the preferred model. We assumed unobserved individual effects (variables left out of the model) in the panel is random and not correlated with regressors.

The panel random effect model takes the form

$$y_{it} = \alpha + x_{it}\boldsymbol{\beta} + \mathbf{z}_i\boldsymbol{\delta} + \alpha_i + \varepsilon_{it} \tag{1}$$

assuming α_i are independent and identically distributed random effects under no time- constant $E(\boldsymbol{x}_{it}^{'}\alpha_i) = 0$ and no time-varying unobserved heterogeneity $E(\boldsymbol{x}_{it}^{'}\varepsilon_{is}) = 0,\ \ for\ \ all\ \ s, t = 1, \ldots, T$ assumptions (Ludwig & Brüderl, 2018).

Table 3 shows the result of the estimated panel random effect model.

Table 3 shows that the levels of globalization and competitiveness have a statistically significant impact on digital technology adoption. The estimated model coefficients are statistically significant at 1% level. We can see that random effect assumptions hold (corr u_i, $X = 0$).

The F-test Baltagi (2013)

$$H_0 : \gamma = 0 \Leftrightarrow H_0 : \mathrm{Cov}(u_i, \mathbf{x}_{it}) = 0 \tag{2}$$

Prob > chi2 = 0.1669 (<0.05) showing all coefficients in the model are different from zero. Two-tail p-values test P>|Z| also validates the results of the F-test. The digital technology adoption rate increases by 0.008 percentage points with a one index point increase in the (KOF) globalization index. With a substantial increase in the globalization level for a country (of 10 index points), the digital technology adoption rate would increase by 0.08 percentage points. The estimated effect would be even larger if more data were available for digital technology adoption across countries. Globalization level impacts the digital technology adoption rate, which increases as a country enters a higher stage of globalization.

The impact of the country's competitiveness on digital technology penetration is also statistically significant and more considerable in extent. For a one index point increase in the GCI, digital technology penetration increases by 0.093 percentage points. That means for a country narrowing the competitiveness frontier (catching up with the competition) by ten index points will increase the technology

