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The spatial heterogeneity and time-varying nature of FDI determinants: evidence from China

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ABSTRACT
This article explores the spatial heterogeneity and time-varying nature of FDI determinants. It also examines the impact of the Belt and Road Initiative (BRI) on regional FDI inflows. Applying both the long-term static model and the short-term dynamic model to a provincial-level dataset in China over the 1979–2018 period, we find that FDI is positively affected by market size, labour costs, openness, transport infrastructure, human capital, and the exchange rate, but negatively affected by population, and more importantly, these effects are heterogeneous across regions and over different time periods. We also find that provinces directly involved in the BRI became less attractive to foreign investors after the launch of the BRI in 2013.

KEYWORDS
FDI; belt and road initiative; regional differences; China

JEL CODE
F21; O11; O47

1. Introduction

Foreign direct investment (FDI), as an important part of globalization since the 1980s, has been growing dramatically worldwide and has drawn extensive research attention over the past few decades. A large body of literature focuses on the impact of FDI on economic growth, but consensus is yet to be reached. Conflicting empirical evidence suggests that the impact of FDI may be country-specific and can be positive (Cai, Chen, and Fang 2018; Paul & Feliciano-Cestero 2019), negative (Doytch and Merih 2011), or insignificant (Anderson, Larch, and Yotov 2019), depending on the economic, institutional, technological conditions, human capital, etc., in host countries (Paul and Feliciano-Cestero 2021).

China, the largest developing country in the world, has experienced impressive economic growth and a dramatic increase in FDI inflows since the late 1970s. Over the past four decades, the economic growth and FDI inflows share a similar pattern of increasing rapidly but having an uneven distribution across regions, which has induced the debate over whether FDI is a contributing factor to regional inequality. Some studies claim that FDI leads to more poverty, isolation, neglection of local

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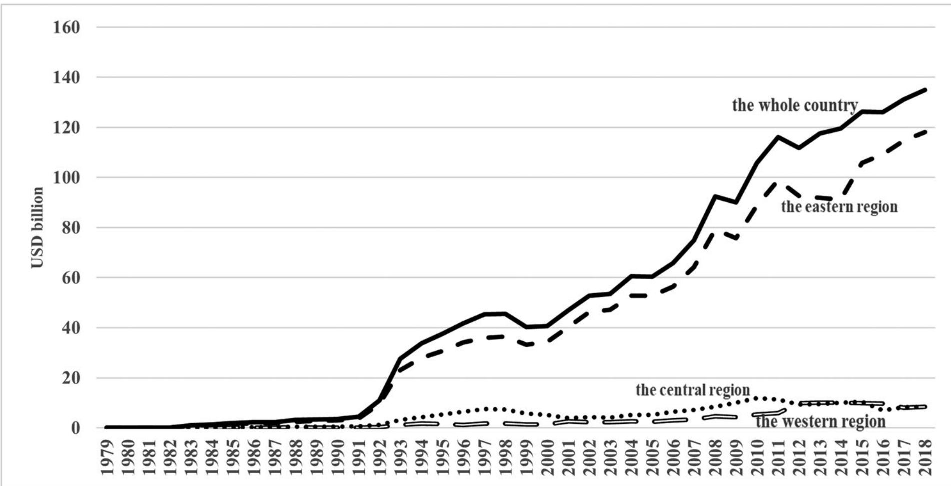

Figure 1. Actual FDI inflows in China, 1979–2018.
Sources: China Statistical Yearbooks (1999–2019); China Statistical Data of 50 Years 1949–1998.

capabilities, and regional inequality (Roser and Cuaresma 2016), while others believe the opposite is true and that FDI can promote equality, reduce poverty, and accelerate the convergence process (McGrattan 2012). Wei, Yao, and Liu (2009) suggest that FDI cannot be blamed for causing regional inequality, but the uneven distribution of FDI has caused regional growth disparities.

As shown in Figure 1, the actual FDI used in China rocketed to $11 billion in 1992 after Deng Xiaoping's 'Southern Tour'. As the momentum continued, China became the largest FDI recipient among developing countries in 1996, surpassing the US and becoming the world's most popular FDI destination. China's total FDI amount climbed from $53.51 billion in 2003 to $134.97 billion in 2018. Figure 1 clearly exhibits the significant heterogeneity of FDI inflows across regions and over time in China. The east coastal region enjoyed preferential government policies, such as lower income tax rates and reduced tariffs for imports used in the production of exports, during China's early attempts to attract FDI. Researchers argue that the uneven geographical distribution of FDI in China is mainly due to the initial preferential policies favouring the eastern coastal provinces (Yu, Xiangyong, and Xian 2008). However, similar preferential policies have been applied throughout the entire country since the late 1990s, while FDI inflows in inland China have failed to catch up. The eastern coastal region received more than 90% of the total FDI in China before 1992 and dropped slightly to 87% in 2018. The data indicate that the differences in the ability to attract FDI across regions are not driven by preferential policies. Against this backdrop, this article attempts to explain why inward FDI is unevenly distributed across regions by investigating the spatial heterogeneity and time-varying nature of FDI determinants.

Moreover, the ability to attract FDI is not only determined by the host country's internal factors, but also influenced by the external environment. President Xi Jinping announced the Belt and Road Initiative (BRI) in September 2013, which aims to connect China to countries along the BRI, thereby promoting China's opening up from

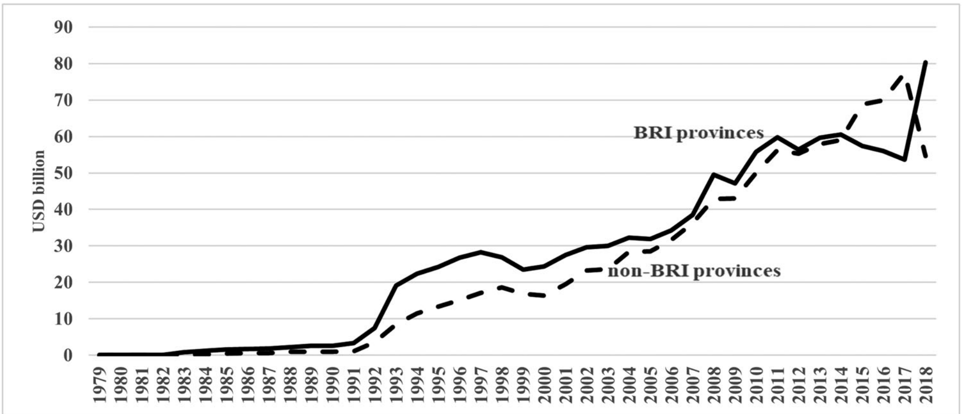

Figure 2. Actual FDI inflows in BRI and non-BRI provinces in China, 1979–2018.
Sources: China Statistical Yearbooks (1999–2019); China Statistical Data of 50 Years 1949–1998.

coastal areas to inland areas. Figure 2 plots actual FDI inflows in BRI and non-BRI provinces over the 1979–2018 period. FDI in BRI provinces was slightly higher than that in non-BRI provinces before the launch of the BRI in 2013 but decreased sharply during the 2013–2017 period, followed by a surge in 2018. Undoubtedly, the BRI has significant implications for international trade and FDI, while the literature on the effect of the BRI on FDI is inadequate. As such, this study investigates how the distribution of inward FDI is affected by the BRI.

Applying both a long-run static model and a short-run dynamic model with an error-correction mechanism (ECM) to a provincial-level panel dataset over the 1979–2018 period, this article finds that FDI is positively affected by market size, labour costs, openness, infrastructure, human capital, and the exchange rate but negatively affected by population, and more importantly, these effects are heterogeneous across regions and over different time periods. We also find that the FDI distribution is affected by the BRI – provinces directly involved in the BRI became less attractive to foreign investors after the BRI launch in 2013. Our results are robust to different model specifications and estimation techniques.

This study adds new knowledge to the literature on FDI from three aspects. First, the extensive literature on FDI inflows addresses the following two broad issues: the impact of FDI on host countries and the driving factors of FDI. The literature, however, assumes a homogeneous effect of each driving factor on FDI. Our study provides evidence for heterogeneity in the effects of FDI determinants across regions and over time. Second, our study considers both the static effect in the long run and the dynamic effect in the short run, complementing the literature that mainly focuses on the static effect. Third, our study extends the literature on FDI from the perspective of foreign policies and the external environment by documenting a negative impact of the BRI on FDI inflows.

