The London School of Economics and Political Science

Essays on Agglomeration, Trade Costs and Foreign Direct Investment

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Declaration

I certify that the thesis I have presented for examination for the MPhil/PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it).

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London, 07th February 2014

Chinchih Chen

Abstract

This thesis is composed of three chapters. The first one investigates the impact of distance, market and supply access and agglomeration externalities on FDI locations. Chapter 2 studies the change in trade costs on FDI locations. Chapter 3 examines the relative effect of trade costs on horizontal and vertical FDI locations.

Chapter 1 provides empirical evidence of the effect of agglomeration with firms from the same country on other location determinants. I use data for the Taiwanese FDI projects in Chinese provinces from 1991 to 1996. In order to estimate the relative change in coefficient magnitude over time, I exploit Taiwan's FDI policy shock in 1991. I find negative effects of the bilateral distance between the home and host country on FDI locations. Sectoral agglomeration with firms from the same country also has significant and positive impact on FDI locations.

Chapter 2 investigates the impact of the change in trade costs on FDI locations. I study the effect on the FDI growth rate and the number of new FDI projects. Taiwan's cross-strait direct flights policy in 2008 provides a quasi/natural experiment on the change in trade costs, arising from the implementation of direct flights between Taiwan and China. I use difference-in-difference estimator with Taiwanese firm-level data for the period 2002 to 2011 to identify the casual effect of the change in trade costs on FDI locations. Furthermore, I decompose the effect of trade costs by identifying the transaction and transport costs channels. Contract and unit value intensity are created to measure the relative effect of trade costs through two channels. I find that the dispersion of Taiwanese FDI after the policy shock in 2008.

Chapter 3 investigates the impact of trade costs on horizontal and vertical FDI locations. I study the relative effects of trade costs on the number of new horizontal and vertical FDI affiliates across industries. I use Taiwanese firm level data during the period 2001 to 2011 in combination with the input-output links between the parent firm and affiliates to identify horizontal and vertical FDI as well as inter-and intra-industry vertical FDI. My findings indicate trade costs have additional negative impact on vertical FDI relative to horizontal FDI. In addition, as an increase in trade costs occurs, vertical FDI affiliates are affected

relatively more than horizontal FDI through both transaction and transport costs channels.

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CHAPTER 3

Introduction

1. Overview of Research methodology

This thesis is divided in three parts. The first part, chapter 1, studies the effect of distance, market and supply access and agglomeration externalities on FDI location choices by investigating Taiwanese FDI in Chinese provinces during the period between 1991 and 1996. The second part, chapter 2, studies the impact of the change in trade costs on FDI location choices by using a unique quasi-natural experiment of Taiwan's cross-strait direct flights policy in 2008. Finally, the third part, chapter 3, studies the relative effect of trade costs on the patterns of FDI by using Taiwanese firm-level data during the period 2001 to 2011. In this thesis, I employ applied econometric methodology to identify the causal effects that are derived from the research questions in each chapter. The applied econometric methodology is conducted through this thesis to address original research questions. The aim of this approach is to identify the casual relationship between the variable of outcome and the variables of interest which is theoretical and empirically relevant. This methodology contain three main components:

A. Literature review

By thoroughly reviewing the relevant literature, I identify the gaps between the theoretical predictions and empirical evidence or gaps among the existing empirical studies. This allows me to formulate the research questions on the basis of the considerations on the theoretical relevance as well as empirical feasibility. Hence, a set of theoretical predictions is defined on the expected effects of the variables of interest on outcomes.

B. Data

To carry out the empirical exercises several datasets are used, both for Taiwan and China. An effort is made to employ the best available data for the research questions investigated. For example, in the first part of the thesis, to be able to assess the effects of distance, market and supply access and agglomeration externalities on FDI locations, I collect Taiwanese FDI data from two data sources. One is the total registered FDI projects, and the other is the public listed firms' FDI affiliates. Both of them are used to better control for measurement errors. With the aim of appropriately capturing the effects of agglomeration externalities, I collect Chinese provincial data on both industrial outputs and the number of firms, because both output and the number of firms are relevant sources to measure sectoral agglomerations.

In Chapter 2, in the case of the assessment of the change in trade costs after the direct flight policy shock on FDI locations, to provide alternative measure of this change I construct the passengers' air travel time across year and province. Since the travel time is considered as a kind of trade costs, passengers' air travel time captures this change in flight time as well as flight connection time if flight transfer needed.

In addition, in Chapter 3, I classify each Taiwanese affiliate's industry code using the information of its primary products to construct the parent-affiliate industry pair. Also, to distinguish the type of each FDI affiliate by using the input-output linkage between the parent and affiliate, several concordance tables are used make compatible different industrial codes, such as ISIC Rev. 4 to 2002 NAICS.

C. Econometric strategies

The empirical approach in this thesis is based on the estimation of reduced-form empirical specifications. Thus, clear theoretical predictions are essential for the formation of the empirical equations and for the interpretation of the magnitude and sign of the estimated coefficients. For instance, section 3 of chapter 2 discusses the transaction and transport costs channels through which the trade costs might have cross-industry impacts on FDI location.

This thesis employs regression analysis to estimate the casual effects from the empirical specification. To be able to interpret the estimated coefficients as causal effects, particular attention is paid to estimating of unbiased coefficients.

Omitted variable bias, reverse causation, simultaneity bias, spurious correlation, unobserved effects, measurement errors or poor proxies are those affecting the validity of the estimates on variable of interests. To validate the coefficients on variables of interest, this thesis mainly uses three identification strategies to eliminate the potential biases.

First of all, I carefully include control variables in the estimated specifications to further control for omitted variable biases. Secondly, since it is extremely difficult to conduct randomized experiments on the effect of trade costs on firms' location choices, the quasi/natural experiments can provide a "as if" experimental identification strategy to estimate the causal effects. In Chapter 2, I identify the cross-strait direct policy in 2008 as a quasi/natural experiment, which I argue it provides a "good variation" in the trade costs.

Finally, I use panel data, both at the aggregate level (panel of provinces and industries) and at the individual level (panel of firms). It allows me to control for unobservable and time invariant characteristics of the observation units. These unobserved variations might be correlated with both the variables of interest and the outcome variable. For example, various fixed effect estimators are used in Chapter 3 to address unobservable industry selection bias or omitted province-industry specific comparative advantage. Also, by using time dummies, I control for common yearly shocks. Furthermore, I employ difference-in-difference estimation to exploit the exogenous variation before and after the policy shock.

2. Overview of thesis

This thesis contains three main research studies, presented in Chapters 1 to 3.

Chapter 1: Distance effect, Market and Supply Access, and Agglomerations: Evidence from Taiwanese FDI in China between 1991 and 1996

Chapter 1 investigates the effect of distance, market and supply access and agglomeration externalities on FDI location choices by investigating Taiwanese FDI in Chinese provinces during the period between 1991 and 1996. The study of the impact of the country or regional characteristics on multinational firms' FDI location choices has produced a large body of empirical literature in recent decades. However, investigations of the change in the distance effect and agglomeration externalities on the location decisions across time are scarcer. I exploit a FDI policy shock that occurred between Taiwan and China in 1991 as a unique quasi-natural experiment to test the theoretical predictions on these variables of interest. Due to the political conflicts across the Taiwan Strait, direct economic activities were banned between Taiwan and China since 1949. Direct trade was opened in 1987, following the removal of restrictions on Taiwanese individuals and firms' FDI in China in 1991. Hence, I use the policy shock to construct two investing periods, 1991 to 1993 as the first period and 1994 to 1996 as the second one in the Taiwanese FDI data. To estimate the relative change in magnitude of the variables of interest on firms' location choices, I run a similar specification as Mayer et al. (2010) by using conditional logit estimation. The variable of outcome is Taiwanese FDI projects across 24 Chinese provinces and 16 manufacturing industries.

To better identify the effects of different agglomeration externalities, I construct two sets of province-industry specific agglomeration variables: market and supply access and sectoral agglomeration. First, market and supply access variables are included to measure the effects of forward the backward linkages across industries and provinces. They are constructed on the basis of Amiti and Javorcik's (2008) approach, using input-output table to define the industrial upstream and downstream relationships. Secondly, I create two sectoral agglomeration variables; one is to measure the agglomeration of all manufacturing firms, and the other is the agglomeration of Taiwanese firms only.

The estimated specification includes provincial control variables in order to reduce omitted variables bias. I find that distance and sectoral agglomerations have consistently significant impacts on firms' location decisions in both periods. The estimates of geographic distance between Taiwan and Chinese provinces, the proxy for trade costs, have consistently and significantly negative signs over two investing periods. As the distance increases, firms are less likely to invest in locations that are further away from the home country. Also, given the provincial factors costs, firms are more likely to invest in the locations where there exist clusters from the same industry in which they can gain extra benefits from agglomeration externalities such as labour pooling or knowledge spillover. Most import of all, after introducing the sectoral agglomeration of Taiwanese firms in the second investing period (1994-1996), the magnitude of estimates on both the distance and sectoral agglomeration declines. At the same time, the estimate of Taiwanese sectoral agglomeration is significant with the expected positive sign. This is because Taiwanese firms gain positive externalities from clustering with other Taiwanese firms from the same industries, such as insightful investing information. On the other hand, the estimates of the market access and supply access variables are not consistently significant with the expected positive sign over two investing periods. Since the domestic market and industrial infrastructures were still under development in China in the early 1990s, upstream or downstream linkages may not have the same impact as strong as other provincial characteristics on firms' location decisions.

These findings in Chapter 1 contribute to the current literature on FDI location in three ways. First of all, given agglomeration externalities and other provincial characteristics, I clearly identify the statistically significant and negative effect of geographic distance, as a proxy for trade costs, on FDI location choices. Secondly, with the Taiwanese FDI firm-level data, the findings present the consistently and significantly positive effect of cross-industry Taiwanese agglomeration on attracting new FDI projects. Finally, by exploiting the Taiwanese FDI policy shock, two investing periods are constructed to examine the relative change in the estimated magnitude of variables of interest across time.

Chapter 2: Does the Distance Matter? The effect of Change in Trade Costs on FDI Locations

Chapter 2 investigates the impact of the change in trade costs on FDI location. I study the effect of change in trade costs on the FDI growth rate and the number of new FDI projects. There are two major empirical obstacles. First, in multi-regional models, without factor price equilibrium across space, there are no clear theoretical predictions of the effect of changes in trade costs on the firms' locations. Secondly, the distance variable, as a major part of trade costs, can be correlated with other unobserved geographical characteristics, such as culture, language or the quality of institutions.

In this chapter, I address these identification issues by employing a unique quasi-natural experiment of Taiwan's cross-strait direct flights policy in 2008. The change in trade costs arises from the implementation of a new transportation mode, and I argue that this change in trade costs is exogenous to Taiwanese FDI activities. Hence, in combination with panel data on Taiwanese FDI projects, I can use difference-in-difference estimation to investigate the casual effect of the change in trade costs on FDI locations. By exploiting the variation of the distance effect before and after this exogenous policy shock across provinces and time, the potential omitted variable biases resulting from unobservable provincial characteristics can be eliminated.

Furthermore, I decompose the effect of trade costs on firms' location choices by identifying the transaction and transport costs channels. Based on the trade literature (Nunn, 2007; Horrigan, 2010; Cristea, 2011), I create contract and unit value intensity to measure the relative effect of trade costs through the transaction and transport costs channels across industry. As for the transaction costs channel, if an industry requires more relationship-specific investments, it will face higher face-to-face communication, information, or matching costs. This causes the industry to pay relatively higher transaction costs than others as the distance between home and host FDI destination increases. As for transport costs, based on the fact that air transportation is fast and expensive, air shipments are used only when timely delivery is valuable enough. This means the air shipments occur when the value of traded goods is high enough to pay for the premium air shipping costs. For sufficiently high value-weight ratio products, the ad-valorem airfreight premium becomes relatively smaller than low ratio ones. Thus, goods imported from more distant locations are more likely to have higher value-weight ratio. In other words, the industry with higher unit value (value-weight ratio) will pay relatively less transport costs than others as the distance between home and host FDI destination increases.

I use the firm-level data of Taiwanese public listed firms' foreign affiliates from Taiwanese Economic Journal (TEJ) during the period between 2002 and 2011. The dataset provides information on affiliates' business name, ownership, locations and primary products. The data is then aggregated to 23 two-digit ISIC Rev. 4 manufacturing industries for 30 Chinese provinces. The variables of outcome are the FDI growth rate and the number of the new FDI affiliates. I attempt to examine the effect of policy shock on the flow level of FDI, instead of FDI stock level, which may not reflect the relative change in FDI projects over time. The main variable of interest is the bilateral distance, as the proxy for trade costs. Also, I use air travel time to approximate trade costs as a robustness check. The results from both measures are qualitatively consistent.

The main estimation strategy follows the same logic as a standard differences-in-differences (DD) specification. I compare the relative change in FDI growth rate and the number of new FDI projects in the post-shock period to the pre-shock period between provinces that are closer to or further away from Taiwan. The difference from standard DD strategy is that I use a continuous measure of the intensity of treatment (i.e. distance between Taiwan and Chinese provinces) and thereby capture more variation in the data. Since the year of openness to direct flights in each province depends on bilateral negotiation progress, I use the first openness year, i.e. 2008, for all provinces to have a single post-shock indicator. I argued that it is feasible that the timely implementation of direct flights and more options for connecting flights change trade costs for all provinces after 2008. Since the trade costs between Taiwan and China change for all provinces right after the policy announcement, I use the initial opening year, 2008, as the cut-off period and define the periods prior to 2008 as the pre-shock periods, and the periods after 2008 (i.e. 2008, 2009, 2010 and 2011) as the post-shock periods. Several sensitiveness and robustness checks are employed at the end.

The empirical results show that after the policy shock, the coefficient of interaction term of the post shock dummy and the distance between Taiwan and Chinese provinces has a consistently and significantly positive sign, i.e., the dispersion of Taiwanese FDI after the policy shock emerges. According to the estimates, the increase in the distance between Taiwan and China provinces by 10 percentage points leads to a 0.32 percent change in the FDI growth rate and a 0.52 percent change in the number of new FDI affiliates in the period 2008-2011. In other words, the remote provinces attract relatively more FDI projects after 2008.

As for the transaction costs channel, the estimate of the interaction term of contract intensity and distance is statistically significant with the expected negative sign. Quantitatively, if the difference in contract intensity between two industries is 10 percentage points, as the distance increase by 10 percentage points, the number of new FDI affiliates in the relatively contract intensive industry will reduce average 0.24 percentage points more than the industry with the relatively low contract intensity. As for the transport costs channel, the magnitude of the estimate is weaker but still statistically significant. If the difference in unit value intensity between two industries is 10 percentage points, as a 10 percent increase in distance, the number of new FDI affiliates in the relatively unit value intensive industry will increase average 0.0049 percentage points more than the industry with the relatively low unit value intensity. Furthermore, after the direct flight shock, there is no clear impact through the transaction costs channel, while firms in the relatively high unit value intensive industries will choose to invest in relative closer locations than relative low intensive ones.

Chapter 3: The Impact of Trade Costs on Horizontal and Vertical FDI—Evidence from Taiwanese FDI in China

Chapter 3 further investigates the impact of trade costs on horizontal and vertical FDI location. I study the relative effects of trade costs on horizontal and vertical

FDI affiliates across industries. Horizontal FDI is understood as occasions when the parent firm establishes foreign production facilities to serve the market locally. By producing the final products in the foreign country, the parent firm can avoid trade costs resulting from exporting goods to the foreign market. Vertical FDI represents that the parent firm divides the production chains to take advantage of cross-country factor cost differentials. The study of the impact of determinants on the patterns of FDI has produced an abundant empirical literature since 1990, especially on the impact of the market access and factor costs differentials. However, there are fewer empirical investigations on the relative impact of trade costs on the distribution of horizontal and vertical FDI activities. Hence, based on horizontal and vertical FDI theoretical models, I test three hypotheses to shed light on the role of trade costs on the patterns of FDI:

1) Trade costs – approximated by bilateral distance - have a negative impact on the formation of new vertical FDI affiliates in comparison to the horizontal FDI;
2) With the same transaction or transport costs intensities, vertical FDI affiliates will be affected relatively more than horizontal FDI as the trade costs increase;
3) The negative impact of trade costs on intra-industry vertical FDI affiliates is smaller than inter-industry vertical FDI.

I use data on Taiwanese FDI affiliates during the period 2001 to 2011 to test my hypotheses. The Taiwanese firm-level dataset provided by Taiwan Economics Journal (TEJ) is on the basis of Taiwanese public listed firms' direct investments in China. The TEJ dataset includes information on location, ownership, primary products and the parent firm's information for each affiliates. By employing this information, I identify 3,023 new multinational affiliates in 87 four-digit ISIC Rev. 4 manufacturing industries and 29 provinces. Observations are included only when their parent firms are from manufacturing sector as well in order to be compatible with the existing literature (ex. Brainard, 1997; Yeaple, 2003). Following Alfaro and Charlton's (2009) and Fajgelbaum et al.' (2013) methods, I use a combination of four-digit International Standard Industrial

Classification Rev. 4 (ISIC Rev.4) industry-level information and U.S. Bureau Economic Analysis (BEA) 2002 Benchmark Input-Output Tables to distinguish horizontal and vertical FDI affiliates. Furthermore, I break down vertical FDI into inter-and intra-industry vertical FDI to assess the impact of trade costs within vertical FDI. Inter-industry vertical FDI is defined when the parent firm and affiliate have different two-digit ISIC Rev. 4 code, while intra-industry vertical FDI pairs share the same two-digit but different three or four-digit codes.

The variable of outcome is the logarithm of total number of each parent-affiliate industry pair in the four-digit ISIC Rev.4 level in each Chinese province. Initially, I assess the effect of distance variable on the number of new FDI affiliates in horizontal and vertical sub-sample respectively. The estimated specifications include controls as well as industry and time fixed effects to reduce omitted variable biases. To identify the relative impact of trade costs on horizontal and vertical FDI, I introduce a set of interaction terms of independent variables and vertical FDI indicator in the full sample. The vertical FDI indicator equals one if the observation is classified as vertical FDI, and zero for horizontal FDI. Hence, the estimate of the distance interaction term catches the additional effect of trade costs on vertical FDI in comparison to horizontal one. The similar strategy is applied to examine the relative effect of trade costs on inter-and intra-industry vertical FDI. In addition, I also decomposed the trade costs into transaction and transport costs channels on the basis of the methods created in Chapter 2. I estimate the relative trade costs effect through these two channels on the patterns of FDI.

