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Being an emerging economy: To what extent do geopolitical risks hamper technology and FDI inflows?

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ABSTRACT

This paper evaluates the impact of geopolitical risk (GPR) on total factor productivity (TFP) and the inflows of foreign direct investment (FDI) for a group of 18 emerging economies between 1985 and 2019. Based on Granger causality panel data tests, we show that the trajectories of these variables cannot be neglected to explain one another. To account for cross-equation influence, we estimate seemingly unrelated regression (SUR) models and uncover a significant and robust negative impact of GPR on TFP and FDI. Counterfactual simulations provide a quantitative approximation of GPR's impact in 2015–2019, which is substantial in terms of TFP growth but small in terms of FDI. For the emerging economies to consolidate their economic progress, geopolitical stability is essential.

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1. Introduction

Trade agreements, multilateral institutions, and economic integration processes are developed to enhance trade opportunities, Foreign Direct Investment (FDI) and international cooperation by securing an environment of stability. They also aim to spread technological progress and economic growth. However, opposing these multinational institutional settings are geopolitical risks such as military and nuclear-related tensions, war and terrorist threats, and actual war or terrorist events resulting in increased geopolitical uncertainty.

Caldara and Iacoviello (2022) collected information on these tensions, threats and events to construct an index "of adverse geopolitical events and associated risks based on a tally of newspaper articles covering geopolitical tensions". This index comprises data since 1990 for 18 emerging economies and is being used in the academic literature to explore the impact of geopolitical risks (GPRs) on different economic dimensions. This information is particularly significant for this set of countries given their positive trajectories in terms of economic progress.

To what extent do geopolitical risks hamper FDI inflows and technological progress? This is the question we aim to answer in this paper, to fill a void in the growing literature relating to emerging economies, which connects geopolitical risks to (i) oil prices and, more generally, to the prices of raw materials; (ii) risk, investment, and financial markets;

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(iii) the tourism industry; (iv) environmental sustainability; (v) military expenditures; and (vi) R&D efforts and economic growth.[1]

Regarding (i), Su et al. (2021) find that higher oil prices and geopolitical risks reinforce one another. This calls for close attention to be paid to the latter as GPRs have the capacity to influence not only oil market fluctuations, but also stock returns, as shown by Alqahtani et al. (2020) for six Gulf Cooperation Council countries, and Kannadhasan and Dasb (2020) for the Asian emerging stock markets. Similarly, Aloui and Hamida (2021) explore how such risks influence the association between oil and stock prices in Saudi Arabia, with different short-term and long-term effects depending on the type of shock that is examined (i.e., oil prices or risks).

With respect to risk, investment, and financial markets, Kim et al. (2019) argue that investors become more reluctant to invest in portfolios of an emerging economy, such as North Korea, when political risks increase. The reason for this is that asymmetric information creates disadvantages for foreign (relative to national) investors in scenarios of geopolitical uncertainty. In terms of FDI, Nguyen and Lee (2021) reveal that countries with a higher level of economic policy uncertainty receive lower FDI inflows and point to a safe-haven *effect*, in which investors tend to shift FDI from risky to safe economies. Bilgin et al. (2020) interestingly provide evidence that GPRs seem to raise government investment to compensate for the negative consequences of geopolitical events. Similarly, Sweidan (2021) suggests that "renewable energy development is expected to increase if the geopolitical risk rises, all else being equal".

There is conclusive evidence that geopolitical stability is necessary for the growth and progress of tourism. Tiwari et al. (2019) uncover the long-run negative influence of geopolitical risks on tourist arrivals in India; Akadiria et al. (2020) unveil a unidirectional causality running from geopolitical risk to economic growth and tourism in Turkey; while, more recently, Lee et al. (2021) describe the negative impact of GPRs on tourism demand for a set of 16 emerging countries.

Finally, the impact of GPRs on environmental degradation (Anser et al., 2021); military expenditures (Khan et al., 2020); and corporate R&D investment (Pan, 2019) has also been considered. Despite this rich array of recent studies, there is no evidence relating the influence of GPR to FDI inflows and total factor productivity (TFP) growth in emerging market economies to complement previous work on their association (see Herzer, 2011, for a set of 33 developing countries), which depends on the levels of human capital, financial development, and trade openness (Herzer and Donaubauer, 2018).

To examine the relationship between GPR, FDI, and TFP growth and be able to assess their cross-equation relationships, we conducted panel data estimation of a system of equations and obtain the following key findings. First, GPR has a stable and significant negative impact on FDI and TFP growth. Second, FDI and TFP growth are positively associated and enhance one another in the FDI and TFP growth equations. Third, FDI and TFP growth are relevant explanatory variables in the GPR equations, with negative and significant coefficients. Fourth, a 10% temporary increase in GPR is very damaging for the trajectory of TFP growth, both in terms of the persistent effects of such shock and the significantly diminished rate of TFP growth that follows the shock.

As noted, GPRs have been identified in the literature as a critical source of sectoral threats in emerging economies. However, beyond the enhanced understanding already achieved on how oil prices, financial markets or the tourism sector suffer in periods of geopolitical turmoil, our analysis will provide a better warning about the consequences that such risks may bring. After this analysis, GPRs should be considered not only a sectoral issue, but a far-reaching constrain detrimental to FDI and technological progress and, therefore, economic growth and welfare. If such warnings are taken seriously, a critical target for emerging economies will be reaching geopolitical stability and minimising risks that may lead to war or nuclear-related tensions, as well as terrorist threats and events.[2]

If there is a significant relationship between political risks/uncertainty and technological progress, between those risks/uncertainty and FDI, and if there is also a significant relationship between FDI and TFP, then it seems reasonable to expect that the three variables are closely intertwined. Yet, no studies have dealt with the simultaneous relationship between GPRs, FDI and TFP, and their feedback effects. Furthermore, the direct impact of GPRs on TFP has not received close attention. To the best of our knowledge, this paper contributes to the field as the first one to simultaneously address the intertwined trajectories of GPR, FDI and TFP.

The rest of this paper is structured as follows. Section 2 provides some background information on the bilateral relationships between GPR, FDI and TFP. Section 3 presents the data and methodology used to empirically assess the multilateral impact among these three variables, which is presented in Section 4. Sections 5 and 6 conduct some robustness checks and simple counterfactual simulations to further ascertain the empirical relationships explored. Section 7 provides a conclusion.

[1] Like ours, these studies use the unique dataset developed by Caldara and Iacoviello (2022) for 18 emerging market economies. We consider the total amount of economies for which data on the GPR is produced, as this increases the amount of cross-section units and the reliability of our results for a set of countries that share the characteristic of being emerging market economies. See Section 3 for further information on this dataset.

[2] Although it is not covered in this analysis, Russia's invasion of Ukraine in February 2022 is a prominent example of the utmost relevance of this claim. Governments, multilateral institutions, and rating agencies quickly acknowledged the rise in geopolitical risks that would result from this war, and highlighted the direct negative impacts and complex ramifications that would follow (see, for example, the IMF-WorldBankjointstatement, on the 1st March 2022, or Fitch's article published just a few days after the start of the conflict).

2. Literature review

This section briefly discusses two strands of literature that elaborate on the interplay between political risk, foreign investment, and economy-wide technological progress.

A thorough review of 4200 papers allowed Yi et al. (2020) to identify the causes of political instability in terms of institutions, democracy, corruption, conflict, war, economy, migration, and inequality, as well as the main actors affected by political instability in terms of economic growth, trade, financial development, tourism, education, health, and property rights, among others. From a business cycle perspective, their analysis also reviews the negative influence of political/policy uncertainty on macroeconomic and financial factors (cycles, inflation, investment, stock markets), and the volatility of energy markets (oil prices above all). Moreover, the determinants of FDI are also addressed by summarising the causal mechanisms, from the environment in which multinational corporates (MNCs) operate to the magnitude of investment inflows, which are diminished in situations of poor institutional quality (which is expressed as, for example, a lack of democracy and policy transparency). In general, the literature on political instability often focuses on developing countries, whereas that on political uncertainty tends to target developed countries.

Among this vast literature, there is a group of studies addressing the relationship between geopolitical risks, stock markets and international investment. For example, Bailey and Chung (1995), Kim and Mei (2001) and Beaulieu et al. (2005) find evidence of a significant effect of political risk on stock exchange performance, stock price fluctuations and market volatility. In this case, political risk is measured through future election outcomes, sovereign default risk and issues pertaining to the future of democracy, human rights, and the country's external trade regime. Studies by Sethi and Luther (1986), Phillips-Patrick (1989), Cherian and Perotti (2001) and Click and Weiner (2010) focus on the harmful effects that political risks and policy uncertainty have on international investment flows, whether they take the form of FDI, portfolio, or loan; and whether this is examined at the country, industry or firm level. This is exacerbated in the case of emerging economies, in which countries risk premia (Cherian and Perotti, 2001) or resource nationalism affecting the value of oil and gas reserves (Click and Weiner, 2010), which may cause extra penalties to the negative influence of GPR on investment flows. It is in this context that we propose a first set of hypotheses (denoted as H), according to which: (i) GPR exerts a negative effect on FDI (H1); and (ii) GPR also exerts a negative effect on TFP growth, especially in emerging market economies (H2).

The second group of studies addresses the link between FDI and technological progress, which may take the form of technological diffusion from MNCs to the recipient countries, knowledge transmission, and R&D investment. These studies identify a diverse FDI–TFP relationship. On the one hand, a positive relationship seems to hold between FDI and the productivity of domestic firms, which increases through imitation of the technological production process and skills acquisition (see, for example, Das, 1987; Wang and Blomstrom, 1992; Glass and Saggi, 1998; Liu et al., 2000; Fosfuri et al., 2001; Bitzer and Gorg, 2009; Woo, 2009; Dasgupta, 2012; among others). On the other hand, some studies point to a negative relationship, which may be unclear or not significant (see, for example, Haddad and Harrison, 1993; Aitken and Harrison, 1999; Alfaro et al., 2004; Ang, 2009; Azman-Saini et al., 2010; among others).