The rest of this article proceeds as follows. Section 2 presents the literature review. Section 3 illustrates the empirical models and data. Section 4 interprets the empirical results, and Section 5 concludes with policy implications.

2. Literature review

2.1. FDI determinants

FDI plays an important role in promoting MNE growth, industrial upgrading, and ultimately, economic development; hence, FDI has attracted extensive attention from MNE managers, policymakers, and researchers. The literature classifies FDI determinants at the following three levels: the micro, macro, and strategic levels (Keeley and Matsumoto 2018; Paul and Feliciano-Cestero 2021). The microlevel determinants focus on firm-specific factors, such as ownership, product advantage, cost advantage, economies of scale, multiplant economy, advanced technology, marketing, and product distribution. The macrolevel factors include market size, growth, taxation, infrastructure quality, political stability, exchange rates, and regulatory constraints in host countries. The long-run strategic factors include protecting existing foreign markets, diversifying business activities, gaining or maintaining a foothold in host countries, and complementing other investments.

Research on FDI from the macroeconomics perspective generally focuses on the following factors that affect FDI inflows in the host country: market size (demand), labour cost, international trade, infrastructure, human capital, population, exchange rate, country risk, institutional regime, taxes, and geographical location. The size of the economy directly indicates the market demand and market size. Product cycle theory indicates that market-share extension is the critical strategy utilized by mature multinational corporations (Dunning 1988). The literature generally agrees that market size has a positive impact on FDI inflows (Lin, Hsiao, and Lin 2015).

Lowering labour costs is an effective way of maximizing capital returns, especially in labour-intensive manufacturing industries. Foreign investors tend to take advantage of the host country's cheap factor inputs where possible. Sun, Tong, and Yu (2002) find that wages had a positive relationship with FDI inflows before 1991 but a negative relationship subsequently. The mainstream empirical research suggests that low wages in host countries encourage FDI (Rong et al. 2020). On the other hand, human capital not only raises output but also enables firms to use advanced technology in production. Cleeve, Debrah, and Yiheyis (2015) suggest that human capital exerts a significant influence on FDI in Africa, and the results are robust to different measures, while Coughlin and Segev (2000) argue that illiteracy has a negative effect on FDI.

A country's openness indicates the extent to which the host country integrates with the rest of the world. Many studies find that openness and trade are complementary, and the higher the international trade (exports and imports) is, the higher inward FDI will be in the host country (Yao 2006; Sanchez-Martin, Arce, and Escribano 2014). However, some cross-country studies find that international trade and FDI are substitutes and negatively related (Horst 1972). If other things remain the same, the higher the international transportation costs and tariff/nontariff trade barriers are, the greater the amount of FDI that firms will undertake in the host country. Moshfique et al. (2018) finds that trade freedom has a strong positive impact on the inflow of FDI. Hence, the exact relationship between the openness of the host country and FDI is an empirical issue.

An economy with good infrastructural investment is more attractive to foreign investors. Blyde and Molina (2015) indicate that a better-developed transportation infrastructure is beneficial to a host country in terms of attracting FDI because foreign firms might be unfamiliar with the environment of the host country. Empirical evidence supports the importance of infrastructure in FDI location decisions (Hou et al. 2020). On the other hand, Peck (1996) argues that although the presence of certain types of basic infrastructure may be significant in attracting the initial interest of potential new investors, some infrastructure types are designed for the specific demands made by new investors. The research results of Alfalih and Hadj (2020) show that infrastructure has no impact on FDI in the short or long term. In the same vein, Coughlin and Segev (2000) show that transportation did not yield statistical significance in attracting FDI.

The 'new' location theory (Krugman 1991; Venables 1993) emphasizes the 'Pecuniary' externalities associated with demand and supply linkages, such as the possibility of using joint networks of suppliers and distributors. It is also argued that knowledge-enhancing activities can only partly be appropriated by firms, implying that an externality is created and diffused to other firms, thereby reducing their costs (Romer 1986). If knowledge spill-overs and pecuniary externalities are important for a firm's competitiveness, population forces will increasingly influence a firm's location decisions. Thus, population is expected to be positively related to inward FDI.

The impact of exchange rates on FDI has been examined in terms of changes at bilateral exchange rate levels between countries and exchange rate fluctuations. Froot and Obstfeld (1991) argue that the real depreciation of the host country's currency benefits home-country purchasers of host country assets, thus leading to an increase in FDI inflows. Harms and Knaze (2021) assert that exchange rate fluctuations have an impact on FDI and that countries with nonfloating exchange rate systems tend to attract more FDI. In general, the higher the ratio of the host country's currency to the US dollar, the more FDI the host country absorbs.

In short, the literature on FDI determinants is extensive and mainly focuses on their static and assumed-homogeneous impacts. Our study extends the literature by exploring the spatial heterogeneity and time-varying nature of FDI determinants in both static and dynamic settings.

2.2. The BRI and FDI

FDI is also affected by the changing international political and economic environment, such as political stability, international cooperation, and free trade areas. After China joined the WTO in 2001, FDI inflows increased dramatically. However, regional economic disparities are significant, especially between the coastal and noncoastal central and western provinces. The coastal region has developed much faster and has benefited from easy access to sea routes at lower transportation costs. The geographical proximity of the coastal provinces to Hong Kong, Macau, Taiwan, Japan, and Korea makes them more attractive to foreign investors. Partially to address the regional disparity, China launched the BRI in 2013. The BRI is a plan to construct trade-boosting infrastructure projects not only for China but also for approximately 65% of the world's population, covering one-third of the world's GDP, and one-quarter of the total world trade. The core aim of the BRI is to promote interconnection between China and countries along the BRI and beyond, reaching out to Europe and African countries. Since the BRI was launched in 2013, international trade and investment between China and BRI countries have also increased significantly. China's trade with BRI countries and investment in BRI countries reached USD1.1 trillion and USD14.4 billion, respectively, in 2017. In the same year, BRI countries launched 3857 firms in mainland China with USD 5.6 billion in investment.

The BRI has become a powerful platform for regional cooperation and integration and has the potential to enable many emerging and developing BRI countries to catch up and prosper, as well as serving as the impetus for sustainable development and growth worldwide. The BRI has attracted great research interest, and the related literature has addressed a wide range of issues. García-Herrero and Xu (2017) estimate potential increases in trade among BRI countries, reporting considerable benefits to EU countries (especially landlocked countries), Eastern Europe and Central Asia and, to a lesser extent, Southeast Asia. Li, Huang, and Dong (2019) confirm that the overall economic freedom, institutional entities, bilateral trade, GDP and patents of countries along the BRI all have a significant impact on outward FDI. Yu et al. (2020) report that China's export potential to partner countries has increased significantly, especially to ASEAN countries and West Asian countries. Cheng and Qi (2021) focus on the industry selection of China's direct investment in BRI countries and find that China's FDI potential in noncarbon-intensive industries is higher than that in carbon-intensive industries. Since the launch of the BRI, China's outward FDI has increased significantly, which has led to increased TFP in BRI countries (Wu et al. 2020) while reducing carbon dioxide emissions in regions along the routes (Li et al., 2021). Meanwhile, the BRI has a 'signalling' effect on foreign investors that China's strategic priority has moved from 'bringing in' towards 'going global'. In the short term, the BRI may trigger competition between 'going global' and 'bringing in' resources. FDI inflows to the BRI provinces decreased significantly compared to non-BRI provinces during the period of 2003–2015 (Luo, Chai, and Chen 2019). The limited literature on the relationship between the BRI and FDI primarily focuses on the impact of the BRI on China's outflow of FDI, while our study explores how the BRI affects regional FDI inflows.

3. Research methodology and data

3.1. Long-run static model

The FDI inflow level depends on government policies and local characteristics. In this study, we follow the literature and explain the variations in FDI in terms of market size, labour costs, openness, infrastructure, human capital, population, and exchange rate. Following Yao and Wei (2007), the baseline empirical specification in natural logarithm is as shown in Eq. (1).

$$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 FE + v_{it} \quad (1)$$

where i ($i = 1,2, \ldots, 29$) and t ($t = 1979, \ldots, 2018$) denote province i and year t, FDI is the dependent variable, X_{it} is a set of explanatory variables, including gdp (proxy for market size), *wage* (labour costs), *export* (proxy for openness), *transport* (proxy for infrastructure), *human capital, population, exchange rate*, and *FE* is a set of dummy variables to control the year (or period) and province (or region) effects.

