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Foreign Direct Investment Inflows and Economic Growth in Singapore: an Empirical approach

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Keywords: FDI; economic growth; Singapore; ARDL Cointegration

JEL classifications: F36; F43; O16; 053.

1. Introduction

A foreign direct investment (FDI) is an investment made by an entity in one country into businesses located in another country. Broadly, FDI includes "mergers and acquisitions, building new facilities, reinvesting profits earned from overseas operations, and intra company loans" (World Bank, 2012). According to the Asian Development Bank (ADB), Asia was the top FDI destination in the world in 2015, with nearly a third of the record setting $1.76 trillion in global FDI flowed into the region. Among Asian countries, Singapore has always been a compelling destination for FDI. In a report by the Global Foreign Direct Investment Country Attractiveness Index (GFICA) 2020, Singapore stood at 7^{th} place with an index of 68.2, just a few points lower than the United States in first place with an index of 75.9.

The importance of FDI on Singapore's economy and development goes way back. Being a modestly sized island with scarce natural resources, Singapore suffered severe problems of poverty and unemployment after her independence in 1959. Because Singapore had limited and insufficient capital, it was crucial for the country's economy and development to attract foreign capital (Siddiqui, 2010). Given the dire circumstances, Singapore's government was set on attracting manufacturing investments that are labour intensive in order to reduce the outstanding unemployment rates. As such, the government made a plethora of efforts to motivate investors. For example, all investment and trade related aspects were liberalized, and 100% of foreign firm ownership was allowed. Companies could freely employ foreign labour with no dependency ratio ceiling enforced as well as freely import foreign materials. Singapore government also initiated the Economic Development Board (EDB) to assist with job creation, industrialization, and overall economic development.

As a result of Singapore's various efforts, the country attracted a great amount of FDI, with the number rising from US$90 million in 1970 to US$1.24 billion in a mere decade (Eudelle and Shrestha, 2017). Out of ten countries that received the most FDIs in 2017, Singapore stood at 5^{th} place with US$62 billion. FDI is crucial to Singapore's economy, as its ratio of inward FDI to stock GDP is one of the highest in the world, at 283.2% in 2013. Singapore has established herself as one of the countries with the highest PPP GDP per capita in the world (World Bank, 2018).

Given the success of Singapore, one may think that the country could not have achieved such great advancement without the help of FDI. FDI is largely considered to positively influence the economic prospects of recipient countries (Bokpin, 2017), especially through labor productivity (Vu et al., 2008), technology transfer (Xu, 2000). De Mello (1999) suggested that although FDI may contribute to long-term growth of the host country, the magnitude of its effects is dependent on the degree of substitution and complementarity between domestic investment and FDI. One may wonder to what extent does FDI influence economic growth in Singapore. Hence, this paper aims to analyze the growth effects of Singapore's FDI while controlling for several other factors, namely, energy consumption, capital, financial development, and trade.

The results of this study are expected to give insights into the miracle growth of Singapore over the past few decades. The successful growth story of Singapore could be an inspiring model for other countries, especially for small economies. The remainder of this study is organized as follows. Section 2 reviews the literature on the subject matter, by discussing recent and related studies on the case of Singapore. Section 3 presents the models, data, and methodologies. Section 4 reports and discusses the empirical results. Section 5 concludes the study.

2. Literature Review

Theoretically, FDI is hypothesized to directly influence growth in the host countries through capital accumulation as well as through the incorporation of foreign technologies and new inputs in production. Empirically, the theoretical benefits of FDI have been widely tested using Neoclassical and endogenous growth (Almfraji & Almsafir, 2014). However, the results are varying. This may be attributed to diverse sample selection (e.g. different countries or groups of countries with varied institutional backgrounds), estimation methodology (e.g. panel versus time series), estimation techniques (e.g. error correction models, Granger causality, ordinary least squares, cointegration), and sample period.