Amidst this debate, our key interest is in the emerging economies, which are receiving increasing attention in the literature. Using a set of least developed economies, Li and Tanna (2019) show that the FDI's direct effect on TFP growth is not robustly significant, although the indirect impacts via (i) interaction effects of FDI with human capital and (ii) FDI's push on institutional quality appear to be strong, with the former being more relevant than the later. In turn, Saurav and Kuo (2020) find consistent evidence of a positive effect of FDI on the productivity of MNCs affiliates in developing countries. While this effect is large and positive for firms in upstream sectors, i.e., suppliers of MNCs, the evidence is mixed for downstream sectors, i.e., buyers and distributors. In contrast, Herzer and Donaubauer (2018) claim that FDI exerts a negative short- and long-run effect on TFP, even though this one-direction causality varies in the long-run amongst alternative groups of countries according to human capital, financial development, and trade openness. Related to this block of literature, we propose a third hypothesis according to which there exists a positive relationship between FDI and TFP growth in emerging market economies (H3).

Additionally, the channel by which GPRs affect TFP growth can be found in the theory of institutions by Acemoglu et al. (2005). These authors explain why economic institutions determine long-run economic growth, which is directly associated with TFP growth as has been well-known since Abramovitz (1956). Acemoglu et al. (2005) start their analysis by outlining the endogeneity of institutions, which explains why they are different across countries and, thereby, cause long-run prosperity heterogeneities. Acemoglu et al. (2005) elaborate on the social conflict view to propose a theory of economic institutions in which the elites (i.e., those that are politically powerful) push for economic institutions that maximise their own rents and not the total rents. As political power is critical in determining political and economic institutions, their study contains a long list of real-world examples for which they explain how political events and the resulting institutional changes have shaped the countries' prosperity. England's experience with the enclosure of common lands; contrasting colonial trajectories (England and Holland versus Spain and Portugal); below par industrialisation experiences of the Russia and Austria-Hungary absolutist monarchies in the nineteenth century; or the impact of dictatorships (Jean-Claude Duvalier in Haiti, Augusto Pinochet in Chile, or Mugabe and the unwinnable Rhodesian guerrilla war) are some examples of those included in the analysis. Our main point here is that had Caldara and Iacoviello's (2022) GPR index been in place at the time of such major events, it would have reacted to such events, as it reacts now to analogous geopolitical threats. In a nutshell, GPRs can be seen as being the other side of the coin to the economic and political certainty induced

by a stable institutional framework. This is the reason emerging market economies is a compelling set of countries to be studied.

Therefore, if there is a significant relationship between political risks/uncertainty and FDI (H1); between those risks/uncertainty and technological progress (H2); and between FDI and TFP (H3); if these hypotheses can be verified and such relationships are empirically relevant, then we further hypothesise that these three variables are closely intertwined (H4), which requires an appropriate consideration of their simultaneous feedback effects. As we explain next, this leads to an econometric methodology based on a panel data system equation estimation, which we complement with traditional individual panel data equation estimation to ensure the stability and robustness of our findings.

3. Data and methodology

Following the preceding discussion, this section (i) provides a statistical examination of the data employed for the empirical analysis; (ii) investigates potential Granger-causality relationships between the three main variables of interest, namely, GPR, TFP and FDI; and (iii) concisely describes the empirical strategy which, as shown in (ii), requires taking seemingly unrelated connections into account.

3.1. Data and descriptive statistics

We construct a dataset from various credible sources. First, regarding geopolitical riskiness, we adopt Caldara and Iacoviello's (2022) set of unique indices measuring geopolitical risk (GPR) for 18 emerging countries.[3] Together with geopolitical risks, from Ahir et al. (2022), we include the new World Uncertainty Index (WUI) to track uncertainty across countries. This index "captures uncertainty related to economic and political developments, regarding both near-term (e.g. uncertainty associated with elections) and long-term concerns (e.g. uncertainty engendered by the impending withdrawal of international forces in Afghanistan, or tensions between North and South Korea)" (Ahir et al., 2022, p. 7). Consideration of this index allows us to better apprehend the cross-equation impact among GPR, FDI and TFP. Note that since both GPR and WUI are available at monthly and quarterly frequencies, they are converted into annual data by averaging over years.[4] Second, net FDI inflows, expressed as a percent of GDP, are taken from the World's Bank World Development Indicators (WDI). Third, TFP cross-sectional time series is obtained from a standard estimation of Solow's residuals using annual capital stock data from the Penn World Table (version 10.0).[5] The combination of information gathered from these different databases on GPR, FDI and TFP leaves us with a weakly unbalanced long panel comprising data on 18 emerging countries over 35 years, 1985–2019.

Empirically testing our hypotheses requires choosing the right econometric method, which depends on the results of some preliminary tests conducted on the explanatory variables (see Section 3.2). Representing some critical macroeconomic conditions, we have income per capita (GDPPC), the proportion of 15–64 years old population over total population (WORKPOP), and inflation (INFL). These variables have been considered in Hermes and Lensink (2003), Alfaro et al. (2009), Bumann et al. (2013), Doytch and Uctum (2016), Zhou et al. (2020), Bilgin et al. (2020), and Nguyen and Lee (2021). Accordingly, we expect GDPPC to have a positive influence on technological progress, but not on the need of FDI inflows; while INFL should have a detrimental effect on both, on account of the worse business atmosphere it causes, which is often associated with a higher level of economic uncertainty.

As in previous studies, we also consider trade openness (TRADE), which is defined as imports and exports of goods and services over GDP. This is accompanied by a measure of financial openness (KAOPEN), which is defined similarly to Bumann and Lensink (2016) and Khalid and Marasco (2019), who use the capital account openness index of Chinn and Ito (2008).[6] Following these just-mentioned empirics and references therein, TRADE and KAOPEN are expected to be positively related to FDI and TFP and negatively related to GPR, since enhanced openness comes hand-in-hand with lower geopolitical risks. Finally, as in Alsagr and van Hemmen (2021) and Gozgor et al. (2019), we use private credit over GDP by banks (PCRGDP) as a proxy of financial development, again with an expected positive influence on FDI.

Summary statistics provided in Table 1 reveal the existence of wide heterogeneities in several variables. For example, although the average TFP growth rate is 0.28%, heterogeneities in technological progress are ample, as reflected in its standard deviation, and extreme maximum and minimum values. This is also the case for the GPR index (with an average of 98.9 points), inflation (53.9%), trade openness (61.0%), and the ratio of private credit over GDP (64.3%), all with large standard deviations. In contrast, FDI inflows behave much more homogeneously than the other variables. In general, country-level data will allow us to exploit the wide range of variation for these variables across countries and over time.

Additionally, Fig. 1 illustrates the inherent volatilities of the eighteen GPR series. Even though the use of annualised data may hide short-run oscillations, some cross-country heterogeneities and trends can be more easily perceived.

[3] We exclude Hongkong from the original dataset because it is a city and a special administrative region of China.

[4] The GPR and WUI open data indices are hosted, respectively, at https://www.policyuncertainty.com/gpr.html and https://worlduncertaintyindex.com/. Note that world uncertainties differ from country-specific geopolitical risks both from a geographic point of view (since the coverage of the WUI amounts to 143 countries) and through the type of collected information.

[5] The Penn World Table (PWT) is hosted at https://www.rug.nl/ggdc/productivity/pwt/.

[6] The Chinn-Ito Index (KAOPEN) is hosted at https://web.pdx.edu/~ito/Chinn-Ito_website.htm.

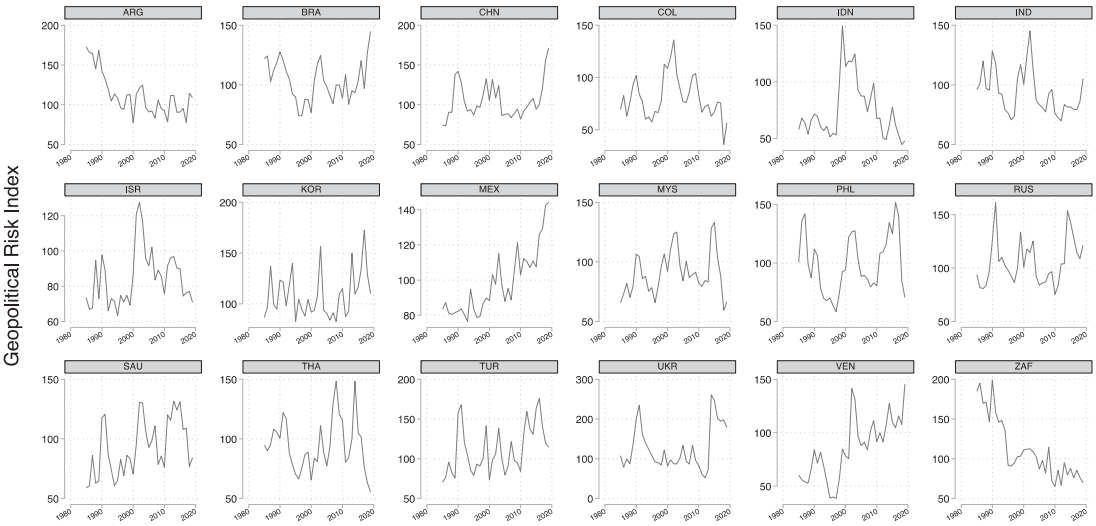


Fig. 1. Geopolitical risk (GPR). 1985–2019. Note: Caldara and Iacoviello (2022) only supply the geopolitical risk (GPR) indices for 18 emerging countries. ARG = Argentina; BRA = Brazil; CHN = China; COL = Colombia; IDN = India; IND = Indonesia; ISR = Israel; KOR = Korea; MEX = Mexico; MYS = Malaysia; PHL = Philippines; RUS = Russia; SAU = Saudi Arabia; THA = Thailand; TUR = Turkey; UKR = Ukraine; VEN = Venezuela; ZAF = South Africa.

