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DISCUSSION PAPER SERIES

IZA DP No. 17495

Regionalism, Productivity, and Innovation

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DECEMBER 2024

ISSN: 2365-9793

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ABSTRACT

Regionalism, Productivity, and Innovation

In this paper, we examine whether, and if so how, an economy's deliberate policy choices of regional cooperation and integration influence underlying determinants of economic growth. Building on models of growth and innovation, we analyze the role of regional integration on labor productivity and firms' probability to innovate using data from a panel of 170 economies and 60,000 firms over a period of two decades. Our results suggest that regionalism, as captured by metrics of regional cooperation and integration, can positively contribute to labor productivity and innovation, in addition to known factors of production.

JEL Classification: F02, F15, O4, O30

Keywords: regional integration, productivity, innovation, Asia

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I INTRODUCTION

In the political and economic literature, regional cooperation and integration (RCI) is generally viewed as effective in deterring conflict through the promotion of economic development through exchanges and cooperation initiatives (Viner 1950; Vicard 2012). This tenet has underpinned international efforts to create formal economic and institutional ties such as the European Union (EU) and European Free Trade Agreement zone (Henrekson et al. 1995), the North American Free Trade Agreement, the Latin American Free Trade Agreement (Brada and Mendez 1988), and the Belt and Road Initiative (Zaman et al. 2021), to name but a few of the initiatives. Progress in RCI is generally associated with economic growth, financial stability, and social inclusion. In turn, this contributes to tackling poverty and enhancing institutional credibility.

Notwithstanding that RCI results from deliberate institutional arrangements among partnering economies, typically over a long period of time, their influence on the determinants of growth is often overlooked in empirical analyses. Empirically, if their omission is a possible source of bias, their inclusion is typically implemented by performing separate regressions on data partitioned by supranational groupings (e.g., Brada and Mendez 1988) or by adding region-specific dummies (e.g., te Velde 2011). In both cases, the influence of complex processes of regional integration disappears as it becomes overly fragmented when the determinants of growth are analyzed through separate regression; or it is buried in the aggregate coefficients of regional dummy variables.

This paper aims to investigate, both at the macro- and the firm-level, the influence of regional integration processes by considering formal indicators of RCI in empirical growth models that focus on productivity. In particular, it addresses the following questions:

1. Does regional integration matter to explain underlying fundamental determinants of growth such as labor productivity and firms' probability to innovate?
2. Do different types of linkages such as trade and investment agreements, mobility of workers and people, and technological connectivity produce uniform effects, if at all, on productivity and innovation?
3. Do international links reflecting spatial relations (e.g., geographic proximity) and economic integration yield similar results?

Answering these questions appears not only relevant to recover the empirical significance of historical choices that have been tying some economies to each other but also to inform policy makers at national and supranational level about the impact of their choices to foster, and at times to reduce, regional integration. Our analysis makes use of national-level data (e.g., productivity per worker, R&D expenditure) and firm-level data (e.g., firms' innovation activity) on an unbalanced panel of about 170 economies over the decade 2010–2021, and on pooled cross-sectional firm-level data of about 60,000 firms surveyed in the same economies in the same decade.

Information on regional integration is obtained from the Asian Development Bank's Asia-Pacific Regional Cooperation and Integration Index (ARCII). Introduced in 2017 (Huh and Park 2017) and extended in 2021 (ADB 2021), the ARCII framework tracks progress in eight dimensions of regional cooperation and integration through 41 indicators. The composite index assesses different channels of regional integration along two distinct dimensions: (i) physical geography, as in the case of regional integration measured across economies in Africa or Latin America; and (ii) institutional and economic choices, for the regional integration of economies that are members of blocs such as the European Union or, in Asia, the Association of Southeast Asian Nations (ASEAN), South Asan Association for Regional Cooperation (SAARC), or Brunei Darussalam–Indonesia–Malaysia–Philippines East ASEAN Growth Area (BIMP-EAGA).

The analysis thus comprises four sets of results that capture data at levels of either the economy or the firm, and whether regional integration is measured according to geography or political-economic settings. It combines for the first time economy metrics of progress in RCI with firm-level outcomes related to economic development. Overall, RCI indicators emerge as relevant explanatory variables of varying influence depending on the indicator considered and its metric of reference (e.g., convergence with respect to a geographic or economic/institutional aggregation): in general, the ARCII dimensions capturing investments in infrastructure and technology, and the vicinity of firms belonging to the same value chain positively contribute to labor productivity and innovation, while financial and monetary integration typically do not. Substantial variations across regions also clearly emerge. The results invite the inclusion of empirical institutional choices in analyses of economic growth and support institutional efforts—especially data collection—that are focused on closer regional cooperation.

The rest of the paper is organized as follows: Section II provides a brief literature on the role of regional integration in economic development and growth. Section III presents a simple theoretical model to frame the link between productivity (or innovation) and its underlying determinants, including the choice to integrate regionally. Section IV introduces the data sources and the working samples. Section V discusses the empirical strategy, presents the baseline results and some extensions, while Section VI tests for the robustness of the results. Section VII offers some concluding remarks.

II LITERATURE

Regional integration is the focus of two broad literature streams. The first is firmly based on the field of political economy (Schmitter 1970; Laursen 2008; Schneider 2017; de Lombaerde 2024). It maps socioeconomic and interest groups, and their incentives in supporting regional integration. The basis of this research is the work of Viner (1950), who suggests that trade agreements (customs unions) are supported when they generate economic benefits that promote rather than divert trade opportunities. Regional integration can lead to better terms of trade (Collier 1979), lower uncertainty, transaction costs (Mundell 1963), financial risk (Haas 1958), and generate spillovers for the common budget (Casella and Frey 1992). These benefits, and realization of the disadvantages for being left out (Baldwin and Venables 1995), may in turn prompt other economies to seek better economic integration within their respective regions (Baccini, Dür, and Elsig 2015).

This literature notes that export-oriented economies and highly productive firms benefit more from regional integration (Milner 1997; Manger 2009; Baccini et al. 2016), while the effects on consumers are unclear (Slaughter 2001; Kono 2008; Hainmueller and Hiscox 2006; Hobolt and de Vries 2016).[1]

[1] Governments tend to support regional integration to ensure political stability and national security (Lake and Morgan 1997) and gain stronger bargaining power in international organizations such as the World Trade Organisation (Mansfield and Reinhardt 2003).

The study of RCI is particularly advanced in Asia, where its relevance is debated amid the region's rapid economic growth and in the context of other regional integration initiatives, in particular the European Union (Soesastro 2006; Webber 2010; Taghizadeh-Hesary et al. 2020; Albis, Kang, and Tayag 2024). Incentives to lift income per capita form a strong pull lever to pursue closer regional integration for Asian economies, despite their heterogeneity (Feng and Genna 2003; Moon 2017). Examples are large cross-border infrastructure investments (Francois, Manchin, and Pelkmans-Balaoing 2009) and tighter collaboration within subregional initiatives such as: ASEAN (Cockerham 2010; Mikic and Jetin 2016; Jetschke and Murray 2020), BIMP-EAGA (Yussof and Kasim 2003; Dent and Richter 2011), and the Indonesia–Malaysia–Thailand Growth Triangle (IMT-GT) (Pomfret and Das 2013), in Southeast Asia; South Asia Subregional Cooperation (SASEC) (Thangasamy 2019) and SAARC (Banik and Gilbert 2010; Kher 2012; Razzaque and Barnett 2014) in South Asia; Central Asia Regional Cooperation (CAREC) in Central Asia (Pomfret 2009); ASEAN+3 (ASEAN plus the People's Republic of China, Japan, and the Republic of Korea in East Asia (Goto and Hamada 1994; Cai 2010); the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) (Batra 2010); and the Greater Mekong Subregion (GMS) initiative (Menon 2007; Tan 2014).[2]

A second stream of research focuses on the economics of regional integration as a tool for development across economies (Baldwin and Venables 1995; de Melo and Panagariya 1995; Vamvakidis 1998; Schiff and Winters 2003) and within economies (Ke 2015). Many of these analyses focus on trade effects, as regional integration often begins

[2] Despite the economic benefits achieved, there is broad agreement in viewing regional integration across Asia as only a long-term process (Roland-Holst, Verbiest, and Zhai 2005; Sally 2010; Webber 2010; de Grauwe and Zhang 2016).

with trade agreements aimed at reducing trade costs (Lee and Shin 2006; Carrere 2006).[3] Benefits also cover higher inflows of foreign direct investments to access a larger regional market (Motta and Norman 1996; Buethe and Milner 2008), and the stock market performance of listed companies (Bechtel and Schneider 2010).

With reference to economic growth, a positive association with regional integration is normally found (Rivera-Batiz and Romer 1991; Henrekson et al. 2005; Ventura 2005; Zaman et al. 2021; Nasir and Gollagari 2020). Some studies suggest regional integration can be linked to higher development outcomes (Avendano, Natividad, and Tolin 2024) and lower income inequality across the newly integrated nations (Campos, Coricelli, and Moretti 2022), though the results for income inequality are less conclusive (ADB 2021). This literature also explores whether growth from regional integration leads to income convergence among member states (Marelli 2007; te Velde 2011).[4] The results point to the existence of a trade-off between the benefits for more economically integrated economies and the equity of how they should be apportioned among and within partner economies (Pina and Sicari 2021).[5]

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[3] These effects are found to be positive and large (e.g., increases of more than 30%—Baier and Bergstrand 2007; Geldi 2012), though their magnitude depends on the econometric specification used (Stack 2009; Stack and Pentecost 2011), especially when integration takes the form of a customs unions rather than partial agreements (Kucik 2015) and the regional agreements can be implemented fully or only partly (Haftel and Thompson 2013).