Many studies in the existing literature have illustrated that FDI indeed positively influences economic growth. Borensztein et al. (1998) claimed that FDI affected economic growth positively and that domestic investment and FDI are complementary. Another study by Hassen and Anis (2012) found that FDI caused economic growth significantly in Tunisia during the period from 1975 to 2009. De Mello (1997) proposed that the effects of FDI on the receiving country's economic growth depend largely on the degree of efficiency of local firms. In neoclassical models, only labour force growth and/or exogenously driven technological progress can cause long-term growth; thus, only by enhancing technological progress can FDI affect economic growth. On the other hand, in endogenous growth theories, FDI is able to contribute to economic growth directly through newer technology and higher capital stock, and indirectly through developing and bettering human capital, institutions, infrastructure, and spillovers. The many positive externalities from FDI include labour training, organizational know-how, and managerial skills. FDI can also support the host economy by helping them penetrate world markets. More studies that found a positive impact of FDI on growth are Baldwin et al. (2005), De Gregorio (2005), Zhang (2001), Pegkas (2015), Durmaz (2017), and Muhammad and Khan (2019). For Singapore, FDI is deemed to facilitate economic growth through successful technological transfers, government's appropriate strategies and policies to take advantage of the FDI inflows, improved human factors, and liberalized trade regime (Lee & Tan, 2006; Bende-Nabende et al., 2011; Zhang, 2001). Empirical studies also found a long-run relationship between FDI and economic growth in the country (Pradhan, 2009), a short-run relationship (Zhang, 1999), a unidirectional Granger causation from FDI to economic growth (Feridun and Sissoko, 2011), or bidirectional Granger causality between the two variables (Flora & Agrawal, 2017).

Meanwhile, other studies showed no evidence of spillover effects. For instance, Aitken and Harrison (1999) found that although FDI raised productivity within firms that received the investment, it also decreased the productivity of domestically owned plants, which contradicted spillover theory. Alalaya (2010) found a significant negative effect for Morocco, Turkey and Tunisia. Various empirical studies have indicated that the effect of FDI on economic growth is largely subject to the institutional circumstances of the receiving countries. Dunning (2009) argued that FDI, particularly resource-seeking FDI, is not always beneficial for the receiving country because it could result in low capital expenditure on plant and equipment and low value-adding activity. Some authors claimed that FDI inflows only have a positive influence on economic growth when the receiving countries have already reached a particular level of wealth (Blomstrom & Kokko, 2003), financial development (Hermes & Lensink 2003), and education (Borenzstein et al., 1998). Wu et al. (2020) documented an inverse U shape relation between FDI and GDP growth. There are also studies that found no significant causal effects between FDI and economic growth (Carkovic & Levine, 2002; Carkovic & Levine, 2005; Irandoust, 2001; Marc, 2011; Rana and Sharma, 2020). Overall, the findings are varied, which accentuates the challenge of making generalized comments on the relationship between economic growth and FDI.

Last but not least, control variables including energy use, capital, financial development, trade, and exports of goods and services are included in the analysis. These additional controls are adopted because the existing literature has shown that they are highly correlated with the two main variables of interest. Energy use is associated with an increase in economic activities caused by FDI inflows into the country, both from production and consumption processes. Azam et al. (2015), while examining the relationship between economic growth and energy consumption for ASEAN-5 economies, discovered a co-integrating relationship among the variables for Singapore. Hermes and Lensink (2003), Azman-Saini et al. (2010), and Duarte et al. (2017) found that developed markets facilitate the positive effects of FDI on economic growth. These studies highlighted the importance of an active financial market and a competent banking system to enable the host country to absorb the FDI inflows more effectively. For this study, financial development is proxied by domestic credit provided by the financial sector and domestic credit to the private sector. In terms of trade, FDI and international trade are highly complementary, evident by FDI being able to increase trade and productivity in receiving economies (Hers et al., 2018). Therefore, it is necessary to control for these variables in the analysis to better account for the nexus between FDI and economic growth.

3. Model, Data, and Methods

3.1. The baseline model and data

This study applies an extended version of the Cobb-Douglas production framework to analyze the impacts of FDI on the income level in Singapore.

We start with the following equation:

$$Y = AE^{\alpha_1}K^{\alpha_2}L^{\alpha_3}\epsilon^{\mu} \quad (1)$$

where *Y* is real domestic output; *E* is energy; *K* is capital; and *L* is labor.

