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Foreign Direct Investment and World Pandemic Uncertainty Index: Do Health Pandemics Matter?

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Abstract: This paper explores the impacts of health pandemics on foreign direct investment (FDI) using the new world pandemic uncertainty index (WPUI). We investigate the effects of pandemics, including COVID-19, on FDI based on a sample of 142 economies and sub-samples (incomes and regions) from 1996 to 2019. The two-step system Generalised Method of Moments estimation of linear dynamic panel-data model (DPDGMM) is used in this study. The estimation results are robust with the results of the two-step sequential (two-stage) estimation of linear panel-data models (SELPDM) and the two-step system Generalised Method of Moments estimation (BBGMM). The results show that health pandemics have negative impacts on FDI. Significantly, the uncertainty caused by pandemics creates adverse shocks on FDI net inflows in Asia-Pacific countries and emerging economies.

Keywords: COVID-19; pandemic; world pandemic uncertainty index; foreign direct investment

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1. Introduction

Uncertainty from health pandemics has severely impacted economies worldwide. Garrett (2008) discusses the short-term and long-term effects of the 1918 influenza pandemic using evidence from print media in 1918 and research papers such as Brainerd and Siegler (2003) and Almond (2006). The pandemic in 1918 had negative impacts on consumer behaviour, savings, long-term human capital, income, and investment (Garrett 2008). Lee and McKibbin (2004) estimate the global economic costs of Severe Acute Respiratory Syndrome (SARS) in 2003. The authors' estimation shows that the 2003 SARS's health and economic cost is about USD 40 billion at least. Lee and McKibbin (2004) emphasise the impacts of SARS on patients and changes of human behaviour in economic activities. The high cost of the SARS shock is associated with the investment losses and changes in spending (Lee and McKibbin 2004).

In 2014, the longest and largest outbreak of Ebola virus disease took place in West Africa (UNDG 2015). According to UNDG (2015), the Ebola pandemic results in a negative social-economic shock in 15 West African economies. A 1.2% loss in the West African region's GDP due to the Ebola pandemic is a big challenge in recovering the impacted economies where most people live below the poverty line at USD 1.25 per day (UNDG 2015). To contain a pandemic such as the Coronavirus Disease 2019 (COVID-19) pandemic, containment measures including lockdown, business closure, and social distancing are implemented to save lives. However, the containment measures cause uncertainty in economic activities, and result in social, economic, financial and political consequences (Brodeur et al. 2020; Fernandes 2020; Tisdell 2020).

Prior to 2020, no indices have been developed to measure uncertainty caused by pandemics. The development of uncertainty index shows higher concerns about uncertainty worldwide. For example, Baker et al. (2016) first introduced the Economic Policy Uncertainty (EPU) index to measure uncertainty resulted from changes in economic policies for 12 countries in 2016 followed by 26 countries in 2020. However, the EPU index is available

for the limited number of countries (mostly advanced economies). In 2018, Ahir et al. developed the World Uncertainty Index (WUI), that measures economic and political uncertainty in general for 143 countries including advanced, emerging, and low-income economies. The COVID-19 pandemic which started in December 2019 accelerated the concerns of uncertainty, which led to the development of the new World Pandemic Uncertainty Index (WPUI) in 2020 (Ahir et al. 2018; WPUI 2020). Separating pandemic uncertainty (WPUI) from aggregate uncertainty (WUI) allows researchers and policy makers to exclusively evaluate the impacts of health pandemics on the economies.

This paper investigates the effects of health pandemic shocks on FDI using the new WPUI index in 142 countries from 1996 to 2019. The estimations are conducted for different sub-samples by regions (Africa, Asia and the Pacific, Europe, Middle East and Central Asia, and Western Hemisphere) and incomes (advanced economies, emerging economies, and low-income economies).

This study follows Nguyen et al. (2019) and Avom et al. (2020) studies with new contributions to the literature. First, to our best knowledge, this is the first study that uses the new WPUI based on the WUI from Ahir et al. (2018) to investigate the impacts of pandemics on FDI. The WUI was used in both Nguyen et al. (2019) and Avom et al. (2020) studies, but the authors did not investigate the effects of pandemics on investment. For example, Avom et al. (2020) use the WUI index to investigate the impact of economic and political uncertainty on FDI regardless of the sources of uncertainty. In our study, instead of using aggregate uncertainty caused by all events, only uncertainty as a direct result of health pandemics (WPUI) is employed to ascertain its impact on FDI. Therefore, evaluating the effect of pandemic uncertainty on FDI inflows separately from aggregate uncertainty will provide important policy implications to economically recover post health pandemics such as the COVID-19. Second, we use a larger panel (142 countries from 1996 to 2019) compared to Nguyen et al. (2019) and Avom et al. (2020) (21 countries from 2003–2013 and 138 countries from 1996–2018, respectively). Third, this paper uses a new estimation technique that is the two-step system Generalised Method of Moments (GMM) estimation of linear dynamic panel-data model introduced by Kripfganz (2019, 2020) or Dynamic Panel-Data GMM (DPDGMM) hereafter. The DPDGMM solves the concerns of incorrect estimates for unbalanced panel data and incorrect degrees of freedom and p-values of the over-identification tests in cases of omitted coefficients (Kripfganz 2020). Our estimation results are robust with the results of the two-step system GMM (Blundell and Bond 1998; Roodman 2009) or Blundell and Bond GMM (BBGMM) and the two-step Sequential (two-stage) Estimation of Linear Panel-data Models (SELPDM) (Kripfganz 2017).

Our findings show that the pandemic uncertainty decreases FDI net inflows worldwide from 1996 to 2019. The significant shocks caused by the pandemic uncertainty on FDI are found in Asia-Pacific countries and emerging economies. The findings suggest that international firms' behaviour is significantly influenced by pandemic uncertainty, which explains why there is a decline in inward FDI flows into host countries as pandemics occur, especially in emerging economies in Asia-Pacific. The reduction in inward FDI means that host countries may face a higher level of unemployment and an economic contraction. Therefore, this study provides important policy implications to economically recover post the COVID-19 pandemic. For example, in addition to immediate responses to pandemics such as containment measures, emerging countries in Asia and the Pacific should implement fiscal and monetary measures to support foreign investors in the long term. Trade agreements and economic clusters will play important roles in reducing the economic impacts of pandemic uncertainty and economically recovering towards sustainable development.

The paper is organised as follows. Section 2 reviews the literature on the effects of uncertainty caused by health pandemics on FDI. Section 3 describes the data and research methodology. Section 4 presents and discusses the empirical results. Section 5 concludes the study with the key findings and implications.

