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Reference: Chellaraj, Gnanaraj/Mattoo, Aaditya (2019). Estimating the knowledge capital model for foreign investment in services : the case of Singapore. In: East Asian economic review 23 (2), S. 11 - 147.
doi:10.11644/KIEP.EAER.2019.23.2.358.

PISSN 2508-1640 EISSN 2508-1667 an open access journal
East Asian Economic Review vol. 23, no. 2 (June 2019)
http://dx.doi.org/10.11644/KIEP.EAER.2019.23.2.358

Estimating the Knowledge Capital Model for Foreign Investment in Services: The Case of Singapore *

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Singapore's inward and outward investments with industrialized countries in both manufacturing and service sectors were skill seeking while outward investments to developing countries were labor seeking. Applying the Knowledge-Capital model, it was found that services Foreign Direct Investment is sensitive to skill differences. A ten-percent decline in skill differences with industrialized countries resulted in a 4.25 percent rise in inbound manufacturing and 1.48 percent rise in inbound services investments. Meanwhile, a ten-percent increase in skill differences with developing countries resulted in a 30 percent rise in outbound manufacturing and 0.38 percent rise in services investments. Furthermore, when services are distinguished by skill-intensity, the impact of relative skill endowments on inbound Foreign Direct Investment in skill-intensive services is significantly different from the impact on other services. However, when services are disaggregated by "proximity" needs, we do not find any significant difference in the impact of relative skill endowments on Foreign Direct Investment.

Keywords: Foreign Direct Investment, Manufacturing; Services, Skills, Proximity
JEL Classification: F00, F21, I25

* Comments from Keith Maskus, Shawn Arita, Ingo Bochert, Caroline Freund, Hiau Looi Kee, Wolfgang Keller, Sumner LaCroix, Sang Hyop Lee, Shiva Makki, James Markusen, Alberto Portugal, Jordan Schwartz, Sudhir Shetty, David Tarr, and Jian Zhang are gratefully acknowledged. The authors are grateful to the Multi-Donor Trust Fund and the Research Support Budget for financial support and to Michelle Chester, Ilmita Hutagalung, Mary Means, Eileen Stratford and Josette Vizmanos for technical support. An earlier version of this paper was published in the World Bank Policy Research Working Paper Series.
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I. INTRODUCTION

Singapore which completed two hundred years of existence in the modern era in 2019, has been remarkably successful in attracting foreign direct investment (FDI) and in recent years also become a significant foreign investor, especially in developing countries (Perry, 2017; Chellaraj et al., 2013; Shin, 2005). This two-way investment has increasingly been in services. In 2014, the share of services was nearly four times larger than manufacturing in inbound investment stock, and nearly three times greater in its outbound investment stock (Table 1, Appendix). In this paper, we apply the Knowledge-Capital (KK) model of multinational enterprises (MNEs) to compare the determinants of Singapore's inbound and outbound manufacturing and services FDI for the period, 1999-2014. The KK model has been previously applied to aggregate and manufacturing investment (Carr et al., 2001 (hereafter CMM); Chellaraj et al., 2013), but it has not been to our knowledge tested for services and most studies on services focus on trade (Constantinescu et al., 2018). The effect of 'skill differences' gives important policy implications for countries such as South Korea (Lee et al., 2018) and Taiwan (Mathews and Hu, 2007).

Singapore has rapidly closed its skills gap with most industrialized countries over the past four decades through the expansion of higher education and by attracting foreign talent (Sim, 2015; Hanushek and Woessmann, 2015; Yusuf and Nabeshima, 2012; Anwar, 2008) along with other FDI promotion policies (Lee et al., 1998). By the 2000s Singapore's skill endowments were similar to those of industrialized countries. As a result, the nature of Singapore's aggregate inward FDI from industrialized countries has shifted from a labor-seeking to a skill-seeking orientation, while its outward FDI in developing countries is labor seeking (Chellaraj et al., 2013). While there is evidence on the determinants of aggregate FDI (Thangavelu and Narjoko, 2014), studies on FDI in specific sectors such as services are rare. The application of the KK model separately to Singapore's manufacturing and service sectors is novel because it incorporates market seeking, skill seeking and labor seeking motivations into a single model.

It is plausible that Singapore's increasing relative skill endowments also underlay the increase in inbound services investment from both industrialized and developing countries. Outbound services investment in developing countries is expected to be labor seeking and in industrialized countries skill seeking. We explore further the significance of two key distinctions between services and manufacturing. First,

services, especially financial, education and health, communications and business services, are on average much more skill intensive than manufacturing (Table 2, Appendix).[1] Therefore, a stronger skill-seeking motivation for FDI in skill intensive services is expected compared to manufacturing and less skill intensive services. Second, services, particularly construction and commerce, but also to some extent business and finance, need greater face-to-face contact between suppliers and customers than goods. Apart from the technological imperative for proximity, there are regulatory imperatives such as restrictions in trade and FDI in services within ASEAN (Athukorala and Narayanan, 2018; Gootiiz and Mattoo, 2017). Meanwhile, preference in bidding for government projects (e.g. light rail projects) in countries such as Thailand is given to firms located in the ASEAN region (Kawai and Naknoi, 2017; Thangavelu, 2015).[2]

This paper proceeds as follows. In the next section we briefly review the KK model to motivate the analysis. In Section 3 we specify the model for estimation and in Section 4 we provide the econometric results. In the final section we discuss the potential economic and policy significance of the findings and offer concluding remarks.

II. THE KNOWLEDGE-CAPITAL MODEL AND PRIOR EMPIRICAL LITERATURE

In this section, the theory behind the knowledge capital model (Carr et al., 2001) is discussed and extended to the service sector (Markusen and Strand, 2009). Since Markusen (1984) and Helpman (1984), the general-equilibrium theory of MNEs has focused on market access to circumvent trade frictions (horizontal FDI) and to employ low-wage labor for labor-intensive portions of production (vertical FDI)[3]. In the former case, multiple plants producing similar goods and services are located in different

[1] As Table 2 shows, there is significant heterogeneity within services and within manufacturing in skill intensity. But even the most skill intensive sectors in manufacturing, such as transport equipment and electronics equipment, have skill intensities comparable with the relatively less skill intensive services sectors such as transport and commerce and much lower skill intensities than sectors such as finance, education and health.

[2] Economc Research Institute for ASEAN and East Asia. <http://www.eria.org/projects/PPP_ComparativeTable_February_2013.pdf > (accessed January 21, 2018)

[3] Baltagi et al. (2007), Bergstrand and Egger (2007) and Egger and Pfaffermayr (2005) included a three-factor model, labor, skills and physical capital.

markets and produce either for local or regional markets. In the latter, headquarters are split from at least some production, and goods are traded in different stages of fabrication.

1. The Knowledge-Capital Model

The general-equilibrium KK model of FDI (Markusen and Maskus, 2002; Markusen, 2002; Carr et al., 2001) makes three principal assumptions. First, services of knowledge-based activities can be geographically separated from production of goods and services, and supplied to production facilities at low cost. Second, these activities are skilled-labor-intensive relative to production. These assumptions generate incentives for firms to fragment production into vertical phases, locating R&D activities where skilled labor is relatively abundant and production where unskilled labor is well endowed. Thirdly, knowledge-based assets are inherently joint inputs and may be deployed simultaneously at multiple production facilities. This characteristic generates firm-level scale economies and supports horizontal investments in facilities that produce the same goods and services in different locations.

Specifically, the KK model combines factor endowments with complex economies of scale to explain FDI location decisions. It assumes two countries and two homogeneous factors, unskilled labor and skilled labor, both immobile across borders. The model also assumes two homogeneous goods or services, one of which is labor-intensive and subject to constant returns to scale. The other is skilled-labor-intensive and demonstrates increasing returns to scale (IRS). Firms in this sector can separate headquarters services from production, which may be located in either the home or foreign countries, or both. These services can be shared across plants, which support firm-level economies of scale in this sector. Finally, there are transport costs in trading goods or services and fixed costs of investing in a new plant.

The model predicts the potential existence of several firm types in the IRS good or service in equilibrium. First, there may be national firms that operate a single plant and headquarters in one country and exports to the other. Second, horizontal MNEs maintain plants in both countries but have headquarters in one location. Finally, vertical MNEs operate headquarters in one nation and a single plant in the other country. Sector, country and market characteristics determine the decision regarding production and to split headquarters from plants.

National firms will be more prevalent in a larger country because size supports local production and the firms can avoid the fixed costs of investing in the smaller nation.