Technology is denoted by the term A and ϵ represents error assumed *N* (iid). Output elasticity is represented by the term $\alpha_1, \alpha_2, \alpha_3$, with respect to energy, capital and labor. The Douglas technology implies a constant return scale when it is restricted to $\alpha_1 + \alpha_2 + \alpha_3 = 1$. Following Le (2016), we allow technology to be endogenously determined by the level of FDI, financial development, and trade openness. The technology expressed by the term A is illustrated as follows:

$$A_t = \varphi {FDI_t}^{\omega} {T_t}^{\vartheta} {F_t}^{\theta} \quad (2)$$

where φ is the constant time-invariant; *FDI* denotes FDI; *T* represents trade openness; *F* stands for financial development.

Equation [1] then becomes:

$$Y_t = \varphi FDI_t^{\delta_1} T_t^{\delta_2} F_t^{\delta_3} E^{\alpha_1} K^{\alpha_2} L^{1-\alpha_1-\alpha_2} \qquad (3)$$

In the baseline model in Equation [3], all the explanatory variables are expected to have positive impacts on Singapore's economic development. Specifically, capital and labour are often considered as basic but important inputs in the production side of an economy, thereby higher levels of these factors will positively affect economic growth (Le, 2016). In the same vein, energy is regarded as the backbone of an economy and an essential element for both economic growth and poverty reduction (Le and Nguyen, 2019). As such, in the energy economics literature, there is a "growth" hypothesis which attributes the cause of economic growth to higher level of energy consumption (Le, 2016). Similarly, financial development is a critical and inextricable part of the growth process and has been widely documented as a driver of economic growth (Le et al., 2019). The financial sector directly provides valuable, growth-promoting, real services. As a result, fostering financial development increases the supply of capital and facilitates the allocation of financial resources to investment and other productive activities (Le et al., 2016). Furthermore, as a city state, and resource-lacking country, trade has played a critical role in Singapore's economic development. The country imports raw materials, intermediate, and final goods. Some of these imports are used in the production of goods for export and domestic consumption, while some are re-exported (Lee, 2012).[1] Our key variable of interest, FDI, is expected to favorably impact the economic prospects of recipient countries through improved labor productivity (Vu et al., 2008) and technology transfer (Xu, 2000).

Each series in Equation [3] is transformed in per-capita terms by dividing both sides by population, while keeping the growth effects of labor constant. All the variables are taken logarithms. The linearized Cobb-Douglas production function is as follows:

$$y_t = \alpha_{0t} + \rho_0 fdi_t + \beta_0 ene_t + \gamma_0 k_t + \delta_0 fin_t + \varphi_0 trade_t + \varepsilon_{0t} \qquad (4)$$

where *t* =1, 2, 3 and *t* refers to the time period. $y_t$is per-capita real GDP (constant 2010 US$); fdi_t is the level of FDI net inflows (constant 2010 US$) per capita; ene_t is the energy consumption which is measured in kg of oil equivalent per capita; k_t is per-capita capital proxied by gross fixed capital formation (constant 2010 US$) per capita; $trade_t$is per-capita trade (constant 2010 US$); fin_t measures financial development, proxied by the domestic credit provided by the financial

[1] We acknowledge that "Institutional quality" could be a critical factor for Singapore's economic growth. However, the data for Singapore was insufficient as this country is fairly young and the earliest data that we could find for the country's institutional quality are in 1996 (from the Worldwide Governance Indicators, World Bank). While the length of time series can vary, most models require at least 50 observations for accurate estimation (McCleary et al., 1980), thus having only 25 data points for institutional quality would be inadequate. Consequently, institutional quality is not included in our baseline models.

sector per capita[2] (constant 2010 US$); all of these variables are expressed in natural logarithms; ε_{0t} is the error term. The coefficients $\rho_0, \beta_0, \gamma_0, \delta_0, \varphi_0$ correspond to the long-run elasticities of real output per capita to FDI net inflows, energy consumption; capital; financial development and trade – all in per-capita terms – respectively. Our main interest in this study is the sign and statistical significance of ρ_0.