My findings indicate that the increase in distance between Taiwan and province j by 10 percentage points reduces the number of new vertical FDI affiliates by 2.48 percentage points in comparison to horizontal FDI. In addition, if both vertical and horizontal FDI affiliates are in the same industry, as the 10 percent increase in distance, the number of the vertical FDI affiliates reduces average additional 4.43 percentage points than horizontal FDI through the transaction costs channel, while the number increases by 0.15 percentage points through the transport costs channel. Finally, trade costs seem having no different impact on inter-and intra- industry vertical FDI location decisions.

CHAPTER 1

DISTANCE EFFECT, MARKET AND SUPPLY ACCESS, AND AGGLOMERATION—EVIDENCE FROM TAIWANESE FDI IN CHINA BETWEEN 1991 AND 1996

1. Introduction

For the past two decades, it has been well recognized that FDI by multinational firms has grown significantly in both developed and developing countries. The World Bank (1993) summarized the benefits that FDI brings: technology transfer, management know-how and export marketing access. There is abundant literature documenting those positive spillovers of FDI on host countries theoretically and empirically. For example, Markusen and Venables (1999) provided a theoretical justification of spillovers through backward linkages. Haskel et al. (2007) and Keller and Yeaple (2009) show FDI leads to significant productivity gains for domestic firms, by using firm level data from the United Kingdom and the United States respectively. Also, Javorcik (2004) employed firm level data from Lithuania to provide evidence consistent with positive productivity spillovers from FDI taking place through the vertical spillover channel, i.e. the contacts between foreign firms and their local suppliers in upstream sectors. Hence, FDI-oriented policies such as discriminated corporate tax or subsidized industrial infrastructure become popular in developing and transitional countries, expecting the increase in inward FDI will bring in much-needed capital, new technologies, or advanced management skills.

Aware of the FDI inflow competition among China's regions, there are plenty of empirical studies investigating determinants of FDI location choices in China for example, Amiti and Javorcik (2008), Debaere et al. (2010), and Chang et al. (2011). The findings demonstrate that local agglomerations and FDI-oriented policies have positive effects on foreign affiliates' locations, while the distance between home country and China, as the proxy for trade costs, has an adverse impact. However, thorough studies on the impacts of distance, market and supply access and agglomeration externalities on regional FDI location decisions are scarcer. Besides, abundant empirical results have documented the separate effect of these location determinants, but to the author's knowledge, the empirical evidence on change in impact of the distance and market and supply access over time is scarce. Furthermore, the empirical findings for FDI locations where both host and home country are developing countries at the early development stage are rare because of the data limitation. In this study, I employ a unique data of Taiwanese FDI in China in the early 1990's to investigate the relative importance of location factors on FDI inflows in the developing country.

I identify the openness of direct cross-strait FDI in 1991 after forty years' ban on bilateral commerce as an exogenous policy shock. The innovation in this chapter is to investigate the relative impact of distance, market and supply access, and agglomeration externalities on firms' location choices by constructing two investing periods for the very first Taiwanese FDI projects in China during the period from 1991 to 1996. The first period is 1991-1993, when no proceeding FDI projects from other Taiwanese firms are observed. I start from a basic profit driven location model, which is based on Mayor et al. (2010), to analyse the first movers' location choices since 1991. The second is 1994-1996. For the following investors, since the new agglomeration externalities such as Taiwanese sectoral agglomeration formed in the later investing period, I can investigate the deviation of the magnitude of the distance and other existing agglomerations effects.

In summary, these findings in Chapter 1 contribute to the current literature on FDI location in three ways. First of all, given agglomeration externalities and other provincial characteristics, I clearly identify the statistically significant and negative effect of geographic distance, as a proxy for trade costs, on FDI location choices. Secondly, with the Taiwanese FDI firm-level data, the findings present the consistently and significantly positive effect of cross-industry Taiwanese agglomeration on attracting new FDI projects. Finally, by exploiting the Taiwanese FDI policy shock, two investing periods are constructed to examine the relative change in the estimated magnitude of variables of interest across time.

The paper is organised as follows: Section 2 provides the theoretical review on relevant FDI location literature and a discussion of the historical background of cross-strait direct FDI policy, while Section 3 outlines the theoretical model. Section 4 describes the data used in the analysis. Section 5 presents the empirical strategy and baseline results. Section 6 reports additional robustness checks. Section 7 offers concluding remarks.

2. Background

2.1 Related Literature on FDI Location Choices

The sources of uneven distribution of economic activities across space have been popular research interests for a long time. According to Marshall (1920), who first introduced the concept of agglomeration economies, the agglomeration of economic activities is likely to be generated through three potential mechanisms: specialized labour market pooling, input sharing and knowledge spillovers. There have been plenty of empirical results showing that firms from the same industry tend to cluster in the same region (such as those of Head et al., 1995; Head & Mayer, 2004; Amiti & Javorcik, 2008).

In the new economic geography (NEG) literature, which emerged following the work of Krugman in 1991, location choices are viewed as determined by a tension between agglomeration forces and dispersion forces. The two agglomeration forces are the "home market effect" and the "price index effect;" the two dispersion forces are the "market crowding effect" and an immobile factor, "agricultural labour." According to Redding (2009), agglomeration forces arise from pecuniary externalities due to a combination of love of variety, increasing returns to scale and transport costs. The dispersion forces arise from product market competition and geographically immobile factors of production or amenities. The "home market effect" implies that, due to the increasing returns to scale and transport costs, firms tend to concentrate production near to large markets. The "price index effect" implies that, because of consumers' love of variety and transport costs, there is a lower cost of living near to large markets. As for the first dispersion force, the "market crowding effect", transport costs imply that firms close to large markets face a larger number of lower-priced competitors than in the smaller one. The second dispersion factor implies that immobile factor agricultural labour in combination with transport costs provides an incentive for dispersed production across regions.

In the ensuing related research, Krugman and Venables (1995) and Venables (1996) were concerned with the idea that, since national boundaries constrain labour mobility, intermediate inputs can be a source of cumulative causation. In a manner analogous to that of classic agglomeration forces, manufacturing firms agglomerate through forward (costs) and backward (markets) linkages. A location with a relatively large share of manufacturing intermediates has costs advantages for final goods production. Conversely, a location with a larger share of the final goods sector provides a larger local market for producers of intermediates. Amiti and Javorcik (2008) were among the first to introduce a supplier access variable to take into account the inter-industry linkages in empirical FDI location analysis at the multiregional level.

The empirical literature on the FDI locations provides evidence that the positive agglomeration externality for multinational firms can result from locating FDI projects in destinations with existing agglomerations from the same country. These externalities include greater availability of specialized inputs and labour as well as technology spillover. Head et al. (1995) discovered that inter-firm linkages within Japanese business groups force members to choose overseas affiliates close to one another. In addition, many researchers have pointed out that all major FDI investors in China, i.e. Hong Kong, Taiwan, Japan and America, are inclined to choose locations favoured by their fellow pioneers because of strong business connections, shared language and culture (He, 2002; Belderbos, 2002; Du et al., 2008; Debaere et al., 2010; Chang et al., 2013). Although China opened its market two decades ago, unreliable local political, social and business environments and less transparent institutions have made China one of the remaining risky investment countries for foreign firms. Even sharing the same language and cultures, investors from Taiwan and Hong Kong still tend to agglomerate in China.

Furthermore, the distance effect is one of the persistent determinants of FDI location choices (Balderbos, 2002; Mayer et al., 2010; Chang et al., 2013). FDI is an international economic activity and setting up a foreign plant requires higher fixed costs than a domestic plant. Egger and Pfaffermayr (2001) assume the plant set-up costs, similarly to trade costs, are of the iceberg type in their empirical study, i.e. an increase in distance leads to an increase in the set-up costs.[1] Also, distance is an important determinant of the transport costs of goods

[1] They assume set-up cost$\gamma=\gamma_0+\rho*\delta$, where$\delta$is the distance, $0\leqq\rho\leqq\infty$. As the distance increases, the costs increase because of the differences in the cultural, political or economic environments, etc.

shipments (Hummels, 2007). Mayer et al. (2010)[2] considered the distance between home and host countries as part of the marginal transaction costs. In the empirical FDI location literature, the distance effect can be taken as a part of marginal production costs instead of as a fixed cost of setting up a foreign affiliate.

In the regional FDI locations empirical literature, few empirical studies provide evidence on both the impact of the distance between the home and host country and the regional agglomeration externalities on FDI location decisions. Chang et al. (2013) find that distance to home has significantly negative effect on both Taiwanese and Japanese multinational firms' locations in Chinese provinces. At the same time, both sectoral agglomeration and same nationality agglomeration have positive and significant impacts on FDI locations. However, they do not consider the regional market and supply access across Chinese provinces, which have been examined by Amiti and Javorcik (2008) and Debaere et al. (2010) by using all FDI projects and South Korean FDI in China respectively.

2.2 Historic background to Taiwanese FDI in China

After 1979, China gradually opened its market to embrace market economies: the Open Door Policy. Due to the special historic and political relationship between Taiwan and China, the government of Taiwan did not relax restrictions on general tourist/ family visits to China until 1987.[3] In the same year, indirect international trade, i.e. trade transferred via a third country like Hong Kong across the Taiwan Strait, started. However, direct investment in China was not allowed. At the same time, Taiwanese firms started facing decreasing profit margins resulting from wage increases and the reduction in local tax incentives. Hence, establishing a new plant in China in order to lower production costs became a popular solution to maintaining profit growth. The Taiwan's government therefore faced

[2] In the cost function they include various transaction costs - distance, ex-colony dummy and language – in order to capture the fact that it is probably easier for a French investor to run a business in a proximate, francophone or ex-colonial country. These costs take the form of fixed costs. However, it seems that at least part of their influence on the location decision operates through the firm's marginal cost.

[3] This was only open for one-way visits. People in China were not allowed to visit Taiwan at the same time. This restriction was gradually relaxed from 1992. Up to now, the individual travel of Chinese people is still restricted.

considerable demand to start legislating the cross-strait trade and investment regulations to protect Taiwanese firms and individuals as well as to maintain national security after 1988, when Taiwan's central bank further lifted the control on foreign exchange.

While Taiwan and China's governments were negotiating the details of regulations on economic activities, tourism, and migration, Taiwanese firms had attempted to invest in China indirectly via the third country since 1990. Governments from both sides did not finalize the official agreements until 1992 and 1993. Before then, the cross-strait economic activities were ruled by temporary agreements, which started acquiring Taiwanese firms to register their FDI in China in 1991. With regard to FDI regulations, Taiwanese individuals and firms can invest in China but with a limit on maximum investment amounts.[4] In addition, FDI projects in specific high technologies were not allowed to invest in China. In the case of the semiconductor industry, for instance, the Taiwanese government only permitted IC foundry firms to invest in technology below 8-inch wafer fabrication. Hence, I employ the open of cross-strait FDI policy as a quasi-experiment to examine the effects of trade costs and agglomerations on FDI location choices in developing countries.

Even with these restrictions, Taiwanese FDI projects in China started growing rapidly. Figure 1 shows that China has become since 1993 the top Taiwanese outward FDI destination. In 2008, China accounted for more than 70 percent of the total amount of Taiwanese outward FDI. Moreover, over 80 percent of the amount of Taiwanese outward FDI is concentrated in Asia, while the share is around 15 percent in America and less than 1 percent in Europe.

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[4] For individuals, the investment can be up to 5 Million New Taiwan Dollars per year. For firms, the investment can be up to 60% of a firm's net capital.

3. Theoretical Model

In this paper, the theoretical framework used to analyse Taiwanese FDI location decisions in Chinese provinces is derived from Mayer et al.'s (2010) and Amiti and Javorcik (2008) models, which study the decision for a firm producing a differentiated good to open a new production facility abroad.

Firms are assumed to compete in a monopolistically competitive environment, with each firm producing a differentiated variety. All varieties of final goods enter symmetrically into the consumer's utility function and all varieties of intermediate inputs enter symmetrically in the firm's cost function.

To create a new plant abroad, a fixed cost occurs, expressed in unit of the numeraire good. Also, the fixed cost does not depend on the province chosen: F_j=F_{fdi}, j for all provinces. This assumption is useful when it comes to deriving a theoretically consistent equation to estimate the conditional location choice for investment abroad. This is feasible because the variation in fixed costs within one country should be smaller than across countries.

Once the fixed cost is paid, the firm can produce and sell goods through its new plant. The marginal cost is conditional on its location strategy. A firm f that has invested in province j incurs the following cost:

$$C_j(f) = v_j(f)\varepsilon_j(f) \tag{1}$$

where $v_j(f)\varepsilon_j(f)$ reflects the input costs utilized in production. The component $\varepsilon_j(f)$ is unobservable and will be the source of the residual term.

In the $v_j(f)$ component, four marginal production costs are considered. Firstly, factor cost, w_j, is equal to the wage level in province j. Secondly, $v_j(f)$ also depends on the costs of intermediate inputs that the foreign plant uses in production. Amiti and Javorcik (2008) hypothesize that firms' profits are positively related to better access to intermediate inputs, which are reflected in a lower intermediate input price index, Q_j. Assuming a number of varieties of intermediate inputs are aggregated by a constant elasticity substitution (CES) subutility function into a composite good, the intermediate inputs price index, Q_j, is defined as:

$$Q_j = \left[\sum_{i=1}^{J} n_i^u (p_i^u \tau_{ij})^{1-\sigma^u} \right]^{\frac{1}{1-\sigma^u}}$$

where n_i^u is the number of varieties of intermediate inputs in province i and p_i^u denotes the price of intermediate input in province i. σ^u is the constant elasticity of substitution of intermediate inputs and $\sigma^u > 1$. The trade cost, τ_{ij}, of shipping a good from province i to j is modeled as Samuelsonian iceberg costs, with $\tau \geq 1$. This means that a proportion of imported inputs, $1 - 1/\tau$, melt in transit. Hence, to deliver one unit of any good from one province to another τ unit must be shipped as only a fraction $1/\tau$ arrives. If $\tau = 1$, there is free trade, and if $\tau = \infty$, there is no trade. In the later empirical specification, I will proxy the intermediate inputs price index by two different supplier access variables, SA_j.

Furthermore, $v_j(f)$ also reflects the distance cost to home country, TC_j. This cost captures the fact that a firm may find it easier to operate in a location that is geographically proximate or culturally close. Since Taiwan shares the same language and culture as China, the distance cost can be the appropriate proxy for trade costs between Taiwan and province j. Finally, there may be some firm-specific information or technology difference across provinces in $v_j(f)$, denoted as A_j. A firm chooses to locate in the province where a large number of other firms from the same industrial group have already invested to benefit from lower costs there, all else being equal.

Each firm's mill price is given by profit maximization, which gives the usual marginal revenue equals marginal costs condition. Following Krugman and Venables (1996), price is a mark-up over marginal costs, denoted:

$$p_j(f) = \frac{\sigma}{\sigma - 1} C_j(f)$$

where firms treat the elasticity of substitution, σ, as if it were the price elasticity of demand.

Output of firm f in province j is sold to consumers (individuals and firms) located within province j and in other provinces within China. Since consumers have constant elasticity of substitution subutility function for each variety, the sales in province *i* by firm *f*'s affiliate located in province *j* are given by:

$$q_{ji}(f) = (p_j(f)\tau_{ji})^{-\sigma} P_i^{-1} E_i \qquad (2)$$
$$P_i = \sum_{r=1}^{R} n_r (\tau_{ri} p_{ri})^{1-\sigma}$$
$$E_i = \gamma Y_i + \mu n_i^d p_i^d q_i^d$$

where P_i is the delivered prices index from all possible product origins for province *i*. E_i denotes the expenditure in province *i* from individual consumers (a proportion γ of gross domestic product in province *i*) and downstream firms (a proportion μ of their total revenue, $n_i^d p_i^d q_i^d$, in province *i*).

Substituting the price with mark-up marginal costs, the quantity that a firm *f* producing in province *j* would deliver to each destination province *i*:

$$q_{ji}(f) = \frac{\sigma - 1}{\sigma G_i} (C_j(f)\tau_{ji})^{-\sigma} E_i \qquad (3)$$
$$G_i = \sum_{r=1}^{R} n_r (\tau_{ri} c_r)^{1-\sigma}$$

The gross profit earned in each destination province *i* for a firm *f* producing in province *j* is

$$\pi_{ji}(f) = (p_j(f) - C_j(f))\tau_{ji} q_{ji} = \frac{(C_j(f)\tau_{ji})^{1-\sigma}}{\sigma G_i} E_i \qquad (4)$$

The fraction multiplying E_i depends on the costs of the firm f relative to its competitors from all other provinces. In the numerator, the profits are decreasing if local (province *j*) production costs increase. Profits also increase if trade costs, τ_{ji}, to each province *i* are lower. The denominator contains the corresponding characteristics of other competitors from other provinces selling goods in province *i*. The elasticity of substitution, σ, captures the idea that competition is fiercer and profits are lower when σ is greater, i.e. varieties are less differentiated from each other.

Summing the gross profits earned in each province and subtracting the fixed costs F_{fdi}, the firm *f's* aggregate net profit to be earned in province *j* is given by:

$$\pi_j(f) = \frac{C_j(f)^{1-\sigma}}{\sigma}\sum_i \frac{\tau_{ji}^{1-\sigma}E_i}{G_i} - F_{fdi} = \frac{C_j(f)^{1-\sigma}}{\sigma}MA_j - F_{fdi} \quad (5)$$

$$MA_j = \sum_i \frac{\tau_{ji}^{1-\sigma}E_i}{G_i}$$

where MA_j is the market access that firm *f* can expect from an affiliate located in province *j*. Thus, the probability that firm *f* will choose among Chinese provinces to invest in province *j* can be written as:

$$\begin{aligned} \mathrm{P}_{\mathrm{j|fdi}}(f) &= \mathrm{P}\{\pi_j(f) > \pi_i(f), \forall\, i \neq j \in \mathrm{fdi}\} \quad (6)\\ &= \mathrm{P}\{C_j(f)^{1-\sigma}MA_j > C_i(f)^{1-\sigma}MA_i,, \forall\, i \neq j \in \mathrm{fdi}\}\\ &= \mathrm{P}\left\{\begin{aligned}(1-\sigma)\ln(\varepsilon_i(f)/\varepsilon_j(f)) &< (1-\sigma)\ln(v_j(f)/v_i(f))\\ &+ \ln MA_j/MA_i, \forall\, i \neq j \in \mathrm{fdi}\end{aligned}\right\} \end{aligned}$$

where $\varepsilon_j(f) \equiv (1\text{-}\sigma)\ln\varepsilon_j(f)$ is a measure of unobserved cost advantage of province *j* for firm *j*.