They are also prominent where the two countries have similar factor endowments, which diminishes incentives for labor-seeking vertical FDI. They also predominate where transport costs are low or FDI barriers are high, characteristics that reduce returns to market-seeking horizontal FDI. Horizontal MNEs become important if the nations are similar in size and relative endowments, transport costs are high and investment costs are low. Horizontal firms prefer to place production capacity in both locations, taking advantage of firm-level scale economies, while selling primarily in local markets to avoid transport costs. However, if the countries vary in factor supplies, headquarters will be in the skilled-labor-abundant and production in the skilled-labor-scarce country. This incentive is strongest where trade costs are low, as it will be economic to supply both markets from the single foreign plant. Vertical FDI is likely if one country is small and skilled-labor abundant, in which case headquarters locate there and produce in the other location.

2. Extension of the KK Model to Services

In the past a need for specific theories for FDI in services has been questioned (Ramasamy and Yeung, 2010; Williams, 1997; Boddewyn et al., 1986). However, there are distinctions between goods and services. When the consumer is far away there is a risk to service quality (Bhattacharya et al., 2012). Thus, low productivity firms will invest abroad and incur the fixed cost of FDI while high productivity firms will both export and invest abroad.

Applying the KK model, Markusen and Strand (2009) explain specific motivations behind services FDI. The restrictions on FDI in services which raise costs have different effects on the decision of services providers to enter the international market (establishment of commercial presence) when compared to other forms of FDI. The service sector is comprised of headquarters with offices in different locations and thus it is feasible to have FDI in services (Markusen and Strand, 2009). Trade and investment costs in services will include technological factors, face to face interaction, natural factors as well as government rules and regulations. There are four regimes for trade and investment in services:

NN – Neither trade nor FDI in services allowed;
TN – Trade in services allowed but not FDI;
NI – FDI in services allowed but not trade;

TI – Both trade and FDI in services allowed.

Under TN there is no geographic fragmentation between headquarters (parent) and host. Under NI such a fragmentation is possible. There are no government restrictions on FDI either in the host or parent, but face to face contact is required although the level of face to face interaction may vary (Yin et al., 2014). Face-to-face is comprised of four main features (Storper and Venables, 2004): It is: (i) An efficient communication technology; (ii) helps solve incentive problems; (iii) facilitates learning; and (iv) provides psychological motivation. Face-to-face is vital where there is imperfect but rapidly changing information which is not easily codified. Hence, investment through a foreign office is possible but exports of services are not feasible. To seek entry into the foreign markets, foreign commercial presence is established and the FDI is market seeking. Under regime TI, allowed refers to developments in technology, communications and changes in government-imposed barriers.

Regulatory policies matter and fall into one of the five categories: (i) quantity-based restrictions imposed on suppliers either in the host or the parent country, ie., import and export quotas. If there is a quota restriction in the host country, there could be tariff jumping through investment. If there are quota restrictions in the parent country, the firm may establish a branch in the host country to produce for the host country or the region, (eg. quotas for non-EU international students in the UK likely contributed to the establishment of the branches of the UK universities in other countries); (ii) there is the price control restrictions which affect the firm's variable costs; (iii) high cost of establishing commercial presence in a country; (iv) the restriction on the use of inputs such as limiting the use of media for promoting the firm; and (v) regulatory barriers can be imposed such as the non-recognition of foreign qualifications, citizenship restrictions regarding work permits for certain jobs and preference given to firms headquartered in a country or region such as ASEAN.

Skill endowments also matter and for sectors such as real estate both skills and proximity matter. In general, falling investment costs encourage the creation of multi-office horizontal MNEs. However, when both trade and investment costs fall, a skilled labor-intensive headquarters in one country and a labor seeking office in another serving both markets could arise. Decreasing trade but not investment costs result in several service firms being concentrated in the large country due to complementarity among services. When both trade and investment in services are liberalized size differences and relative skill endowments play a major role with headquarters

concentrated in skilled-labor abundant countries. This is particularly true of the less skill intensive sectors, where skill intensive operations are headquarters based and labor- intensive operations are based in skill scarce and labor abundant countries. Thus, marketing research for the retail sector would be undertaken in the skill abundant headquarters, and the less skill intensive operations in the labor abundant countries. However, certain services such as, health, education, financial and professional services are more skill intensive than others. Hence if there are two countries with similar skill endowments, an increase in relative skill levels of the host will result in an increase in FDI from the parent to the host country, particularly if regulations in the parent country prevents access to these skills such as the UK restrictions on international students from outside the EU (Lulle et al., 2019; Lomer, 2018).

3. Application to Singapore

Between 1984 and 2011, the Singapore economy dramatically increased its relative skill endowments by sharply increasing the number of college graduates in its population and through the importation of foreign talent to offset brain drain (Ziguras and Gribble, 2015; Ahsan et al., 2014; Jones and Shen, 2008). Singapore also built an increasing skills gap relative to the developing economies A positive impact of skill differences on inward investment observed between 1984 and 1996, reflected the tendency of FDI to seek low-cost labor in Singapore. However, after 1996 inward skill seeking FDI from industrialized partners expanded with a rise in Singapore's skill endowment (Chellaraj et al., 2013).

FDI in the Singapore service sectors has increased significantly during the past three decades. With improvements in airport infrastructure, and as Singapore became a major hub for air travel, service sectors which required face to face interaction such as retailers established branches in the country. Meanwhile, service sectors requiring skilled labor such as international banks and universities set up branches and even regional headquarters in Singapore and in the case of the latter, partly to get around the export (international student admission) restrictions in countries such as the UK.

Table 1 (Appendix) shows the breakdown of Singapore's real manufacturing and services FDI stocks estimates to and from industrialized and developing countries in 2014. 89 percent of the manufacturing and 83.1 percent of services inbound FDI stocks came from industrialized countries. However, developing countries are much more important for outbound investment. 85 percent of all manufacturing outbound

investment and over 53 percent of the services investment went to developing countries in our sample. Overall, services dominate both inbound and outbound investment, with both industrialized and developing countries.

4. Prior estimation

For the US manufacturing affiliates abroad and foreign manufacturing affiliates in the US Carr et al. (2001) estimated the impact of relative skilled labor defined as managerial and professional, technical and kindred workers in parent and host countries on the location of FDI. It was found that a convergence in GDP between the US and any investment partner (holding the sum of their incomes constant) increased affiliate sales in both directions, for the period, 1986-1994. There was substantially greater evidence of horizontal than of vertical FDI, with affiliate sales rising in host countries with skill endowments closer to those of the US. Similar results were found by Markusen and Maskus (2002). These results may have been due partly to the selection of countries, which did not include many developing nations. Braconier et al. (2005) also found evidence to support the KK model using European and Japanese data. For other countries, Gao (2003) found that ethnic Chinese networks played a significantly positive role in inward FDI into China while Phyo et al. (2019) found that this benefits mostly lower income developing countries. Meanwhile, Tanaka (2009) found that Japanese MNEs exhibit a vertical, while the US MNEs exhibit a horizontal motivation. However, a more recent study indicates that the vertical component of the KK model is relevant even for countries with similar endowments (Mariel et al., 2009). Waldkirch (2010) using KK model found that Germany invests disproportionately in other European countries with similar endowments while the reverse was not true. Another study (Awokuse et al., 2012) found that US FDI abroad at the industry level exhibits a complex mixture of motivations. Finally, Lankhuizen (2014) suggests the actual skill levels of the host country are also important.

Carr et al. (2001) pooled bilateral data which could disguise the actual relationships between endowment differences and MNE activity. The reason is that the US was the host in half the observations and the parent in the rest, implying that the sign of their skill-endowments variable (the difference between parent and host in the ratio of skilled to total labor) depended on the direction of the investment. Thus, where the US was a skill-abundant host (parent), an increase in skill differences implied a convergence (divergence) in endowments. This difference makes interpretation of coefficients

difficult and calls for splitting the sample into inward and outward investment (Blonigen et al., 2003).

A second criticism of such studies is the potentially inappropriate pooling of data from developing and industrialized countries. Blonigen and Wang (2004) found that the US outward FDI to large industrialized countries is strongly attracted to countries with higher skill abundance, suggesting a horizontal motivation but the effect was reversed for FDI in developing countries. Addressing the above criticisms, Chellaraj et al. (2013) using relative skilled labor (measured as the population with tertiary education) as a share of total labor force in the host and parent country, estimated the KK model for all sectors and manufacturing sector separately. It was found that the nature of Singapore's two-way investment with the industrialized nations has shifted into skill-seeking activities over the 1984-2007 period, while investments in developing countries increased sharply and became concentrated in labor-seeking activities.

The importance of face to face contact in service sector FDI has also been analyzed although not in the context of the KK model. Fageda (2017) found that air travel enhanced face to face contact and hence increased FDI flows in the service sector in the Catalonia region of Spain. A similar study for Japan showed that air transport reduced face to face communication costs and increased FDI by Japanese MNEs particularly in the service sector (Tanaka, 2016).