Besides the baseline model, we employed export as another proxy for Singapore's openness, since export expansion may also lead to economic growth, following Lee (2012). Indeed, for Singapore's case, the country's growth success and economic restructuring are both largely dependent on its trade activities, especially exporting (Yue, 2016). Singapore has established itself as a regional services hub and a global export manufacturing base, specializing in exporting services including finance, trade, transportation, and logistics.

As such, in Equation [4], the variable "*trade*" is replaced by "*export*" as follows.

$$y_t = \alpha_{1t} + \rho_1 fdi_t + \beta_1 ene_t + \gamma_1 k_t + \delta_1 fin_t + \varphi_1 export_t + \varepsilon_{1t} \quad (5)$$

For robustness check, we used another measure of financial development (*fin2*) (see Table 1) to estimate two additional models and report the results for comparison and completeness.

The World Development Indicators (WDI) of the World Bank database is the main source of data. Subject to data availability, the investigation period of this study spans 1970 to 2018. The descriptions, sources, and statistics of the variables are presented in Table 1. Table 2 presents the correlation matrix among the variables.

From the tables, it can be observed that Singapore has witnessed a drastic increase in both GDP per capita and FDI inflows during the investigation period. GDP per capita of the nation increased almost ninefold, jumping from a mere US$6,787 to US$5,8247. Singapore appears to be a major recipient of FDI, consistently has positive net inflows, and the mean of FDI inflows per capita is around 14% of that of GDP per capita. Trade in general and exports in particular are critical factors of Singapore's economy, with the mean of trade being 3.5 times and that of exports being 1.6 times as large as the mean of GDP per capita in the country. Table 2 illustrates that overall, all variables in the model are positively correlated with each other. Particularly, GDP is statistically significantly and positively correlated with FDI, trade, and exports.

[2] The use of domestic credit provided by financial sector as a measure of financial development is common in the literature, see Le (2016). The choice of indicators for explanatory variables also follow Le (2016).

Table 1: Variable definitions, data sources, and statistical descriptions

Variable	Description	Mean	Median	Maximum	Minimum	Std. Dev.	Observations
y	GDP per capita (constant 2010 US$)	28664.68	28341.67	58247.87	6786.934	15660.4	49
fdi	Foreign direct investment, net inflows (constant 2010 US$) per capita	4006.5	1558.841	16893.6	44.82993	4707.081	49
ene	Energy use (kg of oil equivalent per capita)	3838.243	4422.635	7370.653	1292.241	1636.903	46
k	Gross fixed capital formation (constant 2010 US$) per capita	7783.189	7827.889	15313.91	1673.552	4047.428	49
fin1	Domestic credit provided by financial sector (constant 2010 US$) per capita	23288.58	15787.73	79567.25	1178.227	20575.25	49
fin2	Domestic credit to private sector (constant 2010 US$) per capita	27981.52	23010.67	71004.44	3075.263	20284.86	49
trade	Trade (constant 2010 US$) per capita	100572.6	89621.05	191026.2	18396.63	58966.09	49
export	Exports of goods and services (constant 2010 US$) per capita	46092.55	36668.97	118079.4	4073.862	37353.99	49

Source: Authors' calculation.

Table 2: Correlation matrix: in log level

Correlation Probability	*y*	*fdi*	*ene*	*k*	*fin1*	*fin2*	*trade*	*export*
y	1.000000 -----							
fdi	0.972428*** 0.0000	1.000000 -----						
ene	0.925109*** 0.0000	0.895101*** 0.0000	1.000000 -----					
k	0.978234*** 0.0000	0.953350*** 0.0000	0.908709*** 0.0000	1.000000 -----				
fin1	0.965253*** 0.0000	0.946678*** 0.0000	0.877882*** 0.0000	0.974081*** 0.0000	1.000000 -----			
fin2	0.991150*** 0.0000	0.965240*** 0.0000	0.915104*** 0.0000	0.987017*** 0.0000	0.986248*** 0.0000	1.000000 -----		
trade	0.987591*** 0.0000	0.968253*** 0.0000	0.899080*** 0.0000	0.960193*** 0.0000	0.956156*** 0.0000	0.977084*** 0.0000	1.000000 -----	
export	0.998139*** 0.0000	0.972224*** 0.0000	0.924742*** 0.0000	0.972502*** 0.0000	0.956065*** 0.0000	0.985943*** 0.0000	0.990612*** 0.0000	1.000000 -----

Source: Authors' calculation. Note: *, **, *** denote statistical significance at 10%, 5%, and 1% levels, respectively.