In this study, we focus on the varying effect of FDI driving factors across regions and over time. We introduce a set of *Region* dummy variables and the interaction terms between the explanatory variables and *Region* dummy variables into Eq. (1), as shown in Eq. (2):

$$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} \times Region_j + \beta_3 Region_j + \beta_4 FE + v_{it} \tag{2}$$

where *Region* includes the dummy variables *East*, *Central* and *West*, taking a value of 1 for provinces in the respective region and 0 otherwise. $X_{it} \times Region_j$ denotes the form of the interaction terms between the explanatory variables and *Region* dummy variables.

We then split the full sample period into the following three subsample periods: the pre-Deng south tour period of 1979–1991, the pre-WTO period of 1992–2000, and the post WTO period of 2001–2018. In a similar vein, we introduce a set of *Period* dummy variables and the interaction terms between the explanatory variables and *Period* dummy variables into Eq. (1), as shown in Eq. (3):

$$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} \times Period_k + \beta_3 Period_k + \beta_4 FE + v_{it} \tag{3}$$

where *Period* includes the *pre-1992, 1992–2000, and 2001–2018* dummy variables, which take a value of 1 for that subperiod and 0 otherwise. $X_{it} \times Period_j$ is the form of the interaction terms between the explanatory variables and *Period* dummy variables.

3.2. Short-run dynamic models with ECM

The long-run model may be subject to possible spurious results if the variables in the model are not cointegrated. Although other studies (e.g. Yao 2006; Yao and Wei 2007) have proven that cointegration relationships exist among the variables in the long-run models, it is still useful to run their short-run dynamic forms. The short-run Engel-Granger error-correction mechanism (ECM) model can also test the dynamic relationship between independent variables. If FDI is cointegrated with its influencing factors, the short-term disequilibrium relationship between them can be expressed by an error correction model. We conduct cointegration analysis on the variables to detect the cointegration relationships between the variables, that is, the long-term equilibrium relationships. Then, a short-term model is established based on those long-term relationships, where the error correction term is regarded as an explanatory variable. Moreover, the short-run dynamic model can derive short-run and long-run elasticities at the same time.

Engle-Granger's ECM for cointegration analysis can be conducted using a two-step approach. The first step is to run a regression of Eq. (1) and derive residuals $((\hat{e}_{it}))$. The second step is to run another regression based on Eq. (4) below.

$$\Delta y_{it} = f(\Delta \tilde{X}_{it}) - \theta \widehat{e}_{it-1} + v_{it} \tag{4}$$

where Δ denotes the first difference, $\hat{e}_{it-1}$ is the lagged term of the estimated residuals obtained from the first regression, and $f(\Delta\tilde{X}_{it})$ denotes the short-run form of the original production function shown in Eq. (1).

If θ is significant and positive, there is a long-run stable cointegration relationship between *FDI* and the explanatory variables. The main limitation of Eq. (4) is that the long-run coefficients cannot be estimated, and the short-run coefficients have to be estimated in two steps. To overcome these limitations, Eq. (4) is transformed into Eq. (5) so that the coefficients can be estimated in one single step.

$$\Delta y_{it} = f(\Delta\tilde{X}_{it}) - \theta(y_{it-1} - f(\tilde{X}_{it-1})) + v_{it} \tag{5}$$

The short-run coefficients are obtained from the first term on the right-hand side of Eq. (5). The long-run coefficients are obtained from the coefficients derived from $-f(\tilde{X}_{it-1})$ divided byθ. The dependent variable and explanatory variables will be cointegrated if the long-run coefficients and θ are jointly significant.

There are a number of advantages of using the one-step ECM model specified in Eq. (5) to study the dynamic relationship between FDI and its driving factors. First, both short-run and long-run elasticities can be estimated in one step. Second, the long-run disequilibrium can be corrected to give better estimates of the coefficients involved. Third, the problems of nonstationarity and simultaneity can be avoided because all variables are presented in their first (log) differences and predetermined values (lagged terms). Finally, the estimation process is simple, and the results are easy to interpret.

3.3. FDI and the BRI

To examine the impact of the BRI on the distribution of FDI, we introduce *BRI_region* and *BRI_year* to the baseline model in Eq. (1), as shown in Eq. (6).

$$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 BRI_{region} + \beta_3 BRI_{region} \times BRI_{year} + \beta_4 BRI_{year} + \beta_5 FE + v_{it} \tag{6}$$

where *BRI_region* takes a value of 1 for provinces directly on the BRI route and 0 otherwise. *BRI_year* takes a value of 1 for years after 2013, which is when the BRI announced, and 0 otherwise.

3.4. Variables and data

This study employs a panel data analysis for 29 provinces and municipalities over the 1979–2018 period. Tibet is excluded, and the data for Chongqing are merged with those of Sichuan. Data are mainly collected from *China Statistical Data 50 Years 1949–98* (NBS, 1999) and the *China Statistical Yearbooks* (NBS, various years, 1987–2019). The dependent variable *FDI* is the FDI inflows. *GDP* is the proxy for market size. *Wage* is the labour costs of employees in terms of annual salary. *Human capital* measures the education level, proxied by the number of students enrolled in higher education over the population in each province. *Export* is measured by the ratio of total exports to the GDP of a province. In China, railroads remain the most

Table 1. Summary statistics.

Symbols	Observations	Maximum	Minimum	Mean	S.D.
FDI	1159	12.796	−1.578	6.775	2.989
gdp	1160	15.192	7.780	11.746	1.479
Wage	1160	10.988	7.080	8.483	0.980
Export	1160	1.237	−7.623	−2.515	1.012
Transport	1160	7.928	2.743	5.941	0.988
Human capital	1160	−3.184	−7.716	−5.392	1.196
Population	1160	7.987	1.646	5.295	1.236
Exchange rate	1160	1.832	0.602	1.468	0.291
Region					
East	1160	1	0	0.379	0.485
Central	1160	1	0	0.345	0.476
West	1160	1	0	0.276	0.447
Period					
Pre-1992	1160	1	0	0.325	0.469
1992–2000	1160	1	0	0.225	0.418
2001–2018	1160	1	0	0.450	0.498
BRI	1160	1	0	0.552	0.498
BRI Year	1160	1	0	0.150	0.357

This table shows sample statistics for a panel of 29 provinces and municipalities in China over the 1979–2018 period. All the variables are in logarithmic form. Sources: China Statistical Yearbooks (NBS, 1987–2019, various issues), and China Statistical Data of 50 Years 1949–1998 (NBS, 1999). S.D. = standard deviation. All monetary values are at the 1990 price level.

efficient mode of transportation for moving raw materials and most heavy-industry products over long distances (Sun 1988, pp. 311–68). Consequently, railroad mileage is frequently used as a proxy for transportation capability in the literature. In this article, we use the equivalent mileages of railways, highways and waterways per 1,000 km^2 to measure the transportation capability. *Transport* is used as a proxy for infrastructure. *Population* is proxied by population density. *Exchange rate* controls for the impact of fluctuations in the value of the RMB, and we use the US price index to calculate the real exchange rate in terms of RMB against US dollars (RMB units per US dollar). We include the following set of *Region* dummy variables: *East* takes the value of 1 for an eastern province and 0 otherwise; *Central* takes the value of 1 for a central province and 0 otherwise; and *West* takes the value of 1 for a western province and 0 otherwise.[1] We also include a set of *Period* variables. *Pre-1991* indicates the period pre-Deng's south tour, taking a value of 1 for years before 1991 and 0 otherwise; *1992–2000* is the period after Deng's south tour but before WTO entry, taking a value of 1 for these years and 0 otherwise; *2001–2018* is the post-WTO period, taking a value of 1 for years after 2001 and 0 otherwise. *BRI_region* takes a value of 1 for provinces directly on the BRI route and 0 otherwise. *BRI_year* takes a value of 1 for years after 2013, which is when the BRI was announced, and 0 otherwise. Table 1 provides the sample summary statistics. All monetary explanatory variables are measured at the 1990 price level.