This research is the first attempt to estimate the KK model for the service sector for any country and also the first attempt to separately compare the impact of skills on manufacturing and service sector investments and within differing classes of services such as transport and business services based on skill intensity. As this research incorporates investment objectives for both sectors separately and service sectors grouped by skill intensity as well as proximity, it is an extension of the studies applying the KK model, discussed earlier.

III. EMPIRICAL FRAMEWORK AND DATA

In this section we specify the econometric approach and describe the dataset which is a comprehensive panel of a two-way manufacturing and services FDI stocks for Singapore.

1. Basic specification

The KK model is sufficiently flexible to permit the data to reveal, indirectly, whether investment into and out of Singapore is driven by factor-cost (vertical) motivations, market-seeking (horizontal) motivations, or both. Following Carr et al. (2001) our initial specification is as follows:

$$FDI_{ijt} = \beta_0 + \beta_1 (GDP_{it} + GDP_{jt}) + \beta_2 (GDP_{it} - GDP_{jt})^2 + \beta_3 (SK_{it} - SK_{jt}) + \beta_4 (GDP_{it} - GDP_{jt}) * (SK_{it} - SK_{jt}) + \beta_5 IC_{jt} + \beta_6 INST_{jt} + \beta_7 INFRA_{jt} + \beta_8 TC_{jt} + \beta_9 TC_{jt} * (SK_{it} - SK_{jt})^2 + \beta_{10} TC_{it} + \beta_{11} DIST_{ij} + \beta_{12} COMLANG_{ij} + e_{ijt} \quad (1)$$

The dependent variable is the stock of manufacturing and services FDI invested by country i (parent) in country j (host).[4] For inward investment, Singapore is always the host and for outward investment it is always the parent. Carr et al. (2001) employed majority-owned affiliate sales in manufacturing as their measure of FDI activity. This measure is not available for the Singapore service sector for most years, and hence we analyze investment stocks. Focusing on stocks instead of flows may actually be an advantage, for the former measures reflect long-term decisions to invest and are less volatile, and less dependent on omitted variables, than are annual activity measures (Braconier et al., 2005).

The first right-hand side variable GDP Sum is the sum of parent and host-country real gross domestic product. It captures joint market size and the coefficient is expected to be positive. The next variable is the squared difference in GDP between parent and host nations. This variable captures changes in relative size, holding relative factor endowments fixed, and the theory implies that incentives for market-seeking investment should increase as two countries become more similar in size. Thus, there should be an inverted U-shaped relationship between FDI stock and size differences between two countries, suggesting that the impact should be negative.

The next variable is the difference in relative skill endowments between the parent and host countries. If the parent country is skill-abundant and the recipient country is abundant in lower-skilled labor, an increase in skill differences should raise incentives for vertical FDI, or fragmentation, implying a positive coefficient. However, if they

[4] Definitions of variables and data sources are provided in the following subsection.

have relatively similar endowments, supporting horizontal incentives for FDI, an increase in this difference would diminish investment, generating a negative coefficient. Finally, if the recipient nation is skill-abundant, implying that the skill differences variable is negative, a rise in its endowment would attract skill-seeking FDI, particularly in the skill intensive sectors such as finance and business services. The interaction between market size differences and skilled labor differences is expected to have a negative impact since FDI stocks should be smaller where market size differences are large, for a given difference in skills between Singapore and its partner industrialized country. This variable is designed to capture some of the non-linearities implicit in the KK model.

The variable IC_{jt} captures the costs of investing in the host country, whether that is Singapore for inbound FDI or partner nations for outbound. Higher host-country investment costs should reduce investment. The variable $INST_{jt}$ accounts for institutional constraints which are roadblocks to investment in the host country. Higher host-country institutional constraints should also reduce investment. A number of studies have shown that institutional factors such as corruption reduces investment (Cieslik and Goczek, 2018). Similarly, $INFRA_{jt}$ captures the infrastructure barriers in the host country and should have a negative impact. Numerous studies (e.g., Dollar et al., 2004) have indicated that development of infrastructure is vital to attracting FDI. The next variable, TC_{jt}, is a measure of trade costs (import restrictions) in the host country. If investment is driven by market-seeking incentives, higher host-country trade costs should increase it. But, where investment is undertaken to fragment production networks, higher trade costs can deter FDI. Finally, parent-nation trade costs (TC_{it}) should have a negative impact on FDI stocks since they make exporting output back home more costly. However, in the case of export controls, an increase in trade costs of the parent will result in higher FDI in the host. This is particularly true for certain services sectors such as universities, where parent country trade costs due to export restrictions (eg. admission restrictions on international students) could result in an increase in investment abroad through the opening of branch campuses. Under these circumstances, trade costs of the parent due to export restrictions could have a positive impact.

The interaction term between host-country trade costs and squared skill differences is designed to capture the fact that such costs should encourage horizontal, but not vertical investment, in which case they should matter less when skill differences are large. But, as Carr et al. (2001) point out, this is not a theoretically sharp hypothesis. $DIST_{ij}$ is the distance in kilometers between Singapore and the capital cities of partner countries.

Generally, distance is expected to have a negative impact. However, it is also possible that MNEs from remote countries such as the US could set up regional headquarters in Singapore and reinvest in neighboring countries while nearby countries such as Australia and Taiwan have easy access to regional markets without having to relocate to a country such as Singapore. Under those circumstances, the coefficient could be positive. Finally, $COMLANG_{ij}$ is the common language that is spoken in both Singapore and the partner countries and is a dummy variable. It takes on a value of 1 if Singapore and the partner country has a common language, otherwise it takes on the value of zero[5]. This variable is expected to have a positive impact on both inbound and outbound FDI (Feng et al., 2019; Nordas, 2018).

While coefficient β_3 captures the direct marginal impact of skill differences between the parent and host on investment stocks, the total marginal effect depends on other economic determinants, as suggested by the non-linearities captured in interaction terms. For example, if β_4 is negative and the parent is larger than the host, a reduction in the difference in country size should reduce the sensitivity of investment stocks to host skill differences. In this study, if over time Singapore (as host) grows in size relative to parent, the relationship between skill differences with parent, and FDI should get smaller or become negative, reflecting a shift in incentives from vertical to horizontal FDI.

This framework is applied to both inbound and outbound manufacturing and services FDI stocks in Singapore which should capture the basic influences of the KK model. However, the sample is also split into inbound and outbound stocks separately for industrialized-country and developing-country partners and investigate FDI behavior for these groups separately. In addition, we also aggregate (1) different services categories based on the need for face-to-face contact, i.e., those that cannot be delivered across borders – Construction, real estate, wholesale and retail trade and hotel and restaurant services and by those that do not need as much face-to-face contact – transport, information and communication, financial and insurance services and professional, scientific, technical, administrative and support services; and (2) the service sector categories with high skill intensity-information and communications, financial and insurance services, professional, scientific, technical, administrative and support services, and real estate – and those with lower skill intensity – construction,

[5] Countries that have a common language with Singapore are China, Taiwan, Malaysia and Hong Kong (Chinese), and UK, Canada, Australia, the US and the Philippines (English).

transport, wholesale and retail trade, and hotels and restaurant sectors – are aggregated and re-estimated separately. Both inbound investment and outbound investment with industrialized countries is expected to be skill-seeking. Investment by developing countries in Singapore is small, coming mostly from neighboring ASEAN countries and China, compared to Singapore's corresponding outbound investment. Hence, outbound investment from Singapore to developing countries is expected to be predominantly vertical and we have no particular expectation about inbound investment for manufacturing and services from developing countries.

2. Data sources and description

The dependent variables are Singapore's bilateral manufacturing and services FDI stocks for 1999-2014. The sources of the FDI data are the *Statistical Yearbook of Singapore, Foreign Equity Investment in Singapore* and *Singapore's Investment Abroad,* published by the Department of Statistics, GOS[6]. They are converted into million 1990 US dollars using contemporaneous exchange rates and the US GDP deflator. No disaggregated data on FDI in manufacturing is available. Services data are disaggregated into construction, real estate, transport, commerce, business and finance until 2005. Furthermore, no comprehensive data are available at the industry or firm levels and hence this analysis uses macro level data and addresses the impact of skills on macro level FDI. Since 2006, the commerce sector was further disaggregated into wholesale and real estate and hotel and restaurant services, while the business sector was disaggregated into information and communications as well as professional, scientific, technical, administrative and support services.