Table 1
Descriptive statistics, 1985–2019.

Variable	Description	Obs	Mean	Std. dev.	Min	Max
DTFP	Estimated rate of TFP growth, %	618	0.277	4.348	−39.954	15.638
GPR	Geopolitical risk index	630	98.901	29.107	261.257	35.747
WUI	World Uncertainty Index	630	0.251	0.207	0	1.672
FDI	Foreign direct investment inflows, % of GDP	601	2.014	1.705	−2.757	9.338
GDPPC	GDP per capita, constant GDP	609	8,497	6,965	485	35,286
INFL	Inflation, % annual	585	53.928	313.707	−3.561	4734.914
TRADE	Trade openness, % of GDP	607	61.034	36.287	12.219	220.407
KAOPEN	Financial openness (Chinn-Ito Index)	608	−0.269	1.246	2.322	−1.924
PCRGDP	Private credit to GDP, % of GDP	630	41.624	33.647	1.384	166.504
WORKPOP	15–64 Age population over Total Population, %	630	64.262	4.705	53.918	73.414

Note: The prefix D denotes the log-difference operator.

Table 2
Pairwise correlations.

	DTFP	GPR	WUI	FDI	TRADE	GDPPC	WORKPOP	INFL	KAOPEN	PCRGDP
DTFP	1.000									
GPR	−0.155	1.000								
WUI	−0.003	0.090	1.000							
FDI	0.071	−0.164	0.112	1.000						
TRADE	0.072	−0.027	0.056	0.352	1.000					
GDPPC	−0.076	−0.019	0.055	0.043	0.235	1.000				
WORKPOP	0.107	0.137	0.178	0.357	0.342	0.195	1.000			
INFL	−0.213	0.147	−0.009	−0.100	−0.106	−0.025	0.005	1.000		
KAOPEN	−0.016	−0.192	−0.017	0.141	0.277	0.474	−0.123	−0.153	1.000	
PCRGDP	0.054	0.037	0.033	0.370	0.528	0.179	0.579	−0.012	−0.012	1.000

Note: The prefix D denotes the log-difference operator.

For example, it is straightforward to identify the falling paths of geopolitical risks in Argentina, Colombia, India, and South Africa, in contrast to the deteriorating environment in Brazil, Mexico, and Venezuela. Moreover, Table 2 reports a small positive correlation coefficient between GPR and WUI, indicating that, although they may have synergies in some periods and/or countries, they turn out to be weak on average. In contrast, the statistically significant negative correlations between GPR and the other two dependent variables, the rate of TFP growth and FDI, indicate that the rise of geopolitical risks may hamper economy-wide productivity progress and divert foreign investment flows. Any advance in the assessment of the causal relationship among these three variables is non-trivial in a panel setting and requires further analysis. Fortunately, the rest of the pair-wise correlations are low, and the risk of multicollinearity issues is minimal.

Table 3
Panel unit root tests.

	LTFP	LGPR	FDI	LWUI	TRADE	LGDPPC	WORKPOP	INFL	KAOPEN	PCRGDP
Null: Unit root (assumes common unit root process)										
LLC	Yes	No	No	No	Yes	Yes	No	No	Yes	No
Breitung	Yes	No	No	No	Yes	Yes	Yes	No	No	Yes
Null: Unit root (assumes individual unit root process)										
IPS	Yes	No	No	No	Yes	Yes	Yes	No	No	Yes
ADF - Fisher	No	No	No	No	Yes	Yes	Yes	No	Yes	Yes
PP - Fisher	Yes	No	No	No	Yes	Yes	Yes	No	Yes	Yes

Note: Yes/No represents for Accept/Reject the null hypothesis, respectively, at significant levels of 5% or 1%; The prefix L denotes the logarithm operator; All panel unit root tests are with constant and trend specification. LLC is a short name for Levin et al. (2002), IPS is Im et al. (2003), Breitung is Breitung (2000), and the Fisher-type of Choi (2001).

Table 4
Panel Granger causality tests based on Dumitrescu and Hurlin (2012).

Null hypothesis	$\overline{W} - stat$	$\overline{Z} - stat$	Prob.
LGPR ⇒ DTFP	3.5871	3.3668	0.0008
LGPR ⇒ FDI	4.3283	2.1691	0.0301
FDI ⇒ DTFP	3.6937	3.3875	0.0007
FDI ⇒ LGPR	1.4903	−1.0195	0.3080
DTFP ⇒ FDI	3.5615	3.5615	0.0018
DTFP ⇒ LGPR	3.4583	2.9166	0.0035

Notes: As the panel Granger-causality test requires a strong balanced panel stationary data, the sample is adjusted; Prefixes L and D denote logarithm and log-difference operators, respectively; The arrow shows the causality direction.

3.2. Preliminary tests

As part of the regression analysis, it is critical to assess the existence of (i) Granger causality relationships across dependent variables and (ii) potential spurious correlation due to non-stationary data in the empirical model.[7] We begin with standard panel unit root tests whose results, shown in Table 3, confirm that LTFP, TRADE, LGDPPC, WORKPOP and the financial development indicators KAOPEN and PCRGDP are all characterised by unit roots. The trajectories of LGPR, FDI, LWUI and INFL, on the contrary, are not governed by non-stationary processes. It follows that, to prevent any risk of spurious correlation across variables, the TFP series must be log-differenced (denoted as DTFP) if considered as a left-hand side variable in a regression model.[8]

The panel Granger test based on Dumitrescu and Hurlin (2012) assumes that there can be causality in some countries but not necessarily in all of them. As a result, rejecting the null of absence of causality does not guarantee the existence of a causal connection in *all* countries. It is also worth pointing out that Dumitrescu and Hurlin's (2012) algorithm can effectively accommodate the effect of cross-sectional dependence with block bootstrapped critical values. For this to hold, however, there is a requirement of a strongly balanced panel that reduces the effective sample size.

As Table 4 shows, the test fails to accept the null hypotheses that GPR does not Granger cause DTFP and FDI at 1% and 5% significant levels, respectively. It strongly rejects the null that FDI does not Granger cause DTFP, but it cannot reject a non-causal relation from FDI to GPR. Finally, it statistically rejects the null that DTFP does not Grange cause GPR and FDI. These results point to a significant interplay between our three variables of interest, which is explored in the next section.

3.3. Baseline empirical strategy

To consider the interplay between GPR, FDI and TFP, we simultaneously consider three generic panel models as follows:

$$DTFP_{it} = \alpha_0 + \alpha_1 LGPR_{it} + \alpha_2 FDI_{it} + \sum_{j=1}^{J_1} \delta_{1j} Z_1(j)_{it} + \epsilon_{1,it} \quad (1)$$

$$FDI_{it} = \beta_o + \beta_1 DTFP_{it} + \beta_2 LGPR_{it} + \sum_{j=1}^{J_2} \delta_{2j} Z_2(j)_{it} + \epsilon_{2,it} \quad (2)$$

[7] We consider the log versions of TFP, GPR, WUI and GDPPC. We identify them by adding L to the respective acronyms.

[8] The procedure to determine the existence of causality requires stationary data (Kónya, 2006; Dumitrescu and Hurlin, 2012), meaning that TFP also has to be stationarised.

$$LGPR_{it} = \gamma_o + \gamma_1 DTFP_{it} + \gamma_2 FDI_{it} + \sum_{j=1}^{J_3} \delta_{3j} Z_3\,(j)_{it} + \epsilon_{3,it} \tag{3}$$

where the subscripts i and t identify specific country and year, respectively; prefixes L and D denote the natural logarithm and log-difference operators, respectively; the α's, β's, γ's, and γ's are the parameters to be estimated, while the ϵ's are the residuals. Along our specified hypotheses, we expect $\alpha_1 < 0$, $\alpha_2 > 0$, $\beta_1 > 0$, $\beta_2 < 0$, $\gamma_1 < 0$, and $\gamma_2 < 0$. In turn, $Z_k(j)$ is a set of control variables accounting, as previously discussed, for economic uncertainty (LWUI), macroeconomic conditions (LGDPPC, WORKPOP and INFL), economic openness (TRADE and KAOPEN) and financial development (PCRGDP). In the Appendix, we consider additional explanatory variables related to institutional quality and alternative financial development indices accounting specifically for the institutional quality of the financial sector.