[4] In general, this seems to be the case (Jones 2002; Kutan and Yigit 2007) though divergence is also possible for overly heterogeneous economies and not sufficiently specialized: This could be the case with integration among countries with relatively low levels of income, in which the economy with the lowest income is always better off if it trades beyond its region because it can enjoy the benefits of global, rather than local, gains from trade (Venables 2003). Countries relatively more specialized in higher value productions instead are predicted to benefit the most from regional, as opposed to global, cooperative agreements. Divergence in growth paths can occur also within a economy participating in a regional trade agreement, as the benefits from trade post-integration would overwhelmingly flow to more specialized areas, which now enjoy a larger market (Cuadrado-Roura 2001; Giannetti 2002; Gammadigbe 2021).

[5] The concept of club convergence has extended from income to other areas such as trade and investment, financial openness (Kumari et al. 2018), institutional development (Glawe and Wagner 2021) or learning outcomes. For instance, Glawe and Wagner (2021) the existence of institutional convergence across EU members.

In regard to Asia's regional integration, part of the literature using simulations from computable general equilibrium models suggest that Asia's regional integration is associated with increased volumes of international trade (Jayanthakumaran and Verma 2008) and inflows of foreign direct investments (Nwosu et al. 2013; Erten and Leight 2021), as well as higher economic growth (Wilson and Otsuki 2007; Bong and Premaratne 2018; Shah 2021) and lower income inequality (Yap 2014).

Within both literature streams, there is limited research on the effect of regional integration on labor productivity and innovation, as these tend to be studied independently of institutional shocks such as greater regional integration. Existing work lends empirical support to the hypothesis that the link between closer economic integration and labor productivity is positive (Johansson 2001; Gambardella, Mariani, and Torrisi 2009; Campos, Coricelli, and Franceschi 2022), as is the link between closer economic integration and higher rate of innovation (Rivera-Batiz and Romer 1991; Liu and Qiu 2016; Liu and Ma 2020).

III THEORETICAL MODEL

Labor Productivity

We study the relationship between labor productivity (innovation) and regional integration with the help of a theoretical model to better identify the parameters of interest and the methodology used suited for estimation. We adopt the approach of Piva, Tani, and Vivarelli (2018) to extend their model of knowledge transfer, which is in turn based on Hall and Mairesse (1995). The model analyses the bundle of goods and services produced by of economy *j*, which at time *t* generates value added Y_{jt} according to the production function:

$$Y_{jt} = AC_{jt}^{\alpha}L_{jt}^{\beta}\left(\sum_r K_{rjt}^{\gamma_r}\right)e^{b_{j0}+\delta G_{jt}+\lambda t+\varepsilon_{jt}} \quad (1)$$

where C_{jt} and L_{jt} are the national input of physical capital and labor, respectively, and $K_{rjt}^{\gamma_r}$ represents the level of productive knowledge available to the economy via activity *r*: K_{rjt} includes knowledge-enhancing activities like R&D expenditures, international cooperation and the exchange of ideas through migration and short-term labor movements, technology transfers related to foreign direct investment (FDI), and international trade in goods and services, among others (noting that some activities can be related back to initiatives aimed at strengthening regional integration such as closer institutional links for technology transfers or collaboration on environmental matters). The parameter γ_r represents the proportional increase in productive knowledge resulting from the rth activity (r = 1, 2, …). Finally, the last factor captures other productivity drivers, including an initial economy-specific level of value added bj0, an economy-specific set of initiatives G_{jt} that strengthen regional integration but only indirectly affect productivity (e.g., joint supervision on financial transfers), a deterministic time trend λt representing the exogenous growth of the global technological frontier (λ being the rate of disembodied technical change), and an idiosyncratic error term ε_{jt}.

Transforming (1) in logarithmic form and rearranging it to measure output per employee yields the following:

$$y_{jt} - l_{jt} = a + \alpha(c_{jt} - l_{jt}) + \gamma_1(k_{1jt} - l_{jt}) + \gamma_2(k_{2jt} - l_{jt}) + \cdots + (\alpha + \beta + \gamma_1 + \gamma_2 + \cdots \gamma_{r-1} - 1)l_{jt} + \gamma_r k_{rjt} + \cdots + b_{j0} + \delta G_{jt} + \lambda t + \varepsilon_{jt} \quad (2)$$

where: *y, l, a, c* and k_r represent natural logarithms of *Y, L, A, C*, and K_r.

Empirically, we focus on the estimates of the parameters $\sum_r \gamma_r$ and δ to assess the role of the various forms in which institutional and business decisions advancing regional integration affect labor productivity (output per employee). We hence estimate the specification:

$$\ln\left(\frac{Y}{E}\right)_{jt} = constant + \alpha \ln\left(\frac{C}{E}\right)_{jt} + \gamma_1 \ln\left(\frac{K_1}{E}\right)_{jt} + \cdots + \left(\alpha+\beta+\gamma_1-1\right)\ln(E)_{jt}$$

$$+ \gamma_3 \ln\left(\frac{X+M}{GDP}\right)_{jt} + \gamma_4 \ln\left(\frac{FDI}{GDP}\right)_{jt} + \gamma_5 \ln\left(\frac{BV}{Pop}\right)_{jt} + \gamma_{reg}K_{reg} + b_{j0} + \delta G_{jt} + \lambda t + \varepsilon_{jt} \qquad (3)$$

with: *j* (economy) = 1,…, 172; *t* (time) = 2006,…2021; *reg* = indices of regional integration directly influencing labor productivity; ln = natural logarithm.

Productivity is measured by labor productivity (Output *Y*, over total Employment *E*), while the control impact variables are the physical capital stock (*C*) per employee, the R&D stock (*K* for knowledge) per employee, and the variables for trade, foreign direct investment, and mobility intensity (i.e., import plus export over GDP, foreign direct investments over GDP, and volume of air travelers over population).[6]

The measure of our key impact variables are the coefficients of regional integration γ_{reg}, which represent the direct influence of indicators K_{reg} on labor productivity through regional trade and financial agreements, infrastructure investments, measures to ease peoples' movement, and technological and digital connectivity, and the coefficient δ, which represents the indirect effect of indicators G_{jt} on productivity via other regional

[6] Since we do not adjust these macroeconomic indicators by employee but instead by national GDP and population, we do not add γ_3, γ_4, and γ_5 to the coefficient ($\alpha+\beta+\gamma_1-1$). This is the reason why we isolated K_{rjt} in equation (2).

institutional agreements, co-location of firms in the same value chains, and environmental agreements (see also Section IV, Data).

Taking values per employee permits both standardization of our data and elimination of possible economy size effects. In this framework, total employment (*E*) is a control variable: in case $(\alpha + \beta + \gamma_1 - 1)$ turns out to be smaller than zero, as is often the case (e.g., Piva, Tani, and Vivarelli 2018), it indicates decreasing returns in the labor input.

As it is common in this literature (Hall, Mairesse, and Mohnen 2009; Heshmati and Kim 2011; Kumbhakar et al. 2012; Mohnen and Hall 2013; Ortega-Argilès, Piva, and Vivarelli 2014, 2015), stock indicators should be considered as impact variables instead of flows. Indeed, productivity is affected by the accumulated stocks of different inputs and not only by volatile current or lagged flows. Furthermore, dealing with stocks has two advantages: first, since they incorporate the accumulated investments in the past, the risk of endogeneity is minimized; second, there is no need to deal with the complex and arbitrary choice of the appropriate lag structure for the flows.[7]

Innovation

Equation (3) is informative about the influence of regional integration on productivity at an aggregate, national level, but it does not shed light on decisions made by the agents of that economy. To do so, we focus on firms' decision to innovate and extend the partial equilibrium model discussed in Okara et al. (2023), which draws from Gray (2020). We

[7] The stocks are computed following the Perpetual Inventory Method (PIM):

$$Q_{t0} = \frac{INV_{t0}}{(g + \delta)}; \quad Q_{t1} = Q_{t0}(1 - \delta) + INV_{t1}$$

where *Q* is the stock, *INV* measures the investment flow, δ is a depreciation rate (6% for capital stock; 15% for knowledge capital stock[7]) and *g* is computed as an 'ex post' three-year compound growth rate.

can view equation (1) as describing the aggregate output produced by i = 1….Mj firms in each j domestic economy at a given time t. We can then focus on each *i* firm's demand for *s*, a generic production factor (e.g., skilled labor as in Okara et al. 2023) to produce output Z^i, by representing as:

$$c_S^i(A^i, W)Z^i \tag{4}$$

where c_S^i is the unit requirement of generic factor *s* for firm *i*, which depends on the vector of factor augmenting technologies A^i and the vector of domestic factor prices *W*. In equilibrium the demand for factor *s* across the M_j firms in economy *j* equals its supply, so that:

$$S_j = \sum_{i=1}^{M_j} c_S^i\left(A^i, W\right)Z^i \tag{5}$$

We model regional integration as a set of actions that have the potential of raising the supply of factors available to domestic firms, and hence as $dS_j \geq 0$, acknowledging that some intra-regional initiatives may produce only dS_j = 0.

From equation (6), we trace the domestic partial equilibrium response to a positive shock to S_j due to regional integration by total differentiation:

$$dS_j = \sum_{i=1}^{M_j} Z^i c_{SA^i}^i\, dA^i + \sum_{i=1}^{M_j} c_S^i\, dZ^i + \sum_{i=1}^{M_j} Z^i c_{SW}^i\, dW \tag{6}$$

where $c_{SA^i}^i$ is the response of firm *i*'s unit requirement of factor *s* with respect to that firm's production technologies A^i, and c_{SW}^i is a vector of cross-price derivatives of the unit requirement of factor *s* with respect to domestic factor prices.

Equation (6) suggests that the increase dS_j > 0 in the supply of factor s following closer regional integration is absorbed by changes in: (i) the demand for s, when firm *i* adjusts its technology (dA^i), with likely innovations in its production process; (ii) the firm's output (dZ^i), which can occur through new or higher quantities of the current products; and/or (iii) domestic factor prices (dW), which can enhance or reduce the incentives for more innovation depending on whether the increase in factor *s* due to regional integration lowers or increases its domestic relative price.