4. Empirical results

4.1. Estimation results from the long-run static model

4.1.1. Baseline model

The long-run static model in Eq. (1) is estimated using OLS for the sample over the 1979–2018 period, and we consider heteroscedasticity and robust standard errors.[2]

Table 2. The determinants of FDI in China 1979–2018: Long-run static model.

	Dependent variable: *FDI*(in logs)		
Variables	(1)	(2)	(3)
gdp	−0.062	0.838***	0.869***
	(0.806)	(0.000)	(0.000)
wage	1.012***	0.725***	0.236**
	(0.000)	(0.000)	(0.012)
export	−0.086	0.149**	0.213***
	(0.192)	(0.011)	(0.000)
transport	0.932***	0.818***	0.794***
	(0.000)	(0.000)	(0.000)
human capital	0.419***	0.249***	0.270***
	(0.000)	(0.000)	(0.000)
population	−0.219**	−0.392***	−0.395***
	(0.013)	(0.000)	(0.000)
exchange rate	2.999**	0.593	2.553***
	(0.018)	(0.498)	(0.000)
constant	−8.295***	−12.209***	−9.877***
	(0.000)	(0.000)	(0.000)
Province fixed effect	Yes	No	No
Year fixed effect	Yes	Yes	No
Region fixed effect	No	Yes	Yes
Period fixed effect	No	No	Yes
Observations	1159	1159	1159
R^2	0.925	0.894	0.885

$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 FE + v_{i,t}$

This table reports the results from the above long-run static model to verify the impact of FDI determinants. *FDI* is the actual used foreign direct investment. X_{it} is a set of explanatory variables, including *gdp, wage, export, transport, human capital, population,* and *exchange rate*. *FE* is a set of year (or period) and province (or region) fixed effect variables. We consider heteroscedasticity and robust standard errors. p values are in parentheses. The significance levels at 10%, 5%, and 1% are indicated by *, **, and ***, respectively.

The results are reported in Table 2, where we control the province and year fixed effects in Column (1), the region and year fixed effects in Column (2), and the region and period fixed effects in Column (3). The overall results from our baseline model are consistent with the literature and expectations.

The coefficients on all variables are statistically significant with the expected signs. GDP is found to have a significantly positive impact on FDI, consistent with previous findings in the US and other countries. Provinces with larger markets are attractive to foreign investors. The coefficient on *Wage* is significant and positive, suggesting that higher labour costs help attract more FDI, consistent with the conclusion in Cheng and Kwan (2000). High wages can reflect more productive quality labour force, which is more attractive to foreign investors. The coefficient on *exports is* statistically significant in Columns (2) and (3), suggesting that the open-door policy and the resultant expansion of international trade play a positive role in attracting FDI. Transport also shows a significantly positive impact on FDI across all regressions, suggesting that as the investing environment matures, better-developed regions with superior transportation facilities become more attractive to foreign investors. The coefficient on *human capital* is statistically significant in all regressions, suggesting a positive impact on FDI. Provinces with higher human capital levels are more attractive to foreign investors. We find a negative impact of population on FDI, which is different from the findings in early studies (Head and Ries 1996). The possible reason could be that our sample period is long, and we are able to capture the effect that foreign investors tend to escape from more populated provinces due to the diminishing return on FDI in certain 'hot' provinces where the costs of production are rising rapidly. We find that the foreign exchange rate is positively associated with FDI, consistent with the expectation that RMB devaluation against the US dollar helps boost FDI. The RMB used to be overvalued in the earlier years of economic reform, which hampers business prospect in China for foreign investors and exporters. The gradual devaluation of the RMB has improved China's international competitiveness and attracted more FDI.

4.1.2. Regional analysis

From the perspective of development and political factors, China is divided into the following three major regions: eastern, central, and western regions. FDI is very unevenly distributed across regions, and the coastal region has received the lion's share of the total FDI in recent decades. In this subsection, we investigate how the effect of FDI determinants varies across different regions, namely, the eastern, central, and western regions. The estimation results from Eq. (2) are reported in Table 3, where the eastern region is omitted for comparison purposes. The goodness-of-fit values are high in all regressions. Column (1) presents the results from the long-run static model, which is the same as in Table 2 Column (2) to allow for convenient comparisons. We control for the year fixed effect in Column (2) and the period fixed effect in Column (3). The main effect of all variables is statistically significant with the correct signs, consistent with those from the baseline model.

In this section, we focus on coefficients on the interaction terms between the region dummy variables and explanatory variables. When introducing interaction terms, the interpretation of the main effect (the individual factor) changes. The coefficient on the individual factor represents its effect on FDI in the omitted control group – the eastern region in our case. The coefficients on the interaction terms capture the heterogeneity of the effects of the explanatory variables on FDI across different regions. As shown in Table 3, the effect of GDP is stronger in the central and western regions than in the eastern region, as the coefficients on $Central \times gdp$ and $West \times gdp$ are positive and statistically significant. A 1% increase in GDP will attract approximately 1% more FDI in the central region than in the eastern region. This effect is approximately three times stronger than that in the western region – attracting approximately 0.3% more FDI than the eastern region. The impact of GDP on FDI is the lowest in the eastern region, suggesting that the market advantage of the eastern region has been declining and that the theory of diminishing marginal efficiency is working.

The coefficient on *Wage* is positive and significant (1.028), suggesting that high wages help attract more FDI in the eastern region (the omitted group in the regression). The coefficients on $Central \times wage$ and $West \times wage$ are negative and statistically significant, indicating that the impact of wages on FDI is smaller in the central and west regions. For a 1% increase in labour costs, the increase in FDI in the central region is 0.072% (=1.028–0.956), lower than that in the east region by 0.956% (column 3). Again, we observe this effect is smaller in the western region (weakly

Table 3. The determinants of FDI in China: Long-run heterogeneity across regions.

	Dependent variable: *FDI*(in logs)		
Variables	(1)	(2)	(3)
gdp	0.838***	0.575***	0.600***
	(0.000)	(0.000)	(0.000)
wage	0.725***	1.028***	0.522***
	(0.000)	(0.000)	(0.000)
export	0.149**	0.414**	0.460***
	(0.011)	(0.000)	(0.000)
transport	0.818***	1.460***	1.431***
	(0.000)	(0.000)	(0.000)
human capital	0.249***	−0.152	−0.134***
	(0.000)	(0.155)	(0.196)
population	−0.392***	−0.666***	−0.627***
	(0.000)	(0.000)	(0.000)
exchange rate	0.593	1.271	3.519***
	(0.498)	(0.217)	(0.000)
Central	−0.520***	9.515***	10.116***
	(0.000)	(0.000)	(0.000)
West	−0.961***	5.541***	6.103***
	(0.000)	(0.009)	(0.005)
Central×gdp		0.903***	1.061**
		(0.000)	(0.000)
West×gdp		0.331***	0.312***
		(0.000)	(0.000)
Central×wage		−0.767***	−0.956***
		(0.002)	(0.000)
West×wage		−0.326*	−0.335*
		(0.073)	(0.074)
Central×export		−0.131	−0.083
		(0.206)	(0.459)
West×export		−0.143	−0.124
		(0.270)	(0.349)
Central×transport		−1.634***	−1.624***
		(0.000)	(0.000)
West×transport		−0.956***	−0.913***
		(0.000)	(0.001)
Central×human capital		0.972***	0.978***
		(0.000)	(0.000)
West×human capital		0.406***	0.387***
		(0.001)	(0.001)
Central×population		0.467**	0.383*
		(0.024)	(0.072)
West×population		0.682***	0.610***
		(0.000)	(0.000)
Central×exchange rate		−1.268***	−1.518***
		(0.000)	(0.000)
West×exchange rate		−2.161***	−2.281***
		(0.000)	(0.000)
constant	−12.209***	−16.801***	−14.847***
	(0.000)	(0.000)	(0.000)
Year fixed effect	Yes	Yes	No
Period fixed effect	No	No	Yes
Observations	1159	1159	1159
R^2	0.894	0.917	0.907

$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} \times Region_j + \beta_3 Region_j + \beta_4 FE + v_{i,t}$

This table reports the results of the above long-run static model verifying the long-run impact of FDI determinants across regions. *Region* is a set of dummy variables, including *East*, *Central* and *West*, taking a value of 1 for provinces in the respective region and 0 otherwise. $X_{it} \times Region_j$ is the form of the interaction terms between the explanatory variables and *Region* dummy variables. We consider heteroscedasticity and robust standard errors. p values in parentheses. The significance levels at 10%, 5%, and 1% are indicated by *, **, and ***, respectively.

significant at the 10% level). A 1% increase in labour costs, causes a 0.693% (=1.028–0.335) increase in FDI, which is smaller than that in the eastern region by 0.335%.

