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DETERMINANTS OF INTRA-REGION AND EXTRA-REGION FOREIGN DIRECT INVESTMENT INFLOW IN ASEAN: A SPATIAL ECONOMETRIC ANALYSIS

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Abstract: In this paper, we explore the dominant forms of foreign direct investment (FDI) (horizontal, vertical, export-platform, and complex vertical) in ASEAN countries. To account for the heterogeneity in FDI forms according to their origins, we examine separately extra-ASEAN and intra-ASEAN FDI in ASEAN countries. Using macro-level annual data covering nine countries over 1999–2011 and spatial econometric models, we find that the significance and the signs of the coefficients for the determinants of FDI and of spatial interactions provide an indirect way to test the dominance of particular forms of FDI over others. Our results suggest that the location of extra-ASEAN FDI is affected by host country characteristics (such as market size, infrastructure quality, political stability, trade costs) and by FDI in neighboring countries. Then, extra-ASEAN FDI inflows seem to be dominated by complex vertical FDI. In contrast, the location of intra-ASEAN FDI is affected by a host country's political stability and market size, but also by the market potential of neighboring markets, suggesting that intra-ASEAN FDI inflows are dominated by export-platform FDI. The significance of spatial interactions for both origins of flows warrants the acceleration of economic integration between ASEAN countries to continuously attract FDI.

Keywords: Foreign direct investment, ASEAN, determinants, spatial model

JEL Codes: F21, F23, E22, R12

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1. Introduction

The members of ASEAN[1] have embarked on liberalizing the circulation of goods, services, and capital to achieve an integrated market and production base since the Free Trade Area (AFTA) was signed in 1992 and the Economic Community was signed in 2007 (Bowles 1997; Chia 2011; Petri et al. 2012). With the implementation of a regional investment agreement, called the ASEAN Investment Area (AIA), in 1998, ASEAN countries have become committed to strengthening their investment regimes, attracting FDI from non-ASEAN countries, and developing FDI between ASEAN members. Even though these issues are debatable, attracting and developing FDI are expected to contribute to economic growth both directly and indirectly through so-called "spillover effects" on domestic economies (Smarzynska Javorcik 2004; see also Ni et al. 2017, in which firm-level data were used to study FDI spillover effects in Vietnam, controlling for the origin of foreign investors).

FDI inflows are in actuality unevenly distributed among ASEAN members. Data on FDI show that the bulk of intra-ASEAN flows are received by Indonesia, Malaysia, Singapore, and Vietnam. Extra-ASEAN inflows, which are about five times larger than intra-ASEAN flows, are mainly received by Singapore, followed by Thailand, Indonesia, Malaysia, the Philippines, and Vietnam. Only marginal flows benefit Brunei, Cambodia, Laos, and Myanmar. While every ASEAN member recognizes the benefits of economic integration and of attracting FDI, the question of unequal allocation of FDI flows within the region generates competition between member countries to attract FDI. This dynamic raises questions about the determinants of FDI location in ASEAN for both extra- and intra-ASEAN flows.

The determinants underlying multinational firms' choice of FDI location differ according to the form of FDI being offered, as highlighted in the literature (Blonigen et al. 2007). Traditional models distinguish between forms of horizontal and vertical FDI. Horizontal FDI occurs when multinational firms are driven by a market-access motive to substitute for exports to the destination country (Markusen 1984). In contrast, vertical FDI occurs when multinational firms are driven by cheaper factor inputs found in the destination country, with final goods serving the origin country (Helpman 1984). Both of these forms rely on a two-country framework that models FDI relationships only between the origin country and the destination country of FDI. In contrast, a multilateral framework, which accounts for FDI relationships between origin and destination countries as well as third-party countries,

[1] ASEAN had six members at the time: Brunei, Indonesia, Malaysia, the Philippines, Singapore, and Thailand. Vietnam joined in 1995, Laos and Myanmar in 1997, and Cambodia in 1999.

underpins the forms of export-platform FDI and complex vertical FDI. In export-platform FDI, a multinational firm invests in a particular destination country to produce (final) goods for export to third-party markets (Ekholm et al. 2007; Yeaple 2003). Complex vertical FDI is aimed at establishing production chains across multiple countries to exploit their respective comparative advantages and involves the trade of intermediate inputs between the different firms' affiliates (Baltagi et al. 2007).

Empirical studies on the determinants of FDI – i.e., that which give firms motive to invest – can be roughly grouped into two streams, the first comprising works that make use of micro, firm-level data (see, for instance, a recent contribution from El-Sahli et al. 2017), and the second comprising works that make use of macro, country-level data. We followed the latter stream's approach, which allowed for a broader, albeit indirect, means to test for FDI determinants at a regional level (see a recent review of empirical studies on FDI location, not exclusively in ASEAN, in Groh and Wich 2012). While classical empirical settings can be used to test for proximity, distance, or market potential (see, for instance, Artige and Nicolini 2010), we relied here on spatial econometrics. Our tests focused on the impacts of spatial interactions between neighboring countries that host FDI and their market sizes. These tests provided an indirect way to reveal the dominance of particular types of FDI over others, since spatial interactions are different for the four main types of FDI, as highlighted in the literature.