This simple, partial equilibrium framework yields a straightforward relation between the innovation activity of each firm i and the choices leading to regional integration, which can be empirically tested with the Linear Probability Model:

$$Innov_{ijt} = a_0 + X_{ijt}a_1 + K_{jt}a_2 + R_{jt}a_3 + j_j + t_t + \varepsilon_{ijt} \quad (7)$$

where *Innov* is a binary indicator of innovation activity for firm *i* in economy *j* at time *t*, X_{ijt} is a vector of firm-specific characteristics affecting innovation activity (investment in R&D, holding international patents, firm size), K_{jt} is a vector of economy-level characteristics influencing innovation activity (international trade, labor mobility, capital inflows), and R_{jt} is a set of regional integration indicators. The variables *j* and *t* represent vectors of economy and year fixed effects, and ε_{ijt} is a vector of unobserved characteristics affecting firms' innovation activity.

The parameters of interest are estimated by a_3, which is the influence of regional indicators activity on firms' probability to innovate.

IV DATA

To empirically test specifications (3) and (7), we use economy- and firm-level data as follows:

1. *Labor productivity*. We use national-level indicators measured by output per worker using GDP in constant 2017 international US and ILO estimates on hours worked.

This economy-time sample covers the decade 2012–2022 and is sourced from the International Labour Organization.[8]

2. *Regional integration*. Data is sourced from the Asian Development Bank's ARCII project. The ARCII provides subindexes of regional integration for 2006–2021 on 173 economies, including eight dimensions: trade and investment; money and finance; regional value chain; infrastructure and connectivity; people and social integration; institutional agreements; technology and digital connectivity; and environmental cooperation.[9] These subindexes are derived through principal component analysis (PCA) from a wider set of 41 indicators. Integration is generally measured with respect to a regional space identified by physical geography (e.g., each African economy with the rest of Africa). For Asia, the framework also provides complementary measures of integration within regional cooperation initiatives (i.e. intrasubregional) such as ASEAN, SAARC, and GMS. Hence, the empirical analysis presents results obtained from indicators based on physical geography and for Asia 'economics' too, which are hitherto referred to as 'geography' and 'economics'. The analysis also uses the logarithm rather than the actual value of each of the eight aggregate indicators to interpret its coefficient as a percentage change from the mean value rather than the effect of a well-defined (as opposed to PCA-related) variable.
3. *Firms' innovation activity*. Data is sourced from pooled cross-sectional database covering 2011–2019—the World Bank Enterprise Survey (WBES)—and reported as a binary variable equal to 1 if a firm has introduced either a new product/service

[8] https://ilostat.ilo.org/topics/labour-productivity/# - code GDP_211P_NOC_NB_A.
[9] See (https://aric.adb.org/database/arcii).

over the last 3 years or/and a new process and 0 otherwise.[10] We create a new variable for innovation activity that is equal to 1 if any type of innovation has been developed, and zero if neither a new product/service nor process has been introduced. The survey has a wider collection, and there is a broad positive relation between the number of firms and the economy's population size, as illustrated by the proportions reported in Table 1: firms based in India account for almost 17% of the total number of firms in WBES. Firms in other large economies like Nigeria, the People's Republic of China (PRC), Bangladesh, and Indonesia account for about 2.4%–4% of the sample. Similar proportions belong to economies where firms have been surveyed more than 1 year, like Argentina and Colombia.

4. Control variables influencing either labor productivity or innovation activity, such as national expenditures of R&D, gross fixed capital formation, capital inflows, exports and imports, GDP, the volume of air travel passengers, employment, and population. This information is available from the World Bank Development Indicators (WDI) database.[11]

With the information above we generate two working samples. The first is a panel sample of observations at the national level that includes labor productivity, the ARCII dimensional indexes and various control variables for 2012–2021.[12] Table 2 reports the unconditional means and standard deviation of observations organized by geography (world ex-Asia, Asia (geography)) and economic groups (Asia (economics)) to illustrate

[10] This measure is respectively sourced from question h1: "*Have you introduced new products or services over the last 3 years?*" and question h5 "*During the last 3 years, has the establishment introduced a new or significantly improved process*?". See http://www.enterprisesurveys.org.
[11] See https://databank.worldbank.org/source/world-development-indicators.
[12] The panel is unbalanced with some data gaps with respect to R&D expenditures, especially for small economies such as those located in the Pacific region. This substantially reduces the datapoints to about 60 economies per year.

similarities and differences across these alternative types of aggregation. Similarities include the volume of trade and several indicators of regional integration, suggesting that economies around the world are relatively well connected with others. Notable diversities include the productivity of labor and the amount of capital available per employee (see Figures 1a and 1b), which are much higher for the ex-Asia economies in the working sample, and the higher mobility of people as captured by air transport. We test how regional integration influences labor productivity overall and across various geographic/economic subregions using a panel fixed effects model based on equation (3).

The second working sample is a pooled cross-section of innovation activity at firm level during 2012–2019, which we obtain from merging WBES firm-economy data with economy data sourced from WDI and ADB-ARCII. The initial WBES combined data set comprises 158,781 surveyed firms from 144 economies. Given some missing answers to the variables of interest and economy-specific data availability constraints, the largest working sample is made up of 54,653 enterprises from 67 economies/regional groups across the world for 2012–2019. This working sample is used to estimate the model formalized in equation (7). Relevant summary statistics are reported in Table 3.

Aside from regional differences in the probability to innovate and firm size and 'vocation'—e.g., the higher incidence of Asian (economy) firms holding internationally recognized quality certifications such as ISO points to their vocation as world manufacturers during the period: the averages in Table 3 display striking differences between geography and economics groupings. Space-only aggregation emerges as revealing only some of the innovation activity by firms located on the territory, which instead appears better captured by the economics grouping. These differences support the hypothesis at the core of this paper: that deliberate political and economic decisions to better integrate among groups of economies—i.e., regional cooperation—matter for observed outcome variables such as productivity, innovation, and economic growth.

V EMPIRICAL STRATEGY AND BASELINE RESULTS

Economy-Level Analysis

We first analyze the relationship between regional integration and labor productivity using the panel working sample, to which we apply panel fixed effect estimation using the specification formalized in equation (3). The use of fixed effects techniques removes time-invariant influences on productivity while controlling for economy- and year-specific influences that are not captured by the independent variables included in the regression.

Prior to presenting the result, it is important to highlight that testing for panel unit root (Dickey-Fuller 1979)[13] to economy series on labor productivity does not reject the null hypothesis that a number of series contain a unit root. This may seem problematic as it may generate biased estimates and misinterpretations, as the regression may yield coefficients that are statistically significant even in presence of a spurious relationship. At the same time, this potential problem is contextualized by the short nature of the panel, as this weakens the power of the unit root test and limits its usefulness. In these circumstances we follow Wooldridge's suggestion (2000, section 10.5) and add a time

[13] This is carried out using the Fisher-type *xtunitroot…, dfuller* command in Stata, which combines the p-value of individual Dickey-Fuller tests applied to each productivity series to produce a test for the whole panel.

trend[14] to equation (3) to detrend the original series before using them in regression analysis. In fact, controlling for the time trend makes the estimates of the parameters γ_{reg} (the coefficients associated with regional integration activities that directly influence productivity) and δ (the equivalent coefficients on regional integration initiatives that influence labour productivity only indirectly) as the result of regressions carried out without a time trend but where the dependent variable and all independent variables have been previously detrended.

The results of the baseline regression, performed on economies located in each continent, are reported in Table 4. Model I reports the coefficients obtained without regional indicators, while Model II shows the results obtained when they are included, using their contemporaneous values (i.e., they share the same time t with all other regressors). The common terms on the upper part of Table 4 display relatively little variation between the two models, suggesting a limited influence of RCI with respect to established determinants of productivity. However, as expected, Model II better fits the data than its equivalent without RCI indicators. With respect to the traditional determinants of productivity using specifications like (3), labor productivity is positively related to the amount of capital per employee (e.g., Piva, Tani, and Vivarelli 2018), and mobility as expressed by air transport data (Okara et al. 2023), while labor as a factor of production exhibits decreasing returns to scale (negative log employment). These findings are similar to those found in the literature. The influence of national R&D expenditures per employee on productivity is positive and statistically significant, as is generally found, though the effect is much stronger for economies that are relatively less

[14] We also test the possibility that the time trend is nonlinear, but adding a square time trend does not modify the results and therefore we only consider a linear time trend, which is interpreted as changes in productivity.

endowed with R&D expenditures. This is evident in the relatively flat distribution of the observations relative to the 45-degree line in Figure 2, which is associated with a group of economies that are increasingly integrated in the world economy through trade and investment but historically have little R&D investment relative to GDP—like much of Asia, Africa, the Middle East, and Latin America.

With respect to the regional indicators at the heart of this paper, the results support the hypothesis that regional integration does matter for productivity: labor productivity is positively associated with the localization of other firms within the same value chain in the region with a coefficient of +0.128 (Model II), implying that a 10% increase in that regional indicator is associated with a raise in labor productivity of 1.28%—a small but non-negligible increase. Other positive coefficients are found for indices of infrastructure investments (+0.278) and technological connectivity (+0.058). The positive coefficient for infrastructure investments reflects that these have the largest effect on productivity and are common actions to strengthen regional cooperation, as suggested by the literature (Francois, Manchin, and Pelkmans-Balaoing 2009). In contrast, labor productivity seems negatively related to trade and investment (-0.021), money and finance (-0.054), and migration indicators (-0.154). This is not surprising in view of the previously noted negative sign of R&D expenditures per employee: that productivity is higher in economies that are integrating globally (ADB 2023). The negative sign suggests these economies may still impose significant controls to international movements of capital and people. Integration through institutional arrangements and cooperation on environmental projects emerge as not having a statistically detectable influence on productivity.