2. Literature Review

The relationship between uncertainty and economic behaviour has been documented in the literature. Hassett and Sullivan (2015) review the literature on the impacts of policy uncertainty on governments and firms' behaviour. The authors focus on the link between investment and uncertainty, and the roles of the EPU index developed by Baker et al. (2016) in explaining economic variables such as domestic investment, FDI, and economic growth. Al-Thaqeb and Algharabali (2019) review the literature on the effects of EPU on firm decisions and financial markets. In terms of the impacts of EPU on FDI, Nguyen et al. (2018) find the negative effect of EPU on firm performance, which explains why firms invest more in countries with lower levels of EPU (less uncertainty) than their home countries. Hsieh et al. (2019) confirm that outward FDI increases after a shock in the home country's EPU index.

Economic uncertainty from events such as wars, crises, and trade tensions creates shocks in FDI inflows. Nguyen et al. (2019) employ EPU as domestic uncertainty and WUI introduced by Ahir et al. (2018) as world uncertainty to investigate their effects on FDI net inflows in 23 countries from 2003 to 2013. The study shows the negative relationship between domestic uncertainty and FDI inflows, and the positive impact of world uncertainty on FDI inflows into the host countries (Nguyen et al. 2019). Using a larger dataset of 138 countries from 1996 to 2018, Avom et al. (2020) find that world uncertainty (WUI) decreases FDI net inflows in general. The study also shows that the adverse impact of world uncertainty on FDI in emerging and developing economies is greater than in advanced economies (Avom et al. 2020).

Pandemic uncertainty accelerated in 2019 and 2020 because of the COVID-19 pandemic. Ahir et al. (2018) introduce the WPUI index at the global and country levels in 2020 to capture uncertainty as a result of global pandemics such as SARS, Avian flu (H5N1), Swine flu (H1N1), Middle East respiratory syndrome (MERS), Bird flu, Ebola, Coronavirus (COVID-19), and Influenza (H1V1). The higher value of WPUI indicates a higher level of pandemic uncertainty. Figure 1 shows different levels of WPUI corresponding to different pandemics from 1996 to 2020. The pandemic uncertainty level caused by COVID-19 virus is unprecedented and the worst over the last 25 years.

The WPUI index differs from the WUI index in terms of the meaning and theoretical ground. Although both of the indices are constructed for 143 developed and developing countries from 1996, the WUI index measures *economic and political* uncertainty (Ahir et al. 2018), whereas the WPUI index measures *pandemic* uncertainty (Ahir et al. 2018; WPUI 2020). The WUI index is constructed based on counting the word "uncertainty" and its variants in the Economist Intelligence Unit (EIU) country reports. Therefore, the WUI index presents economic and political uncertainty or aggregate uncertainty caused by all events such as wars, terrorist attacks, debt and financial crises, trade tensions, health outbreaks, the United States presidential elections, and the Brexit (Ahir et al. 2018). In contrast, the WPUI index reflects the frequencies of the word "uncertainty" relating to only health pandemics in the EIU reports (Ahir et al. 2018; WPUI 2020). In other words, the WPUI index measures pandemic uncertainty or particular uncertainty caused by global pandemics such as SARS, Avian flu, Swine flu, Ebola, and COVID-19.

The 2020 WPUI index contributes to the development of uncertainty index worldwide. The EPU index is first constructed by Baker et al. (2016) to measure concerns about uncertainty due to changes in economic policies. Although the EPU index begins a new era of uncertainty evaluation, it is available for a limited number of countries (26 countries as of 2020). Ahir et al. (2018) develop the WUI index to measure economic and political uncertainty in 2018, and the WPUI index to evaluate pandemic uncertainty in 2020 for 143 countries including advanced, emerging, and low-income economies. The high level of uncertainty caused by the COVID-19 pandemic in December 2019 (see Figure 1) motivates the development of the new WPUI index and suggests an adverse relationship between WPUI and FDI. The development of uncertainty index separating pandemic uncertainty (WPUI)

from aggregate uncertainty (WUI) allows researchers and policy makers to exclusively evaluate the impacts of health pandemics on the economies.

Few studies such as Demiessie (2020), Fang et al. (2020), Pinshi (2020) use WPUI to investigate the negative impacts of COVID-19 pandemic uncertainty on economies. However, to our best knowledge, no studies have investigated the impacts of pandemic uncertainty using WPUI on FDI. Demiessie (2020) finds the negative shocks of COVID-19 pandemic uncertainty on investment, employment, prices, import, export in Ethiopia. Fang et al. (2020) use three indices WUI, World Trade Uncertainty Index (WTUI), and WPUI from Ahir et al. (2018) to measure the uncertainty of Turkey's export markets. The higher level of uncertainty in Turkey's export destinations leads to the lower level of the country's economic growth rate (Fang et al. 2020). Pinshi (2020) employs WPUI to investigate the COVID-19 uncertainty shock on the Congolese economy. The study shows a strong impact of the pandemic uncertainty on economic variables such as exchange rate, trade openness, prices, and aggregate demand in Congo.