When a firm chooses its location, the only relevant information is the ordering of the profits. Invariant fixed costs do not affect the profit ordering of provinces and can therefore be omitted. The interpretation of equation (6) is that on the right-hand side (RHS) of the expression is the observed advantage of province *j*: higher market demand and lower production costs. On the left-hand side (LHS) is the unobserved relative attractiveness of province *i*. If the LHS is smaller than the RHS, firms choose province *j* rather than province *i*. In this model, the choice of a location conditional on the firm conducting FDI is a function of the provinces' relative access to relevant markets in terms of demand and their relative production costs.

4. Data

4.1 Independent variable: Taiwanese FDI in China

The Ministry of Economic Affairs (MOEA) in Taiwan, which is in charge of Taiwan's FDI registration, collects data on Taiwanese FDI projects. It provides total FDI amounts and number of FDI projects in Chinese provinces since 1991. In the early 1990s, although Taiwan was an open economy already, international capital inflows and outflows were still controlled or monitored by the government in order to maintain economic stability. FDI in China especially is under much more strict capital controls because of long-term political conflicts. Hence, I can argue that MOEA's FDI data accounts for in order to represent Taiwanese FDI outflows to China. MOEA data covers 27 provinces/regions[5] and 27 ISIC manufacturing industries for all FDI projects. Although full firm-level data is not available due to business security concerns, MOEA provides a list of Taiwanese public listed firms' affiliates in China, including the local address, investment status and products in China from 1991.

As mentioned in the previous section, the restriction on Taiwan's FDI policy in China was lifted after 1990, while China opened its market from 1979. Since there was no agglomeration of Taiwanese firms in China during the period between 1991 and 1993, to examine, without the agglomeration externality from home country firms, the impact of distance effect, market access and other agglomeration economies on location choices provides a quasi-experiment. Naturally, the second investing period (1994-1996) data is designed to investigate the relative change in the effects on these variables of interest. This second investing period is constructed over a short period in order to reduce the time-varying effects of technology shocks. There are 8,870 FDI projects in the first investing period and 1,526 in the second. It shows that China immediately becomes an attractive FDI host country right after the ban was lifted in 1991. Due to the unstable political relationship between Taiwan and China from 1995[6], the amount of outward FDI to China dropped dramatically in 1995 and 1996.

5 In the MOEA dataset, NW Regions include: Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

6 This is 1995–1996 Taiwan Strait Crisis. China government conducted a series of missile tests in the waters surrounding Taiwan from 21st of July, 1995 to 23rd of March, 1996.

Figure 2 illustrates the rapid growth trends in the amount of Taiwanese outward FDI in China according to Chinese Statistical Yearbooks. It is worth noticing that Taiwanese inward FDI in China in 1990 was not collected at the same statistical year, but was reported later in 1992 Chinese Statistical Yearbook. This is because the Chinese Statistical Yearbook started including Taiwan as a FDI source country in 1992 and also imputed the data of Taiwanese FDI value in 1990, which had been allocated in the "other countries" in the 1991's Chinese Statistical Yearbook. Also, the amount of 1990's Taiwanese FDI is quite small and is through the third country, which is difficult to distinguish the exact capital flow. Moreover, there is no industry and province level of Taiwanese FDI data in 1990. Given this data limitation from China Statistical Yearbook, since FDI data collected by Taiwan's government started from 1991, it is reasonable to choose 1991 as the first year of the cross-strait FDI liberalisation.

In Figure 1, before 1991, other Asian countries and the United States were the two major outward FDI destinations. From 1991, when Taiwanese firms were allowed to invest in China, China immediately became the leading outward FDI destination. In particular there was a dramatic increase in Taiwanese FDI projects around 1993, when Taiwan and China officially implemented the cross-strait economic activities agreements. At the same time, the Taiwanese government created a chance for firms that had already invested in China in 1991 and 1992 but not reported yet to re-register their FDI status. Hence, this was the first justification for the construction of the first-investing period group. Those firms, investing before 1993, had not observed any existing Taiwanese firms' clusters in China. Secondly, according to the report of the Chung-Hua Institution for Economic Research (2004), the period between 1991 and 1993 was considered the first investing period of Taiwanese FDI outflows to China. They concluded that there were three major directions in Taiwanese FDI: 1) firms were just starting to set up new plants across China, (2) the average investment amount was small (below one million dollars), and (3) FDI investors were mainly small-medium sized firms. Therefore it was reasonable to aggregate the FDI projects from 1991 to 1993 as the first-investing period group.

On the other hand, after 1991 the importance of Taiwanese FDI in China gradually increased. According to the China Foreign Economic Statistical

Yearbook, the top five leading investing countries with accumulative stock of realized FDI from 1979 to 1999 were Hong Kong (50.32%), USA (8.34%), Japan (8.09%), Taiwan (7.76%) and Singapore (4.82%). Figure 2 shows the relative importance of inward FDI in China. Hong Kong accounts for more than 50% of total FDI in China from 1990-1995, and Taiwan's FDI was in 2nd place in 1992 accounting for 10% of total China's inward FDI. This indicates that since Taiwanese's FDI is an important capital source in the early 1990s, it is worth assessing the location determinates of Taiwanese FDI's for regional FDI policy implications.

Figures 3 and 4 present the geographic distribution of Taiwanese FDI projects in China in 1990-1993 and 1994-1996. These figures indicate that Taiwanese FDI projects were highly concentrated in several Chinese provinces. Table 1 shows that, for all FDI projects, two major investment provinces, Guangdong and Fujian, which together accounted for 50% of FDI projects from 1991 to 1993. The next two popular locations were Shanghai and Jiangsu. These four locations together accounted for over 70% of all FDI projects between 1991 and 1993. On the other hand, for public listed firms, these four were the top FDI destinations, accounting for 72% of total projects, while Guangdong was at the top and Fujian in the fourth place. In 1994-1996, those four provinces were still the dominant FDI destinations for Taiwanese firms. In this paper, I finally cover 24 regions. This is because Xinjiang, Ningxia, Qinghai Gansu, and Shaanxi are geographically remote provinces and investments there are reported aggregately as the North West region. In addition, Tibet is excluded due to its particular political status.

Table 2 demonstrates the industrial distribution of FDI projects. For all project groups over all periods, the distribution of all FDI project is more even than the distribution of FDI projects of public listed firms. In the public listed firm categories, FDI projects are concentrated in foods, electric equipment, electronic equipment and components industries, which account for more than 50% of total projects. Since industrial characteristics may be correlated with market and supplier access and trade costs, in a later section I run regressions for separate industrial groups as a robustness check.

4.2 Market and supply access

The measure of market and supply access is the simplified version derived from Amiti and Javorcik (2008). Both market and supply accesses are highly dependent on trade costs. Both inter- and intra-provincial trade depends on internal trade costs such as freight charges and provincial border barriers. Due to data constraints, a function of distance is used as a proxy for trade costs. The simplest function is the inverse distance rule (Harris, 1954), which assumes that the exponent of distance is equal to -1.[7]

Supply access is constructed to capture the incentives for a firm in industry *s* to locate in province j: 1) share of province j's supply of intermediate goods relative to the rest of the China, ψ_{js} and 2) industry *s* use of intermediate inputs, α_{sk}. Since industries use more than one intermediate input, these output shares are weighted by $\alpha_{sk,}$ the coefficients from the China national input-output tables, provided by National Bureau of Statistics in China. The 1990 and 1992 input-output tables are used in 1991-1993 and 1994-1996 separately. The industrial output Y_{js} is obtained from the annual China Industry Economy Statistical Yearbook. Hence, the higher share of intermediate inputs produced in the relatively closer regions approximates to the lower intermediate price index. In the China input-output tables, there are only 16 manufacturing sectors for both 1990 and 1992. In order to be compatible with the input-output table, first, I mapped Taiwanese FDI industry code into two-digit International Standard Industrial Classifications (ISIC) Rev.4 using the concordance table provided by Taiwan's Directorate-General of Budget, Accounting and Statistics, Executive Yuan. Second, China's industrial output data form the China Industry and Economic Statistical Yearbook, is mapped with China input-output table. Finally, I match China input-output industry code with two-digit ISIC Rev. 4 using the industry description provided by National Bureau of Statistics. While there are 27 manufacturing sectors in the Taiwanese FDI data, the proxy for supply access is defined for 16 input-output sectors.[8]

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[7] I also applied different numbers to this discount parameter and used different distance measurements, such as rail distance. With these modifications, the results are consistent in general.

[8] The China INPUT-OUTPUT table codes industries in a broader classification. For example, the INPUT-OUTPUT table includes only chemical manufacturing, while the Taiwan FDI data includes chemical products and chemical materials.

Finally, the geographic distance between the capital cities of each Chinese province is used for D_{ij}. Since the territory of each province varies in China, following Mayor et al. (2010) idea, the intra-province distance, $D_{ii,}$ is calculated as the radius of the province area. I also construct the supply access with D_{ii} =1, which means zero trade costs within province. The two supply access measurements in 1990 and 1993 are highly and significantly correlated with 0.67 and 0.78 respectively[9]. Hence, considering the huge variation of the size of Chinese province (the standard deviation is 239,571.5), the radius intra-province distance is better to account for the ease of the access within province by controlling the impact of the size of the geographic unit. The detail of supply access is as following:

$$Supply\ Access_{sj} = \sum_{s=1}^{S} \alpha_{sk} \sum_{j=1}^{J} \phi_{js} \times D_{ij}^{-1}$$

$$\phi_{js} = \frac{Y_{js}}{Y_{China,s}} \text{ and } D_{ii} = \sqrt{Area_j / \pi}$$

Furthermore, I construct the supply access from Taiwanese firms for the second investing period. This is derived from Dabaere et al. (2010). Since the share of output of Taiwanese firms is unavailable, the number of accumulated FDI projects up to 1993, FDI_{js}, is used to approximate the number of active Taiwanese firms in industry s and in province j. This is further justified by the status of Taiwanese public listed firm' affiliates in China. In 1994, all affiliates established before 1993 were still operating.

$$Supply\ Access\_TWN_{sj} = \sum_{s=1}^{S} \alpha_{sk} \sum_{j=1}^{J} \theta_{js} \times D_{ij}^{-1}$$

$$\theta_{js} = \frac{FDI_{js}}{FDI_{China,s}}$$

[9] I construct market access with D_{ii} =1 and the correlations between two measurements in 1990 and 1993 are 0.57 and 0.53 respectively.

The measure of market access is analogous to that of supply access, in order to reflect the fact that firms can supply other firms and households on an intra- and inter-provincial basis. The market access is measured as following:

$$Market\ Access_{sj} = \sum_{s=1}^{S} \beta_{sk} \sum_{j=1}^{J} \phi_{js} \times D_{ij}^{-1} + \beta_c \sum_{j=1}^{J} \gamma_j \times D_{ij}^{-1}$$

$$\gamma_j = \frac{GDP_j}{GDP_{China}} \text{ and } \sum_{s=1}^{S} \beta_{sk} + \beta_c = 1$$

The share of industry *s*'s output produced in province j is weighted by β_{sk}, the proportion of industry *s*'s output sold to industry k as the intermediate input, and β_c is the proportion of final production sold for household consumption. β_{sk} and β_c are also calculated from the China input-output tables for 1990 and 1992. Thus, this measure is a proxy for the degree to which firms' revenue benefited from expenditure from the local and all other provinces. However, being close to a large market also leads to a competition effect, i.e., the lower the prices of substitute goods, the lower the demand for the firm's output. In this paper I assume that price competition is stable. In the early 1990s, China was just beginning to develop and a large portion of the market price was still controlled by the Chinese government.

4.3 Agglomeration externalities

Mayer et al. (2010) point out that investors tend to follow other foreign investors in the same industry. They provide two explanations for these agglomeration externalities: 1) there are spillovers across firms from the same industry, and 2) agglomeration may also be due to the fragmentation of production such that firms producing different parts of the same product will tend to locate in the same area in order to save transportation costs. Hence, for the first investing period (1991-1993), I measure this agglomeration using the total number of active Chinese firms in province j in manufacturing industry s in 1990. This data is from the China Industry Economy Statistical Yearbook, which provides the number of firms and amounts of output across industries. For the second investing period (1994-1996), besides the total agglomeration of firms, the agglomeration of

Taiwanese firms in the same industry s in province j is also included. This is approximated by the accumulated Taiwanese FDI projects, since data on existing Taiwanese firms in China is unavailable. This can be justified by the same reasoning as mentioned in the Taiwanese supply access section.

4.4 Provincial variables

Following the existing FDI location literature, the geographic distance is used to measure the distance effect between home and host destination. The distance between Taiwan and Chinese province j is calculated by using Google Earth. The variables in production costs at the provincial level include average worker and staff wages and share of electricity production, as a proxy for the electricity price, which are obtained from the annual China Statistical Yearbook. If a province has higher share of electricity production, the electricity supply in this province is better than others. To control for the impact of infrastructures on trade costs, I include the density of road and rail networks, as obtained from the China Statistical Yearbook. The high school attainment rate for ages over 7 is used to control for human qualities. Government policy incentive is also an important control variable in the literature. Here, I use the total number of special economic zones, open coastal cities and different kinds of national economic and development zone [10] in each province to approximate this policy effect. Furthermore, I include the number of state-owned firms as a proxy for the local market mechanism, i.e. the more state-owned firms, the higher the market rigidity. It is because most Chinese state-owned firms are not operating as profit-driven nor following market oriented entities. Empirical literature (DeCoster & Strange, 1993, and Amiti & Javorcik, 2008) also suggests that other foreign FDI projects in the same province could signal the location's attractiveness. Therefore, the total accumulated foreign stock is included in order to control for the investment environment. Finally, the dummy variable of coastal province is used to control for remaining unobserved geographical characteristics.

To eliminate simultaneity, the dependent variables used in the first investing period (1991-1993) are created from the 1990 data and 1993 data for the second investing period (1994-1996). The explanations for all variables can

[10] It includes: economic and technological development zones, high technology industry development zones, and others.

be found in Table 3. Table 4 shows the descriptive statistics for major variables of interest in 1990 and 1993 respectively. Also, the correlation matrix of all variables is included in the Appendix.

5. Empirical Specifications and Results

Conditional logit is used to estimate the effects of location determinants based on the equation (6). As demonstrated by McFadden (1973), assuming that $\varepsilon_j(f)$ is a Type-1 Extreme Value random error, the probability that the firm *f* will choose to invest in province *j* is equal to:

$$P_j = \frac{\exp(\alpha \ln v_j(f) + \beta \ln MA_j)}{\sum_j \exp(\alpha \ln v_j(f) + \beta \ln MA_j)} \tag{7}$$

Expressing the frequency of the province j being selected by Taiwanese firm as W_j (j=1…J), the probability of observing such FDI pattern is obtained as equation (8):

$$L = \Pi_{j=1} P_j W_j \tag{8}$$

The parameters α and β indicate the characteristics of potential host provinces to Taiwanese FDI are estimated by the maximum likelihood estimation method, which maximizes the likelihood function.

5.1 Baseline Results

Table 5 presents the main results from equation (7), which is derived from firm's profit function. In column (1), I replicate the specification from Amiti & Javorcik (2008) for the first investing period, focusing on the market and supply access without the distance variable. The results are generally in line with their findings: the estimates of both market and supply access variables are with the expected positive signs, while only the market access variable is statistically significant. Also, the sectoral agglomeration is positive and significant. The findings indicate that Taiwanese FDI tend to locate in the province with larger market and supply access as well as agglomeration from the same sector.

In columns (2) to (5), I run specifications based on equation (7) for the first investing period, 1991-1993. In column (2), I run the regression with the distance variable only. The estimate is statistically significant with the expected negative sign. This indicates that Taiwanese firms tend to choose locations closer to Taiwan to save the transaction, transport, and fixed-setup costs as the literature suggests (see Egger & Pfaffermayr, 2001, Mayer et al. 2010; etc.)

In column (3), market and supply access and sectoral agglomeration are included as well as the distance variable. All provincial control variables are included to eliminate the potential omitted variable biases. The results show that distance, market access and sectoral agglomeration are statistically significant with the expected signs. The decreasing magnitude of the distance variable is as expected. Since the bilateral distance between Taiwan and Chinese provinces might be correlated with the unobserved provincial characteristics such as the coastal provinces or the provinces with special economic zones, it might cause omitted variables bias on Taiwanese FDI location choices.

It is worth noting that the effect of supply access is negative and significant. Amiti and Javorcik (2008) also find if both market and supply access variables are included, in some specifications, estimates of one of them become insignificant. They suggest that these two variables might be highly correlated due to the way they are constructed. In this study, the correlation between the market and supply access is 0.66 with the significance at 1% level. Hence, following Amiti and Javorcik (2008), in columns (4) and (5), the specifications include either market or supply access variable. The estimate of market access remains significant with the positive sign in column (4), while the estimate of supply access is still negative but not significant in column (5). In the robustness check, I used the other market and supply access measurement with the zero trade costs (D_{ii}=1) intra-province distance. The estimated results are qualitatively consistent with signs and significance as the other measurement of market and supply access.

The estimated coefficients of sectoral agglomeration are consistently significant with the positive sign as indicated in the literature, such as Mayor and Head (2004) or Mayor et al. (2010). These results indicate that Taiwanese FDI tend to choose the location where the market is larger and has more firms from the same sector.