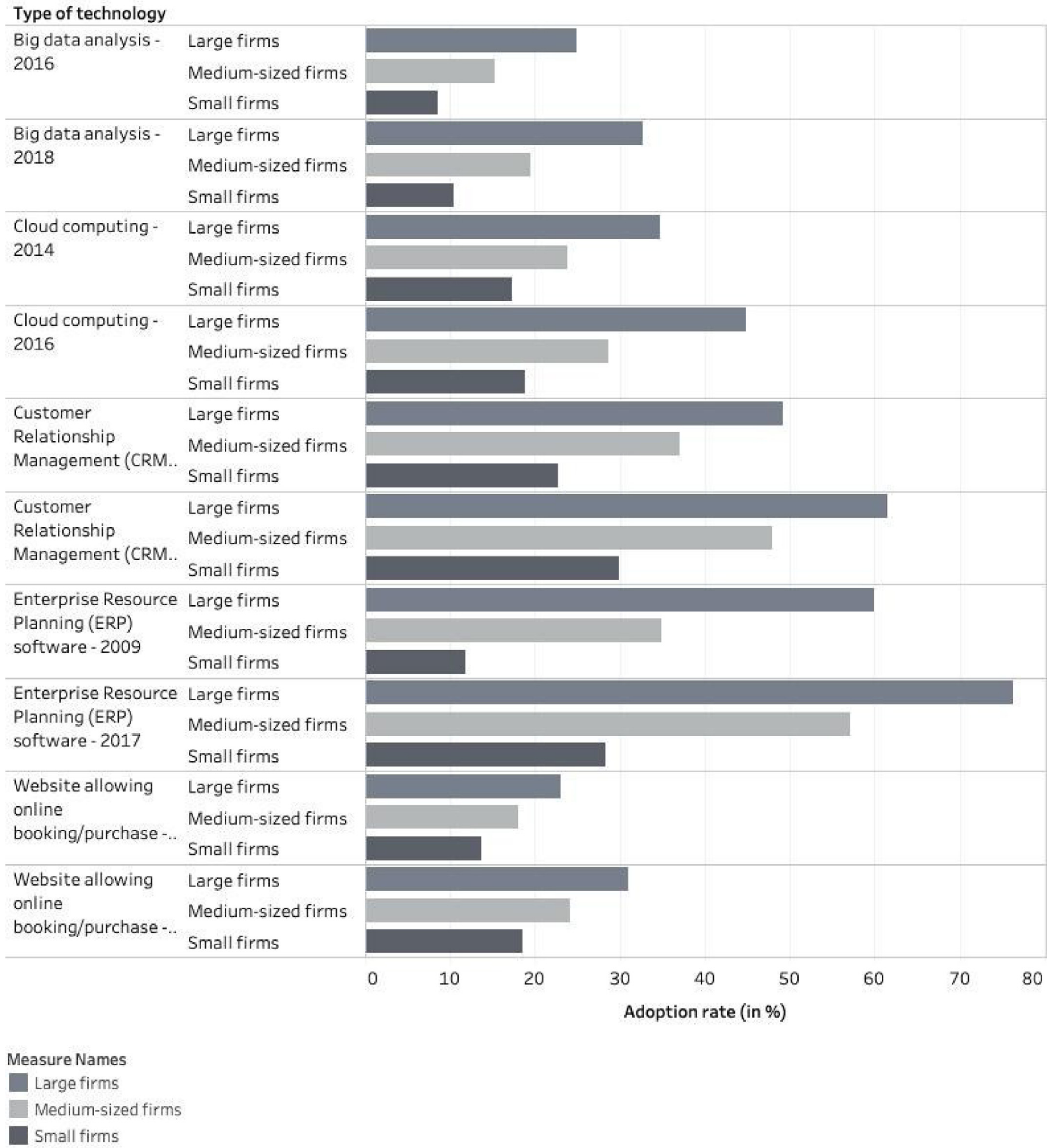

Fig. 1. An adoption rate of selected digital technologies among EU firms 2009–2018 Source: Adapted from OECD, 2019a.

adoption rate by 0.9 percentage points. Competition is good for technology transfer since it stimulates technology spillover.

The effect of the total factor productivity variable on the digital technology adoption rate is not statistically significant in our model, so we do not discuss it. The unobserved effects, variables omitted in the model mirrored in the estimated constant, are statistically significant. Other variables (not identified in our model) influence the digital technology adoption rate. However, our model explains the differences in the countries' digital technology adoption rate at a very high level. The R-squared is 0.802, meaning our model fit can explain 80% of the observed difference in the countries' digital technology adoption.

We use the Hausman test (Hausman, 2015) to prove our estimated model's validity, checked and confirmed by the two-tailed P test and F test.

Table 4 presents the results of the Hausman test in STATA16.