We found only a dozen recent empirical studies that focused on the determinants of FDI location in ASEAN countries, at a macro-level. From a technical point of view, these studies used three kinds of models: traditional panel, gravity, and spatial. Unlike spatial models, traditional panel and gravity models do not permit the consideration of spatial interactions between neighboring countries that host FDI. Instead, simple panel techniques are used to explain FDI inflows received by a sample of destination countries over time. Yet, the source of FDI is unique and is often either one country (e.g., the USA) or a group of countries (regional groups, or the OECD, etc.). Determinants of FDI flows include the characteristics of the recipient countries as compared to their peers (market size, costs, and so forth). Recent studies focusing on ASEAN countries include Masron and Yusop (2012), Barros et al. (2013), Masron (2013), Masron and Nor (2013), and Hoang and Bui (2015).

Gravity models are dedicated to explaining bilateral FDI flows between origin and destination countries. Compared to traditional panel models, they then include the origin country characteristics as additional determinants of the flows. The samples of origin and destination countries are more or less large in these works, covering only one region or the world).

Studies using gravity models try to explain FDI flows principally by the economic size of the origin and destination countries and the distance between them, augmented by other country characteristics. Studies focusing on ASEAN include Blattner (2005), Plummer and Cheong (2009), Eichengreen and Tong (2007), Ismail (2009), Hattari et al. (2013), and Thangavelu and Narjoko (2014). Plummer and Cheong (2009) and Eichengreen and Tong (2007) examined whether FDI received by China comes at the expense of other countries by introducing a variable of FDI inflows to China in the gravity model. They then attempted to capture one third-country effect.

Some of these studies explored the specificities of intra-ASEAN flows of FDI, in particular Rammal and Zurbruegg (2006), Hattari et al. (2013), Plummer and Cheong (2009), Masron and Yusop (2012), Masron (2013), and Thangavelu and Narjoko (2014). They typically attempted to determine the role of the AIA and ASEAN Free Trade Agreement (AFTA) as factors promoting intra-ASEAN FDI.

Finally, to our knowledge, only Uttama and Peridy (2009) used spatial econometrics to explore the determinants of FDI in ASEAN. Spatial models permit the assessment of "third-country effects" more completely, i.e., the FDI received by one country depends on the FDI received by, and on the characteristics of, its neighboring countries, aside from the destination country's characteristics. However, Uttama and Peridy (2009) examined the FDI received by only five ASEAN countries, originating from the US only. Consequently, their study only covered part of extra-ASEAN FDI, and excluded intra-ASEAN flows.

Our paper attempts to explore the particularities of both extra- and intra-ASEAN FDI inflows in nine ASEAN countries using spatial econometrics, which allows us to consider third-country effects more properly.

The rest of the paper is organized as follows. Section 2 contains a review of the literature focusing on empirical works about ASEAN. Section 3 reviews the general principles of spatial effects for FDI. Section 4 presents the spatial models and the collected data. Section 5 reports the tests and results of spatial panel models. Section 6 provides a conclusion, including the policy implications of our work.

2. Explaining FDI flows in ASEAN: A review of the empirical literature

Bowles (1997) underlined that regional agreements and integration in ASEAN are viewed as complementary and not a substitute for integration into the world economy: a strategy that can

be called “open regionalism” (see Chia 2011). Individual ASEAN members, for example, belong to other organizations and have signed various agreements with either them or other countries. This dynamic has facilitated both intra-ASEAN and extra-ASEAN FDI flows into ASEAN, but likely in different ways. Empirical analyses of the determinants of FDI flows in ASEAN should therefore distinguish between these two types of flows.

A dozen published empirical studies have focused on the determinants of FDI location in ASEAN countries (see a more general review of empirical studies on FDI location in Groh and Wich 2012). From a technical point of view, recent studies can be grouped into three types of econometric techniques: simple panel, gravity, and spatial.

Traditional panel techniques are used to explain FDI inflows for a sample of destination countries over time. The source of FDI can be one country, like the US, or one group, like the OECD or the world in general (in the latter case, the dependent variable is the total FDI received). Determinants of such flows are the characteristics of the destination countries (e.g., market size, production costs, investment climate). For instance, Masron and Nor (2013) explored the role of institutional quality on the FDI inflows received by eight members of ASEAN over 2002–2010. Hoang and Bui (2015) used panel data on FDI inflows to six ASEAN countries over 1991–2009 and found that market size, trade openness, infrastructure quality, human capital, and labor productivity are the main determinants of FDI location. Barros et al. (2013) highlighted the importance of countries’ heterogeneity to explain the differences in FDI inflows to 27 Asian countries over 2003–2011 by using quantile regressions. Panel studies that have explored intra-ASEAN FDI flows exclusively used the amount of FDI hosted by each ASEAN country that originated from other ASEAN countries as the left-hand variable. Masron and Yusop (2012) investigated FDI flows between nine ASEAN countries over 1998–2009. They observed an impact of the AIA and other FDI initiatives on these flows. Masron (2013) used dynamic panel techniques with the same data to evidence the impact of the AIA, but also used data on FDI originating from non-ASEAN countries to explain the direction and change over time of intra-ASEAN FDI flows. Rammal and Zurbruegg (2006) differed from the other studies by using data on FDI outflows, rather than inflows, between five ASEAN countries over 1996–2002 (panel data on flows from each country to the other four). They also observed an impact of investment regulations on FDI flows.