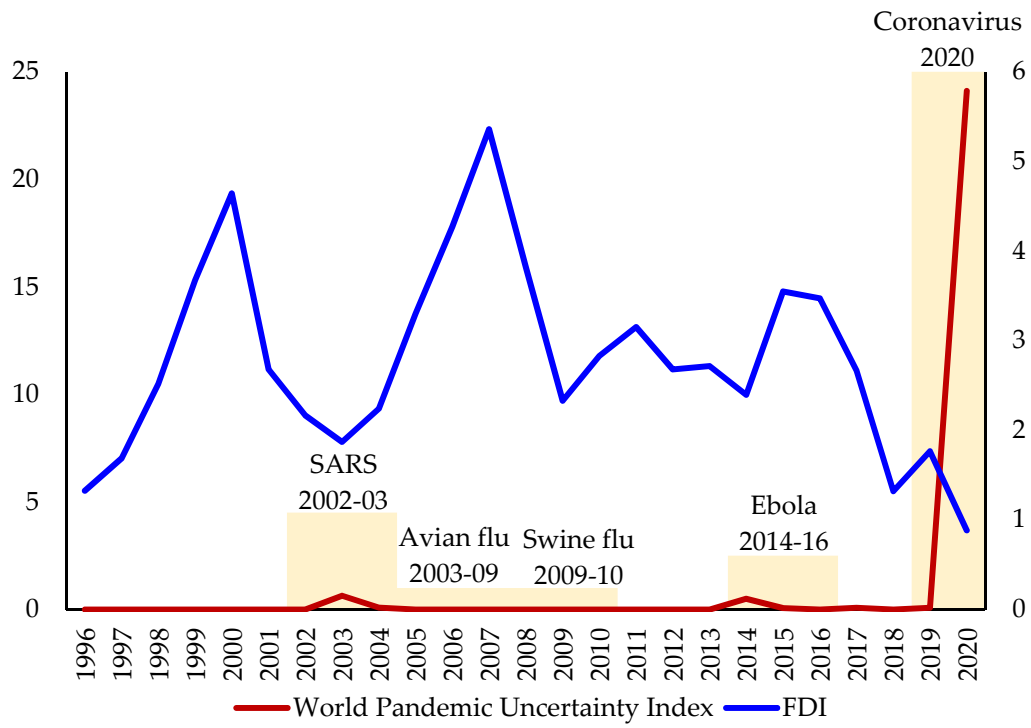

Figure 1. World Pandemic Uncertainty Index and FDI. Source: Authors' calculation based on Ahir et al. (2018), WPUI (2020), the Organisation for Economic Co-operation and Development (OECD 2020b), and the World Bank's World Development Indicators (WB-WDI) at https://databank.worldbank.org/source/world-development-indicators (accessed on 8 January 2021). Note: The World Pandemic Uncertainty Index is the aggregate WPUI worldwide as the simple average of 143 countries (Ahir et al. 2018; WPUI 2020). FDI (the right axis) is the world FDI net inflows as a percentage of GDP from the WB-WDI. FDI in 2020 is computed based on data in 2019 using the prediction of a 50% fall by OECD (2020b).

This paper investigates the effects of health pandemic shocks on FDI using WPUI in 142 countries from 1996 to 2019. The estimations are conducted for different sub-samples by regions (Africa, Asia and the Pacific, Europe, Middle East and Central Asia, and Western Hemisphere) and incomes (advanced economies, emerging economies, and low-income economies). Based on the literature on uncertainty and FDI, we hypothesise that health pandemic uncertainty creates adverse shocks on FDI net inflows. The novelty of our estimations is the use of the WPUI index in the regression model in place of the WUI index. The model with the WUI index used in Avom et al. (2020) work shows the impact of economic and political uncertainty on FDI in general regardless of different sources of

uncertainty. In contrast, our WPUI index-based model investigates the particular impact of uncertainty caused by health pandemics on FDI. Therefore, the results of our study provide important policy implications to economically recover post health pandemics including the on-going COVID-19.

3. Data and Methodology

This paper uses unbalanced panel data of 142 countries from 1996 to 2019. WPUI is available for 143 countries including Taiwan from 1996 to 2020 (WPUI 2020). However, in terms of other variables (see Table 1), data from the World Bank's World Development Indicators is insufficient for Taiwan. Therefore, the total of sampled countries is 142 instead of 143 countries. Except for the WPUI and WUI indices, data for the other variables in 2020 are unavailable for our 142 sampled countries as of January 2021. Hence, we use the panel data of 142 countries from 1996 to 2019 to investigate the impact of pandemic uncertainty on FDI inflows. Following the International Monetary Fund (IMF) classification used by Ahir et al. (2018), the sampled countries are grouped into three income groups (advanced, emerging, and low-income) and five regions (Africa, Asia and the Pacific, Europe, Middle East and Central Asia, and Western Hemisphere) (see Table A1 in Appendix A).

Table 1. Variable definition.

Variable	Definition
FDI	Foreign direct investment net inflows (% of GDP) [1]
WPUI	World Pandemic Uncertainty Index (WPUI) (country level, four-quarter average) [2]
WUI	World Uncertainty Index (WUI) (country level, four-quarter average) [3,4]
GDP growth	GDP growth (annual %) [1]
Domestic investment	Gross fixed capital formation (% of GDP) [1]
Human capital	Secondary school enrolment (% gross) [1]
Financial development	Domestic credit to private sector (% of GDP) [1]
Environmental factor	CO2 emission (metric tons per capita) [1]
Energy security	Total natural resource rents (% of GDP) [1]
Trade openness	Sum of exports and imports of goods and services (% of GDP) [1]

Note: [1] Data obtained from the World Bank's World Development Indicators at https://databank.worldbank.org/source/world-development-indicators (accessed on 8 January 2021); [2] Data obtained from Ahir et al. (2018) and WPUI (2020); [3] Data obtained from Ahir et al. (2018) and WUI (2020); and [4] WUI is used for robustness check.

The dependent variable is FDI net inflows measured as a percentage of GDP. To measure uncertainty caused by health pandemics, WPUI is used in our study. WUI is used for robustness check in our study. WPUI and WUI are available quarterly from 1996. To obtain annual data for WPUI and WUI, we compute the yearly means for each index.

The control variables used in our study are based on the literature on the determinants of FDI such as GDP growth, domestic investment, human capital, financial development, environment factor, energy security, and trade openness (see Table 1). GDP growth plays an important role in attracting FDI. The positive causal relationship between GDP growth and FDI is confirmed by many studies such as Srinivasan et al. (2010), Blonigen and Piger (2014), and Hoang and Duong (2018). Domestic investment in infrastructure development is vital in attracting FDI into host countries, especially in emerging and low-income economies (Khadaroo and Seetanah 2009; Armah and Fosu 2016; Kaur et al. 2016). Human capital is recognised as one of the important FDI determinants (Kumari 2014; Omri and Kahouli 2014; Kaur et al. 2016). Noorbakhsh et al. (2001) find that human capital is the most important factor in attracting FDI in developing countries. Domestic financial development is a significant factor in increasing host countries' FDI attractiveness and FDI performance (Hermes and Lensink 2003; Choong 2012; Ayouni and Bardi 2018). Razmi and Behname (2012) and Hasan and Mahvash (2015) find the positive impact of trade openness in attracting FDI inflows.

Environmental and resource factors such as environmental degradation (CO_2), energy consumption and energy security exhibit causality relationships with FDI inflows. Dinh and Lin (2014) find the dynamic relationship among CO_2 emissions, energy consumption, and FDI. Shahbaz et al. (2015) confirm the bidirectional causality between CO_2 emissions and FDI globally. He et al. (2012) find a unidirectional Granger causality from energy consumption to FDI. Sánchez-Martín et al. (2015) conclude that a better energy security strategy positively influences FDI inflows. Nguyen et al. (2019) and Avom et al. (2020) use environmental factor and energy security as control variables to investigate the impact of uncertainty on FDI. Following the Nguyen et al. (2019) and Avom et al. (2020) studies, we use CO_2 as a proxy of environment factor, and total natural resource rents (percent of GDP) or energy security as a proxy of resource factor in our regression models.

Table A2 in Appendix A presents the data descriptive statistics for the whole sample from 1996 to 2019. The mean of FDI net inflows is 4.15%. Figure A1 and Table A3 in Appendix A show the correlations of the variables. According to Figure A1, Hong Kong, Liberia, the Netherlands, Singapore, and Ireland are the top five countries with the highest levels of FDI net inflows. The figure also shows that Japan, South Korea, Italy, New Zealand, and the United States as the advanced economies have low levels of FDI net inflows. The correlation matrix in Table A3 reports the significant positive correlations between FDI and GDP growth, domestic investment, human capital, financial development, and trade openness. The results suggest that the selection of control variables is consistent with the literature on FDI determinants. All correlation coefficients between the variables are less than 0.7 (see Table A3), which suggests that the variables are not highly correlated.