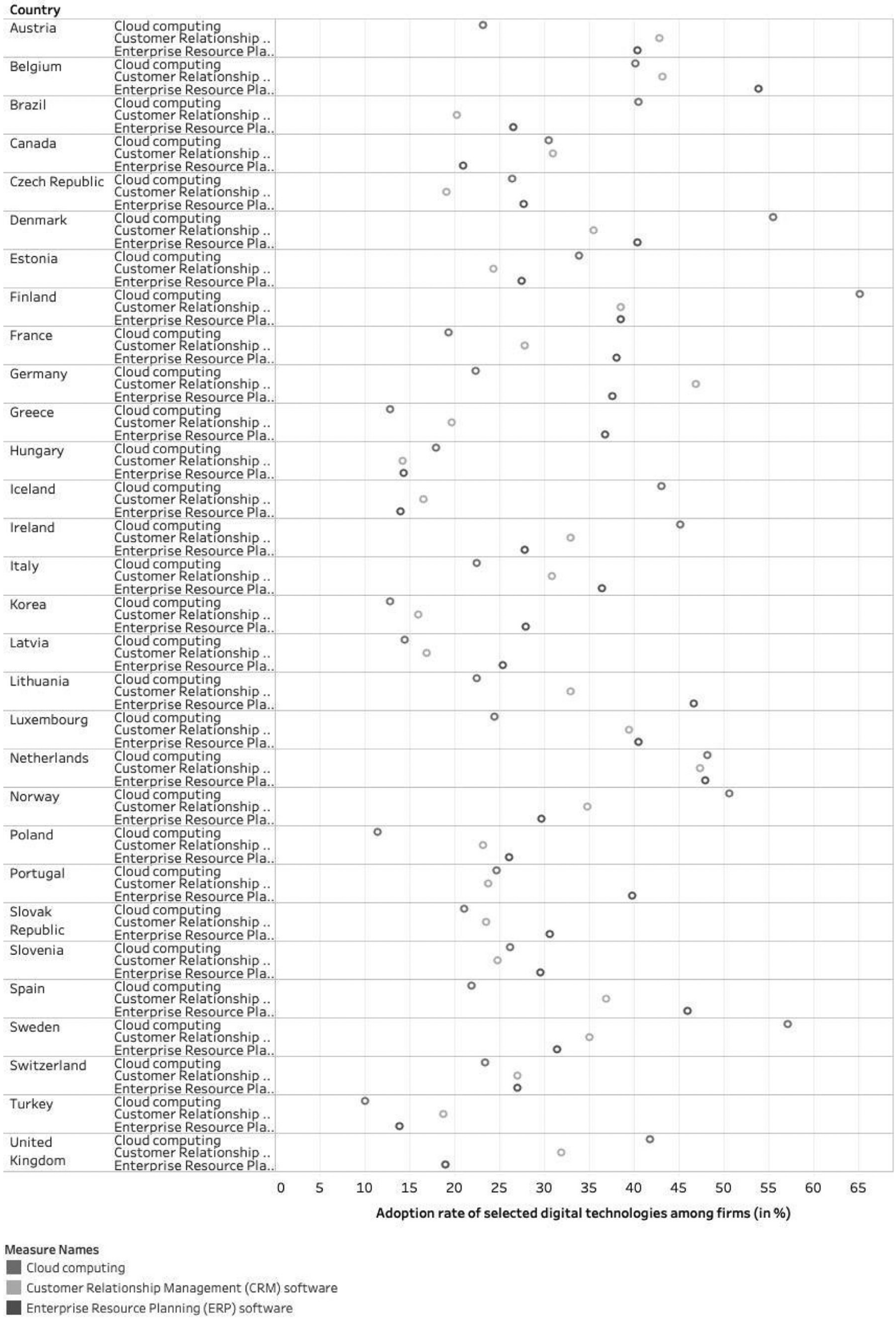

Fig. 2. Digital adoption rate uneven across countries Source: Adapted from Economic Co-operation and Development (OECD, 2019a).