The use of country-level data allows us to exploit the wide range of variation in geopolitical risks across economies and over time. The overall disturbances can be further decomposed into $\epsilon_{it} = u_i + \lambda_t + v_{it}$, where u_i and λ_t capture unobservable individual and time effects.[9] Of course, model (1)–(3) can be estimated, equation by equation, following a standard estimation strategy when dealing with panel data. However, our preceding analysis revealed triangle causal relationships between GPR, FDI and TFP, which implies that the presence of contemporaneous correlations across error terms is most likely to be relevant. Hence, similar to Wang and Wong (2009) and Shabir et al. (2021), we stack all equations in Zellner (1962)'s fashion:

$$\begin{bmatrix} DTFP_{it} \\ FDI_{it} \\ LGPR_{it} \end{bmatrix} = \begin{bmatrix} X_{1,it} & 0 & 0 \\ 0 & X_{2,it} & 0 \\ 0 & 0 & X_{3,it} \end{bmatrix} \begin{bmatrix} \beta_1^{sur} \\ \beta_2^{sur} \\ \beta_3^{sur} \end{bmatrix} + \begin{bmatrix} \varepsilon_1^{sur} \\ \varepsilon_2^{sur} \\ \varepsilon_3^{sur} \end{bmatrix} \tag{4}$$

so that the model can be read as a system of equations of the form $\boldsymbol{Y} = \boldsymbol{X}\boldsymbol{\beta}^{\boldsymbol{sur}} + \boldsymbol{\varepsilon}$, where the $\boldsymbol{Y} = \left(DTFP'_{it}, FDI'_{it}, LGPR'_{it}\right)'$ is a vector – sized $(3NT \times 1)$ – of all vertically stacked dependent variables; $\boldsymbol{X}$ is a $(3NT \times 3K)$ block diagonal matrix comprising all single equation K regressors; and $\boldsymbol{\beta}^{\boldsymbol{sur}}$ is a $(3K \times 1)$ stacked vector of regression coefficients. Note that the overall disturbances $\boldsymbol{\varepsilon}$ can also be re-written as the sum of two-way fixed effects and idiosyncratic errors. The system (4) is the so-called seemingly unrelated regression (SUR) model that takes interrelations between single equations (1)–(3) into consideration. An important characteristic of the SUR model is that it is only valid if one can reject the test of residuals independence (Breusch and Pagan, 1980).

The Zellner's SUR estimator gives $\boldsymbol{\beta}^{\boldsymbol{sur}} = \left[\boldsymbol{X}'\Omega^{-1}\boldsymbol{X}\right]\left[\boldsymbol{X}'\Omega^{-1}\boldsymbol{Y}\right]$, where the weighting matrix $\hat{\Omega}^{-1}$ is obtained from single equation OLS estimates. Thus, the SUR model is actually an application of the generalised least squares (GLS)[10] so that it may also suffer from serial autocorrelation and heteroskedasticity across panel equations. To prevent such potential issues from affecting our empirical results, we report cluster-robust estimates instead of plain GLS estimates (Kolev, 2022).

A final issue refers to the static or dynamic specification of the estimated models. Although some literature claims that the inclusion of a lagged dependent variable (LDV) on the right-hand side of a model could have a substantial impact on the estimated coefficients (Wilkins, 2017), there are two compelling reasons why dynamics should be considered in a setting such as ours. The first is a purely technical reason since it frees estimates from serial correlation. The second is that political processes are usually of a dynamic nature, meaning that the "effects of the current decision will not only resonate in the year impact but will also feed-forward in the future" (Keele and Kelly, 2006). Consequently, the LDV coefficient has a dynamic interpretation, making it a preferable choice for modelling the persistent effects of political-related variables in a $T''N$ and $T \geq 30$ panel (Beck and Katz, 2011; Beck et al., 2014).

The following section begins with a SUR estimation of the simplest model with no control vector $Z(j)$ just as a first check on the instinctive nexus between GPR, TFP and FDI. The information set is subsequently expanded with the $Z(j)$ elements. We have chosen to present results based on the estimation of static and dynamic models and leave the individual equation estimations for Appendix.

4. Results

Table 5 reports SUR estimates of the baseline model. Columns (1) to (3) show the benchmark results in which each dependent variable is regressed on the other equations' dependent variables in addition to LWUI as a unique control variable. The latter is needed to disentangle idiosyncratic geopolitical risks from worldwide uncertainties correctly.[11] The specification giving rise to the results in columns (4) to (6) include trade openness, per capita income levels, the proportion of the working-age population over total population, and inflation. Finally, columns (7) to (9) report the results when financial considerations such as the degree of financial development and openness are included.

[9] In many cases, the time fixed effects can be modelled as $\bar{\lambda}t$ for mitigating the inflation of dummy variables. The difference between the two specifications appears to be negligible when T being large.

[10] The alternative is to renounce to a system equation estimation method, which is against the Panel Granger causality evidence and, in any case, does not deliver substantially different results, as shown in Table A.1 in Appendix.

[11] In any case, the untransformed WUI does not alter the main results and conclusions presented in this paper.

Table 5
SUR baseline estimation.

Variables	(1) DTFP	(2) FDI	(3) LGPR	(4) DTFP	(5) FDI	(6) LGPR	(7) DTFP	(8) FDI	(9) LGPR
LGPR	−2.4096***	−1.7684***		−1.4776**	−1.4700***		−1.8001***	−1.3292***	
	(0.6936)	(0.3638)		(0.5996)	(0.2179)		(0.5620)	(0.2281)	
FDI	0.4867***		−0.0604***	0.4085***		−0.0547***	0.2217**		−0.0392***
	(0.1480)		(0.0111)	(0.1067)		(0.0074)	(0.0970)		(0.0069)
DTFP		0.0697***	−0.0069***		0.0657***	−0.0039		0.0430**	−0.0103***
		(0.0195)	(0.0015)		(0.0156)	(0.0027)		(0.0183)	(0.0033)
LWUI	−0.0615	0.1096	0.0270	−0.2388	0.1111	0.0249*	−0.1596	0.0450	0.0148
	(0.2767)	(0.0767)	(0.0253)	(0.1793)	(0.0710)	(0.0138)	(0.1806)	(0.0746)	(0.0131)
TRADE				−0.0013	0.0069*	0.0015**	0.0076	0.0072*	0.0018**
				(0.0115)	(0.0039)	(0.0007)	(0.0114)	(0.0043)	(0.0008)
LGDPPC				0.9262	−0.6090**	−0.0799	2.3939***	−0.7206**	−0.0157
				(0.6419)	(0.2704)	(0.0518)	(0.7889)	(0.3322)	(0.0568)
WORKPOP				−0.1059	0.0540	−0.0002	−0.0216	0.1153***	0.0028
				(0.0878)	(0.0386)	(0.0076)	(0.0853)	(0.0409)	(0.0077)
INFL				−0.0027***	−0.0002	0.0001**	−0.0009	−0.0003	0.0001
				(0.0005)	(0.0002)	(0.0000)	(0.0009)	(0.0002)	(0.0000)
KAOPEN							0.2240	0.2928***	0.0113
							(0.1906)	(0.0842)	(0.0119)
PCRGDP							−0.0367***	0.0033	−0.0005
							(0.0119)	(0.0043)	(0.0006)
Constant	8.1477**	9.3097***	4.6390***	1.4910	10.2933***	5.2933***	−14.1945*	7.0547*	4.5962***
	(3.4527)	(1.6486)	(0.1396)	(8.0453)	(3.5216)	(0.5310)	(8.5478)	(3.8885)	(0.6603)
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	597	597	597	569	569	569	551	551	551
R-squared	0.2397	0.4360	0.2402	0.3068	0.4722	0.2356	0.3313	0.4989	0.3990
Breusch–Pagan test	0.0000			0.0003			0.0007		

Cluster-robust standard errors in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

The results are stable, with significant negative impacts of GPR on TFP growth and FDI. When these effects are examined on a static basis (Table 5), we find a coefficient of −1.80 in model (7), implying that a 10% increase in geopolitical risks (say from 100, close to the average, to 110) is associated with a 0.18% fall in the growth rate of TFP. This estimation highlights the potential harm to economic growth and international investment caused by risks related to military and nuclear tensions, actual war and terrorist events, or threats in any of these dimensions.

As expected, FDI and TFP growth are positively associated and tend to reinforce one another. The positive influence of FDI on TFP growth in developing countries has already been explored in Li and Tanna (2019), where it is attributed to technological transfer and capital accumulation, and can be enhanced by improving institutional quality. This positive nexus is also reviewed by the World Bank in Saurav and Kuo (2020), who take a firm-level perspective. In our estimation (we still refer to model 7, with all the control variables), the coefficient of 0.22 indicates that a single percentage point rise in the ratio of FDI inflows over GDP (say from 2% to 3%) pushes the growth rate of TFP by 0.22%. Conversely, the influence of TFP growth on FDI (other things equal) can be rationalised through the prospects and guarantees that economies with technological progress provide to foreign long-run investors. In this case, the estimated coefficient amounts to 0.043, meaning that a 10% increase in the rate of TFP growth (say from 0.30%, close to the average, to 0.33%) causes a 0.43 percentage point increase in FDI.

It should also be noted that the influence of DTFP and FDI as explanatory variables in the LGPR equations is negative and significant. This result points to a sort of virtuous circle in which securing technological progress together with FDI inflows is a self-reinforcing strategy to reduce geopolitical risks and, indirectly, succeed in reinforcing TFP growth and FDI inflows. The coefficient of FDI is −0.039, meaning that a single percentage point increase in FDI, diminishes geopolitical risks by 3.9%, while the coefficient of TFP growth is −0.01 meaning that a 10% rise in the growth rate of TFP diminishes them by 1%. In Section 6, we conduct some counterfactual simulations to illustrate to what extent, other things equal, self-reinforcing effects between these three variables contribute to shape their trajectories.

Table 6 provides additional results in a dynamic setting. The appropriateness of the inclusion of lagged dependent variables (LDV, henceforth) in a panel data setting with political-related variables, like ours, has been discussed following the works by Beck and Katz (1995, 2011) and Beck and J.N. (1996), the latter introducing the issue relating to the speed of adjustment of measured and unmeasured variables. Wilkins (2017) outlines the risk of biased estimation if lagged dependent variables are excluded from the analysis, and concludes that "while no panacea, scholars should continue to confidently include LDVs as part of a robust estimation strategy" (Wilkins, 2017, p. 1).[12]

[12] As explained by Keele and Kelly (2006), the inclusion of lagged explanatory variables may result in multi-collinearity issues. Additionally, following the literature, we should expect the contemporaneous impact of the explanatory variables. In the case of WUI, whose use is novel in

Table 6
SUR estimation with lagged dependent variables.