It is worth noting that supply access becomes negative in columns (3) and (5) after the distance variable is included. Mayor et al. (2010) argue that part of the distance effect correlated with the impact of supply access from the home country on FDI locations. In addition, *Surveys: Taiwanese Firms in China* (1993 and 1994), as reported by Taiwan's Chung-Hua Institution for Economic Research, provides extra supporting evidence. Taiwanese firms investing in China in 1993 or before relied on parent firms or other firms in Taiwan to provide equipment (70%), components (75%) and personnel (2.06%). Since the supply access does not include output share from Taiwan in this paper, the supply access of intermediate inputs from Taiwan can be captured by the distance variable.

According to Mayer et al. (2010), with variables of interest in natural log terms, as well as a large number of location choices, the estimated coefficients are close to the elasticity of the probability of average investors choosing a destination. However, there are only 24 locations in this study that this simple quantitative analysis cannot be applied here. Alternatively, based on Schmidheiny and Brülhart (2011)[11], I calculate the own-region elasticity, the percentage change in the expected number of firms in province j with respect to the percentage change in the variables of interest k, for each province. Since the predicted probability of P_j varies by provinces, I select two extreme provinces for the computation of elasticities: Guangdong, the largest province in terms of predicted probability of P_j, and Inner Mongolia, the smallest province in terms of the predicted probability with non-zero FDI projects.

Ccolumn (3) of Table 5 is used as the base specification and the elasticity of distance variable for Guangdong and Inner Mongolia province is calculated respectively. As for Guangdong province, a 10% decrease in the distance, proxy for the trade costs, increases the probability of attracting Taiwanese FDI projects by around 5.9%. On the other hand, as for Inner Mongolia, a 10% decrease in the distance increase the probability of Taiwanese FDI projects by 9.4%, which is close to the estimated coefficient of distance variable. Hence, this exercise indicates that in the conditional logit model with limited number of locations, the elasticity of variable of interest can be analysed as the range value across locations.

Columns (1) to (5) in Table 6 show the results in the second investing period, 1994-1996, when Taiwanese sectoral agglomeration and supply access

[11] Schmidheiny and Brülhart (2011) estimate the own region semi-elasticity: $\varepsilon_{jj}=(1-P_j)\beta_k$, where P_j is derived from equation (7)

exist for the first time. Specifications in column (1) and (2) are the replications of the specifications in column (2) and (3) of Table 5. The coefficients of distance variable in column (1) and (2) are close to those in the first period. Then, in column (3), I include the Taiwanese sectoral agglomeration variable to analyse its influence on other variables of interest. The estimate of Taiwanese sectoral agglomeration is statistically significant with the positive sign. This suggests that firms can gain extra nationality-specific benefits from being closer to the agglomeration of firms from the same country. Since Taiwanese firms faced different business regulations from other foreign countries during 1990s, such as those relating to a firm's registration or to license applications, the national-specific information spillovers can be gained from clustering with other Taiwanese firms.

Note the inclusion of Taiwanese sectoral agglomeration reduce the magnitude of all other variable of interests as shown in column (3). The estimates of distance and sectoral agglomeration variable are still significant with the expected signs. However, both market and supply access variables are not significant. This may indicate that the declining magnitude of these variables reflects the incremental impact of the sectoral agglomeration from the same country.

Furthermore, in columns (4) and (5), the variable of supply access from Taiwanese firms is also included. In both specifications, the estimates of supply access from Taiwanese firms are with the negative sign but not significant. These results, however, are in contrast to other national FDI studies, which suggest firms tend to choose the locations that are closer to the suppliers from the same countries. For example, Debaere et al. (2010) find that South Korean FDI locations in China are positively affected by the supply access from the same country in each province. Similar to total supply access, in early 1990s, Taiwanese affiliates in China still rely on the imports of intermediate inputs from Taiwan.

Quantitatively, I use the specification in column (3) in Table 6 as the base specification to calculate the elasticity of distance variable for the largest and smallest provinces in the second investing period: Guangdong and Guizhou. As for Guangdong province, the 10% decrease in the distance therefore increases the probability of attracting FDI projects by 6.3%, while by 7.8% for Guizhou. Hence, the range of elasticity value of distance variable is smaller than the first investing period after the inclusion of the Taiwanese sectoral agglomeration in the second period. It indicates that the influence of trade costs is decreasing once the new agglomeration effect kick in.

With regard to other production costs, the coefficients are significant only in the first investing period. In Table 5, the coefficients on electricity variable show the expected positive signs, while the positive and significant effect of wages is against the model expectation. Considering the positive and significant education variable, this may suggest that firms tend to locate in the provinces with better quality of labour force, i.e. higher wages. The coefficient of total foreign investments is positive and significant for both investing periods. This indicates that other foreign firms' locations could be the signals of where the good FDI locations in the early 1990s when China's market was still undeveloped. Moreover, the positive and significant estimates of coastal province dummy suggest that Taiwanese FDI tend to locate along the Chinese coast to either have better transportation accesses or be closer to Taiwan.

5.2 Taiwanese public listed firms' FDI

Since we cannot distinguish investors from individuals or firms in the total projects, this may cause worry about a sampling bias for firms' location choices. In practice, these individuals may be members of a firm's board or senior managers attempting to avoid the complicated registration process for a firm. These investments are highly related to firms' profits. Although we assume that FDI projects in the first investing period are green field investment, it is not known from the data whether FDI projects in the second investing period are green field or repeating investments. Location strategies may vary across green and brown field investments. In order to eliminate these concerns, the sub-sample constructed from the data on public listed firms' FDI projects is used for a sensitivity check. There are 130 and 143 green field FDI projects in the first and the second investing periods respectively.

Table 7 presents the results of variables of interest. Columns (1) to (3) report the results for the first investing period and columns (4) to (6) for the second period. First, the findings in columns (1) to (3) show that the estimates of the distance variable remain statistically significant with the expected negative sign. Also, the magnitude of coefficients is similar to the estimates in the first investing period in Table 5. The estimates of market and supply access variables are with the expected positive signs but not significant in column (2) and (3) respectively. The estimated coefficients of sectoral agglomeration are not significant but with the expected positive signs.

In columns (4) to (6), the results show that the magnitude of all variables of interest decreases in the second investing period. In comparison to Table 6, the magnitude of distance variable decreases more from -1.013 (column (1)) to – 0.632 (column (4)). Moreover, the estimates of sectoral agglomeration from the Taiwanese firms are statistically significant and positive. In short, the results in Table 7 suggest that two datasets are in general consistent.

6. Robustness Check

6.1 Coastal provinces

As found in Table 5 and 6, the coastal province dummy is significant and positive in both investing periods. It is worth considering whether firms' location decisions are driven by unobserved geographical effects from coastal provinces. The empirical literature suggests that FDI projects in the coastal provinces tend to benefit from the better access to the international market. Thus, I restrict the data to the coastal provinces only. The main idea is to check that within this choice set, which controls for the geographical fixed effect, the variables of interest are still significant with the expected signs.

Table 8 presents the results for all FDI project and public listed firms' FDI project in two investing periods. Columns (1) to (6) report the results for the first investing period and columns (7) to (12) for the second period. The coefficients of the distance variable and the sectoral agglomeration from Taiwanese firms are significant with the expected signs for both periods. Also, the change in the magnitude of the distance effect between two investing periods demonstrates the same trend as shown in Table 5 and 6. The coefficient of the regular sectoral agglomeration becomes insignificant but with the expected positive signs. It also shows the same trend in estimates' magnitude in Table 5 and 6. However, the coefficients on the market access and supply access variables are not consistent with the expected positive signs and in general not significant in both investing periods. This further implies that the distance might be correlated with the unobserved market and supply access from Taiwan that might have lowered the importance of provincial market and supply access even after control the coastal geographical characteristic.

6.2 Industrial specification

Since industrial characteristics may affect firms' location decisions, I allow for heterogeneity across industries by estimating variables of interest by industry in both investing periods. Table 9 shows the coefficients of these variables of interest for seven industry groups: Food and beverages, Textiles and clothing, woods and furniture, Chemicals, rubber and plastics, Mineral and metal products, Machinery and transport equipment, and Electric machinery and electronics.

The coefficients of the distance variable are in general negative and significant across industry groups for two periods. However, the magnitude of the effect varies across the groups. For example, it has no effect on Woods and Furniture industries in both investing periods, while the distance effect is greater and significant on Machinery and Transport Equipment or Electric Machinery and Electronics manufacturing locations. Besides, for agglomeration externalities variables, on the one hand, there also exist heterogeneous effects across industry groups for the sectoral agglomeration. The estimate for Mineral and Metal products is negative and significant in the first period. Also, the estimate for Textiles and clothing is significantly negative in the second period. On the other hand, for the agglomeration from Taiwanese firms, the estimated effects are in general positive and significant for most industry groups. However, the estimated effects become negative in the Food and Beverages and the Wood and Furniture groups but are not statistically significant. Finally, we observe the greater variation across industry groups on the estimates of market and supply access variables. It is even much more difficult to have consistent empirical predictions on both market and supply access effects. It is likely that the remaining unobserved industrial characteristics have impacts on FDI locations that are not controlled for in this study.

7. Conclusion

This paper examines the factors determining FDI location decisions by using Taiwanese FDI projects at Chinese provincial level during the period between 1991 and 1996. The theoretical model and empirical econometric specification are derived from the works of Mayer et al. (2010) and Amiti and Javorcik (2008), which are based on the new economic geographic model. The analyses focus on the effects of variables of interest not only on the market and on supply access or agglomeration externalities, but also on the distance effect. Most importantly, the innovation in this paper is its investigation of the relative magnitudes of change in the variables of interest in two FDI investing periods.

The findings indicate that the distance effect and the sectoral agglomeration along the national line have consistently significant impacts. Firms will choose to invest in foreign locations, which are closer to the home country and to a large agglomeration of firms from the same country. An average 10 percent decrease in the distance between Taiwan and a Chinese province will increase the probability of investment by around 9 percentage points. Also, a 10 percent increase in the sectoral agglomeration from Taiwanese firms increases the probability by about 3 percentage points. After introducing the sectoral agglomeration from Taiwanese firms at the second investing period, the declining magnitude in coefficients of other variables of interest is as expected. Since the Taiwanese FDI data relates to the period when China's market was at the early stage of development, firms may not have had good access to the final market or to suppliers of intermediate inputs. Hence, the distance effect and agglomeration externalities may be more dominant factors than market and supply access for the firms' FDI location decisions in China at this early stage.

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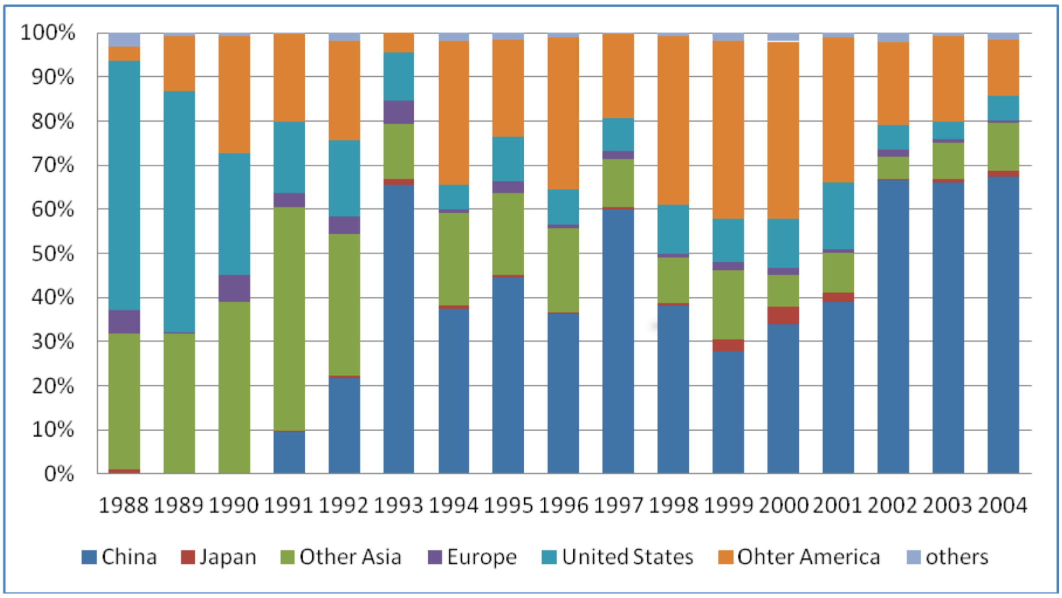
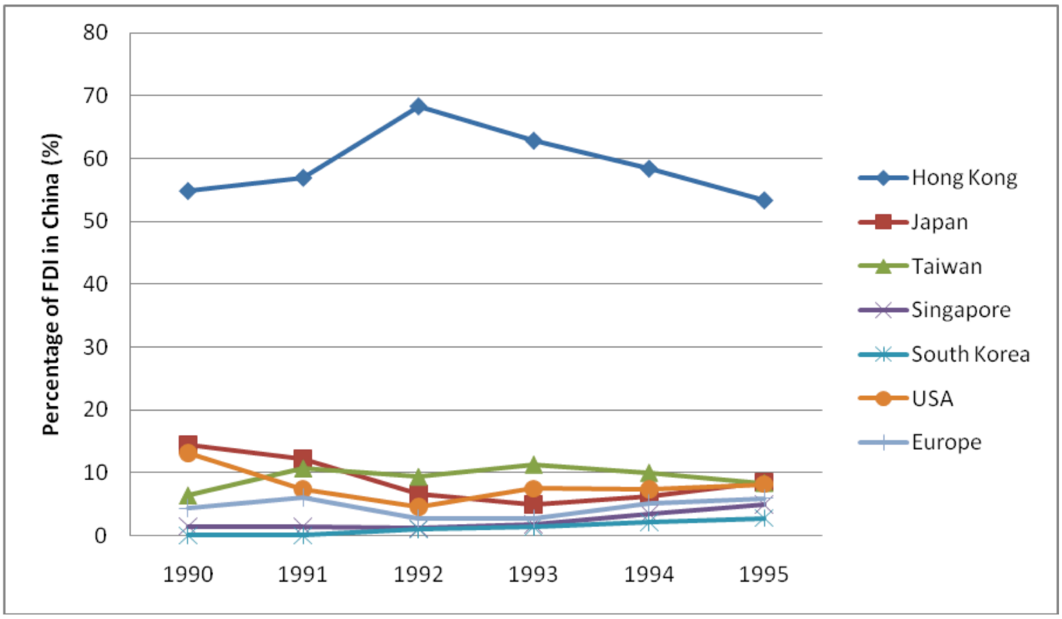


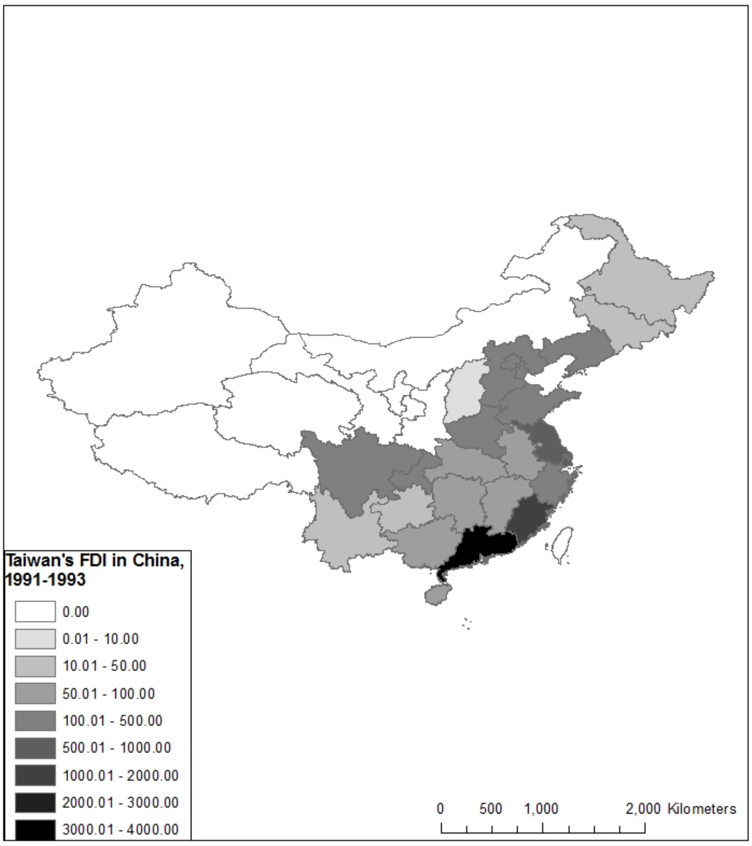
Source: MOEA, 2009

Figure 1 Share of Taiwanese Outward FDI in Major Countries/Regions, 1988-2004



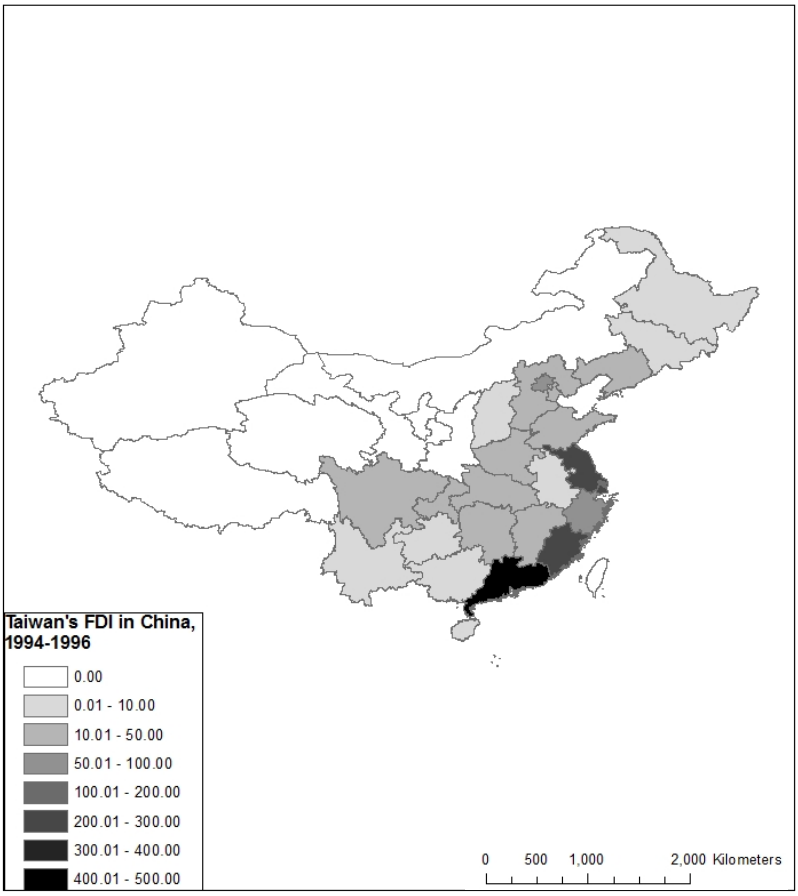
Source: China Statistic Yearbook, 1991-1996