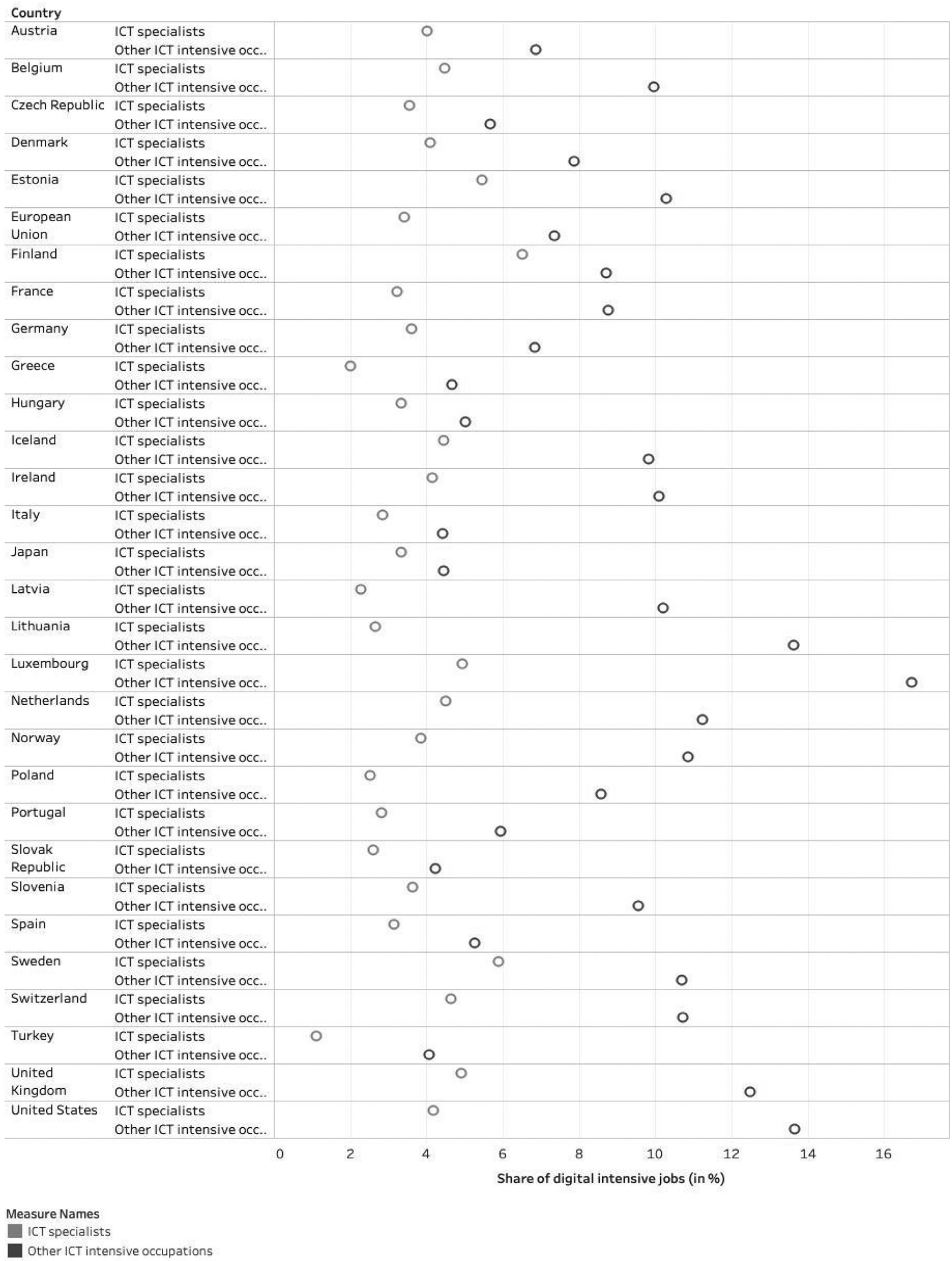

Fig. 3. Share of digital intensive jobs in total employment (in%) Source: Adapted from OECD, 2019a.