Variables	(1) DTFP	(2) FDI	(3) LGPR	(4) DTFP	(5) FDI	(6) LGPR	(7) DTFP	(8) FDI	(9) LGPR
DTFP(−1)	0.2606**			0.2409**			0.0860		
	(0.1145)			(0.1222)			(0.0931)		
FDI(−1)		0.5476***			0.5339***			0.5133***	
		(0.0589)			(0.0579)			(0.0663)	
LGPR(−1)			0.6526***			0.6370***			0.6435***
			(0.0363)			(0.0377)			(0.0374)
LGPR	−2.2607***	−0.5944**		−1.7861***	−0.4323*		−1.9608***	−0.4765*	
	(0.5920)	(0.2517)		(0.5885)	(0.2235)		(0.5015)	(0.2499)	
DTFP		0.0522***	−0.0104***		0.0549***	−0.0089***		0.0461**	−0.0133***
		(0.0139)	(0.0031)		(0.0152)	(0.0026)		(0.0213)	(0.0027)
FDI	0.3021***		−0.0165***	0.2715***		−0.0178***	0.1463		−0.0198***
	(0.0895)		(0.0046)	(0.0873)		(0.0049)	(0.0992)		(0.0054)
LWUI	−0.1020	0.0740	0.0143	−0.1246	0.0956	0.0121	−0.0864	0.0712	0.0120
	(0.2352)	(0.0731)	(0.0142)	(0.2104)	(0.0682)	(0.0142)	(0.2205)	(0.0679)	(0.0150)
TRADE				0.0001	0.0008	0.0008	0.0069	0.0012	0.0008
				(0.0112)	(0.0028)	(0.0005)	(0.0109)	(0.0034)	(0.0006)
LGDPPC				0.7621	−0.4103*	−0.0346	2.5011*	−0.4764*	−0.0179
				(0.9134)	(0.2136)	(0.0474)	(1.3739)	(0.2674)	(0.0535)
WORKPOP				−0.0768	0.0227	−0.0014	0.0040	0.0524*	0.0019
				(0.0979)	(0.0269)	(0.0069)	(0.0900)	(0.0313)	(0.0076)
INFL				−0.0022***	−0.0001	−0.0000	−0.0006	−0.0001	0.0000
				(0.0007)	(0.0001)	(0.0000)	(0.0006)	(0.0002)	(0.0000)
KAOPEN							0.3699*	0.1576*	0.0027
							(0.2112)	(0.0847)	(0.0077)
PCRGDP							−0.0376**	0.0010	−0.0004
							(0.0162)	(0.0038)	(0.0006)
Constant	12.4509***	3.1565***	1.6430***	8.3136	4.7869	2.0718***	−10.8721	4.0166	1.7504***
	(3.7568)	(1.1169)	(0.1557)	(10.4065)	(3.0865)	(0.5278)	(13.9952)	(3.3002)	(0.5898)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	580	580	580	556	556	556	538	538	538
R-squared	0.3143	0.6190	0.5779	0.3594	0.6319	0.5557	0.3686	0.6305	0.5327
Breusch–Pagan test	0.0162			0.0394			0.0156		

Clustered-robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table A.2 in the Appendix provides additional results where the set of explanatory variables include (i) measures of general institutional quality; and (ii) alternative measures of financial development related, also, to the institutional quality of this critical economic sector. As the estimated coefficients on GPR, FDI and TFP are reasonably stable, our findings remain qualitatively unchanged.

In Table 6, we check whether our key coefficients of interest change when a lagged dependent variable is included in the specification. The stability of the results on the impacts of geopolitical risk is remarkable, as well as the general stability of the estimated coefficients across specifications. It is worthwhile stressing that, with one exception, the lagged dependent variables are significant in all models and specifications. The exception can be found in column (7), which shows that the last period's growth rate of TFP has no statistical influence in explaining its current rate, which implies that inertia in the rate of growth of TFP in this set of emerging economies is not significant. The inclusion of the lagged dependent variables contributes explanatory power to all specifications.

Our reference estimation, with all the control variables considered, delivers a coefficient of LGPR on DTFP that amounts to −1.96, somewhat larger than the one resulting from the static regression (−1.80). In turn, the coefficient in the FDI equation amounts to −0.48, which when computed as a long-run coefficient rises to −0.98, somewhat below the −1.33 reported in Table 5, column (8). Finally, the effects of FDI and DTFP on LGPR are also robust to the inclusion of lagged dependent variables in the three-equation system, with significance levels of 1% and coefficients that amount to −0.013 and −0.02, respectively. It follows that in the most complete specification of the GPR equation, the FDI negative impact is larger than the one of DTFP. To the extent that FDI is the outcome of the evaluation and subsequent implementation of managerial decisions, FDI's larger impact than that of technological progress is plausible on account of the economic and political influence on GPR that such global managers may succeed to exert.[13]

the field, we also expect a contemporaneous impact as global turmoil periods have very quick impacts on economic outcomes (Russia's invasion of Ukraine in February 2022 is a prominent example, as explained in footnote 2). Of course, this does not exclude the critical relevance of dynamics in other contexts, for example, in the case of pronounced physical impacts brought on by natural disasters, as shown by Doytch (2020) in her study of FDI determinants.

[13] In March 2021, the US National Intelligence council published a report called "GlobalTrends2040:AmorecontestedWorld". After consulting with top business leaders and legal, public-policy, and risk professionals at Fortune 500 companies in multiple industries, Grant et al. (2021) suggest "that

Table 7
Re-estimation SUR models with adjusted data samples for robustness check.

	Reduced sample 1			Reduced sample 2			Reduced sample 3		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Variables	DTFP	FDI	LGPR	DTFP	FDI	LGPR	DTFP	FDI	LGPR
LGPR	−1.7578***	−0.6450***		−1.9439***	−0.5415**		−1.9830***	−0.5262**	
	(0.6142)	(0.2221)		(0.5788)	(0.2251)		(0.5916)	(0.2260)	
DTFP		0.0368**	−0.0133***		0.0413**	−0.0131***		0.0434**	−0.0139***
		(0.0173)	(0.0027)		(0.0172)	(0.0026)		(0.0173)	(0.0026)
FDI	0.0882		−0.0144**	0.1006		−0.0238***	0.1808*		−0.0188***
	(0.0999)		(0.0063)	(0.0978)		(0.0061)	(0.1070)		(0.0064)
LWUI	−0.0711	0.1039	0.0091	−0.1739	0.1048	0.0061	−0.1279	0.0393	0.0219*
	(0.1729)	(0.0687)	(0.0109)	(0.1833)	(0.0707)	(0.0115)	(0.2028)	(0.0767)	(0.0124)
Lagged dependent	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	480	480	480	498	498	498	470	470	470
R-squared	0.3219	0.6072	0.5085	0.3286	0.6451	0.5694	0.3492	0.6144	0.5853

Note: Reduced samples 1, 2 and 3 exclude the two countries having the highest and lowest mean values of GPR, DTFP and FDI, respectively. All models include lagged dependent variables and a set of macroeconomic condition variables considered in columns (7)–(9) of Table 6.

5. Robustness

5.1. Exclusion of selected economies

Given the structure of our database, with $N = 18 < T = 35$, we check for robustness by conducting subsample estimations affecting the shortest and, thus, most sensitive dimension of our panel. Accordingly, we reduce the amount of cross-section units and exclude the economies that, without necessarily being outliers, have average values of the dependent variables at the periphery of the information set. We conduct estimations for each dependent variable at a time, so that we rule out the possibility that extreme values of any particular key variable or country drive our system estimation results.

The results are reported in Table 7,[14] and need to be compared to the reference specifications in columns (7) to (9) presented in Table 6. This time, however, we do not show all the details and focus on the key coefficients of interest. Reduced sample 1 excludes the two economies having the highest and lowest mean values of GPR, which are Ukraine and Indonesia, respectively. Reduced sample 2 proceeds analogously, with DTFP, meaning that Thailand and Venezuela are the ones excluded. Finally, reduced sample 3 excludes Malaysia and Korea, which are the economies with the highest and lowest mean values of FDI.

The bottom line from this analysis is the stability of our key coefficients of interest. The first observation is that the R-squared remains at approximately the same values as the original ones, which were, respectively, 0.32, 0.61 and 0.51 for each equation. Second, while the coefficients of LGPR and FDI in the DTFP equation were −1.96 and 0.146 (column (7), Table 6), the three reduced subsamples deliver coefficients in the range (−1.76, −1.98) and (0.09, 0.18), respectively. The former coefficient was significant and remains so in Table 7, while the later was not, but becomes significant with reduced sample 3. The coefficients of LGPR and DTFP in the FDI equation were −0.48 and 0.05 (column (8), Table 6), while with the reduced samples they range from −0.52 to −0.65 in the first case, and from 0.037 and 0.043 in the second case. Finally, the coefficients of DTFP and FDI in the LGPR equation, which were −0.013 and −0.02 (column (9), Table 6), take very similar values in the first case, while they range from −0.014 to −0.019 in the second case. In a nutshell, the stability of the estimated coefficients across samples is remarkable, while the one on LWUI is consistently non-significant with just one exception, no matter the sample used.

We conclude that the robustness of our findings is endorsed by the stability of the empirical results across reduced subsamples which: (i) dispense with different periphery values of the information set (affecting recursively each dependent variable); (ii) involve the omission of different economies in each case; and (iii) affects the shortest (and thus most sensitive) dimension of the panel.

company leaders can use a five-pronged approach to managing geopolitical risk": (i) systematic board analysis to enhance companies' resilience; (ii) create short-term, midterm, and long-term response strategies; (iii) think critically about the corporate narrative; (iv) deploy refreshed risk frameworks and guidelines as, they argue, "prudent geopolitical risk management also requires understanding how to deal with issues that cross borders"; and (v) secure stakeholders' hearts and minds.