The results reported in Table 4 suggest that omitting an economy's choices to deepen its integration within a region may not produce excessively biased estimates of otherwise well-known determinants of productivity, as the coefficients of Model I and Model II suggest. However, such omission overlooks insights arising from institutional factors relevant for policy design (e.g., whether or not to participate in a regional infrastructure project), and which could strengthen the effectiveness of other interventions aimed at promoting an economy's economic growth (e.g., government support to the construction industry).

Even when regional indicators are included in the analysis, negative or statistically zero coefficients do not necessarily imply that, say, trade reduces labor productivity. It is instead more likely that higher productivity is experienced by economies that historically have had fewer trade interchanges (see the observations circled in Figure 3).

Caution is also needed when interpreting results obtained on regional aggregations reflecting physical location versus aggregations that reflect economic and institutional choices, as illustrated in Table 5 (the results of the other explanatory variables are in Table 14). As ARCII intraregional indicators are available for all regions, comparisons across the world are only possible when based on geography. This is presented by the examples of the European Union (upper part of Table 5) and Asia (lower part). ARCII intrasubregional indicators are however also available for Asia. This makes it possible to distinguish between effects measured on geographic versus economic/institutional aggregates.

The RCI indicator coefficients for Asia economy in Table 5 (column on the right) indicate that productivity influenced the economy's technological integration with its region (+0.183, implying that a 10% increase in technological integration results in a 1.83 percentage increase in labor productivity) but not by trade, investment, and financial integration, as instead emerges when the analysis is carried out on geographic aggregates (Table 5, left column). Though it is perhaps not surprising that a different spatial aggregation leads to different statistical relations, access to better matching indicators capturing institutional-economic choices with the use of a regional aggregation reflecting those institutional-economic decisions does advance the quality of analyses that can be later used for policy design.

Firm-Level Analysis

Better understanding of whether national choices about regional integration actually enter into the decision-making of businesses can be captured by microeconomic data collected from firms, as those surveyed in the World Bank Enterprise Survey (WBES). Although these data are only cross-sectional—hence, potentially subjected to larger influence from unobserved differences among units of observation—WBES provides detailed information on their innovation activity: a fundamental contributor of national productivity and economic growth (e.g., Rivera-Batiz and Romer 1991).

We estimate first the specification formalized in (7) as a linear probability model by ordinary least squares, using three different dependent variables: the probability of innovating, regardless of type; the probability of introducing a new product or service; and the probability of introducing a new production process. Table 3 reports the unconditional means and standard deviations of the key parameters used in the empirical analysis across three broad regional aggregations. As discussed for economy-level data, the aggregation of economies according to economic and political choices portrays a different picture about innovation activity: in this case, a much higher probability of innovation (last column on the right).

The baseline results are reported in Table 6 for the three dependent variables. The upper portion of the table shows the influence of well-known factors influencing innovation, in aggregate and by type: namely, the amount of investment in R&D; whether the firm is part of an international network or has an international market, as indicated by having an internationally recognized certification; and firm size. All coefficients are positive and statistically significant as commonly found by the literature (Atilio et al. 2020).

With respect to economic and institutional decisions capturing regional integration, firm-level data suggest that innovation is neither driven by regional trade and investment nor by financial market initiatives. It is also not driven by institutional arrangements and cooperation focused on the environment. In contrast, what raises the probability that firms will innovate is the presence in the regions of firms in the same value chain, investments in infrastructure and technology, and people's movements (such as temporary and permanent migration).

Differences in the statistical significance and sign of the coefficients of some variables depend on whether the innovation is about products/services of processes. For instance, in the case of innovation in products/services, the association with the indicator of technology sharing and connectivity is positive and statistically significant (+0.335), while it is nil in the case of innovation in process. This may occur if new products require closer support between supplier and clients than an established equivalent, or when the product/service is technologically more advanced as necessitates of a more advanced technical infrastructure than what had been available. The regional presence of other firms in the value chain is important for innovation but especially so for innovation in process—a sign that this type of innovation may enable firms to unlock better returns when a larger share of the value added is produced in the region possibly due to firms' ability to become more specialized. Investments in infrastructure are also essential to firms' choice of investing in innovation regardless of whether in products or process.

The results confirm that institutional decisions influencing regional integration do affect innovation activity, with varying influence by region and type of aggregation (i.e. geographic vs. economic), as suggested by the results reported in Table 7 for the European Union (on the top half of the table—geography only) and Asia (see also ADB, 2020—especially Figures 2.2.7 and 2.2.10)

VI ROBUSTNESS

The baseline results in Table 4 for panel data and in Table 6 for cross-sectional information are dependent on data quality, empirical specification, and estimation methods. We carried out robustness tests obtaining, by and large, outcomes supporting the baseline results. Some of the tests can only be applied to panel data, though we carried out tests to detect the possible influence of omitted variables also for the cross-sectional analysis.

Using a Parsimonious Model

As an initial step, we checked if the 8 RCI indicators, which are generated with PCA, are a suitably parsimonious set drawn from the underlying 41 indicators used in their creation. We used the Lasso method, which normally generates predictions, for selecting a set of variables out of the 41 available that could fit the data well.[15] Figure 4 plots the cross-validation function after Lasso, suggesting a selection of 35 variables. Used in a regression, these often produced coefficients that statistically were no different from zero. We concluded that using ARCII's eight PCA indicators better preserved parsimony without loss of information, and hence used them for the analysis presented in this paper.

Omitted Variables Bias

Both panel and cross-sectional analyses produce results vulnerable to the influence of likely omitted variables in the regression and self-selection. To address this potential problem, we carried out two separate tests. First, we re-estimated model (3) and model (7) but clustered the standard error at the level of region as a tool to detect possible influences of unobserved sources of variation at supranational level. The results, as reported in Table 8a for panel data, are effectively unchanged relative to the baseline, implying that omitted variables do not appear to be a threat to the baseline results.

In the case of cross-sectional data (Table 8b), the results are substantively similar with a couple of exceptions: notably for the RCI indicator of trade and investments, which becomes statistically zero, and for the indicator of technological integration, which instead becomes statistically significant at the 1% (previously 10%) level.

[15] See https://www.stata.com/manuals/lasso.pdf.

Overall, the results of Tables 8a and 8b do not raise particular alarms about the influence of omitted variables.

In addition to clustering the standard errors, we also applied two recent formal tests of omitted variable bias: first is Oster's test,[16] which aims to uncover the amount of unobserved heterogeneity that is required to invalidate the estimates obtained, using a parametric approach that imposes certain restrictions to the relation between control and unobserved variables.[17] The second test, by Diegert, Masden, and Poirier (2022) ('DMP'), is non-parametric and allows control and unobserved variables to be correlated. This test is therefore less restrictive than Oster. We applied both tests to both panel and cross-sectional specifications as per model (3) and (7).

For the panel, the ratios obtained for the various indices of regional integration are often higher than benchmark of 1, as shown in Table 9. Though Oster's test provides no guarantee that model (3) is immune from unobserved heterogeneity, the large ratios commonly reported in Table 9 reassure that unobserved heterogeneity is unlikely to threaten the baseline estimates, which can be deemed to be 'robust to omitted variable bias'.

[16] This method evaluates the robustness to omitted variable bias by testing the stability of the coefficients when control variables are progressively added in a regression under the assumption that the relationship between treatment and unobservables can be recovered from that between treatment and observables, and that the hypothetical model that includes treatment, observables, and unobserved produces a R_{max} that can be less than 1 (e.g., because of measurement error). Oster's method is used to calculate either: (i) the ratio of unobserved/observed selection ('delta') required to nullify the effect of the treatment; or (ii) the bounds of the treatment coefficient when delta varies between 0 (no unobserved selection) to 1 (equal observed and unobserved selection). Robustness to omitted variable bias occurs if delta is greater than 1 or if beta is never zero when delta is in the interval [0,1]. For more detail see Piracha et al. (2022).

[17] Oster suggests benchmarks with respect to (i) the additional goodness of fit that can be ascribed to unobserved variables (1.3 times the R^2 of the original regression), and (ii) the ratio of unobserved relative to observed heterogeneity consistent with a nil coefficient for the observed variables of interest (ratio: 1)—in our case, the indices of regional convergence.

For cross-sectional data, Table 10 reports the results of the Oster and DMP test. Some of the values of the RCI parameters fall below the set benchmarks, but this is not the case for other coefficients such as those associated with institutional integration, immigration and mobility, and collaboration on environmental initiatives. We take this as a supportive sign that omitted variable bias, though present, is unlikely to substantially influence the results discussed so far.

With reference to the panel, we carried out additional robustness tests, which we summarize here.

Estimating the Model in First Differences

Though panel fixed effects remove the influence of time-invariant economy- and year-specific effects, this relies on the assumption of no serial correlation before demeaning the variables. If instead the error terms are strongly correlated, as it may occur when variables trend, it is preferable to estimate a version based on the first difference of all variables. We do this using model (3), and, as illustrated in Table 11, find estimates that mostly reflect those obtained by variables measured in levels. These demonstrate that changes in labor productivity relate positively relate to changes in the stock of capital per employee, travel intensity, and FDI, and negatively to employment growth, in line with the hypothesis of a diminishing returns to scale technology. Labor productivity also responds positively to changes in indicators capturing infrastructure investments, and negatively to changes in indicators of trade. Changes in the other indicators yield coefficients that are statistically insignificantly different from zero.

Modelling the Time Structure of RCI Indicators

The results in Table 4 were obtained using RCI indicators set at a time contemporaneous with the other covariates and the dependent variable. However, this choice was not statistically verified. To do so, we tested the lag yielding the best fit to model (3) by varying only one RCI at the time, and used the Bayesian Information Criterion ('BIC') for the selection of the best-fitting lag. Once the lags for each of the eight ARCII indicators were obtained, we estimated a new baseline model and further tested its stability by varying the chosen lag structure once more. The results, reported in Table 12, can be directly compared with those in Table 4. These show that the negative and statistically significant coefficient of the indicator for trade and investments and for finance disappear once their respective best-fitting lag is used. While maintaining the same sign, the statistical significance of the RCI indicator for firm in the same value chain is reduced (to a p-value <0.10), and that representing integration in technology is unchanged. No substantive change affects the remaining control variables. Whereas we opted for leaving the baseline model with contemporaneous RCI indicators, modelling the structure of the indicators may be better suited for analyses targeting evaluations and policy design.