Figure 2 Percentage of Inward FDI in China from Major Countries/Regions, 1990-1995



Source: MOEA, 2009

Figure 3 Taiwan's FDI projects in China, 1991-1993



Source: MOEA, 2009

Figure 4 Taiwan's FDI projects in China, 1994-1996

Table 1 Taiwanese FDI in China by province: 1991-1993, 1994-1996

All FDI cases				FDI of public listed firms			
Province	1991-93	1994-96	% of total cases 1991-1996	Province	1991-93	1994-96	% of total cases 1991-1996
Guangdong	3245	425	35.30%	Guangdong	38	41	28.94%
Fujian	1495	202	16.32%	Jiangsu	35	31	24.18%
Jiangsu	933	234	11.23%	Shanghai	13	27	14.65%
Shanghai	934	222	11.12%	Fujian	12	11	8.42%
Zhejiang	454	96	5.29%	Zhejiang	4	11	5.49%
Beijing	306	55	3.47%	Beijing	6	5	4.03%
Shandong	256	41	2.86%	Tianjin	4	7	4.03%
Tianjin	180	38	2.10%	Liaoning	2	3	1.83%
Liaoning	154	30	1.77%	Shandong	4	1	1.83%
Hebei	122	22	1.39%	Hubei	2	1	1.10%
Henan	121	18	1.34%	Sichuan	2	1	1.10%
Sichuan	116	19	1.30%	Hainan	1	1	0.73%
Hunan	78	38	1.12%	Hebei	1	1	0.73%
Hubei	81	23	1.00%	Jiangxi	1	1	0.73%
Hainan	81	4	0.82%	Anhui	1	0	0.37%
Jiangxi	74	11	0.82%	Guangxi	1	0	0.37%
Anhui	59	10	0.66%	Hunan	1	0	0.37%
Guangxi	53	7	0.58%	Inner Mongolia	1	0	0.37%
Heilongjiang	38	10	0.46%	Jilin	0	1	0.37%
Guizhou	30	6	0.35%	Yunnan	1	0	0.37%
Jilin	22	5	0.26%	Guizhou	0	0	0.00%
Yunnan	18	6	0.23%	Heilongjiang	0	0	0.00%
Inner Mongolia	10	3	0.13%	Henan	0	0	0.00%
Shanxi	10	1	0.11%	Shanxi	0	0	0.00%
Total	8870	1526	100%	Total	130	143	

Source: MOEA, 2010

Table 2 Taiwanese FDI in China by industry: 1991-1993, 1994-1996

All FDI cases				FDI of public listed firms			
Province	1991-93	1994-96	% of total cases 1991-96	Province	1991-93	1994-96	% of total cases 1991-1996
Manufacturing Not Classified Elsewhere	1047	98	11.01%	Electrical Equipment	18	20	13.92%
Food	716	110	7.95%	Computers, Electronic and Optical Products	19	18	13.55%
Electrical Equipment	654	143	7.67%	Food	22	14	13.19%
Leather, Fur and Allied Products	743	49	7.62%	Electronic Parts and Components	15	13	10.26%
Fabricated Metal Products	643	128	7.42%	Machinery and Equipment	3	11	5.13%
Plastic Products	652	113	7.36%	Basic Metal	5	6	4.03%
Apparel and Clothing Accessories	624	58	6.56%	Manufacturing Not Classified Elsewhere	6	5	4.03%
Computers, Electronic and Optical Products	493	106	5.76%	Plastic Products	3	8	4.03%
Non-metallic Mineral Products	431	67	4.79%	Other Transport Equipment	2	8	3.66%
Chemical Products	384	67	4.34%	Fabricated Metal Products	4	5	3.30%
Textile Mills	344	73	4.01%	Apparel and Clothing Accessories	5	3	2.93%
Machinery and Equipment	312	101	3.97%	Non-metallic Mineral Products	1	6	2.56%
Electronic Parts and Components	295	75	3.56%	Beverages	1	5	2.20%
Wood and Bamboo Products	285	29	3.02%	Textile Mills	6	0	2.20%
Other Transport Equipment	199	61	2.50%	Pulp, Paper and Paper Products	4	2	2.20%
Chemical Materials	162	60	2.14%	Chemical Products	0	6	2.20%
Pulp, Paper and Paper Products	183	35	2.10%	Rubber Products	5	1	2.20%
Basic Metal Manufacturing	142	33	1.68%	Medical Goods	2	3	1.83%
Rubber Products	108	26	1.29%	Leather, Fur and Allied Products	3	1	1.47%
Beverages	108	21	1.24%	Petroleum and Coal Products	2	2	1.47%
Motor Vehicles and Parts	98	31	1.24%	Motor Vehicles and Parts	0	4	1.47%
Furniture	88	18	1.02%	Chemical Materials	3	1	1.47%
Printing and Reproduction of Recorded Media	79	12	0.88%	Printing and Reproduction of Recorded Media	1	0	0.37%
Medical Goods	50	12	0.60%	Furniture	0	1	0.37%
Petroleum and Coal Products	30	0	0.29%	Wood and Bamboo Products	0	0	0.00%
Total	8870	1526	100%	Total	130	143	

Source: MOEA, 2010

Table 3: Explanation of Variables

Variables	Explanation	Note
Independent variable		
FDI Choice	Firm location choice of industry i in province j	Choice=1 if province j is chosen, choice=0 otherwise
Variables of interest		
Ln distance	ln of distance between Taiwan and province j	Transaction cost of setting up foreign affiliate
Ln market access	Market access of industry i in province j	For 1991-1993 dataset, market access is measured by 1990 data; for 1994-1996 dataset, 1993 data is used
Ln supply access	Supply access of industry i in province j	For 1991-1993 dataset, market access is measured by 1990 data; for 1994-1996 dataset, 1993 data is used
Ln supply access_TWN	Supply access from Taiwan FDI in industry i in province j	Estimated by accumulated Taiwan FDI projects from 1991 to 1993
Ln sectoral agglomeration	# of firms from all countries in industry i in province j	Agglomeration externality
Ln sectoral agglomeration_TWN	Accumulated Taiwan FDI projects from 1991 to 1993 in industry i in province j	Agglomeration externality from same country
Ln wage	Average annual wage of staff and workers in province j	Proxy for marginal production costs
Ln electricity	Share of provincial electricity supply over all China	Proxy for marginal production costs
Provincial control variable		
Ln # stateowned firms	Number of state-owned industrial firms in province j	Control for local endowment
Ln road density	Density of road network in province j	Control for infrastructure issue
Ln rail density	Density of rail network in province j	Control for infrastructure issue
Special economic zones	number of special economic zones, open coastal cities or economic development zones in province j	Control for policy issues
Coastal province	Dummy for coastal provinces	Control for regional effects, D=1 if coastal province, D=0 otherwise
Ln total FDI amount	Stock of Direct Foreign Investment in province j	Proxy for local investment environment
Ln high school ratio	High school attainment ratio in province j	Control for quality of human capital

Table 4: Summary Statistics of Main Variables

	Mean	Std. Dev.	Min	Max
Ln Distance	7.18632	0.517042	5.545021	8.019968
Year=1990				
Ln market access	-6.629141	.3948747	-7.867387	-5.491856
Ln supply access	-7.345473	.5868373	-9.557065	-5.929672
Ln sectoral agglomeration	5.734242	1.413269	0	8.607947
Ln wages	7.635417	.1304795	7.46	7.98
Ln electricity	-3.366815	.7310057	-6.010649	-2.545697
Year=1993				
Ln market access	-6.615524	.376703	-7.314721	-5.559536
Ln supply access	-7.48668	9402439	-9.699134	-5.27539
Ln sectoral agglomeration	5.989487	1.166451	0	8.516593
Ln supply access_TWN	-7.50194	.9554263	-9.917586	5.172994
Ln sectoral agglomeration_TWN	1.920397	1.506287	0	6.196444
Ln wages	8.052083	.1944457	7.78	8.58
Ln electricity	-3.35517	.6908996	-5.741936	-2.533417

Source: China Statistic Yearbook, China Industry Economy Statistical Yearbook, 1991-1997

Table 5 Conditional logit: All Taiwanese FDI projects in China, 1991-1993

	Dependent variable: FDI choice				
	1991-1993 (1)	1991-1993 (2)	1991-1993 (3)	1991-1993 (4)	1991-1993 (5)
Ln distance		-1.309***	-0.939***	-0.907***	-0.949***
		(.0126)	(0.039)	(0.039)	(0.039)
Ln market access	0.673***		1.081***	0.184*	
	(0.233)		(0.225)	(0.096)	
Ln supply access	0.144		-0.946***		-0.049
	(0.217)		(0.210)		(0.093)
Ln sectoral agglomeration	0.423***		0.468***	0.467***	0.484***
	(0.024)		(0.026)	(0.026)	(0.026)
Ln wages	0.994***		2.24***	2.359***	2.255***
	(0.261)		(0.227)	(0.225)	(0.225)
Ln electricity	-1.086***		0.503***	0.431***	0.572***
	(0.119)		(0.110)	(0.110)	(0.110)
Ln road density	1.302***		0.716***	0.641***	0.822***
	(0.190)		(0.142)	(0.140)	(0.141)
Ln fixed-line density	-0.329***		-0.646***	-0.642***	-0.674***
	(0.065)		(0.065)	(0.064)	(0.064)
Special economic zones	-0.101		-0.125	-0.175	-0.097
	(0.126)		(0.112)	(0.111)	(0.112)
Coastal provinces	0.221*		0.422***	0.379***	0.439***
	(0.124)		(0.121)	(0.120)	(0.123)
Ln total FDI amount	0.623***		0.235***	0.277***	0.2***
	(0.066)		(0.042)	(0.041)	(0.041)
Ln # state-owned firms	1.363***		-0.711***	-0.671***	-0.772***
	(0.150)		(0.151)	(0.153)	(0.151)
Ln high school ratio	-0.773***		0.459***	0.355***	0.542***
	(0.126)		(0.131)	(0.126)	(0.132)
FDI case* provinces	212880	212880	212880	212880	212880
FDI case	8870	8870	8870	8870	8870
Pseudo R^2	0.3103	0.1062	0.323	0.3227	0.3227

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%
All independent variables used in 1991-1993 are from 1990; variables used in 1994-1996 are from 1993

Table 6 Conditional logit: All Taiwanese FDI projects in China, 1994-1996

	Dependent variable: FDI choice				
	1994-1996	1994-1996	1994-1996	1994-1996	1994-1996
	(1)	(2)	(3)	(4)	(5)
Ln distance	-1.234***	-0.968***	-0.783***	-0.815***	-0.826***
	(0.0292)	(0.114)	(0.118)	(0.134)	(0.135)
Ln market access		-0.741	-0.799	-0.782	-0.092
		(0.711)	(0.725)	(0.725)	(0.263)
Ln supply access		0.452	0.651	0.741	
		(0.697)	(0.712)	(0.733)	
Ln sectoral agglomeration		0.441***	0.303***	0.295***	0.312***
		(0.0633)	(0.066)	(0.068)	(0.066)
Ln sectoral agglomeration_TWN			0.312***	0.317***	0.313***
			(0.040)	(0.041)	(0.041)
Ln supply access_TWN				-0.135	-0.073
				(0.248)	(0.240)
Ln wages		0.616*	0.278	0.345	0.344
		(0.341)	(0.383)	(0.414)	(0.416)
Ln electricity		0.519**	0.12	0.118	0.129
		(0.202)	(0.218)	(0.217)	(0.216)
Ln road density		0.614***	0.249	0.267	0.266
		(0.215)	(0.212)	(0.211)	(0.211)
Ln fixed-line density		-0.358**	-0.205	-0.216	-0.211
		(0.147)	(0.156)	(0.156)	(0.156)
Special economic zones		-0.297	-0.2	-0.207	-0.212
		(0.183)	(0.179)	(0.179)	(0.180)
Coastal provinces		0.323	0.432**	0.424**	0.449**
		(0.197)	(0.201)	(0.202)	(0.201)
Ln total FDI amount		0.433***	0.262**	0.259*	0.253*
		(0.128)	(0.132)	(0.133)	(0.132)
Ln # state-owned firms		-0.2	0.398	0.407	0.39
		(0.316)	(0.348)	(0.347)	(0.347)
Ln high school ratio		0.995***	0.867***	0.857***	0.886***
		(0.293)	(0.303)	(0.306)	(0.305)
FDI case* provinces	36624	36624	36624	36624	36624
FDI case	1526	1526	1526	1526	1526
Pseudo R^2	0.0924	0.2721	0.2776	0.2776	0.2775

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%
All independent variables used in 1991-1993 are from 1990; variables used in 1994-1996 are from 1993

Table 7 Conditional logit: Taiwanese public listed firms FDI projects in China, 1991-1993 and 1994-1996

	Dependent variable: FDI choice					
	1991-1993 (1)	1991-1993 (2)	1991-1993 (3)	1994-1996 (4)	1994-1996 (5)	1994-1996 (6)
Ln distance	-1.013*** (0.325)	-1.056*** (0.319)	-0.996*** (0.323)	-0.632* (0.357)	-0.693* (0.380)	-0.657* (0.382)
Ln market access	-1.907 (2.402)	0.699 (0.930)		2.707 (3.044)	2.792 (3.040)	1.077 (0.930)
Ln supply access	2.575 (2.150)		0.966 (0.768)	-1.854 (2.921)	-1.731 (2.966)	
Ln sectoral agglomeration	0.385 (0.254)	0.41 (0.251)	0.374 (0.250)	0.149 (0.200)	0.133 (0.217)	0.098 (0.205)
Ln sectoral agglomeration_TWN				0.373*** (0.136)	0.383*** (0.139)	0.388*** (0.140)
Ln supply access_TWN					-0.257 (0.800)	-0.326 (0.789)
Provincial control variables	Yes	Yes	Yes	Yes	Yes	Yes
FDI case*provinces	3120	3120	3120	3432	3432	3432
FDI case	130	130	130	143	143	143
Pseudo R^2	0.3188	0.3169	0.3179	0.3498	0.3499	0.3494

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%
All independent variables used in 1991-1993 are from 1990; variables used in 1994-1996 are from 1993

Table 8 Taiwanese FDI: within Chinese Coastal Provinces

Dependent variable: FDI choice						
1991-1993	All			Public listed		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln distance	-1.381***	-1.222***	-1.416***	-2.048***	-2.104***	-1.681***
	(0.064)	(0.060)	(0.061)	(0.613)	(0.603)	(0.572)
Ln market access	0.429*	-0.752***		-4.348	-2.532	
	(0.254)	(0.198)		(3.046)	(1.808)	
Ln supply access	-1.69***		-1.44***	1.887		-0.674
	(0.227)		(0.176)	(2.374)		(1.445)
Ln sectoral agglomeration	0.547***	0.529***	0.563***	0.679**	0.687**	0.496*
	(0.031)	(0.032)	(0.030)	(0.319)	(0.313)	(0.288)
Other provincial control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	8213	8213	8213	121	121	121
1994-1996	All			Public listed		
	(7)	(8)	(9)	(10)	(11)	(12)
Ln distance	-1.066***	-1.043***	-1.06***	-1.963***	-1.915***	-1.661**
	(0.199)	(0.199)	(0.197)	(0.676)	(0.667)	(0.656)
Ln market access	-1.072	-1.101	-0.806**	4.642	4.485	-0.483
	(0.811)	(0.812)	(0.363)	(3.157)	(3.172)	(1.120)
Ln supply access	0.563	0.338		-4.91*	-5.167*	
	(0.791)	(0.830)		(2.978)	(3.059)	
Ln sectoral agglomeration	0.12	0.131	0.137*	-0.003	0.019	-0.069
	(0.080)	(0.080)	(0.079)	(0.259)	(0.262)	(0.248)
Ln sectoral agglomeration_TWN	0.48***	0.467***	0.464***	0.383**	0.362**	0.378**
	(0.054)	(0.055)	(0.055)	(0.159)	(0.165)	(0.169)
Ln supply access_TWN		0.27	0.305		0.45	0.226
		(0.296)	(0.282)		(0.826)	(0.812)
Other provincial control variables	Yes	Yes	Yes	Yes	Yes	Yes
N	1376	1376	1376	138	138	138

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%
All independent variables used in 1991-1993 are from 1990; variables used in 1994-1996 are from 1993