3.2. Methods

Table 3 reports the results of the Zivot-Andrews unit root test, accounting for one structural break. Overall, we find a mixture of I(0) and I(1) series, but there is no risk of I(2) series. This leads to our choice of Autoregressive-Distributed lag (ARDL) as the estimation method of our baseline model.

Table 3. Zivot-Andrews unit root test results

Variable	Zivot-Andrews (with intercept)			
	Level		First Difference	
	T–statistic (Lag)	Break	T–statistic (Lag)	Break
y	-2.351 (2)	1987	-5.054** (4)	1998
fdi	-6.267*** (0)	1979	-7.163*** (4)	2000
ene	-3.980 (0)	2005	-8.410*** (0)	1995
k	-4.004 (1)	2001	-4.982** (4)	1985
fin1	-3.569 (0)	1979	-9.237*** (0)	1985
fin2	-3.692 (0)	1979	-6.782*** (0)	2010
trade	-3.049 (0)	2009	-6.969*** (0)	1981
export	-2.432 (0)	2008	-5.574*** (4)	1988

Source: Authors' calculation. Note: *, **, *** denote statistical significance at 10%, 5%, and 1% levels, respectively. The maximum lag length is set at 4.

By utilizing ARDL, we are able to capture dynamic effects from the lags of both variables and remove serial correlation in the error term with sufficient lags (Hill et al., 2008). The ARDL(p,q) model is as follows.

$$y_t = \alpha + \sum_{i=0}^{q_1} \beta_{q_1} fdi_{t-q_1} + \sum_{i=0}^{q_2} \beta_{q_2} e_{t-q_2} + \sum_{i=0}^{q_3} \beta_{q_3} k_{t-q_3} + \sum_{i=0}^{q_4} \beta_{q_4} f_{t-q_4} + \sum_{i=0}^{q_5} \beta_{q_5} t_{t-q_5} + \sum_{i=1}^{p} \delta_p y_{t-p} + e_t \qquad (6)$$

4. Empirical Results and Discussion

First, bounds testing to cointegration is employed. Moreover, to account for the structural break in the dependent variable (the year 1987), a dummy variable is incorporated into the estimation.

Table 4 presents the calculated F-statistics for the cointegrating relationships among the six variables. The results reveal that there is not enough evidence to accept the null hypothesis of no cointegration at the 5% significance level for all the models. The cointegration vectors show that FDI, energy, capital, financial development, trade (or export) are all forcing variables of income level, indicating that these variables move together in the long run.

Table 4. Bounds test to Cointegration: Results

Cointegration hypothesis	Lag Structure	F-statistics	Outcome at 10% level	Outcome at 5% level
F(*y,fdi,ene,k,fin1,trade,dummy*)	1,3,4,1,2,4	4.426	Cointegration	Cointegration
F(*y,fdi,ene,k,fin1,export,dummy*)	1,3,4,0,0,4	4.536	Cointegration	Cointegration
F(*y,fdi,ene,k,fin2,trade,dummy*)	4,0,4,1,4,3	4.446	Cointegration	Cointegration
F(*y,fdi,ene,k,fin2,export,dummy*)	1,3,4,0,1,4	4.502	Cointegration	Cointegration

Source: Authors' calculation. Note: *, **, *** denote statistical significance at 10%, 5%, and 1% levels, respectively.

In Table 5, ARDL estimation results for the four estimation models are reported, presenting the coefficient estimates of the long-run and short-run dynamics of the cointegrating equations detected above. First, the results indicate that FDI has a positive and significant impact on economic growth in both the long run and the short run at the 5% significance level. The positive effects of FDI also remain for its two lags, with the coefficients being positive at the 1% significance level. It is therefore can be concluded that not only does FDI have an absolute positive influence on Singapore's economic growth, but it is also one of the two main drivers of the country's growth in the long run. Second, there are many drivers of economic growth in the short run for Singapore, including energy consumption, capital, financial development, trade, and export, indicated by their positive coefficients at the 5% and 1% significance level. However, in the long run, only FDI and trade (including export) have a positive and significant impact on income level, suggesting that the government should focus more on these two sectors to ensure sound long-term growth of the nation.