Gravity models are used to explain bilateral flows between origin and destination countries. Usual explanatory variables in gravity models include the economic size of the origin and

destination countries and the distance between them, augmented by other country characteristics. Studies may, however, differ according to the destination and origin countries under study and according to scale, which can be at regional or global levels. Blattner (2005) analyzed the determinants of bilateral flows of FDI for a panel of 10 countries in East and Southeast Asia, including five ASEAN members over 1981–2002, distinguishing 10 industries. He used a gravity model with partial stock adjustment, including lagged stock of FDI, as an explanatory variable, and found evidence of the impact of usual factors (e.g., GDP, distance, wages) as well as that of a foreign exchange variable.

Plummer and Cheong (2009) explored trends in FDI in and between seven ASEAN countries using a gravity model on a sample of 34 origin countries (27 OECD + 7 ASEAN) and 74 destination countries (OECD, ASEAN, other developing countries) over 1982–2004. Using different control and dummy variables, they found that ASEAN countries suffered from a decrease in total FDI but experienced an increase in intra-region FDI after the 1998 crisis, with no impact of FDI in China on FDI in ASEAN. Eichengreen and Tong (2007) also tested whether China's FDI comes at the expense of other destination countries by attempting to capture a third-country effect of FDI in China in the gravity equation of FDI between a worldwide sample of origin and destination countries. Their sample consisted of 29 OECD-origin countries and 63 OECD and non-OECD destination countries, of which six were ASEAN members, over 1988–2003. They found a positive (complementary) effect of FDI in China on FDI in other Asian countries.

Ismail (2009) proposed a semi-gravity model that included destination country factors only (market size, macroeconomic stability, and supply factors such as technology development, skills availability, and infrastructure). The sample was composed of 18 origin countries (Asian countries and developed countries) and nine ASEAN destination countries over 1995–2003. He determined that market size, GDP per capita, and gravity factors such as distance, border, and language, together with macroeconomic and social factors, affected the attraction of FDI to the region. Interestingly, he also determined that the regional market (or "extended market") of the destination country positively affected FDI inflows to that country, thereby revealing a spatial effect.

Hattari et al. (2013) explored bilateral FDI flows between six ASEAN countries and China and India between 1990 and 2005. Their main conclusions were that distance matters, with a large proportion of bilateral flows occurring between Singapore, Malaysia, and Thailand, and that intra-ASEAN flows have intensified since the 1997 financial crisis. Thangavelu and

Narjoko (2014) applied a complete gravity model to a sample of 30 OECD and nine ASEAN countries over 2000–2009, augmented with dummies for free trade agreements that they regarded as significant to explaining bilateral FDI flows.

While they usually emphasize distance and regional integration, gravity models are based on a bilateral framework that includes only pairs of origin and destination countries, excluding spatial interactions between destination countries, otherwise known as third-country effects. The inclusion of FDI in China as a third-country effect in Eichengreen and Tong (2007) was not sufficient, since China is not the only alternative FDI location for a particular ASEAN country—other ASEAN countries can also act as alternative FDI locations. Excluding spatial interaction does not allow the adequate study of all forms of FDI, such as export-platform and complex vertical FDI. Moreover, the exclusion of spatial interactions in panel and gravity models is a source of bias in econometric estimates, invalidating statistical inference (Anselin 1988). In contrast, Uttama and Peridy (2009) accounted for third-country effects in their exploration of FDI location in ASEAN countries over 1995–2007 at the level of 15 industries. However, they examined FDI originating from the US only, which represents only part of extra-ASEAN FDI, while excluding intra-ASEAN flows. Moreover, their study covers FDI that is received by only five ASEAN countries. Our paper thus attempts to fill these gaps by testing the relevance of spatial interactions to the location of both intra-region and extra-region FDI in nine ASEAN countries, using spatial econometrics techniques.

We rely on papers that used spatial econometrics to study FDI location at the country level, such as Blonigen et al. (2007), Baltagi et al. (2007, 2008), Garretsen and Peeters (2009), Poelhekke and Ploeg (2009), Shepotylo (2012), and Chou et al. (2011) (also, see a recent review in Regelink and Elhorst 2015). Using different samples and techniques, these studies nonetheless all showed that FDI in one country is affected by FDI and/or FDI shocks and/or market potential or other characteristics in neighboring countries.

3. Lessons from the theoretical literature: The expected spatial effects

The theoretical literature has progressively modeled the various motives of foreign firms' operations and, consequently, the different determinants of FDI inflows, including potentially different spatial interactions. Traditional models distinguish between horizontal and vertical FDI. Horizontal FDI is set by foreign companies seeking access to the destination market by avoiding business costs generated by protectionist policies (Markusen 1984). In this case, the size and growth of the destination market and the obstacles to accessing this market (customs

duties and transport costs) are the main determinants of the location of this form of FDI (Dunning and Lundan 2008). In contrast, vertical FDI occurs when multinational firms are driven by the cheaper factor inputs found in the destination country, with final goods serving the origin country (Helpman 1984). Vertical FDI is therefore explained by differences in production costs and factors' endowments between origin and destination countries. Markusen (1997) and Markusen and Maskus (2002) developed a hybrid model ("knowledge-capital model") wherein both of these forms of FDI coexist. Since these forms comprise a two-country, or bilateral, framework, modeling their relationships involves only the origin country and the destination country. In contrast, some authors have extended this bilateral framework by modeling the effect of third countries. Yeaple (2003) highlighted this effect in the presence of complex integration strategies. The level of FDI in a country in this model depends on the policies and characteristics of neighboring countries. On the one hand, Ekholm et al. (2007) defined "export-platform" FDI as an investment in a destination country designed to produce goods for sale in third markets, particularly when the destination country and third markets belong to a free trade zone (with low trade barriers). On the other hand, Baltagi et al. (2007) stressed "complex vertical" FDI, which is aimed at developing production chains across different countries to exploit their respective comparative advantages, exporting intermediate goods to third markets for processing before shipment to the final destination.