Table 9 Taiwanese FDI in China by industry

Dependent variable: Chinese province chosen

1991-1993	Food and beverages	Textiles and clothing	Wood and furniture	Chemicals, rubber and plastics	Mineral and metal products	Machinery and transport equipment	Electric machinery and electronics
Ln distance	-0.844***	-1.41***	-0.271	-1.083***	-1.07***	-0.892***	-0.838***
	(0.116)	(0.134)	(0.168)	(0.110)	(0.112)	(0.171)	(0.118)
Ln sectoral agglomeration	0.682***	0.741***	0.396***	0.398***	-0.207**	0.406**	0.674***
	(0.193)	(0.138)	(0.148)	(0.088)	(0.092)	(0.183)	(0.087)
Ln market access	-2.66	-3.16***	-14.47***	-0.174	-1.601	10.116***	6.753***
	(2.408)	(0.929)	(3.949)	(6.837)	(1.108)	(3.321)	(1.539)
Ln supply access	2.422	2.738***	12.328***	1.054	1.69	-9.536***	-5.723***
	(2.255)	(0.744)	(3.797)	(7.072)	(1.148)	(3.275)	(1.501)
N	824	968	373	1306	1216	609	1442
1994-1996	**Food and beverages**	**Textiles and clothing**	**Wood and furniture**	**Chemicals, rubber and plastics**	**Mineral and metal products**	**Machinery and transport equipment**	**Electric machinery and electronics**
Ln distance	-0.865**	0.04	-2.036	-0.851***	-0.932**	-2.057***	-0.904***
	(0.408)	(0.474)	(1.618)	(0.122)	(0.367)	(0.766)	(0.323)
Ln sectoral agglomeration_TWN	-0.136	0.776***	-0.196	0.324***	0.35**	0.196**	0.346***
	(0.204)	(0.245)	(0.306)	(0.040)	(0.153)	(0.096)	(0.123)
Ln sectoral agglomeration	0.849**	-0.671*	0.52	0.276***	0.072	1.841***	0.387***
	(0.398)	(0.366)	(0.631)	(0.068)	(0.145)	(0.502)	(0.149)
Ln market access	-11.679**	-1.313	-15.015	-0.82	-10.7**	6.856*	-4.452
	(5.498)	(2.145)	(15.012)	(0.737)	(4.586)	(3.663)	(4.628)
Ln supply access	9.122*	2.632	14.298	0.589	11.464**	-8.156**	3.511
	(4.779)	(2.005)	(14.276)	(0.730)	(4.694)	(3.793)	(4.101)
N	131	131	47	1451	228	193	324

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%
All independent variables used in 1991-1993 are from 1990; variables used in 1994-1996 are from 1993

Appendix 1-1 Correlation of variables, 1991-1993

	Ln distance	Ln market access	Ln supply access	Ln sectoral agglomeration	Ln wages	Ln electricity	Ln road density	Ln fixed-line density	Special economic zones	D_coastal provinces	Ln total FDI amount	Ln # state-owned firms	Ln high school ratio
Ln distance	1												
Ln market access	-0.4286	1											
Ln supply access	-0.2407	0.5466	1										
Ln sectoral agglomeration	-0.2114	0.3375	-0.1221	1									
Ln wages	-0.1512	0.2588	0.1493	0.0975	1								
Ln electricity	-0.023	0.3128	0.1792	0.5462	0.0865	1							
Ln road density	-0.4222	0.4974	0.2787	0.0925	0.5646	-0.1079	1						
Ln fixed-line density	0.1512	0.5357	0.3094	0.0398	0.3424	0.0765	0.5387	1					
Special economic zones	-0.4638	0.2429	0.1374	0.24	0.5612	0.1072	0.3865	-0.1089	1				
D_coastal provinces	-0.3105	0.3492	0.1997	0.1086	0.6227	-0.0747	0.5766	0.2965	0.8307	1			
Ln total FDI amount	-0.3573	0.2945	0.1683	0.2258	0.6724	0.0947	0.7697	0.3309	0.7335	0.7852	1		
Ln # state-owned firms	-0.1701	0.1803	0.102	0.5474	-0.1063	0.8914	-0.1792	-0.1949	0.0715	-0.2169	0.0138	1	
Ln high school ratio	0.1489	0.3426	0.2017	-0.0144	0.4831	-0.0566	0.3278	0.7021	0.1198	0.4053	0.3994	-0.3038	1

Appendix 1-2 Correlation of variables, 1994-1996

	Ln distance	Ln market access	Ln supply access	Ln sectoral agglomeration	Ln sectoral agglomeration_TWN	Ln supply access_TWN	Ln wages	Ln electricity	Ln road density	Ln fixed-line density	Special economic zones	D_coastal provinces	Ln total FDI amount	Ln # state-owned firms	Ln high school ratio
Ln distance	1														
Ln market access	-0.5158	1													
Ln supply access	-0.2274	0.429	1												
Ln sectoral agglomeration	-0.2121	0.3781	-0.0318	1											
Ln sectoral agglomeration_TWN	-0.5157	0.4498	0.1679	0.3454	1										
Ln supply access_TWN	-0.3392	0.4159	0.9795	-0.0704	0.2307	1									
Ln wages	-0.2132	0.3399	0.1573	0.0829	0.5036	0.2716	1								
Ln electricity	-0.0008	0.2568	0.1023	0.537	0.2732	0.0408	-0.0534	1							
Ln road density	-0.4189	0.5355	0.2356	0.1177	0.5236	0.2797	0.6257	-0.0964	1						
Ln fixed-line density	-0.1516	0.0046	0.1979	0.0575	0.0867	0.1058	0.2626	-0.009	0.5484	1					
Special economic zones	-0.4816	0.1894	0.0916	0.3375	0.652	0.1538	0.4384	0.2949	0.3788	-0.1393	1				
D_coastal provinces	-0.3105	0.3725	0.1724	0.1396	0.5213	0.2132	0.6879	-0.0636	0.5956	0.2999	0.6329	1			
Ln total FDI amount	-0.5407	0.392	0.1794	0.3328	0.7145	0.2479	0.6217	0.198	0.5873	0.0598	0.8757	0.7635	1		
Ln # state-owned firms	-0.091	0.2608	0.1061	0.5718	0.3094	0.0654	-0.0141	0.8707	0.0043	-0.0397	0.2982	-0.0327	0.3357	1	
Ln high school ratio	0.128	0.2824	0.1286	-0.0025	0.1951	0.0859	0.4759	-0.1072	0.3025	0.6387	0.1223	0.3815	0.3164	-0.0876	1

CHAPTER 2

DOES THE DISTANCE MATTER? THE EFFECT OF CHANGE IN TRADE COSTS ON FDI LOCATIONS

1. Introduction

Trade costs play an essential role in the new economy geography (NEG) models. Without these costs, there is no role for geography. Take Puga's (1999) NEG model for example; he pointed out that trade costs should be interpreted as a package, including not only physical transport costs but also informational, sales and support complications involved in doing business at a distance. Though this simplified model provides analytical insights, its uni-dimensional geography structure is far from real world. First of all, regions are related to each other by a more complicated geographical structure. Bosker et al. (2010) point out that while current NEG empirical studies in multi-countries or multi-regions settings have applied bilateral distances between regions or controlled tariff or border effects in trade costs, their attempts to answer questions like "where on the bell (tomahawk) are we?" still rely on the uni-dimensional NEG model. This might create misleading interpretations of estimated parameters. Since the development of an analytically solvable version of an NEG model with a multi-dimensional geographical structure faces mathematical difficulties (Bosker et al. 2010), in this chapter, I aim at providing solid empirical evidence on the impact of the change in trade costs in the multi-regional framework.

I use a quasi-experiment to circumvent these modelling difficulties on empirical studies: the implementation of Taiwan's cross-strait direct flight policy in 2008. Up to this point, owing to historical political conflicts between Taiwan and China, there were neither direct air nor ocean transportation for passengers and shipments across the Taiwan Strait since 1949. The very first commercial cross-strait direct flight routes between Taiwan and five Chinese provinces started in 2008. This breakthrough negotiation on cross-strait transportation policy happened after the pro-China party candidate won the presidential election in early 2008. Very soon, there were direct flights to and from Taiwan and twenty-five of China's thirty-one provinces in 2011. Hence, direct air transportation between Taiwan and China provides an exogenous and immediate reduction in travelling and shipping costs. The average passenger's air travel time is reduced by around 160 minutes. It takes only one and a half hours from Taipei to

Shanghai with a direct flight, while an indirect one (usually via Hong Kong) can take at least five hours.

I use the geographical distance between Taiwan and Chinese provinces as the treatment in a difference-in-difference identification strategy. This is to investigate the impact of relative change in trade costs across provinces on Taiwanese public listed firms' FDI locations between 2002 and 2011. The change in trade costs arises from the implementation of a new transportation mode, and I argue that this change in trade costs is an exogenous shock on Taiwanese FDI activities. Hence, in combination with panel data on Taiwanese FDI projects, I can use difference-in-difference estimation to investigate the casual effect of the change in trade costs on FDI locations. By exploiting the variation of the distance effect before and after this exogenous policy shock across provinces and time, the potential omitted variables bias resulting from the unobservable provincial characteristics can be eliminated [12]. Also, non-tariff barriers such as language or culture are minimized because Taiwanese firms share the same Chinese origin. The econometric specifications further control for observable time varying provincial and industrial characteristics and the unobservable provincial and industry-time fixed effects. The results indicate that after the shock, firms choose to establish Chinese affiliates further away from Taiwan. Hence, the direct empirical evidence on the dispersion of Taiwanese FDI locations is generally consistent with the NEG prediction in the inter-region labour framework with limited local labour mobility[13].

Even though trade costs are of theoretical importance, the empirical specification of trade costs either in trade or NEG literature is far from being direct and quantifiable. Bilateral distance is commonly used as a proxy for trade costs. The inverse distance is employed as a discount factor to measure region or country market access (Redding and Veneables, 2004; Amiti and Javorcik, 2008). Distance is also an important determinant of transport costs of goods shipments (Hummels, 2007). Moreover, in Mayer et.al (2010), transaction costs, which are approximated by bilateral distances, languages and law origins, can be taken as

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[12] I have to assume that there are no specific and exogenous shocks on trade costs among each province pairs. If the unobserved variation in these trade costs is with a time trend or industrial specific, they can be controlled by including industry-year fixed effects. I also include the time variant provincial variable of transportation infrastructure to control the regional trade costs. In the robustness check, I will estimate the within region variation to justify this assumption.

[13] Since China's "HuKou" (resident registration) system remains in force to prevent rural labour from immigrating to cities, there is still no full labour mobility across Chinese provinces.

one of the determinants of firms' choice of location. Fujita and Mori (2005) summarized that it is important to distinguish the two different types of impediment to trade in space, i.e. transport costs for goods, and communication costs for doing business over space.

This chapter is to my knowledge the first in trade and NEG literature to disentangle the distance effect on FDI locations by identifying the transport and transaction cost channels. I create two intensity indices on the base of the trade literature to investigate the relative effect of these two channels across industries: contract intensity and unit value intensity. As for the transaction costs channel, if an industry with more relationship-specific investments (high contract intensity) experiences higher face-to-face communication costs (Cristea, 2011), it will pay relatively higher transaction costs than others as the distance between home and host FDI destination increases. As for the transport costs channel, if an industry has a higher value-weight ratio (high unit value) on shipments, the share of premium ad-valorem air shipping costs will be lower than the ones with lower unit value. (Hummels and Schaur, 2013). Hence, the industries with higher unit value can afford to ship more goods to further distant regions/countries than those with lower unit values. My findings indicate that for new FDI projects, firms in a high contract intensive (more relationship-specific investment) industry will tend to invest closer to the home country to save transaction costs. On the other hand, firms in a high unit value intensive industry will invest relatively more in the distant locations than ones in the low unit value industry because of the relative advantage on transport costs.

Furthermore, I examine the impact of flight liberation on FDI locations through the transaction and transport costs channel. After the direct flight shock, as the trade costs decrease, the dispersion of FDI locations is expected to occur through the transaction costs channel. Firms with higher contract intensity will tend to locate in the more distant destinations than those with lower contract intensity. On the other hand, as the trade costs decrease, the reduction in the share of premium ad-valorem air shipping costs is higher in the relative low unit value industry than high ones. Hence, the firm with lower unit value will marginally benefit more than the one with higher unit value and will tend to invest relative more in the distant destinations after the reduction in trade costs. The findings show that the estimates of interaction term variables in transaction costs channel are with the predicted positive signs but not significant. As for the transport costs channel, the results are statistically significant with expected negative signs. It indicates that firms in the relatively high unit value intensive industries will choose to invest in relative closer locations than relative low intensive ones because of the reduction in the share of premium ad-valorem air shipping costs.

What are the implications of this paper for today's FDI location decisions, when air transportation is common and becoming cheaper and cheaper? The flight liberalisation across the Taiwan Strait provides a quasi-experiment to investigate how the multinational firms have responded to the change in trade costs on their FDI location choices. My findings can provide policy implications for local governments to boost the FDI inflow. For instance, the improvements in the transportation network and custom service will further reduce trade costs.

The paper is organised as follows: Section 2 provides a discussion of the importance of air transportation and the historical background of cross-strait direct flight policy, while Section 3 outlines the conceptual framework. Section 4 describes the data used in the analysis. Section 5 presents the empirical strategy and baseline results. Section 6 reports additional robustness checks. Section 7 offers concluding remarks.

2. Background

2.1 The importance of air transportation

Given Taiwan's geographic condition, air and ocean transportations are the only methods for people and firms to travel or export/import goods globally. Historically, from a passenger perspective, because of the constraints of Taiwan's harbours and the weather conditions, air transportation is dominant for international passenger travelling to and from Taiwan. Figure 1 shows that the number of international air passengers is far higher than ocean passenger numbers. Besides, the rough wave condition across the Taiwan Strait limits the development of passengers' sea transportation. Figure 1 demonstrates the fact that air transportation remains the dominant mode for the cross-strait transportation.

For goods shipments, air and ocean transportations are equivalently important for Taiwan's exporting and importing industries, and in general they share similar growth trends as shown in Figure 2. After the restrictions of direct shipments to and from China are lifted in 2008, the air shipments not only enjoyed a higher growth rate than ocean shipments, but also gradually had a higher share of total shipments (see Figure 2).

I provide the summarized data on exports and imports as well as the air shipments data in 2007 to draw a broad picture about the potential impact of air transportation on the cross-strait economic activities. The 2006 industry census, conducted by Taiwan's Directorate General of Budget, Accounting and Statistics, shows that the top two industries in total revenue and gross outputs are electronic parts (23%, 9%) and computer, electronic and optical equipment (24%, 23.7%). Taiwan's manufacturing sector is highly concentrated on industries producing electronic, electricity and optical equipment and parts. According to Taiwan's Mainland Affairs Council[14] monthly economic reports, the electrical equipment and parts are the top export and import products from China in 2007. The share of these products in total exports and imports between Taiwan and China is 39 percent and 34 percent respectively. The second main export goods are optical, photographic instruments and parts (15.7%) and import goods are mechanical

[14] It is the official ministry in Taiwan in charge of the economic, social and culture affairs related to China,

appliance and parts (14.9%). Hence, the top two products count for around 50 percent of total exports and imports between Taiwan and China.

The data on air shipments provided by Taiwan's Ministry of Transportation and Communication, shows that these products are also the main products using air transportation in Taiwan. In 2007, on the one hand, electrical equipment and parts account for 40 percent of total weights of exports in air shipments and 20 percent of imports in air shipments. Optical and photographic products account for 9 percent for exports and imports in air shipments respectively. The share of Mechanical appliance and parts in total exports and imports in air shipments is 12 percent and 14 percent. On the other hand, none of them are among the top 10 main products in exports or imports in sea shipments. Since the values of these air and sea shipments are not available, I cannot calculate the share of each product in different transportation modes to total trade value. However, these stylized facts suggest that air transportation is more likely to have greater impact on the bilateral economic activities between Taiwan and China based on Taiwan's industrial structure and trade patterns.

In short, since the air transportation is the dominant mode for Taiwanese people and firms, this paper will focus on the impact of the change in air transportation on Taiwan's firm location choices in China. In Section 5, we show that the estimates of this direct flight shock are robust in controlling for time-varied provincial and industrial characteristics as well as province, industry and time fixed effects.

2.2 The progress of cross-strait direct flights

Taiwan has resumed its economic links with China by opening bilateral trade and allowing Taiwan firms' direct investment, though with certain limitations, since 1991. However, even with these closer mutual economic ties, there were neither direct passenger transportation nor goods shipments through ocean or air transportation between China and Taiwan before 2008. This restriction in transportation is due to Taiwan's national security concerns and other political disagreements between Taiwan and China. Therefore, Hong Kong has become an important transferring port for Taiwanese firms because of its geographic proximity to Taiwan and good international transportation facilities.

During the past decades, the Taiwanese government had attempted to negotiate direct transportation with the Chinese government, but limited progress was achieved. Even though China has become the most important trade partner and attracted the most Taiwanese FDI since 2001, the strong economic demands are still not able to lift this restriction. After winning the president election in the spring of 2008, President Ma Ying-Jeou, who has closer political relations with China, started a new round of cross-strait direct flights negotiations in the May of that year.

To identify this policy as an exogenous shock, I will argue that Mr Ma's winning factors do not come from this cross-strait economic demand but from local political and economic ones. First of all, the scandal of incumbent president Mr Chen Shui-Bian's wife and son-in-law in 2006 had damaged the public support of Mr Chen's party, Democratic Progress Party (DPP). Thus, DPP's president candidate, Mr Hsieh Chang-Ting, was in a disadvantaged campaigning position in 2008. Besides, global economic downturn from 2007 had affected Taiwan's exports that resulted in an increasing unemployment rate. Finally, according to existing voting regulations in Taiwan, voters have to vote personally in the registered ballots. This restrains Taiwanese workers in China from participating, who are more likely to vote for the pro-China candidate than voters reside in Taiwan[15]. In short, we can say that the further economic openness between Taiwan and China is expected if Mr Ma is elected, but for cross-strait direct flights, it is difficult for people to estimate how fast and to what extent this policy will be implemented after the election.

Also, I will argue that this policy shock is applied to all Taiwan's firms and the effects of this policy reach to Chinese provinces. In the first stage, there are only chartered passenger flights to 17 Chinese provinces at the end of 2008[16]. By 31st August 2009, there were regular passenger flights between Taiwan and 21 Chinese provinces. In 2009, the average number of weekly direct flights is around 140. In 2010, there are direct flights for 25 provinces with around 500 weekly flights. In 2011, no new provinces are added but the number of weekly flights

[15] There are no official records of the number of Taiwanese voters who reside in China or their voting rate. According to media and parties' estimates, those voters might count for 3 to 5 percent of total votes, which can affect the result in a close election.