The coefficients on *Central×transport* and *West×transport* are also negative and statistically significant. Infrastructure is less important in attracting FDI in the central and western regions than in the eastern region. Holding all other things equal, with a 1% increase in transport facilities, the increase in FDI is 1.6% smaller in the central region and 0.9% smaller in the western region compared with that in the eastern region.[3] Human capital helped raise more FDI in the central and western regions than in the eastern region, as indicated by the positive significant coefficients on *Central×human capital* and *West×human capital*. This effect is stronger in the central region than in the western region. Population also helps raise more FDI in the central and western regions than in the eastern region. Interestingly, this effect is stronger in the western region than in the central region. The impact of exchange rates on attracting FDI in the weaker in the central and western regions. As shown in Column (3), with a 1% increase in the exchange rate, compared to the eastern region, the western and central regions attract less FDI by 2.3% and 1.5%, respectively. We find no evidence for the varying impact of exports on FDI across different regions, as the coefficients on *Central×export* and *West×export* are insignificant.

In summary, the estimation results in Table 3 support our expectation that since 1979, all regions have experienced tremendous growth in attracting FDI. However, the effects of those main drivers are different across regions, which partially explains the unevenly distributed FDI across regions.

4.1.3. Subperiod analysis

From the perspective of China's opening up policy, the degree of China's opening up to the outside world is gradually expanding, so the development speed of FDI is different in different periods. In this subsection, we study how the driving factors of FDI have different influences during different time periods (pre1992, 1992–2000, and 2001–2018). Table 4 reports the estimated results of Eq. (3). For comparison purposes, *pre-1992* is omitted in all regressions. Column (1) reports the results from the baseline long-run static model, which is similar to Column (3) in Table 2, for easy comparison. We control the provincial fixed effect in Column (2) and the region fixed effect in Column (3). All regressions have high goodness of fit values. The main effects of all variables are statistically significant and marked correctly, consistent with the baseline model in Column (1).

In this section, our main interest is the coefficients of the interaction terms between the *Period* variables and explanatory variables, which capture the differences in the effects of FDI determinants during different periods. As shown in Table 4, wages have a positive impact on FDI in the pre-1992 period. For a 1% increase in labour costs, the increase in FDI is 2.727% (Column 3). At the low wage level in the early years, foreign investors prefer a high wage labour force, perhaps for higher productivity. This effect turns negative after Deng Xiaoping's Southern Tour, as the coefficients on the interaction terms (*1992–2000 × wage* and *2001–2018 × wage*) are negative and statistically significant with a larger magnitude. Rising labour costs

Table 4. The determinants of FDI in China: Long-run heterogeneity over time.

	Dependent variable: *FDI*(in logs)		
Variables	(1)	(2)	(3)
gdp	0.869***	0.756***	0.893***
	(0.000)	(0.002)	(0.000)
wage	0.236**	3.140***	2.727***
	(0.012)	(0.000)	(0.000)
export	0.213***	−0.033	0.164***
	(0.000)	(0.713)	(0.114)
transport	0.794***	0.716**	1.487***
	(0.000)	(0.027)	(0.000)
human capital	0.270***	0.359***	0.142
	(0.000)	(0.008)	(0.295)
population	−0.395***	−0.361	−0.927***
	(0.000)	(0.169)	(0.000)
exchange rate	2.553***	1.696***	1.743***
	(0.000)	(0.000)	(0.000)
1992–2000	1.515***	29.117***	27.325***
	(0.000)	(0.000)	(0.000)
2001–2018	0.373**	29.689***	28.193***
	(0.042)	(0.009)	(0.000)
1992–2000×gdp		0.039	0.036
		(0.730)	(0.775)
2001–2018×gdp		0.015	−0.002
		(0.889)	(0.983)
1992–2000×wage		−3.378***	−2.932***
		(0.000)	(0.000)
2001–2018×wage		−3.369***	−2.925***
		(0.000)	(0.000)
1992–2000×export		0.163	0.285**
		(0.118)	(0.016)
2001–2018×export		0.109	0.074
		(0.263)	(0.509)
1992–2000×transport		−0.003	−0.519
		(0.993)	(0.198)
2001–2018×transport		−0.127	−0.936***
		(0.722)	(0.009)
1992–2000×human capital		−0.154	−0.198
		(0.274)	(0.200)
2001–2018×human capital		−0.038	0.163
		(0.770)	(0.273)
1992–2000×population		0.144	0.467*
		(0.570)	(0.095)
2001–2018×population		0.225	0.773***
		(0.353)	(0.002)
1992–2000×exchange rate		−1.904***	−2.140***
		(0.003)	(0.002)
2001–2018×exchange rate		−1.974***	−1.475***
		(0.003)	(0.018)
constant	−9.877***	−16.801***	−14.847***
	(0.000)	(0.000)	(0.000)
Province fixed effect	No	Yes	No
Region fixed effect	Yes	No	Yes
Observations	1159	1159	1159
R^2	0.885	0.921	0.895

$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 X_{it} \times Period_j + \beta_3 Period_j + \beta_4 FE + v_{i,t}$

The table reports the results of the above long-run static model testing the long-run impact of FDI determinants in different periods. *Period* is a set of dummy variables, including *pre-1992, 1992–2000, and 2001–2018*, that take a value of 1 for that subperiod and 0 otherwise. $X_{it} \times Period_j$ is the form of the interaction terms between the explanatory variables and *Period* dummy variables. We consider heteroscedasticity and robust standard errors. p values are in parentheses. The significance levels at 10%, 5%, and 1% are indicated by *, **, and ***, respectively.

discouraged FDI flows after 1992, and for every 1% increase in labour costs, FDI actually decreased by approximately 0.2% (=2.727–2.932 for 1992–2000; =2.727–2.925 for 2001–2018). With China's rapid economic growth, wages in China have increased significantly, and foreign investors have begun to favour of lower wages for better cost control.

The coefficients on *1992–2000 × population* and *2001–2018 × population* are positive and statistically significant when the regional fixed effect is controlled. For every 1% increase in population density, the amount of FDI absorbed during the 1992–2000 period is approximately 0.5% higher than before 1992, and this figure for the 2001–2018 period is 0.773%. The influence of population on FDI is the lowest before 1992, indicating that over time, foreign investors have become more aware of the population effect. The results suggest that with the support of national policies, the population effect in the 2001–2018 period was strengthened, and economies of scale were formed, which were much stronger than they were in early periods. The coefficient on the *exchange rate* is positive and significant, suggesting that the exchange rate has a positive impact on FDI during the pre-1992 period. The negative and statistically significant coefficients on the *1992–2000*×exchange rate and *2001–2018 × exchange rate* indicate that compared with pre-1992, the impact of the exchange rate on FDI becomes weaker after 1992. For example, as shown in Column (2), after controlling for the province fixed effect, for an exchange rate increase of 1% (the devaluation of RMB by 1%), FDI increases by 1.7% before 1992 but decreases by 0.21% during the 1992–2000 period and by 0.28% during the 2001–2018 period. When controlling for the region fixed effect in Column (3), for an exchange rate increase of 1%, FDI increases by 1.74% before 1992, decreases by 0.4% during the 1992–2000 period, but increases by 0.27% during the 2001–2018 period.

When controlling for regional fixed effects in Column (3), exports' contribution to FDI absorption during the 1992–2000 period is higher than that during the pre-1992 period, while this effect disappears after China's WTO entry in 2001. Meanwhile, we find that transport has a more negative impact on FDI absorption in the post-WTO period, as indicated by the negative and significant coefficient on *2001–2018×transport*. *gdp* and *human capital* have indifferent impacts on FDI during different time periods, as their respective coefficients on *1992–2000×gdp* and *2001–2018×gdp* are statistically insignificant.

In summary, the estimated results in Table 4 support our expectation that all provinces and regions in China experienced significant changes in attracting FDI over the sample period. However, we show evidence that the FDI driver effects exhibit heterogeneity over time.