Blonigen et al. (2007), Ledayeva (2009), Hoang and Goujon (2014), and Regelink and Elhorst (2014), among others, synthetized the expected impacts of spatial interactions in the presence of (and conditional on) the four main types of FDI (see Table 1). Based on the above discussion on the four types of FDI, the tested spatial interactions concern FDI flows in neighboring countries (spatially lagged FDI) and neighboring market potential (spatially lagged market size). In the case of pure horizontal FDI (market seeking), firms are expected to make independent decisions for each market. In this sense, no spatial interaction is expected. Vertical FDI (efficiency seeking) generates competition between destination countries; and thus, FDI hosted in a particular country is negatively affected by FDI hosted by its neighboring countries. A negative spatial interaction is therefore expected between FDI flows hosted by neighboring countries. In the case of pure vertical FDI, the size of neighboring markets should not have a direct influence. However, vertical FDI should also be detected through destination country characteristics; for instance, when a destination country's trade costs are a significant factor for hosted FDI (i.e., trade costs that can be influenced by market

size through scale economies).[2] Export-platform FDI (neighboring market seeking) depends on a neighboring market's potential. FDI is also negatively influenced by FDI in neighboring countries as a result of competition between the areas of settlement (to serve the same (regional) market formed by the destination and neighboring countries, particularly in the case of a free trade zone). In the case of complex vertical FDI, firms fragment their production process, and each production unit is located in a particular country (or region) according to its comparative advantage. Production generates trade of intermediate goods between units located in different countries (or regions). In the presence of gains stemming from an agglomeration of suppliers, natural resources, infrastructures, etc., in neighboring countries, a positive relationship is expected between FDI inflows in neighboring countries.

The dominance of one of the four kinds of FDI is thus indirectly revealed by the significance and the signs of the relationships between the level of FDI in neighboring countries (spatial lag) and between FDI and neighboring market size (see Table 1).

Table 1: Expected signs of the impact coefficients of spatially lagged FDI and of neighboring markets on FDI, according to the forms of FDI

FDI forms	FDI in neighboring countries	Neighboring market potential
Horizontal FDI	0	0
Vertical FDI	< 0	0
Export-platform FDI	< 0	> 0
Complex vertical FDI	> 0	>= 0

Sources: Blonigen et al. (2007), Ledayeva (2009), Hoang and Goujon (2014), Regelink and Elhorst (2014).

4. Econometric models and description of the variables

4.1. The two spatial models

Spatial econometrics is a set of techniques dealing with spatial links in data analysis (Anselin 1988; Anselin and Florax 1995; Getis and Ord 1992). These studies produced two basic models to describe spatial interactions relevant when studying FDI location decisions according to existing empirical studies: the spatial autoregression model (SAR) and the spatial

[2] We thank the reviewer for suggesting this argument.

error model (SEM).[3] In the SAR model, also called the spatial lag model, spatial dependence concerns the dependent variable (FDI inflows) that is spatially lagged. The SAR model in the panel version can be expressed by Equation (1). Following Blonigen et al. (2007), spatial interactions were also modeled through the inclusion of neighboring market size, while the other regressors were spatially dependent[4]:

$$FDI_{it} = \rho.W.FDI_{jt} + \beta \text{ host variables}_{it-1} + \alpha \text{ neighboring market potential}_{it-1} + \mu_i + \varepsilon_{it} \qquad (1)$$

where FDI_{it} is FDI hosted by country i (i = 1, ..., N) at time t (t = 1, ..., T), and μ_i is the destination country fixed effect. Host variables_{it} are destination country i's characteristics (see below), and neighboring market potential measures the market size in neighboring countries (see below); $\rho.W.FDI_{jt}$, with $j \neq i$ (j = 1, …, N), is the spatial autoregressive term, with W acting as a standardized n×n weight distance matrix (see below), and ρ serving as a spatial autoregressive parameter for measuring how FDI in neighboring countries j affects FDI hosted by country i; ρ lies between -1 and + 1. ε_{it} and is a vector of well-behaved error terms. Structural dependence exists if ρ is significant, while its omission would bias the estimation of the coefficients α and invalidate the inference (Anselin 1988). Following Coughlin and Segev (2000), Ledyaeva (2009), and Casi and Resmini (2010), we time-lag the explanatory variables to reduce endogeneity problems, and since it is likely that foreign investors use past information in their location decisions.

The second model is the SEM represented by Equation (2), where errors are spatially autocorrelated (destination country error depends on neighboring country errors):

$$FDI_{it} = \beta \text{ host variables}_{it-1} + \alpha \text{ neighboring market potential}_{it} + \mu_i + \lambda.W.\varepsilon_{jt} + u_{it} \qquad (2)$$

where λ is the autoregressive parameter, lying between -1 and + 1, and u_{it} is a vector of well-behaved error terms. In our case, λ measured how FDI in the destination country i was affected by a shock in the FDI hosted by neighboring countries j. The error term capturing the effects of unmodeled factors, the SEM, may arise due to measurement errors or the omission

[3] The theoretical and empirical literature on FDI suggests spatial autocorrelation, and our results show that I-Moran and LM tests rejected the null of no spatial autocorrelation. We then proceeded with the maximum likelihood estimator on SAR- and SEM-type models, which should be preferred to geographically weighted regression models that are based on spatial heterogeneity (random coefficients) with no spatial autocorrelation. We thank the editor for suggesting we include this point.