Reverse Causality

The final test we carried out on model (3) is whether it is affected by the possibility of reverse causality, whereby the direction of the relationship between regionalization and productivity runs in the opposite direction. That is, regionalization is the effect of higher productivity and innovation activity rather than the other way round. The question on potential reverse causality has been explored in the context of regional an global integration (ADB 2021; Huh and Park 2020).

A possible approach, once the stationarity properties of the series of interest is established, is to test for short-run and long-run bi-variate causality between productivity and each of the ARCII indicators. Because the time series dimension of our panel is small (10 years) panel causality tests would be preferable. Formal tests of reverse causality are, however, challenging, as the underlying assumptions cannot be satisfied (e.g. Leszczensky and Wolbring, 2022). Given the scope of this research, we hence use a heuristic approach using lead and lag indicators one at the time on model (3). A statistically non-zero relationship with the lagged indicator suggests a link running from a regional initiative to productivity. The opposite occurs if the link is between the lead value of the indicator and the dependent variable. Table 13 reports the results for the relationships based on geographic and economic groupings, respectively. As shown, though there is some variation among indicators, in general the link runs from regional indicators to labor productivity. While not within the scope of this work, future applications could explore the direction of this relation for specific dimensions of regional integration or regional groups.

VII CONCLUSION

This study underscores the importance of considering regional integration factors when studying the determinants of economic growth, as highlighted in the case of their impact on labor productivity and innovation. Regional integration does not happen fortuitously but is the result of historical compounded institutional and economic choices that can favor economies of scale, technological diffusion, and structural transformation of space. While geographic factors are still fundamental in explaining regional economic dynamics in Asia and the Pacific, the results suggest economies' institutional choices, proxied by their participation in regional partnerships, can also be a catalyst to the benefits from regional integration.

To our knowledge, this is the first study combining economy-level metrics of regional integration with firm-level indicators of economic performance. The key results suggest that regional integration is increasing to labor productivity and innovation, with infrastructure and connectivity, along with the regional value chain, showing the strongest positive linkages. Firm-level analysis on innovation confirms the importance of regional integration through multiple channels, with variations depending on how the perimeter of regional integration is defined. This study concludes that deliberate institutional and economic strategies aimed at enhancing regional integration can be effective in fostering productivity, innovation, and overall economic growth. It also underscores the importance of better matching policy questions (such as on spurring regional economic growth) with adequate metrics of economies' institutional and economic choices that contribute to defining their physical or economic boundaries.

These findings lend additional empirical support to viewing regional cooperation and the strategic alignment of policies as a tool to maximize the benefits of integration, particularly in dynamic regions like Asia and the Pacific.

FIGURES AND TABLES

Figure 1a: Average (ln) Productivity per Worker by Geographic Region, 2006–2021

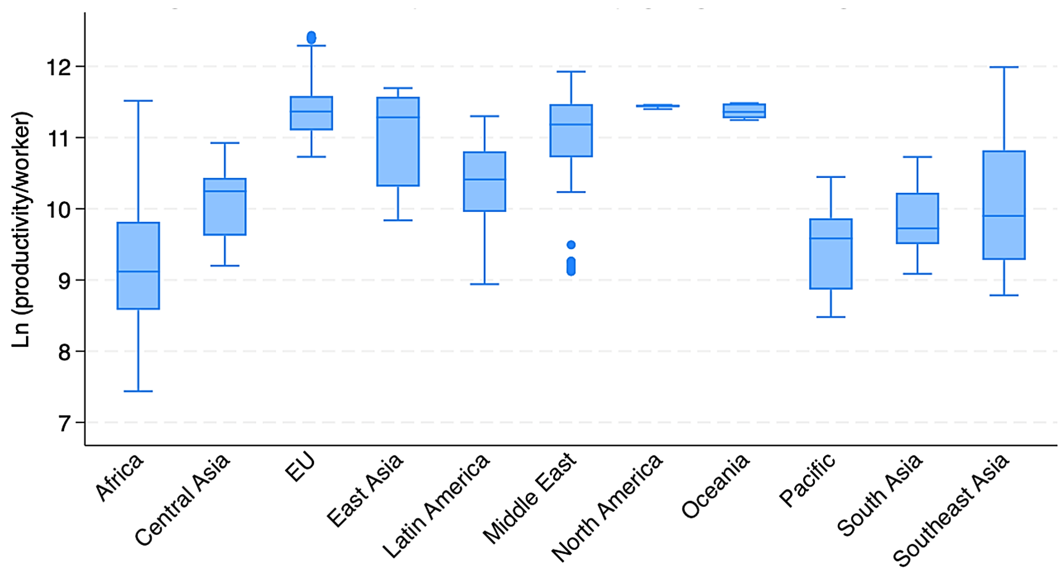
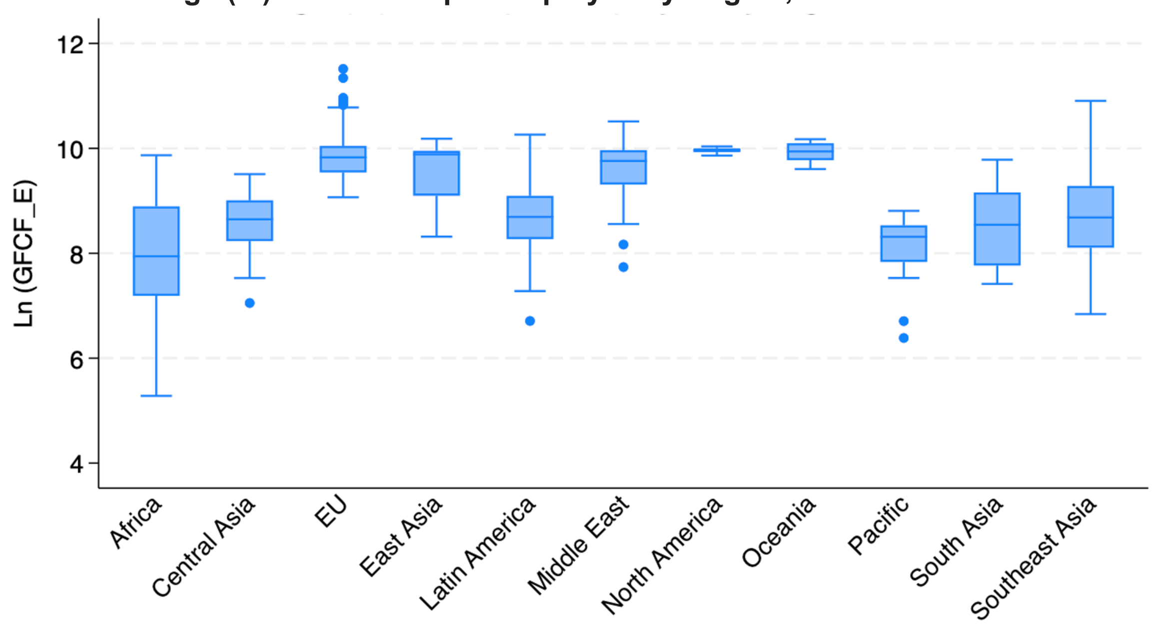


Figure 1b: Average (ln) Investment per Employee by Region, 2006–2021



GFCF_E = gross fixed capital formation (estimated).

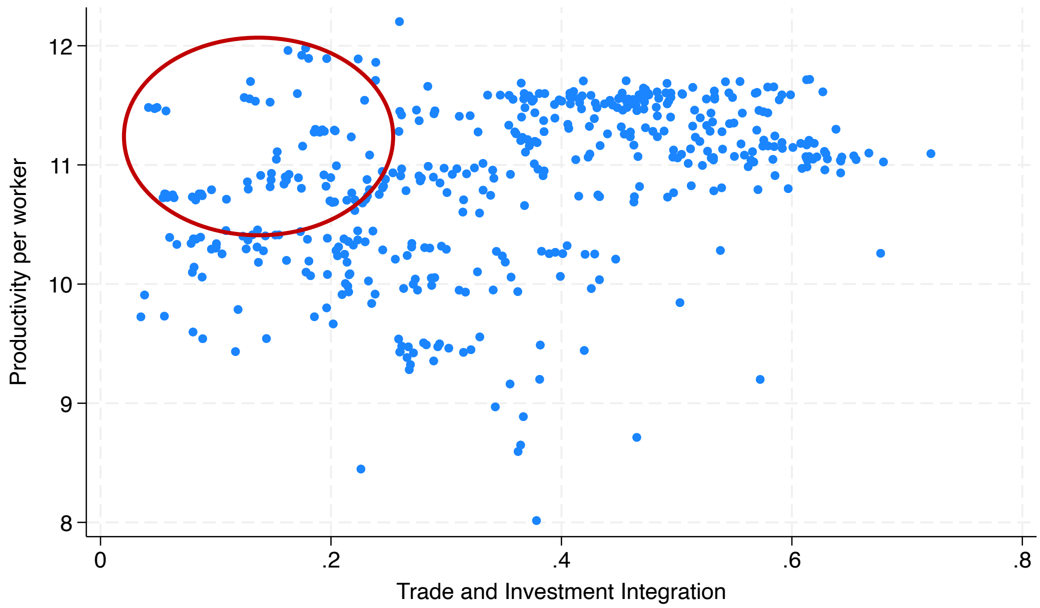
Source: Authors' elaboration, based on World Development Indicators, https://databank.worldbank.org/source/world-development-indicators; and International Labour Organization statistics on labor productivity, https://ilostat.ilo.org/topics/labour-productivity/, accessed on February 2024.

Figure 2: R&D Expenditure and Productivity per Worker

R&D = research and development.