Figure 1 shows a negative relationship between FDI and WPUI. FDI net inflows declined over the pandemic periods such as 2002–2003 (SARS), 2014–2016 (Ebola), and 2019–2020 (COVID-19) when WPUI reached the higher levels. To investigate the impact of health pandemic shocks on FDI inflows, the following dynamic panel model is used:

$$FDI_{it} = \alpha_0 + \alpha_1 FDI_{i,t-1} + \beta WPUI_{it} + \gamma_j X_{j,it} + \varepsilon_{it}, \quad (1)$$

where FDI_{it} is the foreign direct investment net inflows (% of GDP) of country i in year t; WPUI is the world pandemic uncertainty index at the country level; X_j is a vector of control variable j; ε is the error term; and α, β, and γ are the estimated parameters.

Equation (1) is a dynamic model of unbalanced panel data with a lagged dependent variable in a form of an explanatory variable. According to Arellano and Bover (1995) and Blundell and Bond (1998), this type of dynamic model may face endogenous problems, which can be solved by the two-step system GMM. Although the two-step system GMM is improved by Blundell and Bond (1998) (BBGMM) to reduce the bias caused by the fixed effects in short panels, Windmeijer (2005) raises an issue of a bias of uncorrected standard errors. This issue is resolved using the SELPDM (Kripfganz 2017). However, according to Kripfganz (2020), there are several concerns of the estimation results using the BBGMM and SELPDM techniques. For instance, there may be incorrect estimates in unbalanced panel data, which is likely to occur in our study because our data is not balanced. If some coefficients are omitted, degrees of freedom and p-values for the over-identification tests are incorrect (Kripfganz 2020).

Therefore, this study uses the DPDGMM introduced by Kripfganz (2019, 2020) to ensure that our dynamic estimations using the unbalanced and short panel data are not exposed to risks of (i) endogenous problems; (ii) bias caused by uncorrected standard errors or fixed effects in short panels; and (iii) incorrect results of estimators and over-identification tests. Equation (1) is first regressed for the whole sample of 142 countries, then for the sub-samples by income and region. For robustness check, we replace WPUI with WUI and use the SELPDM (Kripfganz 2017) and BBGMM (Blundell and Bond 1998; Roodman 2009) in our study.

4. Results and Discussions

The results of our DPDGMM model with the WPUI are presented in Tables 2 and 3. The results of robustness tests using the SELPDM and BBGMM models with WUI are presented in Table A4 in Appendix A. All AR(2) and Hansen tests are not statistically significant, which shows that our results are consistent and unbiased (Roodman 2009).

Table 2. World Pandemic Uncertainty Index and FDI.

Dependent Variable: FDI	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lag FDI	0.490 ***	0.483 ***	0.423 ***	0.594 ***	0.560 ***	0.587 ***	0.598 ***	0.527 ***
	(0.1010)	(0.0788)	(0.0753)	(0.0871)	(0.0951)	(0.0814)	(0.0858)	(0.0906)
WPUI	−0.0198	−0.0124	−0.0173	−0.0582 **	−0.120 *	−0.0899	−0.110 **	−0.143 *
	(0.0358)	(0.0364)	(0.0385)	(0.0284)	(0.0682)	(0.0566)	(0.0520)	(0.0751)
GDP growth		0.0863 *	0.117 ***	0.110 ***	0.0899 **	0.134 **	0.159 ***	0.140 **
		(0.0441)	(0.0392)	(0.0412)	(0.0451)	(0.0556)	(0.0609)	(0.0583)
Domestic investment			0.133 **	0.0685	0.0891	0.0681	0.0425	0.0544
			(0.0534)	(0.0640)	(0.0667)	(0.0727)	(0.0738)	(0.0722)
Human capital				−0.0737 **	−0.110 ***	−0.0473 **	−0.0487 *	−0.0618 **
				(0.0299)	(0.0414)	(0.0236)	(0.0271)	(0.0305)
Financial development					0.0193	0.0247 *	0.0160	0.00521
					(0.0252)	(0.0140)	(0.0155)	(0.0161)
Environmental factor						0.0983	−0.0200	0.123
						(0.128)	(0.158)	(0.161)
Energy security							−0.136 **	−0.164 ***
							(0.0652)	(0.0598)
Trade openness								0.0731 ***
								(0.0211)
Constant	1.801 ***	1.464 ***	−1.339	5.387 *	6.650 *	1.406	3.613	−0.284
	(0.352)	(0.327)	(1.158)	(2.757)	(3.475)	(1.772)	(2.428)	(2.849)
Observations	3223	3216	3025	2111	1760	1551	1551	1551
Number of countries	142	142	138	132	128	127	127	127
Number of instruments	13	19	25	31	37	43	49	55
AR(2) (*p*-value)	0.4582	0.4104	0.5581	0.0372	0.1592	0.7664	0.7536	0.6878
Hansen test (*p*-value)	0.1758	0.1193	0.3047	0.1019	0.0982	0.4218	0.264	0.1368

Source: Authors' calculation. Note: Standard errors are in parentheses. *, **, *** are significant levels at 10%, 5%, 1%, respectively. The numbers of observations and countries in the estimation models are different due to the unbalanced panel data.

Table 2 shows the significant adverse impact of uncertainty caused by health pandemics on FDI inflows worldwide from 1996 to 2019. The coefficients of WPUI remain negative as shown in columns (1) to (8), and statistically significant in columns (4), (5), (7), and (8) in Table 2. For example, column (8) presents a negative coefficient of WPUI of -0.143, which suggests that a 1 unit increase in world pandemic uncertainty decreases FDI inflows by 14.30%. Therefore, our result shows that the uncertainty from health pandemics adversely impacts the share of FDI inflows. This result is consistent with the Avom et al. (2020) finding of the negative effect of world uncertainty on FDI and confirms the adverse impact of uncertainty on firms' behaviour (Nguyen et al. 2018; Al-Thaqeb and Algharabali 2019; Hsieh et al. 2019).

However, the findings of our results differ from the Avom et al. (2020) findings. In our study, the adverse impact of uncertainty on FDI is directly from a single event that is health pandemics. Avom et al. (2020) draw the conclusion on the negative effects of aggregate uncertainty on FDI regardless of the sources of the events. Therefore, investigating the magnitude of the pandemic shocks on FDI inflows (and firms' behaviour) separately from the aggregate uncertainty will provide important policy implications for governments to recover post health pandemics.