[4] We used modified models as suggested by the literature on FDI. The theoretical literature on FDI and the bulk of empirical studies suggest that adjusted SAR and SEM, which only include a spatial-lagged explanatory variable, the neighboring market, are more appropriate compared to a spatial Durbin model. The levels of the other explanatory variables in neighboring countries were not expected to directly influence the level of FDI in a destination country. However, the other explanatory variables, controlling for only destination country characteristics that are not spatially lagged, such as trade costs, may also allow the assessment of whether some forms of FDI dominate over others. We thank the referee for suggesting this point.

of significant spatial variables, like cultural and geographical features, or when data are collected at the level of political or administrative units instead of economic units. If the spatially autocorrelated error terms in Equation (2) are omitted, then the OLS estimator is not always biased, but the standard errors would be poorly estimated and standard statistical tests would be invalid; therefore, the inference would be incorrect (Anselin 1988).

Following Blonigen et al. (2007), Garretsen and Peeters (2009), and Poelhekke and Ploeg (2009), W is a distance matrix, invariant over time, as follows:

$$W = \begin{vmatrix} 0 & w_{i,j} & w_{i,k} \\ w_{j,i} & 0 & w_{j,k} \\ w_{k,i} & w_{k,j} & 0 \end{vmatrix}$$

where $w_{i,j}$ = (Min $d_{i,j}$) / $d_{i,j}$, for all $i \neq j$, and $d_{i,j}$ is the distance between countries i and j, measured by the great-circle or orthodromic distance between national capitals. Min $d_{i,j}$ is the minimum distance observed in the sample (here, 315.5 km, the distance between Kuala Lumpur and Singapore). This non-standardized matrix is used for neighboring market potential (see below). On the contrary, for $W.FDI_{jt}$ in the SAR and $W.\varepsilon_{jt}$ in the SEM, we use a standardized distance matrix, where the sum of each row is equal to 1, following the usual practice (see, for instance, Blonigen et al. 2007; Garretsen and Peeters 2009; Poelhekke and Ploeg 2009; and Chou et al. 2011). Standardization is obtained by dividing each element $w_{i,j}$ by the sum of its line: $w_{i,j}^{standard} = w_{i,j} / \sum w_{i,j}$.

Spatial autocorrelation is detected with Moran's I statistics and LM tests. LM tests are usually preferred for testing for spatial interactions and allow discrimination between SEM and SAR models (Anselin and Rey 1991). LM-lag and robust LM-lag tests are used to test spatial interactions in SAR models (H0: no spatial interaction between FDI in destination and neighboring countries), whereas LM-error and robust LM-error tests are used to test spatial interactions in SEM models (H0: no spatial interaction in error term). These tests follow a chi-squared with one degree of freedom. The robust versions of these tests are used only when H0 is rejected with the standard version of the tests (Anselin 2005), which is the case here. Details on these tests can be found in Anselin (1988), Anselin and Florax (1995), Anselin et al. (1996), Elhorst (2009), and LeSage and Pace (2009).

4.2. Data and variable description

We examine the determinants of FDI location among nine ASEAN countries[5] over the period 1999–2011, after the 1997 Asian crisis and after the AIA was signed in 1998. The dependent variable is FDI inflows in each country, in a logarithm transformed as Log(1+ annual FDI inflows) to avoid the zero flow problem. The value of FDI in US dollars is deflated by the US GDP deflator index. FDI data are taken from UNCTAD Statistics (used by Masron and Nor 2013; Hattari et al. 2013; Uttama and Peridy 2009). The ASEAN Secretariat also provided data that were used by Thangavelu and Narjoko (2014). Data for GDP, telephones, inflation, trade costs, and domestic credit to the private sector are derived from the World Development Indicators (WDI) of the World Bank. Political stability data are collected from Worldwide Governance Indicators (WGI) of the World Bank Institute. Distance is measured by orthodromic distances between capital cities (measured in kilometers), which are drawn from the CEPII database[6] (as used in Hattari et al. 2013; Ismail 2009; Thangavelu and Narjoko 2014, among others). Unfortunately, we can not use proxies for labor costs due to missing data, particularly for Laos and Cambodia. Summary statistics of variables and sources are reported in Appendix 1 and 2. All variables are in log.

The market size variable measured by GDP (at constant 2000 prices) captures country economic conditions and domestic demand potential and is therefore an important factor for "market-seeking" FDI. Empirical studies on FDI in ASEAN, including Uttama and Peridy (2009), systematically observed a positive effect of a destination country's GDP on FDI inflows. Neighboring market potential is measured as usual by the total GDP of third countries weighted by distance using the non-standardized matrix ($W_{non\text{-}stand}$*GDP), considering that FDI in each country depends on the sum of neighboring markets' sizes rather than on the average size of these markets. The expected signs of this variable according to the form of FDI are shown in Table 1.

Infrastructures comprise services promoting the investors' activities. This variable is only rarely introduced in empirical works on ASEAN. Following Ismaïl (2009), Blattner (2006), and Hoang and Bui (2015), for instance, we use the total number of phones and mobile phone users (per 100 people) to represent the development of infrastructure.