4.2. Estimation results from the short-run static model

The short-run dynamic model in Eqs. (4)–(5) is based on first difference; thus, region and period heterogeneity cannot be explored using dummy variables. As such, we estimate the short-run dynamic model using three regional subsamples (Eastern, Central, and Western) for the regional analysis and three period subsamples (pre-1991, 1992–2000, and 2001–2018) for the period analysis.

Table 5. The determinants of FDI in China: Short-run heterogeneity across regions.

Variables	Controlled random without ECM	Controlled random with ECM	Controlled random without ECM	Controlled random with ECM	Controlled random without ECM	Controlled random with ECM	Controlled random without ECM	Controlled random with ECM
	(1)full sample		(2)East		(3)Central		(4)West	
Δgdp	4.259***	3.955***	3.682***	4.270***	2.816***	2.834*	8.828***	6.046**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.056)	(0.001)	(0.015)
Δwage	−1.041***	−0.702*	−1.343**	−0.271	−1.348	−1.170	−0.698	−1.211
	(0.000)	(0.088)	(0.030)	(0.692)	(0.002)	(0.115)	(0.085)	(0.345)
Δexport	−0.014	0.045	−0.022	0.024	0.049	0.034	−0.085	0.193
	(0.826)	(0.580)	(0.869)	(0.880)	(0.628)	(0.739)	(0.399)	(0.231)
Δtransport	−0.118	0.242*	−0.184	0.387	−0.020	0.036	−0.203	−0.017
	(0.304)	(0.100)	(0.374)	(0.187)	(0.909)	(0.827)	(0.332)	(0.961)
Δhuman capital	0.079*	0.297	0.421**	0.158	0.112	−0.126	0.046	0.307
	(0.066)	(0.211)	(0.358)	(0.607)	(0.697)	(0.738)	(0.232)	(0.498)
Δpopulation	−0.069	−4.344	0.351	−2.153	2.326*	−2.721	−0.084	−1.694
	(0.221)	(0.156)	(0.590)	(0.197)	(0.059)	(0.495)	(0.105)	(0.174)
Δexchange rate	0.438*	0.204	0.535	−0.170	−0.019	0.188	−0.881	0.841
	(0.090)	(0.503)	(0.138)	(0.525)	(0.961)	(0.676)	(0.146)	(0.297)
ECM								
FDI_1		−0.373***		−0.338***		−0.383***		−0.509***
		(0.000)		(0.000)		(0.000)		(0.000)
gdp_1		2.023***		1.914***		2.419***		2.706***
		(0.000)		(0.000)		(0.000)		(0.000)
wage _1		−1.078***		−0.788*		−0.428***		−1.685***
		(0.000)		(0.059)		(0.235)		(0.000)
export_1		0.278***		−0.174		0.607***		0.291
		(0.009)		(0.402)		(0.002)		(0.104)
transport_1		1.215***		0.530		0.385		0.069
		(0.000)		(0.437)		(0.466)		(0.866)
human capital_1		−0.636***		−0.816***		−1.005***		0.016
		(0.000)		(0.002)		(0.000)		(0.862)
population _1		0.798***		1.489		2.921		−0.667***
		(0.001)		(0.159)		(0.217)		(0.001)
exchange rate _1		3.336***		3.312***		4.002***		2.247***
		(0.000)		(0.000)		(0.000)		(0.000)
constant	−0.144*	−10.077***	−0.108	−10.334***	−0.045	−17.406***	−0.640**	−5.252***
	(0.083)	(0.000)	(0.343)	(0.000)	(0.656)	(0.000)	(0.014)	(0.000)
Observations	1130	1130	428	428	390	390	312	312
R^2	0.058		0.059		0.034		0.088	

$\Delta FDI_{i,t} = f(\Delta\tilde{X}_{i,t}) - \theta(FDI_{i,t-1} - f(\Delta\tilde{X}_{i,t-1})) + \varepsilon_{i,t}$

This table reports the results from the abovementioned short-run dynamic model at the regional level to verify the causal relationship between *FDI* and the major variables. The sample is divided into the total sample and three regions, i.e. Eastern, Central, and Western, without ECM as the treatment group, and ECM as the control group. Δ denotes first difference, $\Delta\tilde{X}_{i,t-1}$ is the lagged term of the estimated residual obtained from the first regression, $f(\Delta\tilde{X}_{i,t})$ denotes the short-run form of the original production function shown in equation. '_1' denotes a lag for one period. We consider heteroscedasticity and robust standard errors. The significance levels at 10%, 5%, and 1% are indicated by *, **, and ***, respectively.

4.2.1. Short-run dynamic models with ECM: Heterogeneity across regions

Table 5 reports the estimated results according to Eqs. (4) and (5). For comparison, the short-run model without ECM is used as the treatment group, while the model with ECM is used as the control group. We divide the region into the following four groups: the whole region and three subregions. Columns (1), (3), (5) and (7) are the results without the ECM model, and Columns (2), (4), (6) and (8) consider the ECM model. The main effects of all variables are statistically significant and marked correctly, consistent with the baseline model.

Table 6. Short-run and long-run elasticities across regions.

	(1)Full sample		(2)East		(3)Central		(4)West	
Variables	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
gdp	4.259	5.424	3.682	5.663	2.816	6.316	8.828	5.316
wage	−1.041	−2.890	−1.343	−2.331	−1.348	−1.117	−0.698	−3.310
export	−0.014	0.745	−0.022	−0.515	0.049	1.585	−0.085	0.572
transport	−0.118	3.257	−0.184	1.568	−0.020	1.005	−0.203	0.136
human capital	0.079	−1.705	0.421	−2.414	0.112	−2.624	0.046	0.031
population	−0.069	2.139	0.351	4.405	2.326	7.627	−0.084	−1.310
exchange rate	0.438	8.944	0.535	9.799	−0.019	10.449	−0.881	4.415

This table reports the results from he abovementioned short-run dynamic model to verify the short-run and long-run elasticity. The short-run elasticity is the coefficient of the short-run regression without ECM, and the long-run elasticity is obtained by dividing the lag coefficient involving the ECM regression by θ.

In the short-run model without ECM, Δgdp is significant and positive in all regions, $\Delta wage$ and $\Delta human\ capital$ are significant in the eastern region, and $\Delta population$ is important in the central region but not in other regions. The short-run dynamic model using ECM shows that the long-run coefficients of all variables are very significant across the full sample region. The coefficient θ in Eq. (5) is equal to 0.373 and is statistically significant, which means that there is a cointegration relationship between all explanatory variables.

Starting from the lag dependent variable, the coefficients of the other three subregions are equal to 0.338, 0.383 and 0.509, which are all highly significant, effectively proving that the short-run dynamic model with ECM is more consistent with the data than the model without ECM. The lags of *gdp*, *wage* and *exchange rate* are statistically significant in all regions, which proves that a market size and higher exchange rate are important factors to attract FDI in all regions. Surprisingly, the lag in *wage* shows significant negative effects in all regions, in contrast to the positive impact found in our long-term static model. The results indicate that foreign investors strategically place more emphasis on productivity from the high-quality labour force in the long run, while they are more concerned about profitability and favour low-cost labour in the short run. The lag in *Export* is significantly positive in the full regional sample and the central region but not significantly positive in the western region and not significantly positive in the eastern region, and the symbol is found to be changed. The lag in *Transport* is insignificant in the three subregions. The lag in *Human capital* is only positive and not significant in western China, which may be related to the lack of high-quality labour in western China. The lag in *Population* is not significant in the eastern and central regions, which means that foreign investors will not prioritize the population factor when investing in these two regions. A comparison between the three subregions and the full sample region shows that the long-run coefficients of different variables are significantly different, which also indicates that the influencing factors of FDI attraction in different regions are different. The regression results of the short-run dynamic model with or without ECM support the conclusions of the long-run model to a large extent.

Table 6 reports the results of short-run and long-run elasticity directly derived from Eq. (5). The long-run elasticity is obtained by dividing the short-run coefficients in Table 5 by θ.

Table 7. The determinants of FDI in China: Short-run heterogeneity over time.