Table 2 shows the decline of FDI inflows is within −14.30% and −5.82% in our sampled countries (see columns (4), (5), (7), and (8)). The decrease in FDI inflows may lead to a high level of unemployment and a downfall in GDP. The correlation between FDI and GDP growth is shown in Table 2 (see the positive significant coefficients of GDP growth). During the COVID-19 pandemic, strong containment measures including mass lockdown, business

and school closures, and social distancing were implemented globally. The containment measures led to suspending business activities, job losses and loss of income. For example, OECD (2020b) estimates that the COVID-19 pandemic uncertainty caused a fall of 50% in the world FDI in 2020. The United States' unemployment rate jumped from 4.4% in March 2020 to 14.7% in April 2020 (OECD 2021). IMF (2021) reports that the world GDP growth dropped from 2.8% in 2019 to −4.4% in 2020. The decline of FDI inflows, high level of unemployment, and economic contraction require immediate and long-term responses from governments to support foreign investors during and after the pandemics.

Table 3 presents the impact of pandemic uncertainty on FDI inflows by sub-samples of income (advanced, emerging, and low-income) and region (Africa, Asia-Pacific, Europe, Middle East and Central Asia, and Western Hemisphere). The results show that the impacts of pandemic uncertainty using WPUI on FDI inflows differ among different income and region sub-samples. The coefficient of WPUI is negative and statistically significant at the 1% level in emerging economies, but insignificant in advanced and low-income economies. If the pandemic uncertainty increases by one unit, it may cause an adverse shock of 51.7% on FDI in emerging countries (see Table 3). The result shows that FDI inflows are very sensitive to the pandemic shocks in the emerging countries compared to the advanced and low-income countries. The different impacts of world uncertainty on FDI are also found in economies at different income levels by Avom et al. (2020). FDI inflows in the advanced economies are less likely influenced by uncertainty than in other economies (Avom et al. 2020). However, our results present the separate shocks of pandemic uncertainty on FDI based on the income sub-samples, whereas the Avom et al. (2020) conclusions are based on the aggregate uncertainty caused by all sources of shocks. Our finding suggests that FDI or international firms' behaviour is more sensitive to the pandemic shocks in emerging countries than in advanced countries. Therefore, policy makers should consider implementing long-term fiscal and monetary measures to support international firms that invest in emerging countries during and post pandemics. Other suggestion includes strengthening the investment environment with investment incentive policies in the long term such as easing the liquidity stress, deferring loan repayments, and using economic recovery tax measures such as lower tax rates for businesses.

In terms of regions, we find the adverse shocks of pandemic uncertainty on FDI inflows in Asia-Pacific countries with a negative and significant coefficient at the 5% level (see Table 3). For the Europe subsample, the results suggest that pandemic uncertainty does not create shocks in FDI net inflows. Our finding is consistent with Jonung and Roeger's (2006) findings of fewer impacts of pandemics on the European economies. Overall, our findings show the adverse effects of health pandemic shocks on FDI using WPUI in 142 countries from 1996 to 2019, and the pandemic shocks on FDI inflows in emerging economies and Asia-Pacific are severe.

In terms of the control variables, trade openness significantly affects FDI inflows in the 142 sampled countries (see Table 2). Table 3 shows the important role of trade openness in attracting FDI into advanced and emerging economies, Asia-Pacific, Middle East-Central Asia, and Western Hemisphere regions. The result suggests that economies from different regions should review their current trade agreements and perhaps join economic clusters with developed and developing countries to recover FDI inflows. For example, the Regional Comprehensive Economic Partnership (RCEP), the largest free trade agreement (FTA) in the world signed on 15 November 2020 by 15 Asia-Pacific countries (Association of Southeast Asian Nations 2020), will strengthen trade and investment (including FDI) in Asia and the Pacific. In New Zealand, the Trade Recovery Strategy was launched on 8 June 2020 to help the country recover from the impacts of COVID-19 pandemic (New Zealand Ministry of Foreign Affairs and Trade 2021). The most recent achievement of the Trade Recovery Strategy is the upgraded FTA between New Zealand and China signed on 26 January 2021 (Radio New Zealand 2021). The upgraded agreement will encourage trade and investment, and bring many benefits to both countries for the long-term economic recovery. The RCEP and upgraded agreements will also provide a conducive business environment for investors and reduce the impact of pandemic uncertainty on the economy.

Table 3. World Pandemic Uncertainty Index and FDI by income and region.

Dependent Variable: FDI	Advanced	Emerging	Low-Income	Africa	Asia-Pacific	Europe	Middle East -Central Asia	Western Hemisphere
Lag FDI	0.408 ***	0.432 ***	0.831 ***	0.823 ***	0.522 ***	0.453 ***	0.407 ***	0.426 **
	(0.0680)	(0.120)	(0.0542)	(0.0307)	(0.0678)	(0.0666)	(0.141)	(0.193)
WPUI	−2.282	−0.517 ***	−0.0360	−0.319	−0.0463 **	-	-	0.643
	(2.270)	(0.135)	(0.0345)	(0.264)	(0.0209)			(8.336)
GDP growth	0.350	0.0695 **	−0.0122	0.0340	0.191 **	0.180	−0.0164	0.0704
	(0.227)	(0.0325)	(0.0493)	(0.0566)	(0.0887)	(0.140)	(0.0429)	(0.0758)
Domestic investment	−0.124	0.0397	0.0865 **	0.0953 **	0.0559	0.0319	0.0468	0.111
	(0.0992)	(0.0282)	(0.0368)	(0.0392)	(0.0379)	(0.0713)	(0.0368)	(0.0856)
Human capital	0.0600	0.0272 **	−0.0154	−0.0141	0.0192	0.0368	−0.0220	0.0237 **
	(0.0399)	(0.0116)	(0.0101)	(0.0121)	(0.0223)	(0.0242)	(0.0180)	(0.0113)
Financial development	0.00884	−0.00453	0.00265	0.0415 ***	−0.00104	−0.00112	−0.0169	0.00794
	(0.0094)	(0.0102)	(0.0116)	(0.0143)	(0.0086)	(0.0068)	(0.0242)	(0.0057)
Environmental factor	0.207 *	−0.0271	0.313	−0.579 ***	−0.121	0.0863	0.0657	−0.0581
	(0.108)	(0.0758)	(0.339)	(0.208)	(0.148)	(0.146)	(0.125)	(0.0696)
Energy security	−0.158	−0.0300	−0.00913	−0.0320	0.0167	−0.0160	−0.0378	−0.0183
	(0.111)	(0.0227)	(0.0432)	(0.0323)	(0.104)	(0.0585)	(0.0265)	(0.0374)
Trade openness	0.0535 ***	0.0171 **	0.00836	0.0157	0.0397 ***	0.0253	0.0418 ***	0.0283 ***
	(0.0096)	(0.0081)	(0.0097)	(0.0159)	(0.0112)	(0.0183)	(0.0117)	(0.0057)
Constant	−9.092 **	−2.215 **	−1.137	−1.821 **	−5.173 **	−5.248	0.660	−4.314 **
	(4.583)	(1.020)	(0.716)	(0.846)	(2.072)	(3.304)	(1.562)	(1.803)
Observations	397	658	496	371	205	491	191	293
Number of countries	28	54	45	33	19	34	20	21
Number of instruments	18	18	18	18	18	17	17	18
AR(2) (*p*-value)	0.4357	0.3402	0.6181	0.6936	0.298	0.7455	0.6099	0.5559
Hansen test (*p*-value)	0.7771	0.2685	0.1837	0.395	0.5254	0.6302	0.2945	0.516

Source: Authors' calculation. Note: Standard errors are in parentheses. *, **, *** are significant levels at 10%, 5%, 1%, respectively.