Trade costs for importing and exporting goods to and from the destination country influence the comparative advantages that foreign investors may exploit for trading activities with the

[5] Myanmar is excluded due to data unavailability. We, however, consider that such a set of nine adjacent countries constitutes an unbroken study area for ASEAN, following Regelink and Elhorst (2014).

[6] http://www.cepii.fr/anglaisgraph/bdd/distances.htm.

country of origin as well as with the rest of the world. Low trade costs contribute to the economic integration of the destination country into the world economy. Ismail (2009) used the Trade Policy Index from the Heritage Foundation. Following Hoang and Bui (2015), Masron and Nor (2013), and Plummer and Cheong (2009) for instance, we proxy the variable trade costs by the inverse of the openness measure, which is itself equal to exports plus imports divided by GDP. Masron and Yusop (2012) used the openness ratio as an indicator of trade policy. Trade openness is then used as a proxy, since it embeds trade costs induced by economic and geographic features but also trade policy.[7] As explained above, the trade cost variable allow us to test for vertical FDI. We could not obtain a relevant variable for productivity for the nine countries covered in our study.

Political stability or risk affects the investment environment. Blonigen et al. (2007) explained that political risk partly reflects the cost of investment in the destination country. This variable is widely used in empirical works on ASEAN. Proxies for political risk include the PRS Group–ICRG political risk index as used in Eichengreen and Tong (2007) and Hattari et al. (2013), or corruption as used by Hoang and Bui (2014). We use the Index of Political Stability and Absence of Violence/Terrorism, one of the six WGIs of the World Bank Institute. An increase in the index reflects a decrease in the political risk. Masron and Nor (2013) found that political stability and absence of violence was one of the most significant WGI factors in their study of the importance of governance for FDI location.

The inflation rate reflects macroeconomic instability and uncertainty and can hinder FDI inflows. Inflation was taken into account by Rammal and Zurbruegg (2006). In our study, as per usual, the inflation variable is measured by the annual percentage change in the index of consumer prices. Ismail (2009) used, together with inflation, other proxies for macro-stability, such as the real interest rate or the exchange rate (see also Hoang and Bui 2015). A high degree of financial development facilitates payments between firms and gives access to funds that can benefit foreign investors. Following Barros et al. (2013), for instance, we use the domestic credit provided by the banking sector (% of GDP) to proxy financial development.

5. Results

The spatial econometrics literature has shown that the OLS estimate is inappropriate for models incorporating spatial effects (Elhorst 2003, 2009). We therefore test for the presence of spatial autocorrelation by using the classic Lagrange multiplier (LM) test proposed by

[7] We thank the reviewer for suggesting we clarify this point.

Anselin et al. (2008) and Elhorst (2009), as well as the robust LM test proposed by Anselin et al. (1996, 2008). The latter is called "robust" because the presence of one type of spatial dependence does not bias the test for the other types of spatial dependence (Seldadyo et al. 2010). The classic and robust tests are based on the residuals of the OLS estimate and follow a chi-squared distribution with one degree of freedom. The test results are reported in Tables 2 and 3. The classic tests rejected both assumptions of no spatially lagged dependent variable and no spatially autocorrelated error term. Nevertheless, the robust test results did not allow a clear choice between SAR and SEM, leading us to explore both models.

In the panel version of the SAR model, country-specific effects modeled by μ_i can be treated as fixed or random. The Hausman specification test is used to test random effects (RE) against fixed effects (FE) under the hypothesis of independence between the residuals and the explanatory variables (Elhorst 2009). Test results show that the RE model is more appropriate than the FE model (see Tables 2 and 3). Following Blonigen et al. (2007), Ledyaeva (2009), Garretsen and Jolanda (2009), Poelhekke and Ploeg (2009), and Chou et al. (2011), we use the maximum likelihood estimator provided by Anselin et al. (2008) and Elhorst (2003, 2009) to estimate the parameters of RE models for both types of spatial autocorrelation, SAR (SAR-RE) and SEM (SEM-RE), respectively. The results are similar for both models. We first use data on global FDI; second, we use disaggregated data on FDI inflows into ASEAN. We then perform tests on extra-ASEAN FDI and intra-ASEAN FDI inflows, respectively.

The results for the determinants of FDI location (both extra and intra) in ASEAN countries are reported in Table 2, using OLS, SAR-RE, and SEM-RE, respectively. The estimated coefficients are of the expected signs and are in accordance with conclusions of previous works on ASEAN. First, the coefficients for market size are positive and statistically significant, suggesting that horizontal FDI dominates. Infrastructure variable coefficients are also positive and statistically significant in both models. The coefficients of trade costs are negative and almost statistically significant, which would suggest the presence of vertical FDI (Markusen and Maskus 2002). Political stability (or lower political risk) strongly encourage FDI inflows to the region. However, the coefficients of domestic financial development are not significant, suggesting that foreign firms are financially independent (see also Hoang 2012, for a similar result).

Regarding spatial interactions, the coefficient of the neighboring market potential is not statistically significant, suggesting that the export platform does not dominate. In contrast, the spatial lag coefficient in the SAR-RE model is positive and statistically significant. This

positive relationship between FDI hosted by a particular country and its neighboring countries suggests a form of complex vertical FDI.