[14] We also regressed the model for subsamples of countries (such as non-BRICS and resource rich countries) and confirmed the robustness of our results.

Table 8
SUR estimations with log-level TFP and lagged dependent variables.

Variables	(1) LTFP	(2) FDI	(3) LGPR	(4) LTFP	(5) FDI	(6) LGPR	(7) LTFP	(8) FDI	(9) LGPR
LTFP(−1)	0.9496***			0.9348***			0.9299***		
	(0.0252)			(0.0239)			(0.0256)		
FDI(−1)		0.5466***			0.5335***			0.5134***	
		(0.0583)			(0.0575)			(0.0660)	
LGPR(−1)			0.6533***			0.6379***			0.6442***
			(0.0361)			(0.0376)			(0.0373)
LGPR	−0.0309***	−0.5767**		−0.0241***	−0.4188*		−0.0231***	−0.4714*	
	(0.0067)	(0.2531)		(0.0067)	(0.2253)		(0.0054)	(0.2505)	
DTFP		0.0604***	−0.0117***		0.0633***	−0.0099***		0.0497**	−0.0138***
		(0.0142)	(0.0029)		(0.0154)	(0.0026)		(0.0214)	(0.0028)
FDI	0.0041**		−0.0160***	0.0042***		−0.0175***	0.0022**		−0.0197***
	(0.0018)		(0.0044)	(0.0014)		(0.0048)	(0.0011)		(0.0054)
LWUI	−0.0019	0.0751	0.0141	−0.0025	0.0970	0.0120	−0.0016	0.0717	0.0120
	(0.0026)	(0.0735)	(0.0143)	(0.0021)	(0.0685)	(0.0143)	(0.0022)	(0.0681)	(0.0150)
TRADE				−0.0000	0.0008	0.0008	0.0001	0.0012	0.0008
				(0.0001)	(0.0028)	(0.0005)	(0.0001)	(0.0034)	(0.0006)
LGDPPC				0.0178	−0.4186**	−0.0333	0.0319	−0.4858*	−0.0162
				(0.0177)	(0.2125)	(0.0471)	(0.0210)	(0.2678)	(0.0534)
WORKPOP				−0.0028	0.0235	−0.0015	−0.0017	0.0523*	0.0019
				(0.0019)	(0.0269)	(0.0068)	(0.0013)	(0.0313)	(0.0075)
INFL				−0.0000***	−0.0001	−0.0000	−0.0000	−0.0001	0.0000
				(0.0000)	(0.0001)	(0.0000)	(0.0000)	(0.0002)	(0.0000)
KAOPEN							0.0029	0.1559*	0.0029
							(0.0022)	(0.0849)	(0.0076)
PCRGDP							−0.0004**	0.0011	−0.0004
							(0.0002)	(0.0038)	(0.0006)
Constant	0.3093***	3.0634***	1.6400***	0.3309*	4.7345	2.0612***	0.1582	4.0733	1.7340***
	(0.0734)	(1.1261)	(0.1555)	(0.1884)	(3.0479)	(0.5265)	(0.1636)	(3.2862)	(0.5875)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	580	580	580	556	556	556	538	538	538
R-squared	0.9964	0.6178	0.5761	0.9949	0.6308	0.5545	0.9959	0.6317	0.5580
Breusch–Pagan test	0.0012			0.0068			0.0066		

Clustered-robust standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

5.2. Estimation of the TFP equation in log-levels

Table 8 supplies the results when estimating the TFP equation using TFP log-levels (dependent and lagged dependent variable), but keeping TFP growth rates as explanatory variables in the FDI and LGPR equations. The reason is that consideration of log-TFP levels in these equations is not compatible with the Breusch–Pagan test.[15]

When TFP levels are considered, the persistence coefficient in this equation becomes very large, with values between 0.93 and 0.95 (columns (1), (4) and (7)). Such large coefficients, close to unity, endorse our benchmark specification with TFP expressed in log-differences, which was required after the unit roots test analysis in any case. Another consequence of the large persistence estimates is that the coefficient of determination in these specifications reaches values close to 1. It is worthy to point out, however, that none of the conclusions we reached with the benchmark regression analysis lose weight as the triangle relationship between GPR, technology and investment flows is robust and remains significant across specifications.

6. A simple illustration of GPR's influence on technology and FDI inflows

This section provides a simple illustration of the influence exerted by GPR over technological progress and FDI inflows. We take, as reference, our system estimates in models (7) to (9) in Table 6, including dynamics and all the control variables, and ensure that the initial conditions imposed on the simulation system coincide with the sample average values of GPR, DPTF and FDI (100, 2.0% and 0.3%, respectively). On this basis, we check the response of GPR, FDI and DTFP when a one-off 10% increase in GPR takes place. Since the simulation is based on panel data estimated coefficients, this response should be considered an illustration of the effects of the shock "on average"; that is, representative of the 18 emerging economies considered, but inaccurate from a country-specific perspective.

[15] The SUR estimations with log-level of TFP as a regressor in the FDI and LGPR equations are statistically consistent with Tables 6 and 7 in terms of coefficient signs. These results are not shown but are available upon request.

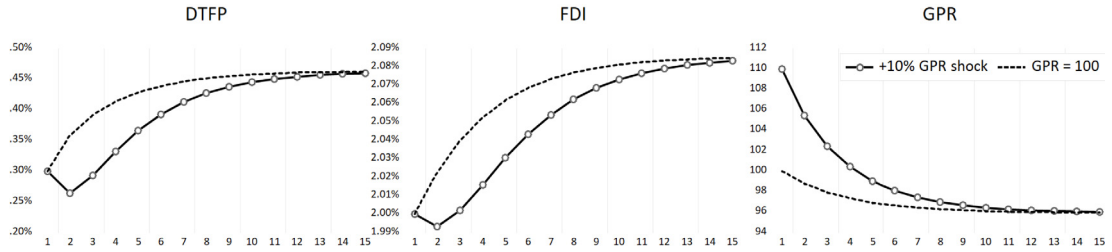


Fig. 2. Deterministic dynamics of GPR, FDI and DTFP in response to a one-off 10% shock in geopolitical risk. Note: Baseline scenario (red line) imposes the initial states of GPR, FDI and DTFP as 100, 2.0% and 0.3%, respectively. The +10% GPR scenario (dotted blue line) implies a one-off GPR shock that raises GPR by 10 index points or 10% of 100.

Table 9
Impulse-responses of technology and FDI to a one-off 10% shock in geopolitical risk.

	DTFP				FDI			
Period	+10% GPR	Baseline	Change	Change%	+10% GPR	Baseline	Change	Change%
0	0.300	0.300			2.000	2.000		
1	0.264	0.358	−0.094	−26.3%	1.993	2.022	−0.029	−1.44%
3	0.293	0.392	−0.099	−25.3%	2.002	2.040	−0.038	−1.85%
4	0.332	0.414	−0.082	−19.8%	2.016	2.052	−0.036	−1.77%
5	0.366	0.428	−0.062	−14.6%	2.031	2.062	−0.031	−1.51%
6	0.393	0.439	−0.046	−10.5%	2.043	2.069	−0.025	−1.21%
7	0.413	0.446	−0.033	−7.5%	2.054	2.073	−0.019	−0.94%
8	0.427	0.451	−0.024	−5.3%	2.062	2.077	−0.015	−0.71%
9	0.437	0.455	−0.017	−3.8%	2.069	2.079	−0.011	−0.52%
10	0.445	0.457	−0.012	−2.7%	2.073	2.081	−0.008	−0.38%
11	0.450	0.459	−0.009	−1.9%	2.077	2.082	−0.006	−0.28%
12	0.454	0.460	−0.006	−1.3%	2.079	2.083	−0.004	−0.20%
13	0.457	0.461	−0.004	−0.9%	2.081	2.084	−0.003	−0.14%
14	0.459	0.462	−0.003	−0.7%	2.082	2.084	−0.002	−0.10%
15	0.460	0.462	−0.002	−0.5%	2.083	2.085	−0.002	−0.07%

Note: Baseline scenario imposes the initial states of GPR, FDI and DTFP as 100, 2.0% and 0.3%, respectively. The +10% GPR scenario implies a one-off GPR shock that raises GPR by 10 index points or 10% of 100.

Fig. 2 shows the trajectories of the variables departing from their initial average values. This is the reason why, in the left panel, the GPR trajectories depart from 100 (baseline) and 110 (+10% GPR shock). In this setting, a one-off shock in GPR takes several years to be absorbed (4 to 5 years to reach 90% of their final converging value). This one-off GPR shock causes major changes in DPTF, but mild changes in FDI. There is an immediate impact of −26.3% in DTFP and strong persistence; two-thirds of the impact remain after 5 years (−0.062) and it takes a decade for 90% of the shock to be absorbed. Regarding FDI, a 10% GPR shock causes an immediate impact of −1.44% on foreign investment inflows. Although it has little impact, the shock is very persistent; the impact of the shock is still −1.51% after 5 years, and it takes 13 years for 90% of the shock to be absorbed.

To round off the previous analysis, we run a within-sample simulation to illustrate the impact of a GPR shock within the context of the 'actual' aggregate trajectories of DTFP and FDI in 2015–2019.[16] The results are presented in Fig. 3. Actual values (continuous line) correspond to the weighted average trajectory of the 18 emerging economies considered, using GDP weights. Simulated values (dashed line) correspond to a scenario in which GPR takes its 2014 value during 2015–2019, rather than falling progressively from 109.8 in 2014 to 96.0 in 2019. In other words, our counterfactual aims at illustrating the positive impact of the (emerging economies aggregate) 12.5% fall in geopolitical risks in 2015–2019. Panel A and Panel B of Fig. 3 plot the 'actual' average trajectories of DTFP and FDI, respectively, together with the simulated trajectory in the absence of such a fall. (See Table 9.)