Data on independent variables come from sources detailed in Carr et al. (2001), updated through 2014. Real GDP is measured in million 1990 US dollars for each country. Annual real GDP figures in local currency were converted into dollars using the market exchange rate. Both GDP and exchange rate data are from the *International Financial Statistics* of the IMF. Carr et al. (2001) define skill abundance as the sum of occupational categories 0/1 (professional, technical, and kindred workers) and 2

[6] The partner countries included in this study are Australia, Canada, USA, Taiwan, Germany, France, Japan, Korea, Hong Kong, United Kingdom, the Netherlands, Switzerland, Norway, New Zealand, Thailand, Malaysia, Indonesia, China, India, Vietnam, Myanmar and the Philippines. Some data points were not publicly available and these were obtained from the Ministry of Statistics, Government of Singapore.

(administrative workers) in employment in each country, divided by total employment. However, Chellaraj et al. (2013) defined it as the proportion of the labor force with tertiary (college or university) education. We use the Chellaraj et al. (2013) definition which has a much narrower focus than the broader definition used by Carr et al. (2001) and does not include administrative and kindred workers without specific skills or university training. The term knowledge-capital involves generation of knowledge and human capital which in most cases require formal university education and hence using the proportion of population with tertiary education is more appropriate than using a broader category of skilled labor which includes those without tertiary education (Alpaslan and Ali, 2018). It is compiled from the various statistical and labor force yearbooks for individual developing countries and from the Department of Statistics, GOS for Singapore. They are taken from the OECD *Education at a Glance* for the OECD countries. In cases where some annual figures were missing, the skilled-labor ratios were taken to equal the period averages for each country. Our skill-difference variable is the relative skill endowment of the country less that of the host. The cost of investing in the affiliate country is a simple average of several indices of perceived investment impediments reported in the *Global Competitiveness Report* (1999-2012) of the World Economic Forum. They include restrictions on the ability to acquire control in a domestic company, caps on FDI in certain sectors, such as airline and education services, regulations such as restrictions on foreign skilled labor, and citizenship restrictions in general, restraints on negotiating joint ventures, strict controls of hiring and firing practices, market dominance by a small number of enterprises, an absence of fair administration of justice, difficulties in acquiring local bank credit, restrictions on access to local and foreign capital markets, and inadequate protection of intellectual property. The resulting indices are computed on a scale from zero to 100, with a higher number indicating higher investment costs. The institutional constraints include lack of transparency and exchange rate stability, high levels of bribery and corruption in the political system, poor legal and regulatory framework, politicized and elected law enforcement and judiciary as in the case of many US states (Dove, 2016; Chellaraj, 2000), widespread gender and ethnic discrimination and high prevalence of unethical practices. The infrastructure barriers are infrastructure quality in the host country and include railroad, ports, air transport, waterways, roads, electric supply and telecommunications and telephone quality. They are also computed on a scale of zero to 100 with zero being the most efficient and 100 being the least efficient. Finally, the trade cost index is taken from the same source and is a measure of national

protectionism or efforts to prevent importation of competitive products including quotas and tariffs. It also runs from zero to 100, with 100 being the highest trade costs. Finally, distance is the number of kilometers of each country's capital city from Singapore and is available online from CEPII (the French Center for Research and Studies on the World Economy).[7]

The skill intensity for different sectors was calculated by GTAP (Global Trade Assistance and Production) of Purdue University. It is the global average for all sectors broadly classified as agriculture, services, government and private. Primary agriculture and service sectors such as construction were intensive in unskilled labor, whereas government and private sectors were highly skill intensive. Private sectors include finance and business services while services include transport and construction[8].

Overall both manufacturing and services outbound FDI stocks to developing countries were far higher than the reverse activity. In contrast, manufacturing and services inbound FDI stocks from industrialized countries were much higher than Singapore's outbound FDI to those nations. It is important to note that there are some years where outward investment stocks to industrialized countries were reported to be zero. Thus, our estimation procedure is Tobit with time and country fixed effects. The fixed effects control for unobserved influences on FDI stocks that are constant over time or country.

3. Endogeneity and instrumental variables

It is evident that causation may run both ways between skill differences, which is our primary determinant of interest, and foreign investment. For example, an increase in inbound FDI may raise the level of skills in Singapore due to professional training

[7] CEPII, Paris, France. <http://www.cepii.fr/anglaisgraph/bdd/distances.htm> (accessed January 21, 2018).

[8] "In Singapore, construction and real estate are classified separately. Some of the tasks in the real estate sector include managing and overseeing construction of property as well as facilities management once the construction is complete, while the actual construction of buildings involves tasks which do not require much beyond a high school education (Chin, 2008). Hence, for the purposes of this research, real estate is classified as skill intensive and construction is classified as less skill intensive."

within MNEs as is evident from FDI in the Indian manufacturing sector (Baranwal, 2019). Moreover, flows of investment may be accompanied by the transfer of skilled engineers and managers within the firm between countries. Thus, the skill-differences variable is likely to be endogenous to investment to some degree. To address this issue we develop instruments that are correlated with skill differences but plausibly not correlated with the regression error.

We incorporate two instrument pairs in the regression and use them together. The first pair is government social-sector expenditures, other than on education, as a percentage of GDP in both host and parent countries. We lag this instrument by ten years to ensure that it is pre-determined rather than endogenous. These figures are taken from the *OECD Statistical Yearbook* (various years) for the industrialized countries. For the developing countries in our sample, they are compiled from the national budget documents of the countries concerned. Prior longitudinal studies indicate that such social expenditures, through improving nutrition and health status, have a positive effect on educational enrollment of children and hence the acquisition of skills (Behrman et al., 2014; Bharadwaj et al., 2013). In turn, future enrollment rates rise in secondary and university education (Alderman et al., 2001; Glewwe et al., 2001). Note that we specifically exclude education expenditures from social spending because the direct impact on later human capital could correlate with the location decisions of MNEs. However, this is not likely to be the case regarding other social expenditures such as those on health and nutrition, which have an indirect effect.

A second pair is female fertility rates in the parent and host countries, which we lag twenty years to approximate the period between birth and university graduation. Long-lagged fertility rates are likely correlated with later educational attainment, as noted by Becker et al. (2010). For example, studies from poor countries indicate that higher fertility rates increase the likelihood of a family remaining in poverty, making it difficult to procure education for children (Black et al., 2005; Rosenzweig and Schultz, 1987). Furthermore, lagged fertility is plausibly exogenous with respect to current FDI-location decisions. Initial experimentation suggests these are appropriate instruments. For example, in a regression of skill differences on lagged social expenditures and fertility rates, the coefficients for both were highly significant.[9] We offer further instrument validation in the results tables (Appendix).

[9] These results are available on request.

IV. RESULTS

We first apply the basic framework to the inbound and outbound manufacturing and services FDI. We then repeat the analysis separately for developing and industrialized country partners for the period, 1999-2014. Finally, we combine service sectors which require face to face interaction and those which do not, and those that are skill intensive and those that are not. These equations are estimated separately for these four different groups. This is undertaken to determine whether there are differences in the impact of relative skills on FDI location between those service sectors that require face to face interaction (proximity) and those that do not, and those that are skill intensive and those that are not.

1. Endogeneity and instrumental variables Regression estimates

Due to the inclusion of endogenous variable (skdiff) interacted with non-endogenous variable (trade cost and GDP difference) our instrumental-variables procedure is to run the first-stage regressions of relative skill differences on the instrumental variable discussed above, along with other exogenous variables, for each sample and use the predicted values to estimate second-stage Tobit regressions. The first stage results will be provided upon request. General specification tests are listed at the bottom of each regression in the tables (Appendix). As may be noted, the Sargan tests indicate that with few exceptions, the variables are uncorrelated with the residuals and serve as appropriate instruments. The F tests and Chi Square tests for weak instruments suggest that, except for a few cases mostly confined to investment to and from developing countries, the instruments perform well.

The first and second columns of Table 3 present second-stage Tobit regression results for manufacturing inbound and outbound FDI stocks respectively in Singapore for the period 1999-2014, while the third and fourth columns present the corresponding results for services. The effect of joint market size, measured by the sum of GDP, on inbound manufacturing investment and the coefficient on squared difference in real GDP are insignificant (column 1). However, for inbound services the joint market size is positive and significant at the one percent level while the squared differences in real GDP are insignificant (column 3). The results also indicate that outbound manufacturing and services investment (columns 2 and 4) from

Singapore rises in market size and falls in GDP size differences, as expected by the KK model and these are significant at the one percent level.