Variables	Controlled random without ECM (1)1979–2018	Controlled random with ECM (1)1979–2018	Controlled random without ECM (2)pre-1992	Controlled random with ECM (2)pre-1992	Controlled random without ECM (3)1992–2000	Controlled random with ECM (3)1992–2000	Controlled random without ECM (4)2001–2018	Controlled random with ECM (4)2001–2018
Δgdp	4.259***	3.955***	4.647***	3.932***	7.193***	5.387***	1.889***	1.457*
	(0.000)	(0.000)	(0.002)	(0.003)	(0.000)	(0.000)	(0.010)	(0.098)
Δwage	−1.041***	−0.702*	−0.998	−0.689	−1.177	−0.372	−0.019	−0.058
	(0.000)	(0.088)	(0.390)	(0.529)	(0.011)	(0.357)	(0.904)	(−0.410)
Δexport	−0.014	0.045	−0.171	0.113	0.043	0.192	0.087*	0.078*
	(0.826)	(0.580)	(0.100)	(0.368)	(0.742)	(0.199)	(0.088)	(0.079)
Δtransport	−0.118	0.242*	1.031	1.941**	−0.144	0.023	0.134	0.116
	(0.304)	(0.100)	(0.281)	(0.037)	(0.742)	(0.941)	(0.156)	(0.212)
Δhuman capital	0.079*	0.297	0.642**	0.614*	0.795***	0.964***	0.296*	0.019
	(0.066)	(0.211)	(0.049)	(0.094)	(0.001)	(0.001)	(0.081)	(0.950)
Δ population	−0.069	−4.344	2.036	3.873	4.006	1.379	−0.077	−0.068
	(0.221)	(0.156)	(0.483)	(0.192)	(0.433)	(0.754)	(0.292)	(0.353)
Δexchange rate	0.438*	0.204	−0.010	0.160	−0.262	−0.516	−0.527	−0.150
	(0.090)	(0.503)	(0.986)	(0.764)	(0.349)	(0.184)	(0.244)	(0.758)
ECM								
FDI_1		−0.373***		−0.296***		−0.289***		−0.058*
		(0.000)		(0.000)		(0.000)		(0.075)
gdp_1		2.023***		0.26***		0.216***		0.088***
		(0.000)		(0.001)		(0.000)		(0.009)
wage _1		−1.078***		0.411		−0.809***		−0.127**
		(0.000)		(0.332)		(0.000)		(0.029)
export_1		0.278***		0.124*		0.310***		0.030
		(0.009)		(0.090)		(0.000)		(0.150)
transport_1		1.215***		0.656***		0.229		0.135***
		(0.000)		(0.004)		(0.238)		(0.001)
human capital_1		−0.636***		0.012		0.045		0.026***
		(0.000)		(0.891)		(0.465)		(0.000)
population _1		0.798***		−0.364**		−0.110		−0.059*
		(0.001)		(0.026)		(0.344)		(0.096)
exchange rate _1		3.336***		0.815***		−0.391		0.236
		(0.000)		(0.006)		(−0.65)		(0.284)
constant	−0.144*	−10.077***	−0.223	−7.214**	−0.513***	6.683***	−0.173*	−0.343
	(0.083)	(0.000)	(−1.29)	(0.042)	(0.000)	(0.000)	(0.051)	(0.690)
Observations	1127	1130	348	348	232	232	493	493
R^2	0.058		0.058		0.160		0.088	

$\Delta FDI_{i,t} = f(\Delta\tilde{X}_{i,t}) - \theta(FDI_{i,t-1} - f(\Delta\tilde{X}_{i,t-1})) + \varepsilon_{i,t}$

This table reports the results from the abovementioned short-run dynamic model at the period level to verify the relationship between *FDI* and the major variables. The samples are divided into four periods (1979–2018, 1979–1991, 1992–2000 and 2001–2018),without ECM as the treatment group and with ECM as the control group. Δ denotes first difference, $\Delta\tilde{X}_{i,t-1}$ is the lagged term of the estimated residual obtained from the first regression, $f(\Delta\tilde{X}_{i,t})$ denotes the short-run form of the original production function shown in equation. '_1' denotes a lag for one period. We consider heteroscedasticity and robust standard errors. The significance levels at 10%, 5%, and 1% are indicated by *, **, and ***, respectively.

In all regions, the elasticity coefficient of *gdp* is the largest for both short-run and long-run coefficients, which means that among all explanatory factors selected by us, market size is the most important factor attracting FDI. The short-run coefficients on *gdp* are significant, which can be interpreted as the short-run elasticity of *gdp* to *FDI*. For every 1% increase in *gdp*, *FDI* will increase by 4.259% in the country, 3.682% in the eastern region, 2.816% in the central region, and 8.828% in the western region in the short run. In the long run, wages are negative in all regions, *transport* and *exchange rates* are positive in all regions, and exports are negative in the east and

Table 8. Short-run and long-run elasticities over time.

	(1)1979–2018		(2)pre-1992		(3)1992–2000		(4)2001–2018	
Variables	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run	Short-run	Long-run
gdp	4.259	5.424	4.647	0.878	7.193	0.747	1.889	1.517
wage	−1.041	−2.890	−0.998	1.389	−1.177	−2.799	−0.019	−2.190
export	−0.014	0.745	−0.171	0.419	0.043	1.073	0.087	0.517
transport	−0.118	3.257	1.031	2.216	−0.144	0.792	0.134	2.328
human capital	0.079	−1.705	0.642	0.041	0.795	0.156	0.296	0.448
population	−0.069	2.139	2.036	−1.230	4.006	−0.381	−0.077	−1.017
exchange rate	0.438	8.944	−0.010	2.753	−0.262	−1.353	−0.527	4.069

This table reports the results from the abovementioned short-run dynamic model to verify the short -run and long-run elasticity. The short-run elasticity is the coefficient of the short-run regression without ECM, and the long-run elasticity is obtained by dividing the lag coefficient involving the ECM regression by θ.

positive in the other regions. *Population* is positive and *human capital* is negative except for in the west.

4.2.2. Short-run dynamic models with ECM: heterogeneity over time

Table 7 reports the estimated results according to Eqs. (4) and (5). For comparison, the short-run model without ECM is used as the treatment group, while the model with ECM is used as the control group. The first group is the short-run dynamic regression results of the whole sample period, which is the same as the first group in Table 5. Columns (1), (3), (5) and (7) are the results without the ECM, and Columns (2), (4), (6) and (8) take the ECM into account. The main effects of all variables are statistically significant and marked correctly, consistent with the baseline model.

Without the ECM, the coefficients of Δ*gdp* and Δ*human capital* are significant across the board. The coefficients of Δ*wage* and Δ*exchange rate* are significant for the full sample from 1979 to 2018 only, while *the coefficient on* Δ *export* is significant for 2001 to 2018. However, the short-run coefficients of Δ*transport* and Δ*population* are not statistically significant in any real time period. The coefficient sign of Δ*wage* has changed, showing a negative sign in all four periods, and the other coefficient signs are in line with expectations. However, the overall fitting degree of the model is low. When the ECM is included in the model, the symbol coefficient number of Δ*transport* changes and shows significant performance during the 1979–2018 period, while the short-run coefficient of Δ*population* still shows no significant performance. The interpretation of the estimated coefficient of ECM is complicated. Starting from the lagged dependent variable, the coefficient θ in Eq. (5) is equal to 0.373, 0.296, 0.289, and 0.058 in the four periods. Since this coefficient is statistically significant, it is easy to prove that ECM is also significant in the short-run model and serves as strong evidence that there is a long-run cointegration relationship between all dependent variables and independent variables. During the 1979–2018 period, the long-run coefficients of all variables are extremely significant, so the explanatory variables we selected can all be considered to be closely related to FDI. In the other three subperiods, the performances of the long-run coefficients of different variables are different, which also indicates that the influencing factors of FDI will change accordingly in different periods. In conclusion, the regression results of the short-run dynamic model with or without ECM support the conclusions of the long-run model to a large extent.

Table 9. Impact of the Belt and Road Initiative (BRI) on FDI.