The immediate positive effect of FDI on Singapore's GDP growth can be explained by prevalent theories and findings in existing studies addressed in the literature review section. In short, the Singapore government has made sure that the influx of FDI into the country is rapidly absorbed and quickly translated into highly efficient production and technology advancement, which results in an increase in GDP. Akinlo (2004) claimed that FDI would best accelerate the host's prospects for growth when the country practiced open trade regimes, had high savings rates and acquired high technology, all of which apply to Singapore. With regards to the positive impact of FDI on GDP growth at the two lags, it can be explained by the large number of multinational companies that have chosen to set up their bases in Singapore. In 2016, next to 154,000 small and medium foreign enterprises were registered in the country. Business owners tend to regard Singapore as an ideal location to grow their businesses, as Singapore appears to be a convenient springboard to tap into other emerging markets in Asia. It can be observed that FDI influxes enabled Singapore to form concrete, well-established base to facilitate and ensure the country's economic growth in the long run. The findings of this study indicate that the Singapore government's efforts to design and implement trade and FDI strategies and plans are effective, and have successfully assisted the nation to transform into an innovation-driven economy and a high-tech manufacturing and regional services hub of the global markets.

Table 5: ARDL estimation results

	Baseline model 1	Baseline model 2	Robustness checks	
	(1)	(2)	(3)	(4)
	Estimation model 1 (*fin1* and *trade*)	Estimation model 2 (*fin1* and *export*)	Estimation model 1 (*fin2* and *trade*)	Estimation model 2 (*fin2* and *export*)
	Long run	**Long run**	**Long run**	**Long run**
fdi	0.211606**	0.161454**	0.427145**	0.200688**
	[0.078664]	[0.067813]	[0.153520]	[0.084559]
ene	0.092584	0.150124**	-0.469399	0.109133*
	[0.097866]	[0.064416]	[0.346037]	[0.059835]
k	0.107337	0.142681*	2.683807	0.092832
	[0.173405]	[0.079803]	[1.568364]	[0.090639]
fin1	-0.098975		-2.745059	
	[0.075623]		[1.472758]	
fin2		-0.078097		-0.183551
		[0.048761]		[0.136944]
trade	0.477099***		1.224763**	
	[0.113948]		[0.452354]	
export		0.392932***		0.413165***
		[0.074593]		[0.071939]
	Short run	**Short run**	**Short run**	**Short run**
D(fdi)	0.016622**	0.016445**	0.020915***	0.014238*
	[0.006748]	[0.007249]	[0.006822]	[0.008015]
D(fdi(-1))	0.03231***	0.042780***	0.018472**	0.055423***
	[0.009180]	[0.011044]	[0.007583]	[0.012245]
D(fdi(-2))	0.02278***	0.030559***		0.041752***
	[0.006825]	[0.007988]		[0.009227]
D(ene)	0.016666	0.013089		-0.005728
	[0.021445]	[0.022823]		[0.025510]
D(ene(-1))	0.069828***	0.076259**		0.067477***
	[0.021924]	[0.027743]		[0.026834]
D(ene(-2))	0.02473	0.078092***		0.081077***
	[0.022531]	[0.026785]		[0.026784]
D(ene(-3))	0.106281***	0.079299***		0.085709***
	[0.024697]	[0.025125]		[0.025219]
D(k)	0.117069***		0.249517***	
	[0.040425]		[0.050817]	
D(fin1)	0.04862**			
	[0.022152]			
D(fin1(-1))	0.04797**			
	[0.020672]			
D(fin2)			0.050012	0.039533
			[0.048393]	[0.056622]
D(fin2(-1))			0.151041***	
			[0.047702]	
D(trade)	0.300433***		0.061793	
	[0.037657]		[0.043049]	