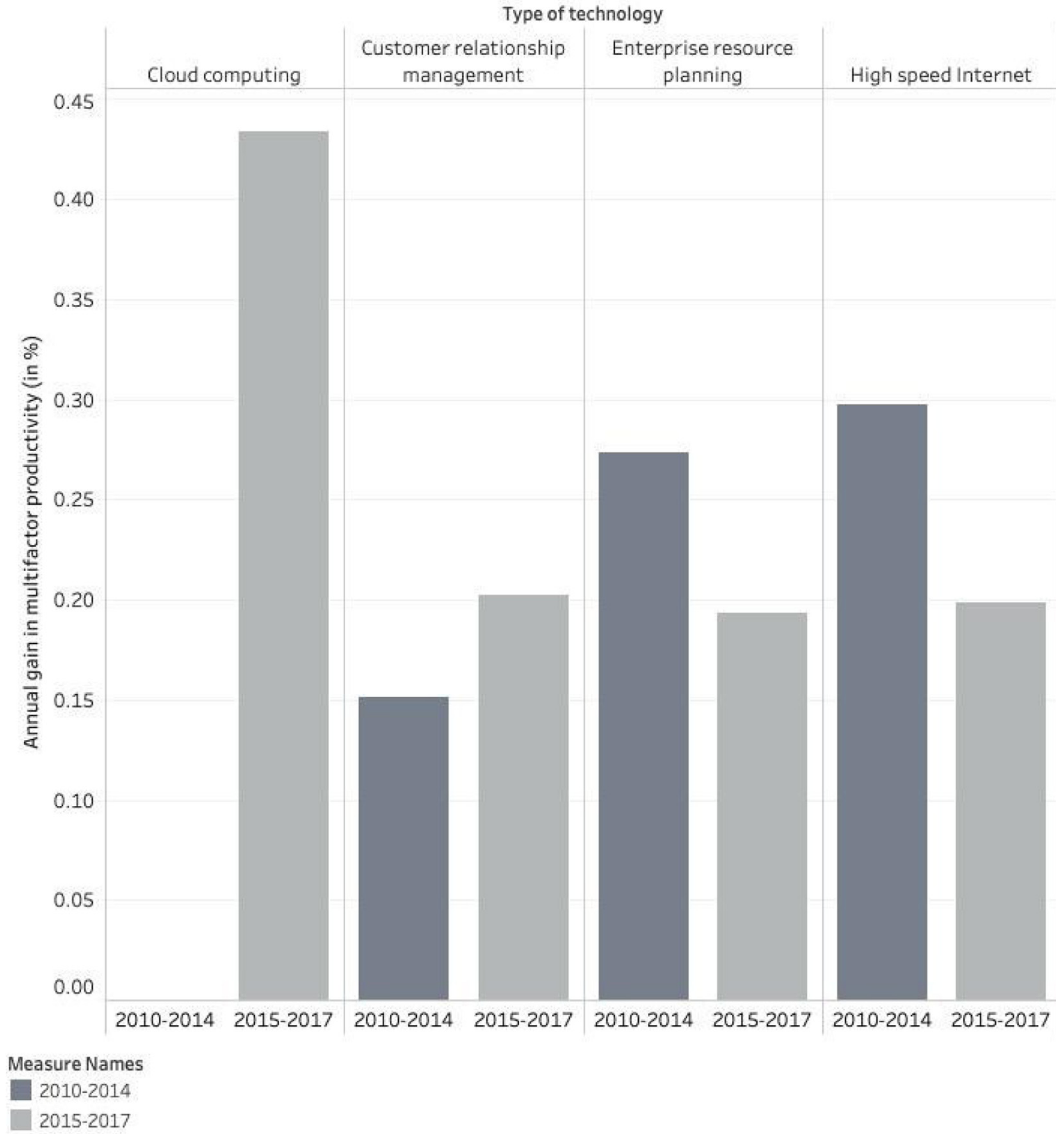

Fig. 4. Adoption of digital technology and productivity in EU 2010–2017 Source: Adapted from Gal, Nicoletti, Renault, Sorbe and Timiliotis (2019).

The Hausman test, under the null hypothesis that the preferred model is a random effect opposite to fixed effect, shows the errors (ui) are not correlated with the regressors (already shown above). We can see that the Hausman test statistics (P-value = 0.149) is not < 0.05 (significant), so accept the null of using a random effect model to estimate globalization's impact on digital technology adoption. The Hausman test results validate our model fit.

Results

Limited empirical study results on the impact of globalization on digital technology penetration exist. A study by Fatima (2017) shows trade openness and foreign licensing agreements are essential determinants for technology transfer. The sample included 30 emerging and developing economies. Research by Meschi et al. (2011) found that imports from industrialized economies benefit innovation diffusion on a sample of 88.561 firms in Turkey. Technological imports from technologically progressive countries benefit local firms' productivity and technology adoption (Bilgin, Lau & Demir, 2012). World Economic Outlook (2018) showed technology and knowledge diffusion across countries are intensified due to increasing globalization. That is particularly the case in emerging market economies. They looked at 45 advanced and emerging market economies across different sectors and patent flow as a technological variable. Our study is the first to our knowledge to use comprehensive globalization (KOF index) and digital technology adoption (DAI index) to study the link between globalization and digital technology transfer.

We found a causal relationship between globalization level and digital technology adoption (one-way Granger cause link). Technology transfer over globalization impacts innovation, so we could be looking at a two-way Granger cause link. Running a random effects panel model on KOF, we estimate (results not presented here due to space constraint) that DAI affects both global competition (measured by the GCI index) and globalization level (measured by the KOF index). Thus, we provide evidence for the two-way Granger cause link between globalization-digital technology and adoption-global competition. Digital technology penetration is a crucial mechanism by which globalization affects global competition and, consequently, innovation.