The investment-cost index in the host country is insignificant in all cases. The parent and host country trade costs are also insignificant in all cases. The variable capturing infrastructure quality is negative and significant in the manufacturing outbound sample as well as the services inbound and outbound samples, suggesting that reductions in such costs encouraged investments in those cases. Thus, both Singapore's manufacturing and services investment abroad and foreign services investment in Singapore seek to avoid infrastructure bottlenecks. The institutional constraints are insignificant in all cases. Distance has an insignificant impact on inbound manufacturing investment stocks but has a positive and significant impact for inbound services stocks. This may indicate that more remote parent countries, such as the United States and the UK, invest significantly more in Singapore in the service sector relative to nearby industrialized countries such as Japan to establish regional headquarters from which to re-invest in neighboring countries. However, distance significantly reduces aggregate outbound manufacturing and services investment from Singapore. Finally, common language English and Chinese has a positive and significant impact in all cases suggesting that it facilitates investment between Singapore and the countries with which it has a common language.

Our main interest lies in the impact of relative skill endowments. The direct coefficient on relative skill differences, specified as the percentage of the labor force with a tertiary education in the parent country less the corresponding ratio in the host country, is negative and significant for both manufacturing and services inbound sample. These findings suggest that inbound investment stocks rose with a relative increase in Singapore skills compared to parent nations, which were predominantly industrialized economies as shown in Table 1. In contrast, the coefficients on skill differences are significantly positive at the one percent level for both manufacturing and services outbound regressions, implying that an increase in Singapore's skills compared to the countries in which it invests tended to increase FDI stocks. As shown in Table 1, Singapore's outbound investment in both manufacturing and services has largely gone to developing countries and in that sample the skill-differences variable is positive for all observations. Thus, an increase in this variable would suggest a rising relative skill endowment in Singapore, which induces a rise in both services and manufacturing outbound FDI stocks. This finding supports the view that Singapore's investment abroad is concentrated in labor-intensive manufacturing and services.

Tables 4 presents manufacturing and services inbound and outbound FDI stocks with developing countries. The first and second columns (Table 4) list the second stage results for manufacturing data with developing countries and the third and fourth the corresponding services data. The joint market size is significant at the one percent level for only the manufacturing and services outbound investment. For inbound investments it was insignificant. The squared GDP difference was insignificant in all cases. The investment cost is negative and significant for only inbound manufacturing from developing countries and outbound services to those countries, the latter most likely responding to services FDI restrictions in countries such as India and China. For both outbound manufacturing and services, the trade costs are positive and significant suggesting the impact of import restrictions in those countries, and hence tariff jumping while the impact of the parent country trade costs are insignificant. Higher institutional barriers have a negative and significant impact only for outbound manufacturing FDI. With the exception of outbound services distance has a negative and significant impact on FDI, while common language has a positive and significant impact for all cases.

The direct impact of skill differences on outbound manufacturing and services FDI to developing countries is positive and significant at the five and one percent level, respectively. Meanwhile, the impact on inbound services investment from developing countries is negative and significant at the one percent level suggesting a horizontal motivation while the impact on inbound manufacturing investment is insignificant. As Singapore's skill endowments rose compared to those in neighboring developing economies, outbound manufacturing FDI stocks grew larger. The negative coefficient in the case of inbound services FDI from developing countries implies that as Singapore becomes more skill abundant relative to partner developing countries they invested more in Singapore, suggesting that skill shortages in the partner developing countries are resulting in outward investment from these countries into Singapore. The results presented in Table 4 should be interpreted with caution as the sample size is small.

Table 5 presents similar results for data covering manufacturing and services inbound and outbound FDI stocks with industrialized countries. The first and second columns list results for manufacturing FDI data with industrialized countries and the third and fourth columns the corresponding results using services data. The joint market size is insignificant for all equations except inbound services investment, while the squared GDP difference is insignificant for all cases. With the exception of

outbound services FDI to industrialized countries, investment costs have a negative and significant impact. The trade costs of the hosts indicate tariff jumping only in the case of the inbound and outbound manufacturing FDI. The trade costs of the parent have a negative and significant impact only in the case of inbound manufacturing FDI. Distance had a negative and significant impact on outbound manufacturing and services FDI while it had a positive and significant impact on inbound services FDI. This suggests that in the case of services FDI, far flung countries such as the US are more likely to set up regional headquarters in Singapore and reinvest in neighboring countries. Finally, in all cases with the exception of outbound manufacturing, common language had a positive and significant impact on FDI location.

For skill differences the direct impact on inbound and outbound manufacturing and services FDI is negative and significant at the one percent level with regards to industrialized countries. Overall inbound investment in skill-intensive manufacturing, such as pharmaceuticals and electronics, also increased during the past three decades, when Singapore sharply increased its skill abundance (Chellaraj et al., 2013). This trend more than offset investment declines in primary manufacturing industries.[10] The situation was similar for services with both inbound and outbound investment seeking high skilled workforce.

The basic results are reinforced by the regressions in Tables 6 and 7. Table 6 breaks the aggregate inbound and outbound service sector samples into two groups based on skill intensity shown in Table 2. Aggregate construction, transport, wholesale and retail trade, and hotels and restaurant sectors are classified as less skill intensive and are aggregated into one group while aggregate information and communications, financial and insurance services, professional, scientific, technical, administrative and support services, and real estate are classified as highly skill intensive and aggregated into another group. The second stage results for the aggregate inbound and outbound FDI for the less skilled sectors are presented in columns 1 and 2 while the corresponding results for the highly skilled sectors are presented in columns 3 and 4. The joint market size is positive and significant at the one percent level for all equations, while the squared GDP difference is also negative and significant for all but inbound less skill intensive sectors. The trade costs of the host are positive and significant only

[10] The regression results arise from the sample of total manufacturing. Unfortunately, separate data for investment by industrialized countries in Singapore by various categories of manufacturing are not available.

for the less skill intensive sectors suggesting tariff jumping. This may suggest that trade barriers are higher both in Singapore and abroad for the less skill intensive sectors such as construction than for more skill intensive sectors such as banking and finance. Infrastructure has a negative and significant impact only for inbound less skill intensive and outbound skill intensive sectors.

While aggregate services inbound FDI exhibited a horizontal skill seeking motivation in Table 3, the results from the disaggregated data indicate that the motivations depended on the categories of services. The inbound FDI for the less skill intensive sectors display a vertical motivation, i.e., as Singapore becomes relatively less skill abundant compared to its partner countries, it receives more FDI in those sectors. Furthermore, as Singapore becomes relatively more skill abundant in the aggregate skill intensive sectors, partner countries invest relatively more in Singapore, suggesting a horizontal motivation. Meanwhile, outbound investment in both categories of services displays a vertical motivation.

Distance had a negative and significant impact on outbound investment for the more skill intensive service sectors and insignificant for the less skill intensive sectors. However, while distance had a negative and significant impact on inbound FDI in the less skill intensive sectors it had a positive and significant impact on inbound FDI in the more skill intensive service sectors. This strongly suggests that MNEs from remote industrialized countries such as the US and UK are more likely to invest in Singapore to reinvest in other countries in the region by setting up regional headquarters as far as the skill intensive sectors are concerned, thus confirming the results discussed earlier in Tables 4 and 8. Thus, investment from far off countries likely has a regional orientation[11].

Next, we disaggregated the various service categories by proximity and non-proximity needs (Table 7). Construction, real estate, wholesale and retail trade and hotel and restaurant services are classified as those requiring proximity or face to face contact, while transport, information and communication, financial and insurance services and professional, scientific, technical, administrative and support services are

[11] The samples were split into developing and industrialized countries separately and the results did not change much and hence they are not reported here. While the less skill intensive sectors displayed a vertical motivation for both inbound and outbound investment regarding both industrialized and developing countries, they displayed a horizontal motivation for both inbound and outbound investment from industrialized countries and inbound investment from developing countries in the more skill intensive sectors.

classified as non-proximity or those that do not require much face to face contact. As is evident there is no difference between the two categories of services regarding the impact of skill with both exhibiting vertical motivation. Thus, when we distinguish between services on the basis of skill-intensity, we find a significant difference between the impact of relative skill endowments on inbound FDI in skill-intensive services and its FDI in other services. However, when services are disaggregated on the basis of "proximity" needs, we do not find any significant difference in the impact of relative skill endowments on inbound or outbound FDI in proximity services compared to its impact in non-proximity services. Investment costs are negative and significant only for inbound FDI regarding sectors which require face to face contact as are trade costs of the parent. Infrastructure costs are negative and significant at the five percent level except for inbound FDI in the non-proximity service sector.