D(trade(-1))	0.10524***		0.100558***	
	[0.033477]		[0.033420]	
D(trade(-2))	-0.04475			
	[0.029175]			
D(trade(-3))	0.0923***			
	[0.029600]			
D(export)		0.404170***		0.411366***
		[0.050562]		[0.050042]
D(export(-1))		0.026992		0.011359
		[0.049221]		[0.048197]
D(export(-2))		-0.062364		-0.059346
		[0.040711]		[0.042242]
D(export(-3))		0.085685**		0.130494***
		[0.039642]		[0.043316]
	Adjustment	**Adjustment**	**Adjustment**	**Adjustment**
ect(-1)	-0.283035	-0.463235***	-0.049717***	-0.442136***
	[0.055544]	[0.080149]	[0.012170]	[0.076451]
dummy	0.174736***	0.033794***	0.206354***	0.091921***
	[0.021943]	[0.015067]	[0.011390]	[0.024817]
Constant	1.147384	2.613144***	0.409307***	2.798727***
	[0.219552]	[0.449226]	[0.092186]	[0.481732]
Observations	40	40	40	40
R-squared	0.912905	0.892206	0.919914	0.900320
Normality	YES (J-B stat = 0.213)	YES (J-B stat = 0.764)	YES (J-B stat = 0.985)	YES (J-B stat = 0.741)
Serial correlation	NO (F-stat = 2.554*)	NO (F-stat = 1.477)	NO (F-stat = 2.326*)	NO (F-stat = 1.265)
ARCH effects	NO (F-stat = 0.8326)	NO (F-stat = 0.382)	NO (F-stat = 0.998)	NO (F-stat = 0.968)
Stability	YES	YES	YES	YES

Note: Robust standard errors are in brackets. *, **, and *** denote statistical significance at 10%, 5%, and 1% levels, respectively. D(.) denotes the first difference and (-L) denotes the lagged variable. Post-Estimation Diagnostic Checks included: Jarque-Bera Normality Test (H0: the data is normally distributed); Breusch-Godfrey LM test for serial correlation (H0: there is no serial correlation of any order up to 2 lags); ARCH effects for conditional heteroscedasticity (with 2 lags) (H0: a series of residuals (rt) exhibits no conditional heteroscedasticity (ARCH effects)); Ramsey and CUSUM tests are used to check the stability.

The error correction term is significantly negative, implying that a given variable returns to equilibrium after deviation from it. The absolute value of the estimated error correction term in the models implies that it takes about 3.53 years (1/0.2803) to correct the disequilibrium in the *trade* equation and about 2.16 years (1/0.4632) to correct it in the *export* equation.

Finally, diagnostic and stability tests including the Jarque-Bera Normality Test, Breusch-Godfrey LM test for the presence of serial correlation, ARCH effects for conditional heteroscedasticity, and Ramsey and CUSUM tests checking for stability are employed to confirm the goodness of fit of the ARDL models. Overall, the results suggest that, at the 5% significance level, the models are correctly specified and there are no major diagnostic problems. The estimation results are also qualitatively robust across all model specifications. Specifically, in the long run, the coefficient of our main variable of interest, FDI, is statistically significant (at the 5% level) and positive across all the models. The same findings apply to trade and export variables which are also found to be statistically significant (at the 5% level) and positive for all estimation models. For other control variables, we find the impacts are qualitatively similar, which are statistically insignificant at the 5% level. Similar findings are also observed for all the estimation models in the short run. As such, we may conclude that our findings are relatively robust to different proxies of openness and financial development.

6. Conclusion

This study aims to explore the relationship between FDI and economic growth in Singapore from the year 1970 to 2018. The findings indicate that while there are multiple drivers of the country's economic growth including FDI, energy consumption, capital, financial development, trade, and export in the short run, FDI and trade (including export) are the main drivers of long-term growth. This suggests that Singapore's "economic miracle" is indeed attributable to effective strategies in managing inward FDI and promoting trade activities. The empirical findings thus emphasize the crucial role of FDI in assisting national economic development. It is recommended that the Singapore government should pay sufficient attention to take advantage of the positive externalities of FDI inflows to facilitate efficient utilization of resources, enhancement of human factors, and higher production. However, it should be noted that increasing economic activities may result in the degradation of environmental quality and resources in the country (Panayotou, 2016). As such, it would be meaningful to explore the dynamics between FDI, trade, capital flows, economic development, and environmental policies to ensure sustainable development.