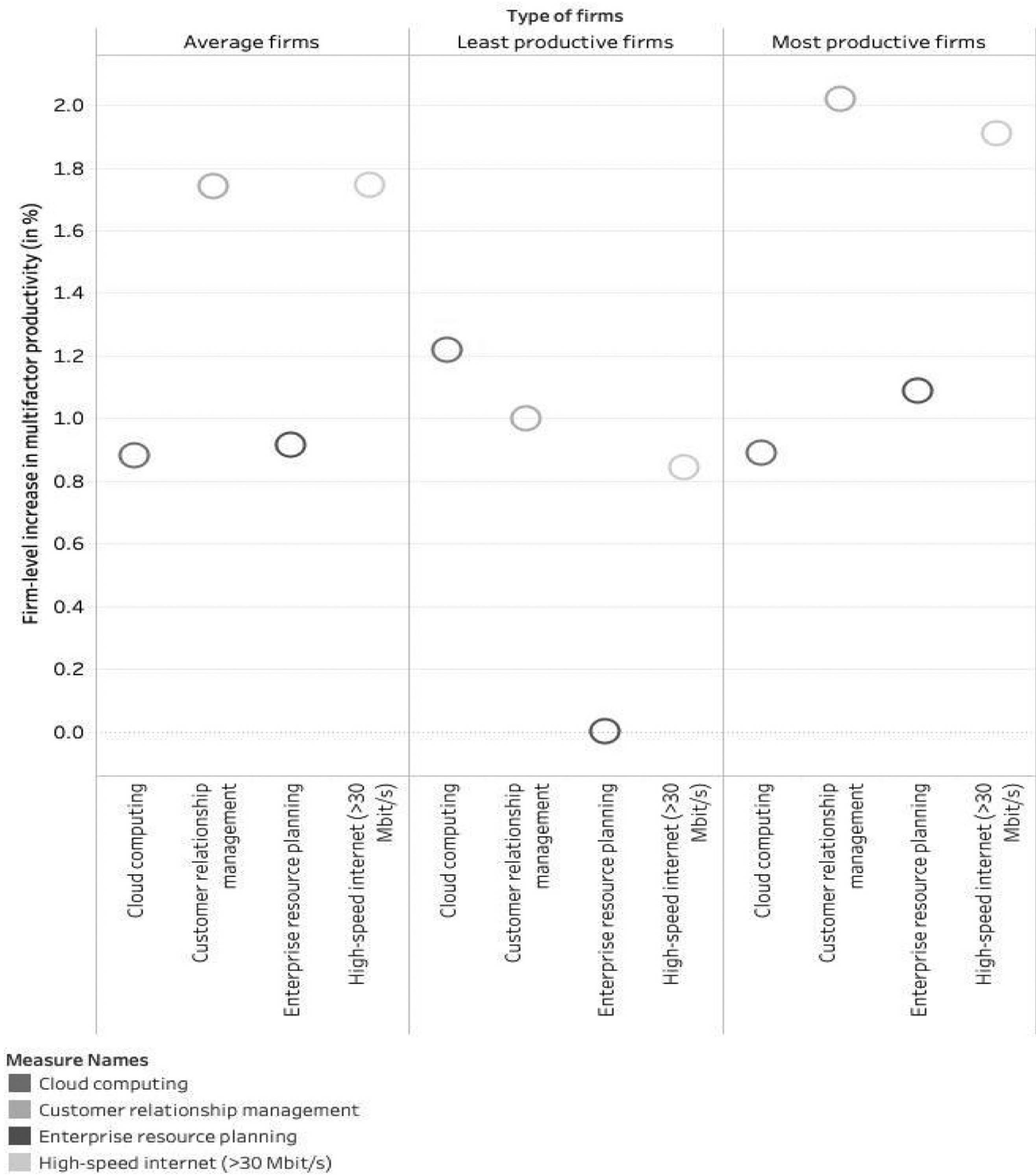

Fig. 5. Firm-level increase in multifactor productivity and digital adoption in the EU Source: Adapted from Gal et al. (2019).