[16] These 17 provinces are: Beijing, Chongqing, Fujian, Guangdong, Guangxi, Hainan, Hubei, Hunan, Jiangsu, Liaoning, Shanxi, Shandong, Shanghai, Sichuan, Tianjin, Yunnan and Zhejiang.

increases to 780. However, the progress in air shipments is slower than passenger flights. The direct air shipment flights opened in 2 provinces only (Shanghai and Guangdong) in 2008 and 5 provinces (Chongqing, Fujian, Guangdong, Jiangsu, and Shanghai) in 2011[17]. Hence, it is expected that these five provinces might work as shipping hubs and enjoy better transportation advantages. Owning to this extra cost advantage, as shown in Section 5, the dummy variable for provinces with the direct air shipments will be used to further control this regional costs impact on Taiwan FDI locations. On the other hand, direct ocean passenger cruises and shipments started from 15 December 2008 for the most important ports in Taiwan and China. In short, at the end of 2011, Taiwan has generally enjoyed the same access to China as Hong Kong in direct passenger flights.

Figure 3-1 and 3-2 present the simplified flight routes between Taiwan and China before and after direct flight policy. Before 2008, the air transportation to and from China had to bypass a third country. In this simple demonstration, I use Hong Kong as the major transferring hub based on its geographic location and relative advantages in air transportation capacity to and from China. In Figure 1-2, we can observe that due to the constraint of a no-fly zone in the middle of the Taiwan Strait, direct flights to southern China will fly via the Hong Kong Air Control Zone, while flights to northern China can choose to fly via either Shanghai or the Beijing Air Control zones.

[17] Direct passenger flights are also allowed to carry goods. Depending on the type of carriers, however, the shipping capacity is far lower in passenger flights than pure air shipment flights.

3. Conceptual framework

This paper firstly analyses the general effect of the time and cost shocks from the introduction of cross-strait direct flights on Taiwan FDI locations in China. In comparing the pre and post-direct flight periods, the question of whether firms tend to agglomerate or disperse across the space after the transportation shock is not trivial. The empirical findings can shed light on the theoretical multi-region models. Secondly, how the increase in transport accessibility can affect the firm location choices is straightforward: an increase in transportation efficiency (more transportation options) decreases firms' shipping or communication costs, causing operational profit increase, both of which resulted in the distribution change of FDI locations[18]. Hence, I focus on two specific costs channels: transaction costs and transport costs.

3.1 Transaction costs

First of all, this paper wants to identify how heterogeneous transaction costs occur across industries through a specific channel. Industries that require relationship-specific investments might incur higher transaction costs than lower ones. For example, the senior managers will need more face-to-face meetings to precede the relationship-specific investment, and with this the communication and coordination costs increase. Cristea (2011) argues that exports of sophisticated manufacturers, which require strategic inputs of unverifiable quality, and whose sales involve intensive searching and matching, are the type of goods that are most dependent on face-to-face interactions that incur higher transaction costs. Besides, according to Mayer et al. (2010), the bilateral distance between home and host countries has a significantly negative effect on firm location decisions. Hence, I try to investigate the relative impact of transportation shocks on firm in an industry requiring higher relationship-specific investments than others, i.e. investment in further away locations will decrease for industry with relationship-specific investments.

[18] Be aware that the effect of direct flights on FDI locations might occur through a number of different channels. However, in this paper, I will focus only on the impacts of transaction and transport costs.

To measure the level of relationship-specific investments for final goods, Nunn (2007) constructed a contract intensity index by: 1) using the 1997 USA I-O Use Table to identify which intermediate inputs are used, and in what proportions, in the production of each final good, and 2) using data from Rauch (1999) to identify which inputs require relationship-specific investments. Rauch (1999) allocated goods into three categories depending on the thickness of exchange markets: a) sold on an organised exchange, b) reference priced in a trade publication, or c) neither. Inputs in b and c categories can be thought of as having an intermediate to high level of relationship-specificity. For each final good, Nunn (2007) established two contract intensity measures of the proportion of its intermediate inputs that are relationship-specific. The detail of contract intensity is described below:

$$Contract\ Intensity\ 1 = \sum_j \theta_{ij} R_j^{neither}$$

$$Contract\ Intensity\ 2 = \sum_j \theta_{ij} (R_j^{neither} + R_j^{ref\ price})$$

$$\theta_{ij} = \frac{u_{ij}}{u_i},$$

where u_{ij} denotes the value of input j used in industry i, and u_i denotes the total value of all inputs used in industry i. $R_j^{neither}$ is the proportion of input j that is neither sold on an organized exchange nor reference priced; and $R_j^{neither}$ is the proportion of input j that is not sold on an organized exchange but is reference priced

Following Nunn (2007), this paper uses the *contract intensity 1*, the more restrict measure, to emphasize the effect of transportation shock on the transaction costs through this particular channel[19]. Nunn (2007) also provides contract intensity for 29 3-digit ISIC Rev.2 manufacturing industries[20]. To be compatible with Taiwan's FDI industry classification, I use UN correspondence tables to match ISIC Rev.2 with ISIC Rev. 4 and construct contract intensity value for 23 2-digit industries. The author recognises that the usage of United States Input-output table in 1997 might not disclose the true cross industry

[19] I also use the second measure to estimate the specification. The results are qualitatively consistent.
[20] Data is available on Nunn's website: http://www.economics.harvard.edu/faculty/nunn

contract intensity due to following reasons. First, the production processes in United States and China might exist huge difference in terms of labour costs or productivities. Second, the input-output table used is out of date. Given the rapid development in technology in recent decades, the input-output ratio in 1997 might largely deviate from the current one. However, due to the lack of up-to-date relationship-specific investment data and the concordance tables among China and United States' Input-output industry codes, I still employ Nunn's (2007) data to construct approximation of the index to measure the cross-industry contract intensity in China.

By applying Nunn's (2007) measurement of contract intensity (CI) for relationship-specific investments across industries, I argue that the higher the contract intensity (the higher requirement for relationship-specific investments), the higher the transaction costs. Hence, firms with higher contract intensity might tend to establish the foreign affiliate in a closer location. Thus, a negative coefficient of the interaction variable of the contract intensity and distance between Taiwan and Chinese province indicates that provinces, where they are further away from Taiwan, will have relatively fewer FDI projects in industries for which relationship-specific investments are more important (i.e. high contract intensity industries).

3.2 Transport costs

Harrigan (2010) demonstrates how relative distance affects comparative advantage. In his theoretical model, the relevant country characteristics are geographical location, and the product characteristics are timeliness-adjusted transport costs. Based on the fact that air transportation are fast and expensive, air shipments are used only when timely delivery is valuable enough. This means the air shipments occur when the value of traded goods is high enough to pay for the premium air shipping costs. For example, in the case that two watches are with similar weight (100g) but different values (one is \$100 and the other is \$10), the unit value is 1(\$/g) and 0.1 (\$/g) respectively. Since the air freight is measured mainly based on products' weight, both watches have the same air freight (e.g. \$10). Hence, the share of the air freight in the high price watch's unit value is 10, while the share in the low price watch is 100. Therefore, the high price watch is more likely to be shipped by air than the low price watch due to the relative low share of the air freight in the unit value.

Since airplanes have an advantage on speed over land and sea-based modes of transport, they are used disproportionately for goods with high unit value that are produced far from where they are sold. In the previous example, the production plant of high value watches seems more likely to be located further away from the markets and use timely air delivery. By using the trade data on U.S. imported goods with detailed shipping costs, one of his major empirical findings is that goods imported from more distant locations will have higher unit vales. Equation (1) shows the econometric specification used in Harrigan (2010):

$$v_{ic} = \alpha_i + \beta d_c + other\ controls + \varepsilon_{ic} \tag{1}$$

where v_{ic} is the logarithm unit value of imports of product i from country c. Unit value is defined as the f.o.b. dollar value of imports per physical unit, so it does not include the transport charges. α_i is the fixed effect for 10-digit HS product code i; and d_c is the distance of c from U.S.

Harrigan (2010) uses a within-product estimator to control for which goods a country exports as well as for differences in physical characteristics of products. Harrigan's (2010) findings show that the estimated coefficient β is statistically significant with the expected positive sign. The unit value is higher when they come from more distant locations. Hummels and Schaur's (2013) also point that for sufficiently high value products, the ad-valorem air freight premium becomes relatively small compared to low value ones.

The next question is if distance is a feasible proxy for the transport costs. Hummels (2007) investigated the main components of transport costs (freight-custom value ratio) for international trade flows either via air or ocean shipping by using panel data of USA imported products from 1975 to 2004. In his model, the distance variable is one of the factors affecting the ad valorem transport costs of USA imported products. The further the distance between USA and the import country, the more the cost increases. Besides, Alfaro and Charlton (2009) point out that distance, a proxy for transport costs, has a consistently negative effect on vertical FDI locations. As the bilateral distance increases, the multinational activities decrease.

Based on Harrigan (2010), I establish a product fixed effects estimation using a product-country-year panel data, which is of USA imported products on five-digit SITC Rev. 2 code during the period 1990 to 2004 provided by Hummels (2007)[21]. The product fixed effects estimated specification is shown in equation (2):

$$v_{ict} = \alpha_0 + \alpha_1 tariff_{ict} + \alpha_2 gdp_{ct} + v_c + v_t + v_i + \varepsilon_{ipt} \qquad (2)$$

where v_{ict} is the unit value of product i in air shipments (f.o.b value-weight ratio) imported from country c in year t. Two time varying country or country-product characteristics are included as Harrigon (2010) suggests: gdp_{ct} and $tariff_{ict}$. Besides, I also include country and time dummies to control for the unobservable time and country characteristics, which might cause the omitted variable bias on the estimate of unit value. And then, the unit value intensity of a two-digit ISIC Rev.4 industry j is measured as an average value of the estimated individual-specific error of product i in equation (2), where product i is categorised into aggregated industry j. The detail formulation of this intensity is as following:

$$Unit\ Value\ Intensity_j = \frac{\sum_{i \in j} \hat{g}_i}{N_{i \in j}}$$

$$\hat{g}_i = \bar{v}_i - \bar{v}_c - \bar{v}_t - \hat{\alpha}_1 \overline{tariff_{ict}} + \hat{\alpha}_2 \overline{gdp_{ct}}$$

Hence, this intensity measure will just reflect the industrial characteristic in the unit value across country and year.

According to Harrigan's (2010) predictions, with higher unit value intensity, this industry will tend to invest in the locations further away from the home country than lower ones. Given the same air transport costs, industries with higher intensity will pay relatively lower ad valorem air freight costs. Hence, the positive coefficient of the interaction variable of unit value intensity and the

[21] This dataset also includes the GDP and tariff data. The detail please see David Hummel's website: http://www.krannert.purdue.edu/faculty/hummelsd/datasets.asp

distance indicates that provinces, which are relatively far away from Taiwan, will have relatively more FDI projects from industries with higher unit value intensity.

3.3 Descriptive Statistics for Contract and Unit Value Intensity

Contract intensity is not highly correlated with unit value intensity. The correlation is -0.152. A list of the contract and unit value intensive industries is provided in Table 1. The ranking of industries appears to be sensible. For contract intensity, the lesser industries tend to have primary inputs such as basic metals or food products, while the most contract intensive ones seem to use more inputs requiring relationship-specific investment, such as motor vehicles, computers, and electronic and optical products. For unit value intensity, the least intensive industries seem to be heavier than the most intensive ones. For example, the final goods in furniture and wood products industries are much heavier than Pharmaceutical products.

4. Data

4.1 Data sources

The data of Taiwan public listed firms' FDI in China is from the Taiwan Economic Journal (TEJ). TEJ not only provides the addresses and product information of firms' FDI in China, but also other firm level data such as employment, net profit per employee, etc. Based on this information, I can classify each FDI into the 2-digit ISIC Rev.4 system. Also, for China's other industrial and provincial data, these are taken from the Chinese Statistical Yearbook and China Yearly Industry data. Finally, the cross-strait direct flights data is collected from Civil Aeronautics Administration (CAA).

The FDI data used is from 2002 to 2011 to avoid other major trade or economic policies implemented in the same period to eliminate identification issues. For instance, both China and Taiwan joined the WTO in 2001, which in turn caused further economic integration across the Taiwan Strait. The tobacco industry is not included because of 1) none of Taiwan's public listed firms have invested in this industry in China; 2) tobacco is considered as an exclusive state-owned industry in China. Tibet is not included in the data due to its highly political concerned status. Thus, there are 30 province/municipal/autonomous areas. Figure 4 illustrates the total of Taiwan's public-listed firms' FDI in China in 2002 and 2011. In 2011, coastal provinces are still the most attractive locations for Taiwan's firms, but there is higher firm density in the middle of China compared to 2002.

Based on TEJ data, the growth rate of Taiwanese FDI projects and the number of new FDI projects from 2002 to 2011 in each province are established. By using these two dependent variables, I attempt to catch the effect of policy shock on the flow level of FDI, instead of FDI stock level, that it may not reflect the relative change in FDI projects.

The major variables of interest are the trade costs between Taiwan and China. Due to data constraints on calculating precise cost measures, I employ the distance between Taiwan and Chinese provincial capital as the proxy for these costs[22]. The distance is calculated by using Google Earth.

4.2. Estimated passenger air travel time

It has been considered that transportation time can be taken as a type of cost. Longer passenger travelling times equate to them bearing higher costs. To provide an alternative to approximate cross-strait transporting/transaction costs, I estimate total average passenger journey times by using flight booking systems at airline and travelling websites[23]. The travelling time of each direct flight after 2008 is referred to in airline companies' timetables. The major issue of estimating the total travelling time of indirect flights is to establish reasonable flight transfer time. The number of daily connecting flights to and from the transferring hub, for example Hong Kong, will affect the reliability of the measurement of transfer time. For indirect flights between Taiwan and China, passengers can arrive in all provincial capitals within 2 stops. Based on this transferring condition, I assume Hong Kong is the first stop because of its frequent flights and route coverage to and from China[24]. Also, there are frequent daily flights between Hong Kong and Taiwan, which is one of the busiest international flight routes. In 2011, there were 414 flights weekly.

From 2002 to 2011, Hong Kong had regular direct flights to 25 Chinese provinces[25]. To reach those provinces without direct flight connections, we need another stop in China, such as Beijing, Shanghai or Xian where Chinese domestic flight hubs are located. Hence, the transfer time can be assumed: 1) if the first stop is via Hong Kong, it will take 90 minutes and the second stop via China's domestic airports will need 150 minutes; 2) after 2008, if the first stop is via China's domestic airports, it will take 150 minutes. Transferring flights in China's airports on average takes a longer amount of time than in Hong Kong, since there are less connecting flights and less efficient transferring services. Although the fixed flight transferring time across airports is not realistic, this simplified measure attempts to catch the general air travel patterns between

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[22] Distance is commonly used as the proxy for trade costs in NEG or trade literature. Disdier and Head (2008) provide a thorough evaluation of the distance effect on trades.

[23] For examples, I use booking website such as Skyscanner (www.skyscanner.net) and airline companies' website: China Airline, Eva Airways, etc.

[24] Other alternative first stops include Macau, Cheju Island or Seoul.

[25] According to Hong Kong International Airport Annual Report (2002-2011), 6 provinces without direct flight connection are: Gansu, Inner Mongolia, Ningxia, Qinghai, Tibet, and Xinjiang. Besides, In 2011, Taiwan also has compatible direct flights to those 25 provinces with an average of 3300 fights per month.

Taiwan and China. Take Shanghai for example, before 2008, it took 95 minutes to travel from Taiwan to Hong Kong and then another 135 minutes from Hong Kong to Shanghai. Factoring in transfer time, a passenger needs 320 minutes to reach the destination. After 2008, it takes only 105 minutes from Taipei to Shanghai with a direct flight.

Figure 5 demonstrates the estimated travelling time in 2006 and 2011 and the travelling time save ratio too. We can see that remote provinces save more minutes after cross-strait direct flights open, while provinces closer to Taiwan save more on a relative level. However, we shall bear in mind that this measure simplifies the complexity of flight transfers by giving fixed flight connecting times for all destinations.

4.3 Descriptive statistics

Figure 6-1 demonstrates that the relationship between the growth of Taiwan's public-listed firms' FDI and the distance between Taiwan and Chinese provinces has changed from downward sloping to upward sloping in 2011. Figure 6-2 shows that the relationship between new FDI projects and distance remains downward sloping while the magnitude decreases gradually. Table 1-2 presents the descriptive statistics of main variables.

5. Empirical strategies and results

5.1 Empirical strategy

The main estimation strategy follows the same logic as a standard differences-in-differences (DD) specification. I will compare the relative change in FDI growth rate and new FDI projects in the post-shock period relative to the pre-shock period between provinces that are closer to or further away from Taiwan. The difference from standard DD strategy is that I use a continuous measure of the intensity of treatment (i.e. distance between Taiwan and Chinese provinces) and thereby capture more variation in the data. Because the date of openness to direct flights in each province depends on bilateral negotiation progress, I use the same date of initial openness for all provinces. The development of cross-strait flights suggests that after agreements have been signed, it takes less than two months to operate. Besides, it also allows passengers of direct flights to connect to other domestic local flights. Even for provinces without direct flights, the total travelling time will change as well. Therefore, in this paper, I use the initial opening year, 2008, as the cut-off period and define the periods prior to 2008 as the pre-shock periods, and the periods after 2008 (i.e. 2008, 2009, 2010 and 2011) as the post-shock periods. In the following sections, I will employ a number of procedures to check that this chosen cut-off is consistent with the data.

The main estimating equation assumes that the growth rate of an industry's FDI in a Chinese province is proportional to the change of the distance between Taiwan and a Chinese province. This is written as equation (3):

$$n_{ipt} = \beta_0 + \beta_1 Distance_p \times I_t^{post} + \Phi \boldsymbol{X}_{\boldsymbol{ipt-1}} + \Theta Y_{\boldsymbol{pt-1}} + v_p + v_{it} + \varepsilon_{ipt} \qquad (3)$$

where i indexes industries, p indexes provinces and t indexes time periods, which are from 2002 to 2011. The variable $Distance_p$ is the logarithm of the distance between Taipei, Taiwan and a Chinese province p capital, defined in the previous section, and I_t^{post} is an indicator variable that equals one for the periods after 2007 (i.e. 2008, 2009, 2010 and 2011). The outcome of interest, denoted n_{ipt} is either the growth rate of Taiwanese public-listed firms' foreign affiliates or the logarithm of total number of Taiwan public-listed firms' new FDI projects. The equation also includes province and industry-year fixed effects (v_p and v_{it}), time variant industry-provinces and province characteristics ($\boldsymbol{X}_{ipt-1}$ and $\boldsymbol{Y}_{pt-1}$), which include a set of geographic and industrial agglomeration variables.