Because the results on global FDI may mask the heterogeneity in the determinants according to the origin of FDI inflows, we perform the same tests on extra-ASEAN FDI and intra-ASEAN FDI inflows, respectively (Table 3). As previously found with global FDI, the location of extra-ASEAN FDI is also positively affected by destination country market size, infrastructure quality, and political stability, and negatively affected by trade costs. In contrast, the effect of inflation is less robust, but is ultimately significantly negative in the SEM-RE model. Moreover, in the case of extra-ASEAN FDI, we detect the presence of horizontal, vertical, and complex vertical FDI: FDI in a destination country is attracted by its market size (horizontal) and trade costs (vertical). However, in the case of pure vertical FDI, the impact of spatially lagged FDI should be negative, yet we observe a positive impact. These results indicate that a form of complex vertical FDI may dominate (see Table 1).

In contrast, the location of intra-ASEAN FDI is not affected by infrastructure, inflation, or trade costs, but is positively affected by the destination country's political stability and market size, as well as by the market potential in neighboring markets. This would suggest the existence of both horizontal and export-platform FDI. However, the effect of the neighboring market potential is more than three times greater than the effect of the destination country market size; additionally, spatially lagged FDI is not significant, suggesting that the export-platform FDI would dominate. This conclusion is reinforced by the insignificant impact of trade costs, which can be explained by low barriers to trade within the AFTA, suggesting that the export-platform strategy is not affected. Overall, these results seem to reject the vertical and vertical complex forms of FDI for intra-ASEAN flows.

Thus, our results show great diversity in the determinants of extra-ASEAN and intra-ASEAN FDI inflows to ASEAN countries. Extra-ASEAN FDI is dominated by complex vertical FDI, suggesting that extra-region foreign firms fragment the manufacturing process across neighboring countries to take advantage of the AFTA. On the other hand, intra-ASEAN FDI inflows are designed to select foreign markets in the form of export-platform FDI. In addition, political stability still plays a very important role for the location of FDI of both types.

Table 2: Determinants of location of FDI in ASEAN over 1999–2011
Dependent variable: Global FDI

Model	(1)	(2)	(3)
Estimator	**OLS**	**SAR - RE**	**SEM - RE**
CONSTANT	-2.196	4.739	-3.183
	(0.746)	(0.498)	(0.731)
MARKET SIZE	0.426 ***	0.599 ***	0.527 ***
	(0.001)	(0.000)	(0.001)
NEIGHB MARKET	0.438	-0.718	0.410
	(0.426)	(0.233)	(0.599)
INFRASTRUCTURE	0.412 ***	0.253 **	0.483 ***
	(0.003)	(0.037)	(0.007)
INFLATION	-0.011	-0.008	-0.101
	(0.234)	(0.180)	(0.167)
TRADE COSTS	-1.998 ***	-0.959	-1.818 *
	(0.000)	(0.110)	(0.010)
POLITICAL STABILITY	0.293	0.495 ***	0.421 *
	(0.209)	(0.005)	(0.054)
FINANCIAL DEVELOPT	-0.001	-0.002	-0.006
	(0.882)	(0.713)	(0.327)
RHO spatial lag FDI		0.716 ***	
		(0.000)	
LAMBDA spatial lag error			0.739 ***
			(0.000)
Number of observations	117	117	117
R^2 or pseudo R^2 (estimate ML)	0.651	0.880	0.881
Hausman test		(0.370)	(0.877)
Tests of spatial autocorrelation			
Moran's I (Error)	8.36***		
	(0.000)		
LM (Lag)	64.37 ***		
	(0.000)		
Robust LM (lag)	15.79 ***		
	(0.000)		
LM (error)	73.41 ***		
	(0.000)		
Robust LM (error)	24.84 ***		
	(0.000)		

Note: *p*-values in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Determinants of location of the extra-ASEAN and intra-ASEAN FDI over 1999–2011

Dependent variable	Extra-ASEAN FDI			Intra-ASEAN FDI		
Method	**OLS**	**SAR - RE**	**SEM - RE**	**OLS**	**SAR - RE**	**SEM - RE**
CONSTANT	-2.348	-3.147	-2.601	-38.912 ***	-33.059 **	-37.313 ***
	(0.758)	(0.672)	(0.788)	(0.000)	(0.011)	(0.004)
MARKET SIZE	0.361 **	0.537 ***	0.471 ***	0.687 ***	0.690 ***	0.693 ***
	(0.018)	(0.000)	(0.009)	(0.000)	(0.007)	(0.009)
NEIGHB MARKET	0.467	-0.567	0.387	3.057 ***	2.473 **	2.899 ***
	(0.448)	(0.370)	(0.632)	(0.000)	(0.026)	(0.009)
INFRASTRUCTURE	0.466 ***	0.250 *	0.497 **	-0.214	-0.034	-0.021
	(0.003)	(0.057)	(0.011)	(0.256)	(0.873)	(0.929)
INFLATION	-0.013	0.010	-0.015 *	-0.007	-0.003	-0.001
	(0.236)	(0.128)	(0.079)	(0.570)	(0.769)	(0.929)
TRADE COSTS	-2.049 ***	-0.909	-1.908 **	0.168	-0.077	-0.234
	(0.002)	(0.158)	(0.012)	(0.834)	(0.942)	(0.837)
POLITICAL STABILITY	0.363	0.528 ***	0.451 *	0.937 ***	1.117 ***	1.173 ***
	(0.165)	(0.008)	(0.067)	(0.004)	(0.001)	(0.000)
FINANCIAL DEVELOPT	0.001	-0.000	-0.004	-0.004	-0.005	-0.005
	(0.905)	(0.986)	(0.552)	(0.589)	(0.561)	(0.580)
RHO spatial lag FDI		0.714 ***			0.193	
		(0.000)			(0.280)	
LAMBDA spatial lag error			0.702 ***			0.246
			(0.000)			(0.142)
Number of observations	117	117	117	117	117	117
R^2 or pseudo R^2	0.626	0.862	0.886	0.419	0.581	0.599
Hausman test		(0.548)	(0.874)		(0.006)	(0.257)
Tests of spatial autocorrelation						
Moran's I (Error)	8.19***			6.49***		
	(0.000)			(0.000)		
LM (lag)	63.62 ***			40.38 ***		
	(0.000)			(0.000)		
Robust LM (lag)	10.66 ***			11.84 ***		
	(0.001)			(0.001)		
LM (error)	70.55 ***			44.06 ***		
	(0.000)			(0.000)		
Robust LM (error)	17.59 ***			15.52 ***		
	(0.000)			(0.000)		