Countries with a high level of globalization have intensive digital technology penetration, improving their competition, productivity, and innovation. Differences in digital technology adoption across countries mirror differences across countries in the level of globalization. Our study provides strong empirical evidence on globalization as a critical factor for digital technology transfer and adoption. Future research is needed to explore and explain the transmission channel between globalization and digital technology adoption on firm-level data. The level of globalization is associated with a lower barrier to digital technology adoption since local firms pressure government and local markets to lower barriers to technology transfers. Globalization lowers technology barriers, benefits digital technology transfer, and adopts pressing global competition and forces local firms to innovate, thus driving multifactor productivity. Globalization is a necessary, but not sufficient, condition for digital technology penetration. We need more country-level and firm-level studies to explore

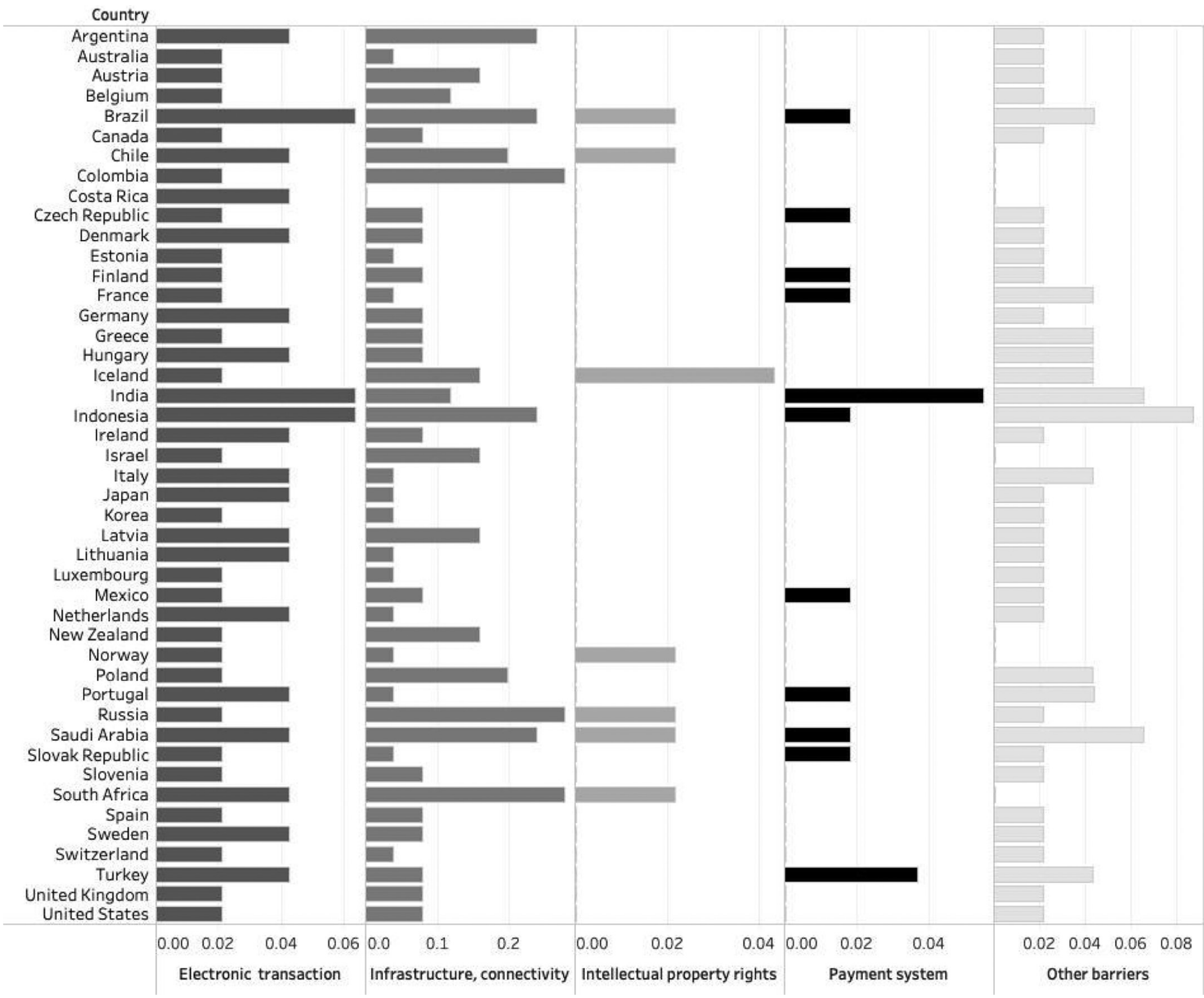

Fig. 6. Barriers to digital technology adoption Source: Adapted from OECD (2018).

Table 2
Sample descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
dai	366	.5	.194	.139	.871
kof	364	63.026	14.483	5	91.3
gci	278	4.217	.669	2.79	5.76
tfp	226	1.01	.091	.62	1.31

Source: Authors' calculation with STATA 16.

Table 4
Hausman (2015) specification test.

	Coef.
Chi-square test value	5.339
P-value	.149

Source: Authors' calculation with STATA 16.

Table 3
Random effect regression results.

dai	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
kof	.008	.001	9.08	0	.006	.01	***
gci	.093	.017	5.39	0	.059	.127	***
tfp	−0.017	.065	−0.26	.795	−0.144	.11	
Constant	−0.374	.081	−4.61	0	−0.533	−0.215	***
Mean dependent var		0.591	SD dependent var			0.170	
Overall r-squared		0.802	Number of obs			206.000	
Chi-square		443.124	Prob > chi2			0.000	
R-squared within		0.002	R-squared between			0.818	

Source: Authors' calculation with STATA 16.
*** p<.01, ** p<.05, * p<.1.

the nature behind globalization and the digital technology adoption mechanism. Our study is the first step in this process.

Conclusion

Globalization is a key channel by which digital technology penetration affects innovation, but not the only one. Globalization, for example, also has a critical impact on global competition and multifactor productivity. We have provided empirical evidence using the random effects panel data model for 183 countries on globalization Granger-causing digital technology adoption across countries. Our study is the first to our knowledge to use multidimensional and complex variables for globalization (KOF index), global competitiveness (GCI index), and digital technology adoption (DAI index) in a single study. Digital technology adoption rates across countries reflect differences in the level of globalization internationally.