Finally, we estimate separate regressions for construction, real estate, transport, commerce (wholesale and retail trade and hotel and restaurant services were aggregated into commerce category until 2005 and have very few observations for separate estimation), business (information and communication services, and professional, scientific, technical, administrative and support services were aggregated into business category until 2005 and have very few observations for separate estimation) and finance and insurance services The skill difference coefficients are presented in Table 8. For the relatively skilled sectors, the coefficient for financial services is considerably larger than the corresponding coefficients for business and real estate,), with all of them having a negative impact. As Singapore becomes more skill abundant, inward FDI in these sectors increases confirming our results in Table 6. Similarly, for the relatively less skilled sectors, the skill difference coefficient for the transport sector is larger than the corresponding coefficients for construction and commerce) confirming the results from Table 6 column 1. For the non-proximity sectors group, the coefficient for the transport sector which is positive and significant, is larger than the corresponding coefficient for the financial and business sectors both of which are negative and significant. Finally, for the proximity sectors, coefficients for commerce is considerably larger than for the construction and the real estate sectors.

2. Economic significance

As noted earlier, the total impact of skill differences depends on both the direct coefficient and the interaction coefficients. Thus, the average annual impact of changes

in manufacturing and services FDI stocks as a result of changes in skill differences may be derived as follows:

$$\partial FDI/\partial(SK_{it} - SK_{jt}) = \beta_3 + \beta_4 (GDP_{it} - GDP_{jt}) + 2*\beta_9 (TC_{it} * (SK_{it} - SK_{jt})) \quad (2)$$

We are interested in assessing the economic importance of the effects of changes in skill differences for inbound FDI from industrialized countries. In the case of equation (2), a unit change in (SK_{it} - SK_{jt}) is an extremely large variation relative to the underlying sizes of skill ratios and the direct derivative is not meaningful. Accordingly, we calculate the implied total elasticity at the sample means for all equations with instruments and report them in each Table (Appendix). Since our primary regression results are, first, that both Singapore's manufacturing and services outward FDI to developing countries is strongly labor-seeking and, second, that both inward manufacturing and services FDI from the industrialized nations has a skill seeking focus, we disciss the relevant elasticities.

The elasticities calculated from Table 4, column 2 indicate that a ten-percent increase in skill differences with developing countries, which occurred as Singapore became more skill abundant relative to that group, resulted in a 30 percent rise in outbound manufacturing FDI stocks, or $735.44 million, to the average recipient during 1999-2014. Similarly, from Table 4, column 4, a ten-percent increase in skill differences with developing countries resulted in a 0.38 percent rise in outbound services FDI stocks, or $243.27 million, to the average recipient. Thus, we find an elastic and economically large response of outward Singaporean manufacturing and services investment in the neighboring developing economies, suggesting a clear vertical orientation to that activity. Turning to inward FDI from the industrialized nations for manufacturing, in Table 5, column 1, a ten-percent decline in skill differences with industrialized countries resulted in a 4.25 percent rise in inbound manufacturing FDI stocks, or $134.66 million from the average parent. Similarly, a ten-percent decline in skill differences with industrialized countries resulted in a 1.45 percent rise in inbound services FDI stocks, or $107.72 million from the average parent (Table 5, column 3). The much smaller impact on services could be due to relative trade and investment barriers in the sector, which likely hinders FDI in response to changes in relative skills.

V. IMPLICATIONS AND CONCLUDING REMARKS

Singapore's inbound investment with all countries in the sample is skill seeking in both manufacturing and services sectors while for outbound investment it is labor seeking. With industrialized countries, both inbound and outbound investment displayed a skill seeking motivation. Meanwhile, Singapore's skill share rose considerably relative to the neighboring developing countries in ASEAN and China supporting outward vertical investment in those countries in both sectors. While skill differences have an insignificant impact on inbound manufacturing investment from developing countries, they have a negative and significant impact on inbound services investment, suggesting that Singapore's abundant skills and shortages of skills in partner developing countries result in horizontal investment from those countries.

There were some distinctions between the manufacturing and service sectors when the trade and investment costs are taken into consideration. For outbound services FDI to developing countries, both investment and trade costs of the hosts had a significant impact unlike manufacturing, clearly indicating significant restrictions and barriers to trade and investment in the partner developing country service sectors. The positive impact of trade costs indicate tariff jumping for both manufacturing and services. There are restrictions in a number of service sectors in developing countries for both trade and FDI. For instance, there are caps on FDI in the transport sector in both India and China as well as trade restrictions, such as how many flights are allowed between Singapore on the one hand, and China and India on the other. In contrast, trade cost of the host mattered only for the manufacturing sector with regards to FDI with industrialized countries. Investment costs also mattered for the manufacturing sector. However, it also had a negative and significant impact on inbound services investment. Finally, the elasticities indicate that the response to changes in relative skills was much higher for the manufacturing than the service sector, most likely reflecting higher trade and investment barriers in services, particularly in developing countries.

The motivation for inbound investment in the service sector is related to skill intensity rather than on the need for proximity. With respect to the less skill intensive categories – aggregate transport, construction and commerce – both inbound and outbound investments are labor seeking. Furthermore, while inbound investment in the skill intensive categories is skill seeking, outbound investment is labor seeking. Most of Singapore's outbound investment has gone to the ASEAN region as well as China and hence this result is not surprising. Thus, when services are distinguished on

the basis of skill-intensity, there is a significant difference between the impact of relative skill endowments on inbound FDI in skill-intensive services and inbound FDI in other services. However, when services are disaggregated on the basis of "proximity" needs, there is no significant difference in the impact of relative skill endowments on either inbound or outbound FDI in proximity services compared to the corresponding FDI in non-proximity services. Trade costs of the hosts mattered when service sectors were grouped into less skill intensive sectors, both for inbound and outbound investment, which suggests tariff jumping. It was not significant for the skill intensive sectors.

Our results also suggest that MNEs from remote industrialized countries such as the US and the UK may invest more in Singapore to reinvest in neighboring developing countries for services but not for manufacturing. In contrast, nearby countries such as Australia may have the luxury of directly investing in the ASEAN region from their own countries without having to invest first in Singapore. However, it should be noted that the results vary by the category of service sectors. While MNEs in less skill-intensive service sectors do not exhibit this pattern, i.e., distance reduces investment, MNEs in more skill intensive sectors such as finance do, i.e., distance increases investment. Thus, while MNEs in the service sectors such as banking and finance are likely to invest in Singapore to reinvest, this is less likely in the case regarding sectors such as transport. These results suggest the need for further research to understand and model investments made to facilitate onward regional investments, particularly for the service sectors.

APPENDIX

Table 1. Singapore's Manufacturing and Services FDI Stocks to and from Developing and Industrialized Countries in the Sample (% of total in parantheses), 2014 (1990 Billion US$)

Category	Total (1990 Bill US$)	Developing (1990 Bill US$)	Industrialized (1990 Bill US$)
Manufacturing Inbound	**70.8 (100.0)**	**18.7 (11.0)**	**69.1 (89.0)**
Manufacturing Outbound	**62.1 (100.0)**	**52.8 (85.0)**	**9.3 (15.0)**
Services Inbound	**248.4 (100.0)**	**39.6 (15.9)**	**208.8 (83.1)**
Less Skill Intensive	*32.5 (100.0)*	*7.3 (10.1)*	*25.2 (89.9)*
Skill Intensive	*215.9 (100.0)*	*32.3 (15.0)*	*183.6 (85.0)*
Services Outbound	**167.0 (100.0)**	**89.1 (53.3)**	**77.9 (46.7)**
Less Skill Intensive	*76.2 (100.0)*	*69.7 (91.4)*	*6.5 (8.6)*
Skill Intensive	*90.8 (100.0)*	*19.4 (21.4)*	*71.4 (78.6)*

Source: Foreign Direct Investment in Singapore, Singapore Investment Abroad, Department of Statistics, Government of Singapore.

Less Skill Intensive: Construction, transport, wholesale and retail trade and hotel and restaurant services

Skill Intensive Services: Information and communications, finance and insurance, real estate and professional, scientific, technical and administrative

Table 2. Global Average Skill Intensity for Selected Categories of Manufacturing and Service Sector Industries (% of Total Factors of Production), 2010

Category of Industry	Skilled Labor (%)	Unskilled Labor (%)	Other Factors (%)
MANUFACTURING			
Petroleum	5.1	10.1	84.8
Textiles	9.6	29.5	60.9
Chemicals	13.1	13.1	63.2
Metal Products	3.9	33.9	52.2
Paper	15.1	30.2	54.7
Electronic Equipment	15.2	24.4	60.4
Transport Equipment	16.0	30.7	53.3
SERVICES			
Water Transport	10.6	22.5	66.9
Air Transport	12.6	29.6	57.8
Other Transport	14.6	33.5	49.9
Commerce	15.2	35.9	48.9
Construction	15.4	36.1	48.5
Business Services	18.3	19.1	62.6
Communication	20.6	21.5	57.9
Financial Services	27.1	24.4	48.5
Education and Health	35.5	35.5	29.0

Source: Dimaranan, B. V. and R. A. McDougall. 2006. GTAP 6 Data Base Documentation – Chapter 6: Data Base Summary: Protection and Support. <https://www.gtap.agecon.purd ue.edu/resources/download/704.pdf> (accessed January 21, 2018)

Note: Skill intensity in percentage is calculated for the world as a whole. Skilled labor includes professional workers such as managers and administrators, professionals and para professionals. While unskilled labor includes production workers such as farm workers and clerks. “Other Factors” include capital, natural resources, land and indirect tax.