In this context, the first noteworthy observation is that the growth rate of TFP has been on a downward trend in the emerging economies, falling from −0.12% in 2014 to −2.33% in 2019. Had geopolitical risks not decreased, such a fall would have been steeper, leading to −2.52% in 2019. The 0.2 percentage points difference in 2019 is the response to the fall of 12.5% in GPR and accounts for around 10% of the actual fall in DTFP. This is close to a one-to-one relationship. Regarding FDI inflows as a rate of GDP, there has been an overall increase from 1.84% in 2014 to 2.17% in 2019, not resulting from

[16] Note that there is no true actual trajectory, since we have constructed the aggregate series using GDP weights. Moreover, we illustrate the within-sample impact of geopolitical risks using coefficient estimates for the whole sample period. Still, we believe it is a worthwhile exercise to have such an illustration embedded into a real context approximation in which the influence of geopolitical risks can be straightforwardly assessed.

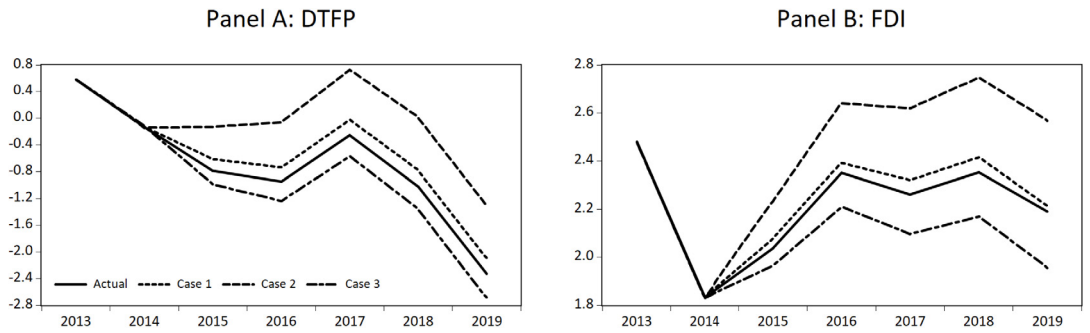


Fig. 3. 2015–2019 counterfactuals: stability and one standard deviation shocks in geopolitical risks. Note: 'Actual' corresponds to the weighted-average aggregate trajectory for the set of 18 emerging economies; 'Case 1' corresponds to a counterfactual assessment in the hypothetical situation that aggregate geopolitical risks had remained unchanged in 2015–2019 (rather than fall by 12.5%). It thus fixes the GPR at the panel mean value, 98.9, over the period 2015–2019. 'Case 2' and 'Case 3' adjust the panel mean of GPR by −/+1 standard deviation over the period 2015–2019, respectively (−/+29.1).

a sustained upward trend but from an initial rise and a subsequent reduction. In the absence of falling geopolitical risks, FDI inflows would have attained 2.12% of GDP rather than 2.19%. This overall net effect of −0.05 percentage points, which can be ascribed to the dynamic effects taking place in the up-and-down evolution of FDI, confirms the mild influence of GPR identified in the previous simulation.

In Case 2, GPR is reduced by one standard deviation and causes a significant positive effect on the growth rate of TFP, which moves to −1.29% in 2019, rather than 2.33%. In this case, a one standard deviation change for 5 years comes with a single percentage point difference in the growth rate of TFP, while FDI is also boosted and attains 0.48 additional percentage points (2.57% rather than the actual 2.19%). In contrast, when GPR is increased by one standard deviation, as in Case 3, the TFP growth rate falls to −2.68% (by 0.35 extra percentage points) and FDI only reaches 1.96% (0.23 percentage points less). This shows that at this level of GPR in the emerging economies, significant gains are to be expected from succeeding in keeping GPRs significantly down. Even though stabilisation helps (Case 1), lessening GPRs comes with key rewards in terms of technology progress and FDI inflows (Case 2).

Since TFP growth involves the whole economy, many factors may determine its path. Among them, GPR must be considered as our results consistently show this is a non-negligible determinant accounting for their trajectory. In contrast, GPRs are not highly detrimental of FDI inflows, possibly because FDI inflows in the emerging economies only amount, on average, to 2% of GDP. The GPRs impact on FDI when FDI inflows are quantitatively more relevant should be further examined to check whether larger inflows simultaneously come with a larger sensitivity with respect to GPR.

Although this exercise is not country-specific and is meant to provide a mere illustration of how GPRs may hamper technology and FDI inflows in emerging economies, it provides an illustration of the sharp contrast between embarking on new cooperation agreements or strengthening already existing economic and policy relationships or, alternatively, being caught in situations in which geopolitical risks rise, thereby threatening economic prosperity. Whether bilateral or multilateral, cooperation projects and policies aiming to ensure a stable political and institutional setup have bonus gains in terms of technological progress and inward investments. The situation in March 2022 is a compelling reminder of the relevance of such policies. As Kammer et al. (2022) put it at the IMF, "the consequences of Russia's war on Ukraine have already shaken not just those nations but also the region and the world, and point to the importance of a global safety net and regional arrangements in place to buffer economies".

7. Conclusions

Economic, policy and social issues are intertwined. This paper brought into consideration the harmful effects that GPRs have over two crucial economic processes: technological progress and international long-term investments. These are two of the most critical sources of economic progress and social welfare when such progress is well distributed. Accordingly, the most important lesson from this research is that for the emerging economies to consolidate their economic progress, geopolitical stability is essential.

Using up-to-date panel Granger causality tests and SUR system estimation methods, we uncovered the structurally stable negative effects of GPRs on technological progress and FDI inflows. System estimation was needed to properly consider cross-equation feedback effects across the three variables. This revealed that technology and FDI are also influential in limiting the extent of GPRs, since quicker technological progress and being more integrated in the global stream of long-run investment flows helps in providing more stable socio-political setups. A simple illustration on how larger GPRs do hamper technology revealed a major impact on TFP growth, but a mild one on FDI inflows, at least when they are quantitatively small.

Beyond the sectoral effects of geopolitical risks on oil prices, financial markets, and the tourism industry, we have seen that the literature also warns on the side-effects of GPRs in terms of environmental sustainability and military expenditures. The findings in this paper not only reinforce those in previous studies but, we believe, place the issue of geopolitical stability as an absolute priority. Policy-wise, our results call for sustained progress towards stable international economic and political relationships, institutional quality, and internal cohesiveness among diverse stakeholders. Especially in the emerging market economies, all of these factors should take a relevant place in the governments' agenda in view of minimising geopolitical risks and enhancing economic prosperity through much-needed FDI inflows and technological progress.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

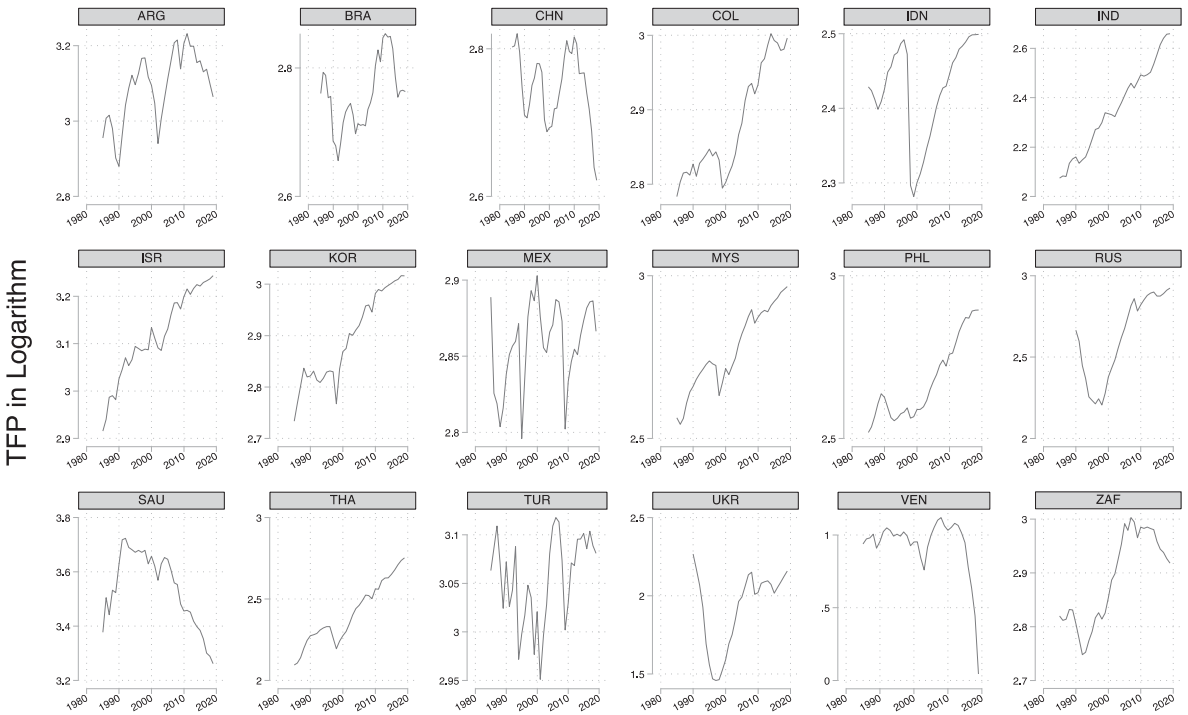


Fig. A.1. Dynamics of Total Factor Productivity (TFP) in logarithm. Note: ARG = Argentina; BRA = Brazil; CHN = China; COL = Colombia; IDN = India; IND = Indonesia; ISR = Israel; KOR = Korea; MEX = Mexico; MYS = Malaysia; PHL = Philippines; RUS = Russia; SAU = Saudi Arabia; THA = Thailand; TUR = Turkey; UKR = Ukraine; VEN = Venezuela; ZAF = South Africa.