We observe that the results of several control variables are not statistically significant in the estimations of all sub-samples (see Table 3). For example, domestic investment determines FDI inflows in only low-income economies and Africa. A one-unit increase in domestic investment will create more than 8.5% and 9.5% increase in FDI in low-income and Africa sub-samples, respectively (see Table 3). This result supports the findings of Khadaroo and Seetanah (2009) and Kaur et al. (2016) of the important role of domestic investment or infrastructure development of host countries in attracting FDI into low-income economies in Africa. Our results in Table 3 also show that foreign investors are more sensitive to financial development and environment factor in Africa than other regions. The probable explanation for this result is that most of countries in Africa are low-income economies with limited development in infrastructure and financial system (Calderón and Servén 2008; Mlachila et al. 2016). Due to digitalisation, international firms have relied on the convenience of fast communication and transportation, and reliable banking service, which are more readily available in emerging and developed countries than low-income economies. Therefore, African governments should consider investing more in quality infrastructure and financial services for sustainable economic development. Infrastructure and financial developments are especially vital to reduce the impact of pandemic uncertainty on African economies.

Regarding energy security, Table 2 shows the negative relationship between energy security and FDI inflows worldwide. This result means foreign investors is more likely to invest in countries that are more independent of natural resource (lower shares of total natural resource rents in GDP). Our finding is consistent with the conclusion of Sánchez-Martín et al. (2015) on the positive impact of good energy security strategy on FDI inflows. However, in our sub-sample estimations, no direct causality from energy security to FDI is found (see Table 3). A possible reason is that international investors is less sensitive to host countries' energy security strategy within a specific region or income group. In terms of environment factor, we find the effects of CO2 emission on FDI are mixed (see Tables 2 and 3). This result confirms the indirect relationship between environmental pollutant and FDI in the Dinh and Lin (2014) study.

Our results are consistent and unbiased. The number of instruments is less than the number of countries (see Tables 2 and 3), which does not weaken and bias the Hansen over-identifying restrictions test. The p-values of Hansen test in Tables 2 and 3 do not reject the validity of instruments used in our estimations. The p-values of AR(2) do not reject the assumption that the error term does not exhibit second-order serial correlation.

5. Conclusions

The impacts of pandemic uncertainty on world economies have been documented in the literature. With the acceleration of uncertainty in 2020/2021 due to the COVID-19 pandemic, this is the first study that investigates the impacts of health pandemics on FDI net inflows using the new pandemic uncertainty measure WPUI in 142 economies from 1996 to 2019. Our findings show that the uncertainty caused by health pandemics leads to a decrease in FDI net inflows worldwide. Using the income and region sub-samples, this paper proves that pandemic uncertainty creates adverse shocks on FDI net inflows in Asia-Pacific countries and emerging economies from 1996 to 2019.

Our findings suggest that pandemic uncertainty highly affects international firms' behaviour and is associated with a decline of inward FDI flows into the host countries. Furthermore, FDI or international firms' behaviour is more sensitive to the pandemic shocks in emerging economies and the Asia and the Pacific region than in other economies and regions. The negative impact of pandemic uncertainty may lead to a high level of unemployment and a downfall in GDP. The shocks from health pandemics require urgent actions from governments for economic recovery and sustainable development.

To respond to pandemics, governments across economies and regions need to use extensive fiscal and monetary policies and face the consequences. For instance, tax measures were immediately implemented in most countries to respond to the economic impacts caused by COVID-19 (OECD 2020a). The immediate tax measures consist of reductions in tax rates such as Corporate Income Tax and Value Added Tax, tax waivers, tax reimbursement, and enhanced tax loss provisions (carry-forward or carry-backward). In addition, the expansionary monetary policy was implemented worldwide. Central banks across countries cut monetary policy rates, bought back government bonds, suspended bank dividends to increase the money supply, deferred loan repayments, or suspended loan requirements (OECD 2020a). The collapse of global economic activities and government financing during the COVID-19 pandemic have led to many countries being in debt, recession, and slow recovery until 2024 (IMF 2020). If governments do not take actions early to support international firms, the shocks from pandemic uncertainty on FDI inflows are likely to increase, and economic recovery is unpredictable.

Our study provides important policy implications to economically recover post the COVID-19 pandemic, especially for emerging countries in Asia and the Pacific. Besides immediate responses to pandemics such as containment measures, fiscal and monetary measures to support foreign investors are needed in the long term. For example, economic recovery tax measures such as lower tax rates to support investment should be implemented. Easing the liquidity stress and deferring loan repayments for businesses should be continued. Labour force as a determinant of FDI should be retrained. The investment environment should be strengthened with investment incentive policies via trade and investment agreements. Reviewing and updating current trade agreements will provide a conductive business environment for investors and encourage trade and investment regionally and internationally. Joining economic clusters will also bring benefits to countries for long-term economic recovery post pandemics.

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Data Availability Statement: Publicly available datasets were analysed in this study. This data can be found here: https://databank.worldbank.org/source/world-development-indicators (accessed on 8 January 2021); https://worlduncertaintyindex.com/wp-content/uploads/2020/10/WPUI_Data.xlsx (accessed on 8 January 2021); https://worlduncertaintyindex.com/wp-content/uploads/2020/10/WUI_Data.xlsx (accessed on 8 January 2021).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