Note: *p*-values in parentheses.* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

6. Conclusion and policy implications

We use spatial econometric models to explore the determinants of FDI location in ASEAN countries in post-crisis Asia over 1999–2011. LM tests detect spatial autocorrelations in the OLS estimates, leading us to use the maximum likelihood method of Anselin et al. (2008) and Elhorst (2003, 2009) to estimate the parameters of SAR and SEM models. The Hausman specification test indicates that the RE model is more appropriate than the FE model for panel versions of SAR and SEM models.

First, we explore the determinants of FDI location (intra- + extra-ASEAN) in ASEAN countries. The results show that the destination country's characteristics, such as market size, infrastructure, trade costs, and political stability, have a significant impact. Regarding spatial interactions, neighboring market size does not significantly affect the location of FDI, while neighboring countries' FDI inflows do exert a positive effect. These results indicate that a form of complex vertical FDI may dominate.

To explore the heterogeneity of FDI determinants by origin, we examine separately extra-ASEAN FDI and intra-ASEAN FDI in ASEAN countries. The location of extra-ASEAN FDI depends on the destination country's characteristics, such as market size, infrastructure, trade costs, political stability, and inflation. We also find evidence of the complex vertical form of FDI. Thus, extra-ASEAN firms that invest in ASEAN countries aim to build international production chains. By contrast, the locations of intra-ASEAN FDI are affected by political stability, as well as the market size of destination and neighboring countries. This indicates that the export-platform form of FDI may dominate intra-ASEAN FDI.

These results should, however, be challenged with further robustness tests, such as the use of other estimators and spatial models, or by the inclusion of additional determinants, such as productivity or labor costs.

Our results, if confirmed, may have several policy implications. First, the dominance of complex vertical FDI indicates a close, positive relationship between neighboring countries in FDI attraction—or, in other words, complementarity between ASEAN countries in terms of attracting FDI. This implies that regional integration can help ASEAN to attract complex vertical FDI aimed at forming transnational production chains in this region. Therefore, the ASEAN countries must enhance the free movement of intermediate goods through the elimination of trade barriers. Second, we find that host country characteristics are important for attracting FDI. Market size is an important factor for FDI inflows, but the smallest or

least-developed ASEAN countries (e.g., Vietnam, Laos, Cambodia, Myanmar) can also attract more FDI by improving their political environment and/or infrastructure, and by cutting trade costs through accelerated trade liberalization. Lastly, ASEAN countries must invest in port infrastructure and logistics services to decrease the costs of international transport, thus shortening the economic distance with neighboring markets for attracting export-platform FDI, and must also develop international production chains to attract complex vertical FDI in the region.

Appendix I: Data sources

Variables	Definition	Source
FDI	Global FDI, extra-ASEAN and intra-ASEAN FDI inflows to ASEAN	UNCTAD Statistics and ASEAN Secretariat
Market size	GDP	World Development Indicators
Neighboring market potential	Overall size of third countries' GDP weighted by distance ($W_{Non\text{-}Stand}$* GDP)	World Development Indicators
Infrastructure	Number of phones and mobiles for ten thousands inhabitants.	World Development Indicators
Inflation	Annual change in the consumer prices index	World Development Indicators
Trade costs	The inverse of the openness ratio (openness ratio = exports plus imports divided by GDP)	World Development Indicators
Political stability	Index of Political Stability and Absence of Violence/Terrorism	Worldwide Governance Indicators
Financial development	Domestic credit to the private sector (% of GDP)	World Development Indicators
Distance matrix	The great distances between capitals.	CEPII

Appendix II: Descriptive statistics

Variable	Mean	STD Dev.	Min	Max
LnFDI global	7.14	2.29	0	11.04
LnFDI intra-ASEAN	4.78	2.44	0	9.47
LnFDI extra-ASEAN	6.88	2.48	0	10.81
LnGDP	10.50	1.62	7.33	12.52
$LnW_{Non\text{-}Stand}$* GDP	12.26	0.33	11.48	12.94
LnTELEPHONES	3.35	1.47	-0,38	5.22
INFLATION	6.90	15.54	-2.31	128,42
TRADE COSTS	0.85	0.36	0.21	1.68
FINANCIAL DEVELOPMENT	58.44	43.46	5.59	158.51
POLICAL STABILITY	-0.16	0.97	-2.13	1.40

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