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APPENDIX

The ARDL bounds testing procedure is performed in this study as follows. In the first step, we employ the bounds testing procedure to test whether there exists cointegrating relationship(s) among the variables (Pesaran and Pesaran, 1997; Pesaran et al., 2001).

Unrestricted error correction model (UECM) regressions are estimated as follows:

$$\Delta y_t = \alpha_0 + \alpha_1 . y_{t-1} + \alpha_2 . fdi_{t-1} + \alpha_3 . e_{t-1} + \alpha_4 . k_{t-1} + \alpha_5 . f_{t-1} + \alpha_6 . t_{t-1} + \sum_{i=1}^{k} \alpha_{7i} . \Delta y_{t-i} + \sum_{i=0}^{m} \alpha_{8i} . \Delta fdi_{t-i} + \sum_{i=0}^{n} \alpha_{9i} . \Delta e_{t-i} + \sum_{i=0}^{p} \alpha_{10i} . \Delta k_{t-i} + \sum_{i=0}^{q} \alpha_{11i} . \Delta f_{t-i} + \sum_{i=0}^{r} \alpha_{12i} . \Delta t_{t-i} + \alpha_{13} . DUMMY_t + \varepsilon_t \qquad [Eq. A1]$$

On the right-hand side, y, fdi, e, k, f, and t are the income, FDI, energy, capital, financial development and trade, respectively; Δ is the first difference operator; k, m, n, p, q and r are the lag lengths; α_0 is the drift, and ε_t are white noise errors. α_i (i=1 to 6) are the long-run multipliers; α_i (i=7 to 12) are the short-run multipliers. DUMMY is a dummy variable corresponding to the structural break identified by the Zivot-Andrews unit root test. The optimal lag lengths are determined by the Akaike Information Criteria (AIC).

We then proceed with performing the F-test on the joint level significance of the lagged variables, indicating the presence of a long-run relationship. The null hypothesis of "no cointegration" in the equation [Eq.1], i.e., the coefficients of the lag level variables are zero, is tested as follows:

$$F(y_t | fdi_t, e_t, k_t, f_t, t_t): \ \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0 \qquad [Eq. A2]$$

Next, we test the hypothesis by generating the general F-statistics from the variables computed in levels. Then, critical values from Pesaran et al. (2001) are used for comparison. Based on the properties of the series, two sets of critical values are considered, namely, the lower critical bound assuming the variables in the ARDL model are all stationary, and the upper critical bound for the purely I(1) series. If the variables are fractionally integrated, we then compare the computed F-statistics with these upper- and lower- critical bounds. If the computed F-statistic for the joint significance of the variables in level is smaller than the lower critical bound, we cannot reject the null hypothesis of no cointegration at the confidence level. In this case, no cointegration is documented among the variables. On the contrary, if the computed F-statistic is larger than the upper critical bound, we reject the null hypothesis, meaning that the variables are cointegrated. Meanwhile, if the computed F-statistic falls within the critical value band, we cannot conclude on the cointegration outcome.

The error correction representation related to the selected ARDL is specified as follows:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} . \Delta y_{t-i} + \sum_{i=1}^{m} \beta_{2i} . \Delta fdi_{t-i} + \sum_{i=1}^{n} \beta_{3i} . \Delta e_{t-i} + \sum_{i=1}^{p} \beta_{4i} . \Delta k_{t-i} + \sum_{i=1}^{q} \beta_{5i} . \Delta f_{t-i} + \sum_{i=1}^{r} \beta_{6i} . \Delta t_{t-i} + \beta_7 . DUMMY_t + \varphi ECM_{t-1} + u_t \qquad [Eq. A3]$$

where the parameters β_{ij} are the short-run dynamic coefficients, ECM_t is the residuals obtained from Equation [A1], i.e., the error correction term, and the coefficient of the lagged error correction term (φ) indicates the speed of adjustment back to long-run equilibrium after a short run shock. φ is expected to be statistically significant and negative.