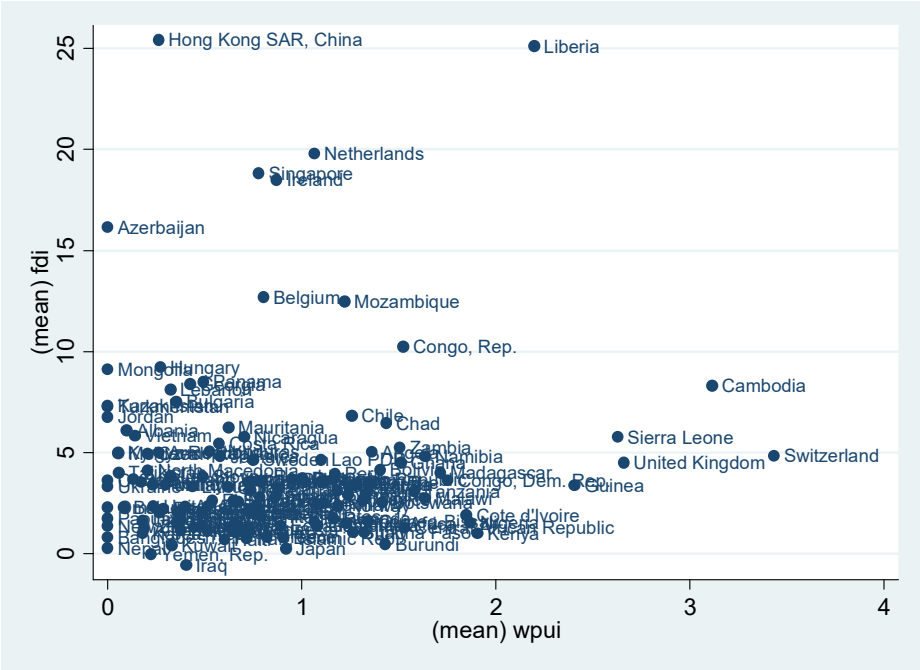

Figure A1. The correlation between WPUI and FDI. Source: Authors' calculation.

Table A1. Country list.

No.	Country	Code	Income	Region	No.	Country	Code	Income	Region
1	Afghanistan	AFG	3	MCD	72	Korea, Rep.	KOR	1	APD
2	Angola	AGO	2	AFR	73	Kuwait	KWT	2	MCD
3	Albania	ALB	2	EUR	74	Lao PDR	LAO	3	APD
4	United Arab Emirates	ARE	2	MCD	75	Lebanon	LBN	2	MCD
5	Argentina	ARG	2	WHD	76	Liberia	LBR	3	AFR
6	Armenia	ARM	2	MCD	77	Libya	LBY	2	MCD
7	Australia	AUS	1	APD	78	Sri Lanka	LKA	2	APD
8	Austria	AUT	1	EUR	79	Lesotho	LSO	3	AFR
9	Azerbaijan	AZE	2	MCD	80	Lithuania	LTU	2	EUR
10	Burundi	BDI	3	AFR	81	Latvia	LVA	1	EUR
11	Belgium	BEL	1	EUR	82	Morocco	MAR	2	MCD
12	Benin	BEN	3	AFR	83	Moldova	MDA	3	EUR
13	Burkina Faso	BFA	3	AFR	84	Madagascar	MDG	3	AFR
14	Bangladesh	BGD	3	APD	85	Mexico	MEX	2	WHD
15	Bulgaria	BGR	2	EUR	86	North Macedonia	MKD	2	EUR
16	Bosnia and Herzegovina	BIH	2	EUR	87	Mali	MLI	3	AFR
17	Belarus	BLR	2	EUR	88	Myanmar	MMR	3	APD
18	Bolivia	BOL	3	WHD	89	Mongolia	MNG	3	APD
19	Brazil	BRA	2	WHD	90	Mozambique	MOZ	3	AFR
20	Botswana	BWA	2	AFR	91	Mauritania	MRT	3	MCD
21	Central African Republic	CAF	3	AFR	92	Malawi	MWI	3	AFR
22	Canada	CAN	1	WHD	93	Malaysia	MYS	2	APD
23	Switzerland	CHE	1	EUR	94	Namibia	NAM	2	AFR
24	Chile	CHL	2	WHD	95	Niger	NER	3	AFR
25	China	CHN	2	APD	96	Nigeria	NGA	3	AFR

Table A1. *Cont.*

No.	Country	Code	Income	Region	No.	Country	Code	Income	Region
26	Cote d'Ivoire	CIV	3	AFR	97	Nicaragua	NIC	3	WHD
27	Cameroon	CMR	3	AFR	98	Netherlands	NLD	1	EUR
28	Congo, Dem. Rep.	COD	3	AFR	99	Norway	NOR	1	EUR
29	Congo, Rep.	COG	3	AFR	100	Nepal	NPL	3	APD
30	Colombia	COL	2	WHD	101	New Zealand	NZL	1	APD
31	Costa Rica	CRI	2	WHD	102	Oman	OMN	2	MCD
32	Czech Republic	CZE	1	EUR	103	Pakistan	PAK	2	MCD
33	Germany	DEU	1	EUR	104	Panama	PAN	2	WHD
34	Denmark	DNK	1	EUR	105	Peru	PER	2	WHD
35	Dominican Republic	DOM	2	WHD	106	Philippines	PHL	2	APD
36	Algeria	DZA	2	MCD	107	Papua New Guinea	PNG	3	APD
37	Ecuador	ECU	2	WHD	108	Poland	POL	2	EUR
38	Egypt, Arab Rep.	EGY	2	MCD	109	Portugal	PRT	1	EUR
39	Eritrea	ERI	3	AFR	110	Paraguay	PRY	2	WHD
40	Spain	ESP	1	EUR	111	Qatar	QAT	2	MCD
41	Ethiopia	ETH	3	AFR	112	Romania	ROU	2	EUR
42	Finland	FIN	1	EUR	113	Russian Federation	RUS	2	EUR
43	France	FRA	1	EUR	114	Rwanda	RWA	3	AFR
44	Gabon	GAB	2	AFR	115	Saudi Arabia	SAU	2	MCD
45	United Kingdom	GBR	1	EUR	116	Sudan	SDN	3	MCD
46	Georgia	GEO	2	MCD	117	Senegal	SEN	3	AFR
47	Ghana	GHA	3	AFR	118	Singapore	SGP	1	APD
48	Guinea	GIN	3	AFR	119	Sierra Leone	SLE	3	AFR
49	Gambia, The	GMB	3	AFR	120	El Salvador	SLV	2	WHD
50	Guinea-Bissau	GNB	3	AFR	121	Slovak Republic	SVK	1	EUR
51	Greece	GRC	1	EUR	122	Slovenia	SVN	1	EUR
52	Guatemala	GTM	2	WHD	123	Sweden	SWE	1	EUR
53	Hong Kong SAR, China	HKG	1	APD	124	Chad	TCD	3	AFR
54	Honduras	HND	3	WHD	125	Togo	TGO	3	AFR
55	Croatia	HRV	2	EUR	126	Thailand	THA	2	APD
56	Haiti	HTI	3	WHD	127	Tajikistan	TJK	3	MCD
57	Hungary	HUN	2	EUR	128	Turkmenistan	TKM	2	MCD
58	Indonesia	IDN	2	APD	129	Tunisia	TUN	2	MCD
59	India	IND	2	APD	130	Turkey	TUR	2	EUR
60	Ireland	IRL	1	EUR	131	Tanzania	TZA	3	AFR
61	Iran, Islamic Rep.	IRN	2	MCD	132	Uganda	UGA	3	AFR
62	Iraq	IRQ	2	MCD	133	Ukraine	UKR	2	EUR
63	Israel	ISR	1	EUR	134	Uruguay	URY	2	WHD
64	Italy	ITA	1	EUR	135	United States	USA	1	WHD
65	Jamaica	JAM	2	WHD	136	Uzbekistan	UZB	3	MCD
66	Jordan	JOR	2	MCD	137	Venezuela, RB	VEN	2	WHD
67	Japan	JPN	1	APD	138	Vietnam	VNM	3	APD
68	Kazakhstan	KAZ	2	MCD	139	Yemen, Rep.	YEM	3	MCD
69	Kenya	KEN	3	AFR	140	South Africa	ZAF	2	AFR
70	Kyrgyz Republic	KGZ	3	MCD	141	Zambia	ZMB	3	AFR
71	Cambodia	KHM	3	APD	142	Zimbabwe	ZWE	3	AFR