Table 3. Second-Stage Tobit Results for Singapore's Manufacturing and Services Inbound and Outbound FDI with Year and Country Fixed Effects, 1999-2014

Regressors	Manufacturing Inbound 1999-2014	Manufacturing Outbound 1999-2014	Services Inbound 1999-2014	Services Outbound 1999-2014
GDP Sum	0.0003 (1.38)	0.001*** (6.27)	0.002*** (7.01)	0.002*** (4.17)
GDP Diff. Squared	-4.99e-13 (-0.08)	-6.09e-11*** (-5.46)	2.80e-11 (1.93)	-6.88e-11*** (-5.49)
Skill Diff.	-12734** (-2.23)	26930*** (6.22)	-34588*** (-4.83)	79691*** (2.75)
GDP Diff.*Skill Diff.	0.002 (1.49)	-0.008*** (-4.86)	0.001 (1.58)	-0.010*** (-3.18)
IC Host	167.73 (0.48)	-33.90 (-1.26)	103.14 (0.58)	16.33 (1.12)
INST Host	-539.47 (-0.94)	17.33 (0.65)	298.96 (1.11)	14.11 (0.31)
INFRA Host	252.24 (0.36)	-137.22*** (-2.82)	-1656.88** (-1.97)	-214.52*** (-2.66)
TC Host	323.78 (0.54)	-15.42 (-0.54)	2092 (1.01)	3.79 (0.10)
TC Host*Squared Skill Diff.	-762.21 (-1.64)	-123.22 (-0.54)	-2341 (-1.78)	110.87 (1.16)
TC Parent	-14.60 (-0.75)	-1687 (-1.88)	29.28 (0.89)	-239.87 (-1.01)
Distance	0.48 (1.07)	-0.434*** (-2.38)	1.01*** (8.03)	-3.22** (-2.08)
Common Language	1564** (1.96)	4279*** (5.22)	10644*** (11.87)	2894** (1.99)
Intercept	-9693 (-0.61)	39276*** (2.03)	-26782 (-1.47)	20481 (0.81)
Observations	352	352	352	352
Elasticity	0.544	2.00	0.535	1.80
Sargan P Value	0.09	0.146	0.121	0.15
F test for Weak Instruments	9.75	13.09	12.56	15.55
Durbin ChiSq	10.21	13.17	16.54	
Log Likelihood	-2724	-2735	-3278	-3242

Note: t-statistics in the paratheses; *** Significant at 1% level; **Significant at 5% level

Table 4. Second-Stage Tobit Results for Singapore's Manufacturing and Services Inbound and Outbound FDI with Developing Countries with Year and Country Fixed Effects with instruments, 1999-2014

Regressors	Manufacturing Developing Inbound 1999-2014	Manufacturing Developing Outbound 1999-2014	Services Developing Inbound 1999-2014	Services Developing Outbound 1999-2014
GDP Sum	-0.0001 (-1.09)	0.007*** (8.87)	-0.0002 (-1.84)	0.008*** (9.97)
GDP Diff. Squared	6.22e-10 (1.62)	2.21e-09 (0.95)	6.55e-09 (1.41)	-1.70e-09 (-0.73)
Skill Diff.	551.36 (0.51)	29696** (2.36)	-21317*** (-4.34)	97591*** (3.64)
GDP Diff.*Skill Diff.	0.0001 (1.72)	0.003 (1.74)	-0.009 (-1.68)	-0.055*** (-5.96)
IC Host	-50.65*** (-2.65)	28.13 (0.20)	-140.82 (-0.78)	-67.07** (-2.21)
INST Host	-242.36 (-1.03)	-13.49** (-2.07)	425.29 (0.32)	46.34 (1.24)
INFRA Host	139.33 (0.68)	-26.14 (-0.54)	-633.01 (-0.31)	51.29 (1.27)
TC Host	-19.03 (-0.78)	68.01** (2.05)	265.82 (1.11)	87.47** (2.49)
TC Host*Squared Skill Diff.	-132.63 (-1.20)	-182.33 (-1.29)	-587.33 (-1.49)	-174.22 (-1.76)
TC Parent	0.32 (0.18)	-57.22 (-0.40)	291.65 (0.92)	-581.66 (-1.01)
Distance	-0.08** (-2.71)	-1.92** (-5.33)	-2.38*** (-4.99)	0.50 (0.69)
Common Language	78.66** (1.96)	4211*** (3.17)	1067** (1.97)	14552*** (3.10)
Intercept	1682 (0.83)	-6467 (-1.63)	-564.33 (-0.02)	-12334 (-0.81)
Elasticity	-1.51	3.00	2.53	5.08
Observations	128	128	128	128
Sargan P Value	0.08	0.101	0.109	0.109
F test for Weak Instruments	9.07	11.06	11.13	11.33
DurbinChi Sq	9.45	11.44	11.72	11.87
Log Likelihood	-597	-1129	-1092	-1147

Note: t-statistics in parantheses; ***Significant at 1% level; **Significant at 5% level

Table 5. Second-Stage Tobit Results for Singapore's Manufacturing and Services Inbound and Outbound FDI with Industrialized Countries with Year and Country Fixed Effects, 1999-2014

Regressors	Manufacturing Industrialized Inbound 1999-2014	Manufacturing Industrialized Outbound 1999-2014	Services Industrialized Inbound 1999-2014	Services Industrialized Outbound 1999-2014
GDP Sum	-1.36e-06 (-0.08)	-0.00002 (-1.38)	0.0023*** (5.80)	0.0004 (0.80)
GDP Diff. Squared	1.26e-12 (0.12)	1.03e-11 (1.33)	2.39e-11 (1.84)	-1.61e-11 (-1.15)
Skill Diff.	-92805*** (-14.46)	-11812*** (-7.07)	-70891*** (-5.46)	-72660*** (-2.73)
GDP Diff.*Skill Diff.	0.003 (1.36)	-0.001 (-1.78)	0.004 (1.49)	0.0001 (0.05)
IC Host	-234,62** (-2.00)	-57.28*** (-5.52)	-90.26** (-2.00)	-25.55 (-1.62)
INST Host	100.23 (1.56)	-33.60** (-2.01)	849.96 (0.63)	-212.22** (-1.97)
INFRA Host	-5566*** (-3.21)	26.97 (1.06)	-3345** (-2.22)	-1119*** (-6.08)
TC Host	733.45** (2.31)	69.22*** (4.77)	179.32 (0.74)	-37.18 (-0.61)
TC Host*Squared Skill Diff.	3211 (1.64)	-431.34 (-1.32)	448.37 (1.62)	1169 (0.49)
TC Parent	-61.33** (-2.11)	-180.71 (-1.07)	-85.18 (-1.47)	-14.68 (-0.59)
Distance	0.73 (1.92)	-0.29** (-2.63)	2.38*** (6.63)	-1.24*** (-2.83)
Common Language	5211*** (8.89)	-1426 (-1.33)	4212*** (2.65)	8810*** (3.01)
Intercept	-36458 (-1.82)	9196** (2.40)	-17574 (-0.91)	-8667 (-0.29)
Elasticity	-0.445	0.540	-0.148	0.368
Observations	224	224	224	224
Sargan P Value	0.12	0.12	0.14	0.15
F test for Weak Instruments	12.22	12.34	14.45	15.98
Durbin ChiSq	11.87	11.25	14.01	15.11
Log Likelihood	-1882	-1290	-2093	-2016

Note: t-statistics in parantheses; ***Significant at 1% level; **Signficnat at 5% level

Table 6. Second-Stage Tobit Results for Singapore's Categories of Services Inbound and Outbound Investment with Year and Country Fixed Effects Aggregated by Skill Intensity, 1999-2014