Source: Authors' elaboration, based on World Bank Enterprise Surveys (WBES), https://www.enterprisesurveys.org/en/enterprisesurveys; and International Labour Organization (ILO), https://ilostat.ilo.org/topics/labour-productivity/, accessed on February 2024.

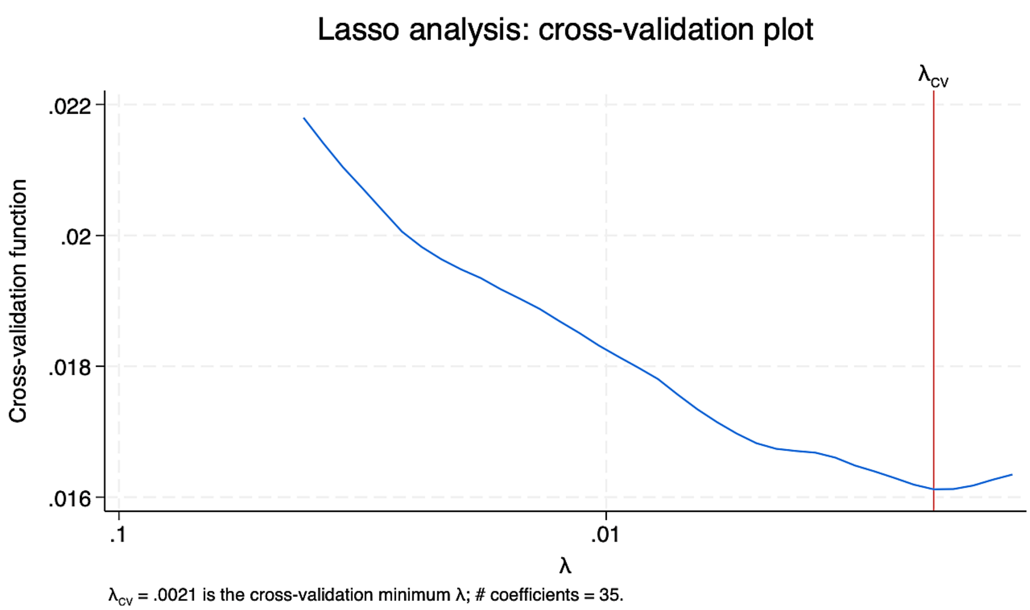
Figure 3: Dimensional Index (Trade and Investment) and Productivity per Worker



Note: Cluster circle in red denotes economies with high productivity per worker and relatively low trade and investment linkages.

Source: Authors' elaboration, based on ADB Asia Pacific Regional Cooperation and Integration Index (ARCII), https://aric.adb.org/database/arcii; and International Labour Organization, https://ilostat.ilo.org/topics/labour-productivity/, accessed on February 2024.

Figure 4: Lasso Analysis: Cross-Validation Plot



Source: Authors' elaboration.

Table 1: Number of Firms Surveyed by World Bank Enterprise Survey, by Economy and Year

Economy	Number of firms (N, %)		Survey year
India	9,191	16.8%	2014
Argentina	2,341	4.3%	2006, 2010, 2017
Nigeria	2,366	4.3%	2014
Colombia	2,317	4.2%	2006, 2010, 2017
Mexico	2,224	4.1%	2006, 2010
Peru	2,102	3.8%	2006, 2010, 2017
Kenya	1,732	3.2%	2013, 2018
PRC	1,663	3.0%	2012
Bangladesh	1,426	2.6%	2013
Indonesia	1,305	2.4%	2015
Philippines	1,185	2.2%	2015
Uruguay	1,044	1.9%	2006, 2010, 2017
Guatemala	987	1.8%	2006, 2010, 2017
Venezuela	973	1.8%	2010
Malaysia	908	1.7%	2015
Kazakhstan	894	1.6%	2013, 2019
Morocco	892	1.6%	2013, 2019
Thailand	874	1.6%	2016
Bolivia	837	1.5%	2006, 2010, 2017
Ecuador	834	1.5%	2006, 2010, 2017
Paraguay	847	1.5%	2006, 2010, 2017
Cambodia	782	1.4%	2013, 2016
Chile	770	1.4%	2010
Ghana	700	1.3%	2013
Honduras	727	1.3%	2006, 2010, 2016
Tanzania	700	1.3%	2013
Uganda	712	1.3%	2013
Zambia	697	1.3%	2013
Poland	666	1.2%	2013, 2019
Mozambique	589	1.1%	2018
Myanmar	601	1.1%	2016
Senegal	577	1.1%	2014
Sweden	583	1.1%	2014
Zimbabwe	581	1.1%	2016
Jordan	547	1.0%	2013
Lebanon	556	1.0%	2013
Mongolia	519	0.9%	2013, 2019
Slovenia	442	0.8%	2013, 2019
Armenia	357	0.7%	2013
Azerbaijan	382	0.7%	2013
Estonia	370	0.7%	2013, 2019
Lao PDR	359	0.7%	2016
Latvia	408	0.7%	2013, 2019
Cameroon	313	0.6%	2016
Costa Rica	318	0.6%	2010
Cote d'Ivoire	336	0.6%	2016
Nicaragua	320	0.6%	2016
Panama	340	0.6%	2006, 2010
Tajikistan	346	0.6%	2013
Bulgaria	291	0.5%	2013
Czech Republic	251	0.5%	2013
Hungary	296	0.5%	2013
Kyrgyz Republic	264	0.5%	2013
Lithuania	281	0.5%	2013, 2019
Slovakia	261	0.5%	2013
Greece	206	0.4%	2018
Benin	147	0.3%	2016
Mali	151	0.3%	2016

Economy	Number of firms (N, %)		Survey year
Niger	144	0.3%	2017
Portugal	171	0.3%	2019
Togo	149	0.3%	2016
Italy	118	0.2%	2019
Jamaica	114	0.2%	2010
Barbados	70	0.1%	2010
Cyprus	54	0.1%	2019
Malta	64	0.1%	2019
TOTAL	54,653	100.0%	

PRC = People's Republic of China, Lao PDR = Lao People's Democratic Republic.
Source: World Bank Enterprise Survey (WBES) database, https://www.enterprisesurveys.org/en/enterprisesurveys, accessed on November 2023.

Table 2: Unconditional Means of Main Variables of the Panel Sample

Variable	World ex-Asia	Asia (geography)	Asia (economic)
Ln productivity/employee	11.01	10.34	10.30
	(.61)	(.71)	(.58)
Ln RD/employee	6.19	4.82	4.87
	(1.63)	(1.76)	(1.51)
Ln GFCF/employee	9.44	8.99	8.96
	(.649)	(.718)	(.612)
Ln employment	15.54	16.57	16.94
	(1.33)	(1.79)	(1.74)
Gross trade/GDP	.968	.942	.922
	(.545)	(.756)	(.628)
Net FDI/GDP	.065	.043	.036
	(.257)	(.061)	(.049)
Air transport/population	.013	.008	.007
	(.016)	(.015)	(.012)
ARCII indicators (value)			
Trade and investments	.400	.192	.156
	(.151)	(.087)	(.098)
Money and finance	.630	.366	.317
	(.240)	(.096)	(.108)
Value chain	.510	.450	.457
	(.061)	(.045)	(.047)
Infrastructure	.598	.518	.501
	(.096)	(.137)	(.120)
People	.494	.399	.362
	(.113)	(.095)	(.120)
Institutional arrangements	.673	.653	.692
	(.189)	(.072)	(.099)
Technology	.392	.322	.318
	(.071)	(.074)	(.083)
Env. Cooperation	.473	.335	.332
	(.113)	(.045)	(.044)
N	367	102	184

Note: Asia Geography includes: Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan), South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), East Asia (People's Republic of China (PRC); Hong Kong, China; Japan; Republic of Korea; Mongolia), Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam).
Asia economy includes: ASEAN (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam), BIMPEAGA (Brunei Darussalam, Indonesia, Malaysia), BIMSTEC (Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, Thailand), CAREC (Afghanistan, Azerbaijan, PRC, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, Uzbekistan), GMS (Cambodia, PRC, Lao PDR, Myanmar, Thailand, Viet Nam), IMT-GT (Indonesia, Malaysia, Thailand), SAARC (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), SASEC (Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Sri Lanka), other Asian economies (Armenia; Hong Kong, China; Japan, Republic of Korea; Timor-Leste).
Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators; Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii, accessed on February 2024.

Table 3: Unconditional Means of Main Variables of the Cross-Sectional Sample

Variable	World ex-Asia	Asia (geography)	Asia (economic)
Innovation (any type)	.633	.542	.647
	(.482)	(.498)	(.478)
Innovation product/service	.525	.342	.395
	(.499)	(.474)	(.489)
Innovation process	.470	.487	.575
	(.499)	(.500)	(.494)
Firm's R&D investment	.287	.256	.306
	(.452)	(.467)	(.461)
Firm size	3.31	3.67	4.24
	(1.39)	(1.40)	(1.48)
Firm has international certificate	.218	.336	.420
	(.413)	(.472)	(.494)
N	32,624	22,029	23,540

Note: Geographic Rest of the World includes: Africa, EU, Middle East, North America, Latin America, Oceania, the Pacific.
Economy Asia includes: ASEAN (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam), BIMPEAGA (Brunei Darussalam, Indonesia, Malaysia), BIMSTEC (Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, Thailand), CAREC (Afghanistan, Azerbaijan, People's Republic of China (PRC), Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, Uzbekistan), GMS (Cambodia, PRC, Lao PDR, Myanmar, Thailand, Viet Nam), IMT-GT (Indonesia, Malaysia, Thailand), SAARC (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), SASEC (Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Sri Lanka).
Source: World Bank Enterprise Survey (WBES) database, https://www.enterprisesurveys.org/en/enterprisesurveys, accessed on November 2023. Based on largest working sample (economic Asia + geographic Rest of the World).