Our study has been limited by the digital technology adoption rate index's data availability, which is only available for several years across 183 countries. However, the index represents the best quality dimension indicator to measure a country's digital technology adoption dynamics. Restricted data model selection is also limited, not permitting us to apply more advanced panel data econometric methods.

The research undertaken in this paper suggests that globalization is a critical factor in the penetration and diffusion of digital technologies. This research proves the effectiveness of most aspects of the research model developed in Section 3. However, the results indicate that globalization and the digital technology adoption link in the research model are not as pronounced as stated. The reason lies in the limited data availability over time for the DAI. Our model explains about 80% of the changes in digital technology adoption and globalization's impact, even with this limitation. Future theoretical work is required to develop this research model further.

The study shows that globalization is a tool for lowering technology transfer barriers and for helping boost innovation and productivity. The self-reinforcing mechanism behind globalization and digital technology adoption lead policymakers and practitioners to view globalization as a source of competition and as a determinant of productivity. Globalization directly affects technology adoption, which increases innovation and productivity, and therefore competitiveness and globalization (strong Granger causality).

Future research should attempt to expand this study. Adding more variables to the equation would allow future researchers to employ more advanced panel data econometric techniques and improve the model's overall fit. The best fit is apparent, with a substantial likelihood to be accurate. However, for the remaining 20 percent, we still need to develop the theoretical model (including new variables) and search for a more pronounced impact of globalization. The one we have found in our study is statistically significant, but we are sure that it is even more extensive than the estimated parameters we have displayed here. The main limitations of our study lie in the limited data availability (digital adoption index) and impossibility to use more advanced panel data modeling (dynamic panel data modeling).

Countries seeking to increase economic growth through a rise in multifactor productivity through innovation should engage more in globalization processes. That will boost technology and knowledge transfer, increase the digital technology adoption, rising globalization and development.

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