Source: Ahir et al. (2018). Note: Countries are differentiated based on the IMF classification. Under the income columns, 1 = Advance economies, 2 = Emerging economies, and 3 = Low-income economies. Under the region columns, AFR = Africa, APD = Asia and the Pacific, EUR = Europe, MCD = Middle East and Central Asia, and WHD = Western Hemisphere.

Table A2. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
FDI	3365	4.1542	6.9871	−40.41	103.34
WPUI	3408	0.1064	1.4173	0	56.47
WUI	3408	0.1701	0.1513	0	1.34
GDP growth	3373	3.9968	5.2580	−62.08	123.14
Domestic investment	3167	22.4165	6.9589	−2.42	79.46
Human capital	2324	77.1766	31.8555	5.28	163.93
Financial development	2742	48.6492	45.8159	0	235.72
Environmental factor	2971	4.5057	6.4641	0.02	70.04
Energy security	3232	8.6702	12.1076	0	86.25
Trade openness	3275	80.3199	48.9515	0.03	442.62

Source: Authors' calculation.

Table A3. Correlation matrix.

Variables	FDI	WPUI	WUI	GDP Growth	Domestic Investment	Human Capital	Financial Development	Environmental Factor	Energy Security	Trade Openness
FDI	1.000									
WPUI	−0.005 (0.796)	1.000								
WUI	−0.057 *** (0.001)	0.057 *** (0.001)	1.000							
GDP growth	0.095 *** (0.000)	0.019 (0.264)	−0.105 *** (0.000)	1.000						
Domestic investment	0.205 *** (0.000)	−0.005 (0.766)	−0.083 *** (0.000)	0.197 *** (0.000)	1.000					
Human capital	0.113 *** (0.000)	−0.065 *** (0.002)	0.098 *** (0.000)	−0.213 *** (0.000)	0.080 *** (0.000)	1.000				
Financial development	0.127 *** (0.000)	−0.038 ** (0.048)	0.055 *** (0.004)	−0.152 *** (0.000)	0.165 *** (0.000)	0.593 *** (0.000)	1.000			
Environmental factor	0.019 (0.293)	−0.028 (0.123)	−0.064 *** (0.001)	−0.015 (0.410)	0.134 *** (0.000)	0.504 *** (0.000)	0.391 *** (0.000)	1.000		
Energy security	0.008 (0.652)	−0.002 (0.904)	−0.086 *** (0.000)	0.133 *** (0.000)	0.076 *** (0.000)	−0.282 *** (0.000)	−0.326 *** (0.000)	0.207 *** (0.000)	1.000	
Trade openness	0.422 *** (0.000)	0.029 * (0.095)	−0.073 *** (0.000)	0.031 * (0.078)	0.193 *** (0.000)	0.263 *** (0.000)	0.295 *** (0.000)	0.152 *** (0.000)	−0.008 (0.646)	1.000

Source: Authors' calculation. Note: *p*-values are in parentheses. *, **, *** are significant levels at 10%, 5%, 1%, respectively.

Table A4. Robustness tests.

Dependent Variable: FDI	WPUI			WUI		
	DPDGMM	SELPDM	BBGMM	DPDGMM	SELPDM	BBGMM
Lag FDI	0.527 *** (0.0906)	0.527 *** (0.0906)	0.531 *** (0.0699)	0.563 *** (0.0979)	0.563 *** (0.0979)	0.568 *** (0.0740)
WPUI or WUI	−0.143 * (0.0751)	−0.143 * (0.0751)	−0.144 ** (0.0673)	0.127 * (0.0688)	0.127 * (0.0688)	0.113 (0.0703)
GDP growth	0.140 ** (0.0583)	0.140 ** (0.0583)	0.133 ** (0.0581)	0.127 ** (0.0603)	0.127 ** (0.0603)	0.125 ** (0.0591)
Domestic investment	0.0544 (0.0722)	0.0544 (0.0722)	0.0531 (0.0710)	0.0354 (0.0557)	0.0354 (0.0557)	0.0352 (0.0552)
Human capital	−0.0618 ** (0.0305)	−0.0618 ** (0.0305)	−0.0645 *** (0.0242)	−0.0762 ** (0.0322)	−0.0762 ** (0.0322)	−0.0783 *** (0.0268)
Financial development	0.00521 (0.0161)	0.00521 (0.0161)	0.00496 (0.0143)	0.0125 (0.0178)	0.0125 (0.0178)	0.0131 (0.0145)
Environmental factor	0.123 (0.161)	0.123 (0.161)	0.106 (0.159)	0.244 (0.167)	0.244 (0.167)	0.237 (0.170)
Energy security	−0.164 *** (0.0598)	−0.164 *** (0.0598)	−0.164 *** (0.0616)	−0.125 ** (0.0593)	−0.125 ** (0.0593)	−0.134 ** (0.0602)
Trade openness	0.0731 *** (0.0211)	0.0731 *** (0.0211)	0.0726 *** (0.0210)	0.0626 *** (0.0212)	0.0626 *** (0.0212)	0.0629 *** (0.0226)
Constant	−0.284 (2.849)	−0.284 (2.849)	0.104 (2.823)	1.018 (2.269)	1.018 (2.269)	1.168 (2.245)
Observations	1551	1551	1551	1551	1551	1551
Number of countries	127	127	127	127	127	127
Number of instruments	55	55	55	55	55	55
AR(2) (*p*-value)	0.6878	0.6845	0.688	0.664	0.6605	0.661
Hansen test (*p*-value)	0.1368	0.1368	0.145	0.3019	0.3019	0.333

Source: Authors' calculation. Note: Standard errors are in parentheses. *, **, *** are significant levels at 10%, 5%, 1%, respectively. Although our sample consists of 142 economies, the estimations is for 127 countries due to the unbalanced panel data.

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