Table 4: Baseline Results—Panel Sample

Ln productivity/employee	**I**	**II**
Ln R&D/employee	.038**	.034**
	(.016)	(.014)
Ln GFCF/employee	.247***	.225***
	(.043)	(.035)
Ln employment	-.479***	-.429***
	(.168)	(.120)
Gross trade/GDP	-.056	-.054
	(.046)	(.036)
Net FDI/GDP	.020*	.022***
	(.010)	(.008)
Air transport/population	1.20***	.805**
	(.29)	(.274)
Year	.014***	.013***
	(.003)	(.002)
ARCII indicators		
Ln trade and investments		-.021**
		(.010)
Ln money and finance		-.054***
		(.015)
Ln value chain		.128**
		(.060)
Ln infrastructure		.278***
		(.070)
Ln people		-.154**
		(.064)
Ln institutional arrangements		.137
		(.179)
Ln technology		.058**
		(.02)
Ln environmental cooperation		-.052
		(.129)
Constant	-12.47***	-13.28***
	(4.26)	(3.64)
Economy FE	Yes	Yes
Year FE	Yes	Yes
F-stat	19.17	32.02
R^2 within	.5926	.6825
R^2 between	.2742	.3738
R^2 overall	.1963	.2740
N	469	469

Robust standard errors. L1–L4= variable lagged once.... lagged four times.
FDI = foreign direct investment, GFCF = gross fixed capital formation, R&D = research and development.
Note: Includes Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan), South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), East Asia (People's Republic of China; Hong Kong, China; Japan; Republic of Korea; Mongolia), Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam).
Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii. Accessed February 2024.

Table 5: Geographic versus Economic Aggregation

Ln productivity/employee	Geography	Economic
ARCII indicators – European Union		
Ln trade and investments	-.022*	
	(.012)	
Ln money and finance	-.082	
	(.060)	
Ln value chain	.085	
	(.122)	
Ln infrastructure	.242**	
	(.121)	
Ln people	-.074	
	(.120)	
Ln instit. arrangements	-.808**	
	(.392)	
Ln technology	-.052	
	(.118)	
Ln environ. cooperation	-.016	
	(.146)	
ARCII indicators – Asia		
Ln trade and investments	-.053**	-.003
	(.026)	(.012)
Ln money and finance	-.096***	-.018
	(.025)	(.018)
Ln value chain	.244***	.127
	(.085)	(.81)
Ln infrastructure	.321**	.317***
	(.125)	(.079)
Ln people	-.223**	-.108***
	(.104)	(.017)
Ln instit. arrangements	.284	-.114
	(.289)	(.154)
Ln technology	.097	.183***
	(.080)	(.066)
Ln environ. cooperation	.265	.223
	(.358)	(.168)

Robust standard errors. Estimates based on Model II in Table 4 with the addition of interaction terms between the ARCII indicators and regional aggregates. Coefficients for Asia are a linear combination of the corresponding coefficients for North America + coefficient of interaction with Asia indicator. Source: ILO (labor productivity), WB-WDI (RD, GFCF, Employment, gross trade/GDP, Net FDI/GDP, Air transport, population), ADB (ARCII database).
Note: Only inter-regional (i.e. geography) ARCII indicators are produced for regions outside Asia. European Union includes: Bulgaria, Cyprus, Czech Republic, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden.
Asia geography includes: Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan), South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), East Asia (People's Republic of China (PRC); Hong Kong, China; Japan; Mongolia; Republic of Korea), Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam).
Asia economy includes: ASEAN (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam), BIMPEAGA (Brunei Darussalam, Indonesia, Malaysia), BIMSTEC (Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, Thailand), CAREC (Afghanistan, Azerbaijan, PRC, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, Uzbekistan), GMS (Cambodia, PRC, Lao PDR, Myanmar, Thailand, Viet Nam), IMT-GT (Indonesia, Malaysia, Thailand), SAARC (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), SASEC (Bangladesh, Bhutan, India, Maldives,

Myanmar, Nepal, Sri Lanka), other Asian economies (Armenia; Hong Kong, China; Japan; Republic of Korea; Timor-Leste).
Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii. Accessed February 2024.

Table 6: Baseline Results—Pooled Cross-Section

Probability to innovate	Innovation (pooled)	Product Innovation	Process Innovation
R&D investment (firm)	.300***	.313***	.313***
	(.004)	(.005)	(.005)
Ln firm size	.031***	.022***	.033***
	(.001)	(.002)	(.002)
Firm has int'l certif.	.044***	.050***	.041***
	(.005)	(.005)	(.005)
Ln GDP growth	.016***	.016***	.013**
	(.005)	(.005)	(.006)
Gross trade/GDP	-.057	.072	.033
	(.102)	(.109)	(.109)
Net FDI/GDP	2.52***	1.79***	1.93***
	(.550)	(.582)	(.585)
Ln air transport/population	8.08**	3.02	15.25***
	(3.18)	(3.59)	(3.67)
ARCII indicators			
Trade and investments	-.435***	-.497***	-.216**
	(.086)	(.095)	(.098)
Money and finance	-.437***	-.376***	.033
	(.122)	(.134)	(.138)
Value chain	1.19***	.959**	2.35***
	(.418)	(.458)	(.470)
Infrastructure	1.31***	1.66***	.681**
	(.281)	(.306)	(.311)
People	1.41***	1.37***	.493
	(.340)	(.370)	(.392)
Institutional arrangements	-1.52***	-.889***	-1.06***
	(.238)	(.231)	(.235)
Technology	.190*	.335***	-.152
	(.103)	(.115)	(.115)
Environmental cooperation	-2.13	-2.67*	-6.60***
	(1.31)	(1.41)	(1.46)
Constant	-.242	-3.40***	-2.61**
	(.525)	(1.07)	(1.09)
Economy FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adj R^2	.2418	.2182	.2447
N	54,653	54,503	54,221

Pooled cross-section with robust standard errors. FDI = foreign direct investment, GFCF = gross fixed capital formation, R&D = research and development.
Source: World Bank Enterprise Survey (WBES) database (innovation data), https://www.enterprisesurveys.org/en/enterprisesurveys); World Bank Development Indicators (GDP growth, gross trade/GDP, net FDI/GDP, air transport/population), https://databank.worldbank.org/source/world-development-indicators; Asian Development Bank (ARCII indicators), https://aric.adb.org/database/arcii, accessed on February 2024.

Table 7: Geographic versus Economic Aggregations—Cross-Sectional Sample

Probability to innovate	Geography Innovation (pooled)	Geography Product Innovation	Geography Process Innovation	Economic Innovation (pooled)	Economic Product Innovation	Economic Process Innovation
European Union						
Trade and investments	.127	.015	.655**			
	(.254)	(.197)	(.271)			
Money and finance	-1.01**	-.716**	-1.90***			
	(.512)	(.349)	(.637)			
Value chain	2.72***	2.70***	1.50			
	(.837)	(.830)	(.970)			
Infrastructure	.991***	.900***	.657*			
	(.344)	(.277)	(.370)			
People	-.588**	-.431*	-.918**			
	(.272)	(.236)	(.356)			
Institutional arrangements	-2.58***	-2.00***	-2.34**			
	(.745)	(.621)	(1.01)			
Technology	1.88***	1.19**	2.64**			
	(.664)	(.557)	(1.05)			
Environmental cooperation	.497	.378	1.40***			
	(.516)	(.442)	(.499)			
Asia						
Trade and investments	-.450	-.409	-.501**	.271	.156	.226
	(.255)	(.250)	(.221)	(.190)	(.140)	(.154)
Money and finance	.530	.552*	.792***	-.296***	-.057	-.260***
	(.350)	(.279)	(.296)	(.109)	(.076)	(.089)
Value chain	1.46**	1.43**	2.20***	.411*	.074	.755***
	(.714)	(.692)	(.588)	(.231)	(.197)	(.186)
Infrastructure	-.658	-.797	.101	.092	-.120	.271**
	(.583)	(.511)	(.493)	(.166)	(.141)	(.126)
People	.299	.065	.469**	-.199*	-.156	-.166*
	(.268)	(.257)	(.195)	(.113)	(.100)	(.098)
Institutional arrangements	.785*	.497	.857***	.016	.033	-.043
	(.404)	(.375)	(.319)	(.121)	(.075)	(.091)
Technology	-1.54***	-.560**	-.1.90***	-.792***	-.154	-.907***
	(.270)	(.279)	(.237)	(.150)	(.127)	(.113)
Environmental cooperation	3.35***	1.36	1.93*	1.96***	.391	1.45***
	(1.28)	(1.20)	(1.05)	(.547)	(.458)	(.428)

Pooled cross-section with year fixed effects and standard errors clustered at economy level.
Note: Asia Geography includes: Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan), South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), East Asia (People's Republic of China (PRC); Hong Kong, China; Japan; Republic of Korea; Mongolia), Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam).
Asia economy includes: ASEAN (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam), BIMPEAGA (Brunei Darussalam, Indonesia, Malaysia), BIMSTEC (Bangladesh, Bhutan, India, Myanmar, Nepal, Sri Lanka, Thailand), CAREC (Afghanistan, Azerbaijan, PRC, Georgia, Kazakhstan, Kyrgyz Republic, Mongolia, Pakistan, Tajikistan, Turkmenistan, Uzbekistan), GMS (Cambodia, PRC, Lao PDR, Myanmar, Thailand, Viet Nam), IMT-GT (Indonesia, Malaysia, Thailand), SAARC (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), SASEC (Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Sri Lanka), other Asian economies (Armenia; Hong Kong, China; Japan, Republic of Korea; Timor-Leste).
Source: World Bank Enterprise Survey (WBES) database (innovation data), https://www.enterprisesurveys.org/en/enterprisesurveys; World Bank Development Indicators (GDP growth, gross trade/GDP, net FDI/GDP, air transport/population), https://databank.worldbank.org/source/world-development-indicators; Asian Development Bank (ARCII indicators), https://aric.adb.org/database/arcii, accessed on February 2024.