Regressors	Less Skilled Sectors Inbound 1999-2014	Less Skilled Sectors Outbound 1999-2014	Skilled Sectors Inbound 1999-2014	Skilled Sectors Outbound 1999-2014
GDP Sum	0.0004***	0.0004***	0.001***	0.001***
	(2.97)	(5.21)	(7.09)	(3.64)
GDP Diff. Squared	-8.34e-12	-1.24e-11***	-5.18e-11***	-5.63e-11***
	(-1.82)	(-4.99)	(-6.33)	(-5.09)
Skill Diff.	53680***	44956***	-27808***	29242***
	(5.36)	(7.64)	(-3.85)	(2.95)
GDP Diff.*Skill Diff.	-0.002**	-0.001***	-0.003***	0.001
	(-2.10)	(-2.79)	(-2.69)	(0.32)
IC Host	30.11	40.33	173.39	12.10
	(1.38)	(1.32)	(0.32)	(0.72)
INST Host	-6865***	14.33	450.87	-9.52
	(-4.22)	(1.44)	(0.51)	(-0.27)
INFRA Host	-693.83***	-12.52	344.60	-200.25***
	(-3.45)	(-0.89)	(0.92)	(-2.92)
TC Host	456.44***	179.90***	844.60	12.33
	(3.85)	(3.15)	(0.92)	(0.35)
TC Host*Squared Skill Diff.	-338.66	-326.33	1222	-742.95
	(-1.32)	(-1.73)	(1.67)	(-1.55)
TC Parent	-14.93	-11.56	45.22	-105.52
	(-1.04)	(-1.47)	(0.55)	(-0.92)
Distance	-13.27***	0.37	1.09***	-0.69***
	(-4.71)	(1.26)	(6.57)	(-4.66)
Common Language	5273***	386.20	9378***	12022***
	(5.49)	(0.59)	(2.80)	(4.36)
Intercept	38489***	4747	-30942	914.44
	(2.68)	(1.01)	(-1.29)	(0.213)
Elasticity	-2.61	6.19	0.62	0.78
Observations	352	352	352	352
Sargan P Value	0.114	0.131	0.138	0.121
F test for Weak Instruments	11.18	12.82	15.71	14.77
Durbin ChiSq	11.58	14.55	18.51	15.94
Log Likelihood	-2933	-2603	-3196	-3213

Less Skilled Sectors = Construction + Wholesale and Retail Trade + Transport + Hotel and Restaurant Services is labor seeking both inbound and outbound

Skilled Sectors = Information and Communications + Financial and Insurances + Real Estate + Professional, Scientific, Technical, Administration and Support Services is skill seeking inbound but labor seeking outbound.

Note: t-statistics in parantheses; ***Significant at 1% level; **Significant at 5% level

Table 7. Second-Stage Tobit Results for Singapore's Categories of Services Inbound and Outbound Investment Aggregated by Proximity with Year and Country Fixed Effects, 1999-2014

Regressors	Proximity Inbound 1999-2014	Proximity Outbound 1999-2014	Non-Proximity Inbound 1999-2014	Non-Proximity Outbound 1999-2014
GDP Sum	0.0004***	0.001***	0.002***	3.21e-04
	(5.32)	(11.32)	(7.51)	(0.38)
GDP Diff. Squared	-1.12e-11***	-5.56e-11***	3.55e-11***	-1.58e-11
	(-4.29)	(-11.04)	(3.32)	(-1.42)
Skill Diff.	11283***	16850***	35696***	60617***
	(3.06)	(6.59)	(2.96)	(3.93)
GDP Diff.*Skill Diff.	-0.001**	-0.005***	0.0004	-0.002***
	(-2.02)	(-6.10)	(1.58)	(-3.77)
IC Host	-26.22**	38.73	69.78	96.96
	(-2.34)	(1.43)	(1.68)	(1.29)
INST Host	-4.33	-3.68	6.99	8.27
	(-0.52)	(-0.33)	(0.18)	(0.22)
INFRA Host	-39.37***	-68.21**	0.95	-171.63***
	(-2.55)	(-2.04)	(0.04)	(-2.54)
TC Host	-31.30	-22.77	-50.34	42.81
	(-0.49)	(-1.28)	(-1.70)	(1.23)
TC Host*Squared Skill Diff.	-147.24	-78.64	-799.65	-994.92
	(-1.92)	(-0.81)	(-1.72)	(-1.82)
TC Parent	-18.22**	-222.55	-42.16	-162.19
	(-2.07)	(-1.26)	(-1.15)	(-1.79)
Distance	-0.001	-0.003	-1.20	-0.38
	(-0.01)	(-0.08)	(-1.57)	(-1.15)
Common Language	2278***	4617***	-1763	7657***
	(3.56)	(6.22)	(-0.88)	(2.23)
Intercept	-278.61	1806	2745	7655**
	(-0.22)	(0.18)	(1.23)	(2.00)
Elasticity	-1.55	1.73	-0.77	1.73
Observations	352	352	352	
Sargan P Value	0.141	0.129	0.109	0.103
F test for Weak Instruments	14.83	12.29	10.60	10.55
Durbin Chisq	16.03	12.77	11.11	10.86
Log Likelihood	-2621	-2743	-3205	

Proximity = Construction + Real Estate + Wholesale and Retail Trade + Hotel and Restaurant Services have vertical impact.

Non-Proximity = Transport +Information and Communications + Financial and Insurance + Professional, Scientific, Technical, Administrative and Support Services have vertical impact.

Note: t-statistics in parantheses; ***Significant at 1% level; **Significant at 5% level

Table 8. Second-Stage Tobit Results for Singapore's Services Inbound Investment by categories with Year and Country Fixed Effects with instruments 1999-2014

Regressors	Commerce Inbound 1999-2014	Business Services Inbound 1999-2014	Financial Services Inbound 1999-2014	Construction Inbound 1999-2014	Real Estate Inbound 1999-2014	Transport Inbound 1999-2014
GDP Sum	0.001***	-2.82e-06	0.001***	-0.0000	-0.00003	0.001***
	(4.62)	(-0.03)	(2.82)	(-0.05)	(-1.37)	(10.83)
GDP Diff. Squared	-1.39e-11	-2.10e-12	5.40e-11***	-1.29e-12	1.17e-12	-1.93e-11***
	(-1.36)	(-0.67)	(6.24)	(-1.63)	(1.65)	(-4.64)
Skill Diff.	33065***	-18629***	-56886***	537.10***	-1473.64**	66573***
	(2.63)	(-3.56)	(-9.08)	(2.58)	(-2.31)	(6.65)
GDP Diff*Skill Diff	0.001	-0.001***	0.002	-0.00001**	0.0003	0.001
	(0.61)	(-4.74)	(1.17)	(-2.37)	(1.35)	(0.75)
IC Host	-80.81	-87.40	-272.07	-2.14	-19.35	-131.60
	(-0.07)	(-0.49)	(-0.54)	(-0.23)	(-0.45)	(-0.49)
INST Host	-343.98	-103.01	-304.42	-9.20	1.72	-529.13
	(-0.24)	(-0.34)	(-0.36)	(-0.59)	(0.02)	(-1.19)
INFRA Host	-573.14	693.61	1901	18.25	30.49	-636.06
	(-0.44)	(1.92)	(1.89)	(0.98)	(0.36)	(-1.17)
TC Host	342.42	-40.09	-249.24	7.48	6.08**	906.52**
	(0.92)	(-0.13)	(-0.29)	(0.47)	(2.39)	(1.96)
TC Host*Squared Skill Diff.	204.45	-862.05	-601.98	30.06***	-35.15	-95.83
	(0.32)	(-1.74)	(-1.32)	(3.21)	(-0.84)	(-0.34)
TC Parent	46.03	-27.71***	-18.28	-0.392	-15.94	-8.56
	(1.32)	(-2.92)	(-0.83)	(-0.78)	(-0.22)	(-0.58)
Distance	-1.90**	0.804***	2.33***	-0.017	0.155***	-1.71***
	(-2.20)	(2.90)	(9.95)	(-1.79)	(5.54)	(-6.98)
Common Language	3607**	1906***	4735***	38.31***	487.45***	9266***
	(2.40)	(7.25)	(6.17)	(3.16)	(4.91)	(7.01)
Intercept	12699	-6942	-26162	-62.563	-1103.95	18725
	(0.36)	(-0.82)	(-1.15)	(-0.15)	(-0.57)	(1.50)
Observations	352	352	352	352	352	352
Elasticity	-1.85	2.37	1.49	-1.76	0.86	-3.24
Sargan P Value	0.10023	0.08234	0.10334	0.0987	0.1455	0.1455
F test for Weak Instruments	10.08	8.65	10.55	9.66	21.76	21.18
Durbin Chisq	9.86	8.73	11.21	10.03	19.83	20.58
Log Likelihood	-3214	-2523	-2949	-1444	-1841	-2944

Proximity = Construction + Real Estate + Wholesale and Retail Trade + Hotel and Restaurant Services have vertical impact.

Non-Proximity = Transport +Information and Communications + Financial and Insurance + Professional, Scientific, Technical, Administrative and Support Services have vertical impact.

Note: t-statistics in parantheses; ***Significant at 1% level; **Significant at 5% level

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First version received on 12 October 2018

Peer-reviewed version received on 2 December 2018

Final version accepted on 8 March 2019