Table A.1
Individual fixed-effects models.

	Panel-corrected GLS						Driscoll–Kraaystandard errors					
FE model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Variables	DTFP	FDI	LGPR	DTFP	FDI	LGPR	DTFP	FDI	LGPR	DTFP	FDI	LGPR
LGPR	−1.7883***	−0.4312***		−0.9089***	−0.2768**		−1.8008**	−0.9601***		−0.9541*	−0.6879**	
	(0.5772)	(0.1642)		(0.1909)	(0.1344)		(0.7590)	(0.3453)		(0.4814)	(0.3165)	
FDI	0.2989***		−0.0099*	0.1586***		−0.0084*	0.2648*		−0.0268***	0.1218		−0.0203*
	(0.1048)		(0.0060)	(0.0414)		(0.0043)	(0.1461)		(0.0085)	(0.0832)		(0.0107)
DTFP		0.0233**	−0.0072***		0.0165***	−0.0060***		0.0377**	−0.0071***		0.0236	−0.0055*
		(0.0098)	(0.0018)		(0.0060)	(0.0008)		(0.0171)	(0.0023)		(0.0147)	(0.0028)
LWUI	−0.0233	−0.0447	0.0075	−0.1386	−0.0473	0.0027	−0.0634	0.0875	0.0136	−0.1716	0.0311	0.0154
	(0.1399)	(0.0432)	(0.0094)	(0.1040)	(0.0642)	(0.0061)	(0.1933)	(0.0596)	(0.0168)	(0.1695)	(0.0603)	(0.0167)
TRADE				0.0019	0.0132	0.0000				0.0068	0.0064	0.0017**
				(0.0049)	(0.0109)	(0.0009)				(0.0126)	(0.0056)	(0.0008)
LGDPPC				2.5474***	0.3008	−0.1171				2.3471**	−0.6662	−0.0154
				(0.2712)	(0.5212)	(0.1079)				(0.9239)	(0.4188)	(0.0739)
WORKPOP				−0.0128	0.1660***	−0.0001				−0.0082	0.1167**	0.0005
				(0.0325)	(0.0521)	(0.0195)				(0.0927)	(0.0501)	(0.0096)
INFL				−0.0012***	−0.0001**	0.0000***				−0.0010	−0.0004	0.0001**
				(0.0002)	(0.0000)	(0.0000)				(0.0010)	(0.0003)	(0.0000)
KAOPEN				0.2125**	0.2679**	−0.0114				0.2584	0.3012***	0.0040
				(0.1002)	(0.1074)	(0.0171)				(0.1805)	(0.1100)	(0.0143)
PCRGDP				−0.0340***	−0.0014	0.0007				−0.0363**	0.0028	−0.0004
				(0.0072)	(0.0052)	(0.0005)				(0.0139)	(0.0056)	(0.0010)
Constant	5.4680*	1.3080	4.5758***	−19.8619***	−8.9199**	5.4449***	5.3605	5.2740***	4.4803***	−16.4441*	2.5202	4.5659***
	(2.9961)	(0.8741)	(0.1102)	(4.1928)	(3.5338)	(1.1218)	(3.6039)	(1.5506)	(0.0459)	(8.3663)	(4.8471)	(0.8937)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	597	597	597	551	551	551	597	597	597	551	551	551
Number of cid	18	18	18	18	18	18	18	18	18	18	18	18

Robust standard errors in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table A.2
SUR estimations with different control sets.

	Institutional quality						Financial structure development								
FE model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Variables	DTFP	FDI	LGPR	DTFP	FDI	LGPR	DTFP	FDI	LGPR	DTFP	FDI	LGPR	DTFP	FDI	LGPR
LGPR	−2.1634***	−0.9068**		−1.3490**	−1.1907***		−2.1634***	−1.1194*	−2.0686***		−1.4302**	−1.8476***		−1.0833	−1.8129***
	(0.4042)	(0.4440)		(0.5330)	(0.3069)		(0.4042)	(0.5974)	(0.3127)		(0.6487)	(0.3182)		(0.6669)	(0.3286)
FDI	0.0847		−0.0271**	0.3796***		−0.0465***	0.0847	0.3490***		−0.0663***	0.3249**		−0.0602***	0.3191**	
	(0.1219)		(0.0110)	(0.0969)		(0.0117)	(0.1219)	(0.1260)		(0.0097)	(0.1296)		(0.0102)	(0.1341)	
DTFP		0.0219	−0.0167***		0.0912***	−0.0127**			0.0515**	−0.0037*		0.0503**	−0.0047**		0.0484**
		(0.0298)	(0.0031)		(0.0294)	(0.0050)			(0.0202)	(0.0020)		(0.0218)	(0.0021)		(0.0201)
EFWIDX				−1.4525***	0.8227***	−0.0363									
				(0.4556)	(0.1986)	(0.0561)									
INSTQUA	−0.6619	1.7859***	−0.4348***												
	(1.1618)	(0.6234)	(0.1144)												
IMF-FID							4.3615	−4.7286*	−1.0480**						
							(3.2572)	(2.6741)	(0.4667)						
IMF-FIA										−2.1706	0.2307	0.0194			
										(2.1041)	(1.2457)	(0.2530)			
IMF-FIE													2.9582*	0.0824	−0.2674
													(1.5992)	(1.3249)	(0.2408)
Macro-control	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	356	356	356	367	367	367	367	554	554	554	554	554	554	554	554
Number of cid	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18

Robust standard errors in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.
Note: EFWIDX is the Economic Freedom Index taken from the Fraser Institute; INSTQUA is the average of six institutional quality indicators of the World Governance Indicators Database (i.e., corruption control, government efficiency, political stability, regulatory quality, the rule of law, and voice accountability); IMF-FIA, -FID, -FIE are financial development indices proxying for financial institutions access, financial institutions depth and financial institutions efficiency, respectively. Macro-control sets vary across SUR specifications. Specifically, Model (1)-(3) replace TRADE by EFWIDX; Model (4)-(6) replace LWUI by INSTQUA; Model (7)-(15) replace KAOPEN by IMF-FID, IMF-FIA and IMF-FIE, respectively.

Table A.3
Dynamic models with IV-2SLS and GMM estimators.

	IV-2SLS				System-GMM			
FE model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables	DTFP	LTFP	FDI	LGPR	DTFP	LTFP	FDI	LGPR
DTFP(−1)	0.1533**				0.1186*			
	(0.0734)				(0.0647)			
LTFP(−1)		0.9358***				0.9498***		
		(0.0134)				(0.0279)		
FDI(−1)			0.5314***				0.4816***	
			(0.0645)				(0.1049)	
LGPR(−1)				0.6290***				0.5755***
				(0.0394)				(0.0474)
LGPR	−1.0556**	−0.0190**	−0.5452**		−1.6912*	−0.0098*	−0.5525**	
	(0.4462)	(0.0077)	(0.2146)		(0.8844)	(0.0051)	(0.2357)	
FDI	0.0583	0.0041**		−0.0181***	0.2686	0.0021*		−0.0128*
	(0.0869)	(0.0018)		(0.0059)	(0.1708)	(0.0011)		(0.0074)
DTFP			0.0392**	−0.0087***			0.0557**	−0.0086***
			(0.0181)	(0.0027)			(0.0261)	(0.0024)
LWUI	0.0486	0.0000	0.0636	0.0128	0.2542	−0.0019	0.0506	0.0174
	(0.2330)	(0.0019)	(0.0663)	(0.0161)	(0.3773)	(0.0030)	(0.0814)	(0.0191)
TRADE	0.0154	0.0002	0.0045	0.0007	0.0333	0.0003**	0.0045	0.0001
	(0.0101)	(0.0001)	(0.0034)	(0.0006)	(0.0235)	(0.0001)	(0.0045)	(0.0006)
LGDPPC	1.7384**	0.0295***	−0.3494	−0.0359	−0.4569	0.0271*	−0.4772	0.0278
	(0.8400)	(0.0067)	(0.2500)	(0.0420)	(1.0451)	(0.0143)	(0.3509)	(0.0378)
WORKPOP	−0.1042**	−0.0018***	0.0762***	0.0037	0.0359	−0.0009	0.0599**	−0.0004
	(0.0418)	(0.0007)	(0.0211)	(0.0061)	(0.1925)	(0.0009)	(0.0281)	(0.0049)
INFL	−0.0004	−0.0000	−0.0001	0.0000	−0.0012	−0.0000	0.0001	−0.0000
	(0.0006)	(0.0000)	(0.0002)	(0.0000)	(0.0009)	(0.0000)	(0.0001)	(0.0000)
KAOPEN	0.3053**	−0.0044	0.1801**	0.0033	0.6080*	0.0023	0.1962	−0.0071
	(0.1372)	(0.0095)	(0.0801)	(0.0076)	(0.3622)	(0.0017)	(0.1355)	(0.0145)
PCRGDP	−0.0474***	0.0674***	−0.0005	−0.0001	−0.0420*	−0.0005***	0.0069	0.0002
	(0.0180)	(0.0197)	(0.0033)	(0.0006)	(0.0218)	(0.0001)	(0.0051)	(0.0005)
Constant	−3.5953	0.0671	1.7997	1.8275***	9.8300	−0.0378	3.2230	1.7421***
	(7.0785)	(0.0617)	(1.6070)	(0.3263)	(9.7791)	(0.0665)	(2.8206)	(0.3916)
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	524	537	537	517	551	551	550	539
Number of cid	18	18	18	18	18	18	18	18
AR(2) Test					Passed	Passed	Passed	Passed

Robust standard errors in parentheses.
$^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

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