	Dependent variable: *FDI*(in logs)					
Variables	(1)	(2)	(3)	(4)	(5)	(6)
BRI_region	0.310***	0.334***	0.181***	0.195***	0.446***	0.313***
	(0.000)	(0.000)	(0.012)	(0.011)	(0.000)	(0.000)
BRI_ year					0.355***	0.379***
					(0.004)	(0.003)
BRI_region×*BRI_year*					−0.702***	−0.753***
					(0.000)	(0.000)
gdp	0.927***	0.936***	0.848***	0.880***	0.938***	0.880***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
wage	0.685***	0.118	0.699***	0.216**	0.144	0.247**
	(0.001)	(0.189)	(0.001)	(0.023)	(0.207)	(0.036)
export	0.255***	0.327***	0.135**	0.199***	0.323***	0.192***
	(0.000)	(0.000)	(0.023)	(0.000)	(0.000)	(0.001)
transport	0.908***	0.844***	0.826***	0.802***	0.814***	0.768***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
human capital	0.296***	0.302***	0.254***	0.273***	0.267***	0.234***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
population	−0.277***	−0.248***	−0.346***	−0.345***	−0.220***	−0.318***
	(0.001)	(0.001)	(0.000)	(0.000)	(0.002)	(0.000)
exchange rate	−0.083	2.474***	0.607	2.548***	2.470***	2.545***
	(0.927)	(0.000)	(0.487)	(0.000)	(0.000)	(0.000)
constant	−13.416***	−10.746***	−12.561***	−10.305***	−11.229***	−10.822***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Year fixed effect	Yes	No	Yes	No	No	No
Region fixed effect	No	No	Yes	Yes	No	Yes
Period fixed effect	No	Yes	No	Yes	Yes	Yes
Observations	1159	1159	1159	1159	1159	1159
R^2	0.889	0.880	0.895	0.885	0.882	0.887

$FDI_{it} = \beta_0 + \beta_1 X_{it} + \beta_2 BRI_{region} + \beta_3 BRI_{region} \times BRI_{year} + \beta_4 BRI_{year} + \beta_5 FE + v_{it}$

This table reports the results from the above long-run static model to examine the impact of BRI on FDI. *BRI_region* takes a value of 1 for provinces directly on the BRI plan, and 0 otherwise. *BRI_year* takes a value of 1 for years after 2013, which is when the BRI was announced, and 0 otherwise. *BRI_region*×*BRI_year* is the form of the interaction terms between region and year of BRI. We consider heteroscedasticity and robust standard errors. p values are in parentheses. The significance levels at 10%, 5%, and 1% are indicated by *, **, and ***, respectively.

Table 8 reports the results of short-run and long-run elasticity directly derived from Eq. (5). The long-run elasticity is obtained by dividing the short-run coefficients in Table 7 by θ.

The *gdp, export, transport* and *human capital* variables are presented in the form of the expected signals, which are of high significance in both the short and long run. It has been proven that a large market size, a greater the degree of openness of the country, more convenient transportation and a higher labour force quality are undoubtedly the four leading factors for attracting foreign investment into China. In the long run, *population* is positive in the whole period but negative in the three sub-periods. The *exchange rate* shows a negative effect from 1992 to 2000, while the other periods show a positive effect. This indicates that the influence of these two factors on attracting *FDI* fluctuates greatly under the influence of time and may be less important than other variables. Surprisingly, the elasticity of *wages* is negative in the short and long run, which does not support the assumption that high wages will accelerate FDI inflows.

Moreover, as shown in Table 8, the differences in the short-run and long-run elasticities are much smaller over a relatively longer period (e.g. the whole sample period from 1979 to 2018 and the third subperiod from 2001 to 2018) than that over a shorter period (e.g. the first and second subperiods). Within a relatively short period, there exists a huge gap between the short-run and long-run elasticities, which is perhaps because the long-run effect has yet to be fully materialized.

In conclusion, the estimation results of the long-run static model and the short-run dynamic model are consistent. The estimation of the short-run dynamic model is complementary to ensuring the stability of the long-run static model. Our results confirm that the large market size, greater openness, complete infrastructure, highly skilled workers, low population density and currency depreciation are the reasons for FDI inflow into China.

4.3. FDI and the BRI

In 2013, China announced the construction of the 'One Belt and One Road' and the development of the 'Belt and Road' economic zone, which is an important component of China's strategy to comprehensively open-up once again. We investigate how FDI varies across BRI and non-BRI regions and BRI announcement times. Table 9 reports the estimated results from Eq. (6). The results for the main explanatory variables are consistent with those from our baseline model in Table 2. In this section, we focus on the coefficient on *BRI_region*, which captures the difference in attracting FDI between BRI provinces and non-BRI provinces; the coefficient on *BRI_year*, which captures the difference in attracting FDI before and after the BRI launch in 2013; and the coefficient on *BRI_region*×*BRI year*, which captures whether BRI provinces attract more (or few) FDI compared to non-BRI provinces after the BRI launch in 2013.

In Columns (1)–(4), we examine the variation in FDI across the BRI region. The coefficient of *BRI_region* is positive and statistically significant, indicating that 18 provinces on the BRI corridor have attracted more FDI than non-BRI provinces. The results are robust after controlling for different fixed effects, for example, the year fixed effect in Column (1), the period fixed effect in Column (2), the year and region fixed effects in Column (3), and the region and period fixed effect in Column (4).

In Columns (5)–(6), we introduce *BRI_year* and the interaction terms between *BRI-region* and *BRI-year*. We control for period fixed effects in Column (5) and regions and period fixed effects in Column (6). The coefficient on *BRI_year* is positive and statistically significant, indicating that after the implementation of the BRI plan, China attracted more FDI.

The coefficients on *BRI_region*× *BRI year* are negative and statistically significant, indicating that BRI provinces attracted less FDI after the BRI plan started in 2013. One plausible explanation is that since the launch of the BRI in 2013, China's opening policy has strategically changed from 'bringing in' (capital and/technology) towards 'going out' to shift production capacity to low-income BRI countries where there is ready demand. Most of China's 'going out' enterprises are from BRI provinces. 'Going out' may induce resource competition with 'bringing in', and the likely outflows of human capital, financial capital, and materials and other resources may make these BRI provinces less attractive to foreign investors. Our results are consistent with Luo, Chai, and Chen (2019), who found that FDI in BRI provinces decreased significantly compared to non-BRI provinces during the period of 2003–2015.

5. Conclusion

In this study, we investigate the spatial heterogeneity and time-varying nature of FDI determinants over the 1979–2018 period. We also explore the impact of the BRI on regional FDI inflows. Our main findings are as follows. First, we find a positive impact on FDI from GDP, labour costs, exports, transport infrastructure, human capital, and exchange rate, while population has a negative impact on FDI. Second, the effects of these FDI determinants are heterogeneous across regions. All of their impacts are weaker in the underdeveloped central and western regions, except for GDP and human capital, whose impacts are stronger. Third, the effects of FDI determinants are, to a lesser extent, also heterogeneous over time. Their impacts are weaker in the underdeveloped central and western regions, except for GDP and human capital, whose impacts are stronger. The impacts of wage and exchange rates became weaker with more opening up after Deng Xiaoping's Southern Tour. Fourth, we find that BRI provinces attract more FDI than non-BRI provinces over the sample period. However, the BRI provinces have become less popular and have attracted less FDI than non-BRI provinces since the BRI was launched in 2013.

Our findings have important policy implications in China regarding regional economic convergence and balanced development. Policymakers should consider the level of economic conditions (i.e. wages, infrastructure) across different regions and design tailored policies to enhance the policy impact. For instance, to attract more FDI, the eastern region may increase investment in infrastructure as its impact is stronger in the eastern region than in the western and central regions, the central region should design policies to attract talent, and the west region should pay attention to population. Our findings are also of high policy relevance to BRI planning. Government policy should take a more balanced view regarding the 'going out' and 'bringing in' strategies. Policymakers should encourage BRI provinces to actively participate in international trade, explore local comparative advantages, optimize industrial layout, and enhance the attraction to foreign investment.

Notes

1. The Eastern region includes Beijing, Tianjin, Shanghai, Hebei, Liaoning, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; the Central region consists of Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan; and the Western region includes Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang. Tibet is excluded due to incomplete data. Chongqing is included in Sichuan province due to lack of separate data.
2. We have checked for correlations among the main variables and performed the Variance inflation factor (VIF) test, and the results suggest that our data possess the required properties and our models do not suffer from serious multicollinearity problems.
3. Based on the results in Column (3), the impact of transport on FDI in the central region is negative 0.193% (=1.431-1.624).

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