Table 8a: Addressing Selection with Regional Clustering (Panel Data)

ARCII indicators	**Geographic groups**	**Economic groups**
Ln trade and investments	-.021**	-.007
	(.010)	(.008)
Ln money and finance	-.054***	-.028**
	(.015)	(.010)
Ln value chain	.128**	.093
	(.060)	(.058)
Ln infrastructure	.278***	.290***
	(.070)	(.069)
Ln people	-.154**	-.108***
	(.064)	(.020)
Ln institut. arrangements	.137	-.067
	(.179)	(.082)
Ln technology	.058**	.067*
	(.022)	(.036)
Ln environ. cooperation	.067	.109
	(.118)	(.099)

Regression based on Model II in Table 4. Standard errors clustered at regional level.

Table 8b: Addressing Selection with Regional Clustering (Cross-Sectional Data)

ARCII indicators	**Geographic groups**
Trade and investments	-.435
	(.245)
Money and finance	-.437***
	(.069)
Value chain	1.19
	(1.02)
Infrastructure	1.31***
	(.468)
People	1.41***
	(.678)
Institutional arrangements	-1.52**
	(.725)
Technology	.190***
	(.032)
Environmental cooperation	-2.13
	(2.64)

Regression based on the baseline model for Innovation (pooled) in Table 6. Standard errors clustered at regional level.

Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii, accessed on February 2024.

Table 9: Oster Test for Omitted Variable Bias (Panel Data)

Geographic indicator

ARCII indicators	**R_{max} relative to R^2 of Model II (Table 4)** **1.3x**
Ln trade and investments	13.55
Ln money and finance	10.64
Ln value chain	.
Ln infrastructure	.
Ln people	.
Ln institutional arrangements	1.94
Ln technology	1.28
Ln environ. cooperation	0.36

Note: using Oster (2019) benchmark of an R_{max} = 1.3 R^2, a value above 1 suggests that unobserved heterogeneity is at least equal to the amount of fit generated by the observed variable of the original regression for the estimated coefficient to be statistically equal to zero. This is viewed as highly unlikely. The negative sign indicates that omitted variables would work in opposite direction to the estimated coefficient. The dot "." indicates an improbably large delta.

Economic indicator

ARCII indicators	**R_{max} relative to R^2 of equivalent of Model II (Table 4)** **1.3x**
Ln trade and investments	1.77
Ln money and finance	9.69
Ln value chain	.
Ln infrastructure	2.26
Ln people	.
Ln institutional arrangements	-0.82
Ln technology	0.61
Ln environ. cooperation	0.73

Note: using Oster (2019) benchmark of an R_{max} = 1.3 R^2, a value above 1 suggests that unobserved heterogeneity is at least equal to the amount of fit generated by the observed variable of the original regression for the estimated coefficient to be statistically equal to zero. This is viewed as highly unlikely. The negative sign indicates that omitted variables would work in opposite direction to the estimated coefficient. The dot "." indicates an improbably large delta.

Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii, accessed on February 2024.

Table 10: Breakdown Point Analysis (Test of Omitted Variable).

Results in percentages

	Geography		Economic	
ARCII indicators	**Oster**	**DMP**	**Oster**	**DMP**
Trade and investments	1.49	.069	1.99	.133
Money and finance	0.84	.029	1.72	.076
Value chain	2.79	.083	3.95	.141
Infrastructure	20.11	.019	.076	.026
People	4.23	.153	3.67	.194
Institutional arrangements	5.22	.235	106.7	.268
Technology	.94	.035	.23	.013
Environmental cooperation	9.25	.132	5.65	.127

Model based on equation (7) for innovation. Oster (2019) relies on a parametric method that imposes a linear relationship between observed and omitted variables. Diegert, Masten and Poirier (2022) (DMP) rely on non-parametric methods that do not super-impose a restriction on the relation between observed and omitted variables. Critical breakdown points for Oster is ~1. For DMP it varies and for regressions where there are several controls (e.g., fixed effects), it can be much less than 0.5.
Source: Oster (2019); Diegert, Masten and Poirier (2022).

Table 11: Analysis in First Differences (Based on Model II, Table 4)

Diff. Ln productivity/employee	II
D. RD/employee	.005 (.009)
D. GFCF/employee	.134*** (.024)
D. Ln employment	-.269*** (.069)
D. Gross trade/GDP	.042 (.056)
D. Net FDI/GDP	.009*** (.003)
D. Air transport/population	1.35*** (.326)
Year	-
ARCII indicators	
D. Ln trade and investments	-.011** (.005)
D. Ln money and finance	-.004 (.006)
D. Ln value chain	-.035 (.033)
D. Ln infrastructure	.126*** (.035)
D. Ln people	.008 (.022)
D. Ln institutional arrangements	.055 (.062)
D. Ln technology	-.012 (.014)
D. Ln environmental cooperation	.151 (.123)
Constant	.012*** (.001)
F-stat	27.46
R^2 within	.3992
R^2 between	.2983
R^2 overall	.3600
N	363

Regression in first differences with robust standard errors.
Note: Includes Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan), South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), East Asia (People's Republic of China; Hong Kong, China; Japan; Republic of Korea; Mongolia), Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam).
Source: World Bank Enterprise Survey (WBES) database (innovation data, https://www.enterprisesurveys.org/en/enterprisesurveys; World Bank Development Indicators (GDP growth, gross trade/GDP, net FDI/GDP, air transport/population), https://databank.worldbank.org/source/world-development-indicators; Asian Development Bank (ARCII indicators), https://aric.adb.org/database/arcii, accessed on February 2024.

Table 12: Modelling the Time Structure of the ARCII Indicators

Ln productivity/employee	
Ln RD/employee	.043**
	(.016)
Ln GFCF/employee	.262***
	(.045)
Ln employment	-.478***
	(.139)
Gross trade/GDP	-.030
	(.048)
Net FDI/GDP	.021**
	(.009)
Air transport/population	1.17***
	(.36)
Year	.012***
	(.002)
ARCII indicators	
Ln trade and investments	-.005 (L1)
	(.010)
Ln money and finance	-.033* (L1)
	(.018)
Ln value chain	.107*
	(.055)
Ln infrastructure	.104 (L1)
	(.092)
Ln people	-.004 (L4)
	(.048)
Ln institutional arrangements	.025 (L1)
	(.223)
Ln technology	.082** (L4)
	(.037)
Ln environmental cooperation	.079 (L1)
	(.178)
Constant	-8.11**
	(3.74)
Economy FE	Yes
Year FE	Yes
F-stat	19.73
R^2 within	.6249
R^2 between	.3301
R^2 overall	.2466
N	455

Robust standard errors. Source: ILO (labor productivity), WB-WDI (RD, GFCF, Employment, gross trade/GDP, Net FDI/GDP, Air transport, population), ADB (ARCII database). L1-L4= variable lagged once.... lagged four times.
Note: Includes Central Asia (Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan), South Asia (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka), East Asia (People's Republic of China; Hong Kong, China; Japan; Republic of Korea; Mongolia), Southeast Asia (Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, Timor-Leste, Viet Nam).
Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net

FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii. Accessed February 2024.

Table 13: Reverse Causality Using P-Values of Model (3) with 1 and 2 Lags and Leads

ARCII indicators	**Geographic**				**Economic**			
	L2	**L1**	**F1**	**F2**	**L2**	**L1**	**F1**	**F2**
$^{-}$Ln trade and invest.	.331	.290	.721	.464	.088*	.754	.734	.324
$^{-}$Ln money and finance	.060*	.289	.290	.045**	.011**	.101	.305	.019**
$^{+}$*Ln value chain*	.148	.473	.033*	.108	.033**	.270	.064*	.247
$^{+}$*Ln infrastructure*	.443	.149	.000***	.002***	.693	.018**	.000***	.000***
$^{-}$Ln people	.401	.084*	.015**	.001***	.000**	.000***	.000***	.000***
$^{\cdot}$Ln institutional arrang.	.899	.571	.946	.590	.020**	.630	.081*	.047**
$^{+}$*Ln technology*	.513	.034**	.075*	.287	.138	.000***	.031**	.325
$^{\cdot}$Ln envir. cooperation	.344	.433	.097*	.907	.365	.355	.035**	.566

The symbol +/- on the top left of each indicator reports the sign (*italic* if positive) and statistical significance (nil if the symbol is "$^{\cdot}$") of the underlying contemporaneous value of the indicator, as used for Model II in Table 4. L2 = lagged twice; L1 = lagged once; F1 = forward once; F2 = forward twice. Reverse causality is possible in case of lagged or contemporaneous coefficients with p-values>.1 followed by p-values<.1 for either F1 or F2.

Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii. Accessed February 2024.

Table 14: Geographic versus Economic Aggregation (Panel Sample)

Ln productivity/employee	**Geography**	**Economic**
Ln RD/employee	0.040**	0.029**
	(0.016)	(0.011)
Ln GFCF/employee	0.220***	0.237***
	(0.040)	(0.035)
Ln employment	-0.362***	-0.437***
	(0.131)	(0.107)
Gross trade/GDP	-0.044	-0.037
	(0.042)	(0.037)
Net FDI/GDP	0.022**	0.025***
	(0.009)	(0.008)
Air transport/population	0.826***	0.965***
	(0.270)	(0.313)
Year	0.011***	0.013***
	(0.003)	(0.002)
ARCII indicators	Yes (see Table 5)	Yes (see Table 5)
Economy FE	Yes	Yes
Year FE	Yes	Yes
R^2 within	0.7389	0.7527
R^2 between	0.1815	0.3387
R^2 overall	0.2186	0.3117
N	469	551

Estimates based on Model II in Table 4 but with an additional interaction term between each ARCII indicator and main regions around the globe.
Source: International Labour Organization (labor productivity), https://ilostat.ilo.org/topics/labour-productivity/; World Bank World Development Indicators (R&D, GFCF, employment, gross trade/GDP, net FDI/GDP, air transport, population), https://databank.worldbank.org/source/world-development-indicators, Asian Development Bank (ARCII database), https://aric.adb.org/database/arcii. Accessed February 2024.

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