The coefficient of interest in equation (3) is β_1, and the estimated coefficient of β_1 measures the additional growth in FDI growth rate experienced by provinces with relative distance to Taiwan after cross-strait direct flights started in 2008 (relative to before). A positive coefficient indicates that after open direct flights, provinces further away from Taiwan benefited from a greater increase in the FDI growth rate than those closer to Taiwan after 2008, relative to before 2008.

This is the balanced panel data from year 2002 to 2011 with many zero value FDI observations. To deal this zero-value issue, Tobit or Poisson estimators for the level or count data of dependent variable are econometric solutions suggested in FDI empirical literature. These two non-linger specifications can account for the province-industry observations where no FDI is observed, the existence of zeros in the dependent variable data (Alfaro & Charlton, 2009; Paniagua, 2011). In this study, based on difference-in-difference estimation strategy, I employ OLS with fixed effects instead of count number estimators to control for zero value issue to obtain consistent coefficient estimates for two reasons. First, since the Tobit model cannot estimate fixed effects in the panel data, it is unable to control for unobserved time invariant provincial or industrial characteristics. On the other hand, I run the baseline specifications using the Poisson with fixed effects as the sensitivity check. The coefficients of the β_1 in equation (3) is with expected positive sign but not significant. Second, FDI growth rate, one of the dependent variables, cannot be applied in the count models.

Since Taiwanese FDI is a province-industry panel dataset, I can use the fixed effect estimations to deal with the zero value problems. The advantage of using a fixed effect estimator is that it controls for which FDI project in industry i invests in which province: if a province does not receive a FDI project in industry i from Taiwan, then that province's distance to Taiwan is (appropriately) irrelevant to the effect of distance on the FDI growth or the number of new FDI projects within industry *i*. Also, the fixed effects model allows to recognize how the relevant variables evolve through time and to identify the specific time, industry or province effects.

5.2 Baseline Estimates

The results of main estimating equation (3) are shown in Table 2. In Table 2, four specifications for each outcome of interest are reported. The first three specifications are reported in column (1)-(3) and (5)-(7) for FDI growth rate and new FDI projects separately. The first specification, reported in column (1) and (5), includes year, province and industry-year fixed effects only, without additional controls. In column (2) and (6), two agglomeration variables are included. $Taiwan\ Firm_{ipt-1}$, the logarithm of total Taiwan public listed firms FDI in industry i in province p, controls for Taiwanese agglomeration. $Total\ Firm_{ipt-1}$ is the logarithm of total numbers of firms in industry i in province p and is used to allow for industrial agglomeration. This is done to ensure that the effect of opening direct flights is not confounded by other changes in local industrial agglomerations.

The third specification, in columns (3) and (7), report the estimates for our baseline specification. In addition to the control for local industrial agglomerations, I also include wage and market access variables in the estimated specification because firms' location decisions might be driven by labour costs and market accessibility. $Wage_{pt-1}$ is the logarithm of average salaries of workers and staff in province p at year t-1. This is used to proxy the factor price differentials between Taiwan and Chinese provinces. $Market\ Access_{pt-1}$ is the logarithm of measure of local market size in province p at year t-1. The market access of province p is the summation of: 1) distance discounted final consumption of all other provinces q, $q \neq p$, and 2) province p's final consumption discounted by the radius of area.

The estimated coefficient of the distance interaction term, $Distance_p \times I_t^{post}$, reveals the average increase in the outcomes of interest arising from direct cross-strait flights from 2008.[26] According to the estimate in column (3), increasing the distance between Taiwan and province p of 1 percent increases the FDI growth

[26] I report standard errors clustered at the province- isic2 industry level. There are total 690 province-industry clusters.

rate by 0.032 percent on average. The estimated coefficient for new FDI projects from column (7) indicates that a 1 percent increase in distance increases the number of new FDI projects by 0.052 percentage points.

Column (4) and (8) of Table 2 report the robustness of results by adding other provincial variables to control for other geographical factors that have an impact on Taiwan firms' location decisions. It is well documented that firms tend to invest more in regions with better infrastructures as well as better local government support. Therefore, I use the natural log of density of rail length and natural log of the number of national level special economic zones in each province to control these determinants of location choices. These estimates are positive and significant while the magnitude becomes smaller than baseline specifications.

5.3 Sensitivity to Variable Definitions

The first sensitivity check tests the robustness of estimates to the use of alternative post-shock dates. Estimates of equation (4) using alternative cut-off dates are reported in Table 3, columns (1)-(3) and (7)-(9). Each cell reports the coefficient of interest (i.e., β_1) from the regression. Each row reports results using an alternative definition of the post-shock period. The first row uses the baseline definition of the post-shock period, which is 2008 and later. The second row uses 2009 and later as a similar but alternative definition. The estimates show that the results remain robust to the choice of slightly different adoption dates.

The second sensitivity test is also reported in Table 3 by using an alternative trade costs measure that is more close to reality. As discussed in section 4.2, the passenger air travelling time is constructed by two components: actual flight time and estimated transfer time together. Thus, the remaining columns of Table 3 report results from equation (4).

$$n_{ipt} = \beta_0 + \beta_1 traveltime_{pt} + \beta_2 traveltime_{pt} \times I_t^{post} + \Phi \boldsymbol{X}_{\boldsymbol{ipt-1}} + \Theta Y_{\boldsymbol{pt-1}} + v_p + v_{it} + \varepsilon_{ipt} \quad (4)$$

The results in columns (4)-(6) and (10)-(12) show that the estimates generally remain positive and are consistently significant. Even though the transfer time in this simple measure is fixed for all destinations, it reflects the variation of connection capacity in each airport. The passenger, however, will have to wait a longer time for the connecting flight to a more remote destination than a popular one. Hence, by using this alternative measure, this direct flight policy shock does affect firms' costs structure and their FDI location choices.

5.4 The impact of transaction costs and transport costs on location choices

In this section, we further examine the impact of transaction and transport costs on locations of new FDI projects. Following equation (3), the estimated coefficient of the distance interaction terms, $Distance_p{\times}CI_i$ or $Distance_p{\times}UVI_i$, reveal the relative effects of distance on the location choices through transaction and transport cost channels across industries. In Table 4, the results present different specifications, which test the impact of individual channel and the joint impacts. Columns (1) and (2) show that as the bilateral distance increases, the contract intensive industries will invest less than less intensive ones. Quantitatively, if the difference in contract intensity between two industries is 10 percentage points, as the distance increase by 10 percent, the number of new FDI affiliates in the relatively contract intensive industry will reduce on average 0.24 percent more than the industry with the relatively low contract intensity. The findings in Columns (3) and (4) indicate that industries with higher unit value intensity will tend to invest at locations relatively further away than less intensive ones. If the difference in unit value intensity between two industries is 10 percentage points, as the distance increases by 10 percent, the number of new FDI affiliates in the relatively unit value intensive industry will increase on average 0.0043 percent more than the industry with the relatively low unit value intensity. Columns (5) and (6) present the joint impacts of two channels. The transaction costs channel remains statistically significant with the expected negative sign, while the estimates of transport channel are with the expected positive sign but not significant.

In the next step I examine whether direct flight shock will lead to further change in the firm's location choices through these two channels. The estimated coefficients of post shock interaction term, $Distance_p{\times}CI_i{\times}Post$ or $Distance_p{\times}UVI_i{\times}Post$, reveal the average effects of direct flights through each specific channel.

After the direct flight shock, as the trade costs decrease, the dispersion of FDI locations is expected to occur through the transaction costs channel. Firms with higher contract intensity will tend to locate in the more distant destinations than those with lower contract intensity. Column (1) and (3) of Table 5 show that the estimated coefficients of inverter term variable is with predicted positive sign but not significant.

On the other hand, as the trade costs reduce, the change in the share of premium ad-valorem air shipping costs is higher in the low unit value industry than high ones. Hence, the firm with lower unit value will marginally benefit more than the one with higher unit value and will tend to invest relative more in the distant destinations after the reduction in trade costs. The results in column (2) and (4) are statistically significant with expected negative signs. This indicates that firms in the relatively high unit value intensive industries will choose to invest in relative closer locations than relative low intensive ones because of the higher reduction in the share of premium ad-valorem air shipping costs. Finally, the general post-distance variable is included in column (5) and (6) to further control other unobservable effects through the distance variable. The results are similar for the transport costs channel, while the signs of interaction term in the transaction costs channel become negative but not significant.

In short, the results provide solid support that the two intensity measures can disentangle the composition effects of trade costs through transaction and transport costs channels with nontrivial economic magnitudes.

6. Robustness checks

6.1 Flexible estimates

Estimation in equation (3) requires that a fixed post-shock date is chosen. However, since the openness of these direct air flights starts gradually from 2008, reasonable cut-off dates range between 2008 and 2009. To further investigate the robustness of this cut-off, I use a number of different strategies to examine whether the patterns in the data are consistent with the year 2008 as a fixed post-shock date. The first strategy is to estimate a fully flexible estimating equation written as follows

$$n_{ipt} = \beta_0 + \sum_{j=2002}^{2011} \beta_j Distance_{pt} \times I_t^j + \Phi X_{ipt\text{-}1} + \Theta Y_{pt\text{-}1} + v_p + v_t + v_i + \varepsilon_{ipt} \quad (5)$$

where all variables are defined as in equation (3). The only difference is that, in equation (5), the distance measure interacts with each of the time-period fixed effects and year 2002 is as the base year. The estimated vectors of β_j's reveal the correlation between distance and the outcomes of interest in each time-period.

In this estimation, it is expected the estimated β_j's are to be constant over time for the years before the policy shock. Also, I expect coefficients to be positive and larger in magnitude for the years after policy shock because of the gradual openness of direct flights. Estimates of equation (5) are reported in Table 6. Column (1) and (2) report estimates for FDI growth rate and columns (3) and (4) report estimates for new FDI projects with control variables. The first specification includes province, time and industry fixed effects only; the second includes the additional controls for industrial agglomerations on firm's location choices[27].

The results illustrate several important facts. First, there are no clear trends of the estimated interaction effects during the time periods immediately prior to the policy implemented. I will confirm this impression with a more formal

[27] I also regress with full control variable sets but the results are not clear to demonstrate this trend. This can be caused by the noise of correlation among these control variables and interaction terms.

analysis in the next section. The second insight is that after 2008, the magnitude of the distance variable increases with positive sign in some specifications, such as column 4. This indicates that provinces, which are further away from Taiwan, benefit more from this transportation shock than those closer to Taiwan. This implies the cross-strait flight policy affects firms' cost structure in terms of trade costs so that firms are more willing to invest in a further location than before.

6.2 Rolling estimates

The second strategy to check for the chosen cut-off data is similar to the structural break test. This method is proposed by Nunn and Qian (2011) to check the structural break when there are a small number of time periods in the sample. The idea of this approach is attempt to work as close as possible to the standard statistical tests for detecting structural breaks.

I examine four-year time segments of the full panel. For each window, I estimate the baseline specification from equation (3), defining the latter two years as the post-shock period. The estimated coefficient for the interaction between distance and the post-shock indicator variable shows the average increase in FDI growth rate and numbers of new FDI projects between the pre and post periods for further away provinces relative to closer provinces. Those estimates are expected to be close to zero until the cut-off begins to coincide with the date that agreements are signed.[28] Prior to the policy shock, there is no reason to anticipate that further away provinces have a higher FDI growth rate or an increase in new FDI projects.

The estimates are reported in Table 7. Columns (1) and (2) report the estimated coefficients for FDI growth rate and number of new FDI projects using a sample that includes four year periods, ranging from 2002 to 2005. For these regressions, the post indicator variable I_t^{post} takes on the value of zero in 2002 and 2003 and the value of one in 2004 and 2005. Since the direct cross-strait flights did not start until 2008, the results from this specification can be interpreted as a placebo experiment. It is the same in columns (3)-(6). Columns (3) and (4) examine the 2003-2006 periods and use a post indicator variable that equals one in 2005 and 2006, while columns (5) and (6) examines 2004-2007 and use an

[28] The results are robust to the choice of different window lengths, such as 5 or 6 years

indicator variable that equals one in 2006 and 2007. The estimated coefficients of interest in these three placebo experiments are close to zero and insignificant. There is no evidence of a differential relationship between the distance and the FDI growth rate or the number of new FDI projects in these early pre-shock time periods.

Columns (7) and (8) show estimates for time periods ranging from 2005-2008 with a post indicator variable equaling one in 2007 and 2008. In this specification, one of the two years in the post period coincides with the post-shock period. Thus, it is expected that the estimates capture some of the effects of the operation of direct cross-strait flights. The results demonstrate that the magnitude of coefficients is increasing and even become positive and significant.

Columns (9) and (10) report estimates for 2006-2009, with a post indicator variable that equals one in 2008 and 2009. Here these two post years coincide with the post-shock period. I expect the coefficients to capture more fully the introduction of direct flights. The results show larger positive significant estimated coefficients.

Columns (11) and (12), as a final check, report estimates for 2007-2010, with a post indicator variable equal to one in 2009 and 2010. Since 2008 is included in the pre-shock time period, the results are expected to be insignificant. Taken together, the results confirm the findings from the previous flexible estimate: the impact of policy shock on the relationship between the distance and the change of FDI growth rate and the number of new FDI projects starts after 2008.

6.3 Examining within Region Variation

It is a concern that the results of the impact of the policy shock might be simply capturing the fact that Chinese coastal regions are, on average, more attractive for foreign investors compared to inland regions. Hence, the increase of FDI growth rates or new FDI projects in coastal provinces can be different from the rest of provinces for reasons other than the openness of direct cross-strait flights. Here I employ an alternative strategy and estimate the effect of this transportation shock within region variations only. I add regional fixed effects that interact with time-period fixed effects to the baseline specification, equation (3). With the region-year fixed effects, the coefficient of interest, β_1, is identified from within-region variation only. An additional benefit of the region-year fixed effects is that they capture any historical region-wide shocks that affected provinces within a region similarly.[29]

Columns (1) and (3) in Table 8 report baseline estimates for comparison, while the remaining columns of the table report estimates with the region-year fixed effects, with and without the set of baseline control variables. The estimates show that the point estimates are reduced, but remain positive and significant. The smaller point estimates might reflect a loss of precision arising from the fact that there are relatively few provinces within each region.

6.4 Lagged Dependent Variable

In the baseline specification, I have controlled for unobserved omitted variables by adding provincial fixed effects. However, there might be other time-variant omitted variables that exist that can cause the upward or downward bias of the estimates. One of the potential omitted variables can be the lagged dependent variable. As far as FDI is concerned, the investment in the previous year at province p can be an indicator for future investors. This might lead to an upward bias of the estimate. To better control this potential bias, I add a one-year lagged dependent variable in the baseline regression. Table 9 reports these estimates. In column (5) and (8), the estimated specifications include the interaction term of lagged dependent variable and the post shock indicator. Columns (1)-(4) show that the lagged dependent variable does not affect estimates different from the baseline specification for the FDI growth rate, while columns (5)-(8) report that the estimates of coefficients are smaller and even become not significant in column (8). It indicates that some new FDI projects can be the continuing investment from the previous year. Hence, in controlling for the lagged dependent variable, this can absorb the variation that should not be explained by the direct flight policy shock.

[29] Coastal region includes 13 provinces: Liaoning, Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Jiangxi, Shandong, Guangdong, Guangxi and Hainan

7. Conclusions

In this paper, I examine the impact of implementing a new transportation mode on firms' location choices by using a unique quasi-natural experiment of Taiwan's cross-strait direct flights policy. As an island and exporting oriented country, air transportation has taken an important position in Taiwan's international economy in recent decades. More than 90% of international passengers to and from Taiwan are via air transportation. Also, air shipments have kept growing since 2000.

Owing to historical political conflicts between Taiwan and China, there have not been any direct air or ocean transportation for passengers and shipments across Taiwan Strait since 1949. The very first commercial cross-strait direct flight routes between Taiwan and five of Chinese provinces started in 2008. The breakthrough in the negotiation progress in cross-strait transportation policy happened after the pro-China party candidate won the presidential election in early 2008. Very soon, there were direct flights to and from Taiwan and twenty-five out of thirty-one of Chinese provinces in 2011. This policy shock dramatically changed existing air transportation patterns. For example, the average passenger's air travelling time has been reduced by around 160 minutes. It takes only one and a half hours from Taipei to Shanghai with a direct flight, while an indirect one (usually via Hong Kong) can take at least five hours. Based on the direct flight policy shock between Taiwan and China, I employ a differences-in-differences strategy to estimate the general causal effect of the trade costs on Taiwanese public listed firms' FDI location choices in twenty-three ISIC two-digit manufacturing industries in thirty Chinese provinces during the period 2002-2011.

The findings shed light on the theoretical concept of the effect of trade costs on the distribution of firm locations in the new economy geography (NEG) multi-regions model. In theory, the mathematic difficulties in modelling trade costs with multi-dimensional geography structure make the prediction of agglomeration or dispersion process inconclusive. In this paper, given the existing Chinese regional transportation networks, I aim at introducing the exogenous direct flight shock between Taiwan and China in order to investigate the impact of change of trade costs on firm locations.

Furthermore, I attempt to investigate the composition of trade costs by identifying how transaction and transport costs affect firms' location choices through the distance channel. To measure these effects, I construct the transaction intensity and transport intensity to investigate the relative impacts of these costs among industries when the transportation shock occurs. As for transaction costs, if an industry requires more relationship-specific investments, it will face higher face-to-face communication costs. Hence, it will pay relatively higher transaction costs than others as the distance between home and host FDI destination increases. As for transport costs, based on the fact that airplanes are fast and expensive, they will be used for shipping only when timely delivery is valuable enough of the traded good to pay for the premium shipment costs. For sufficiently high value products, the ad-valorem airfreight premium becomes relatively small compared to low value ones. Thus, goods imported from more distant locations will have higher unit vales. The industry with higher air shipments' value-weight ratio will pay relatively less transport costs than others as the distance between home and host FDI destination increases.

The empirical results indicate that after the policy shock, the interaction term of the post shock dummy and the distance between Taiwan and a Chinese province (as a proxy for trade costs) has consistent and significantly positive effects on FDI location choices. According to the estimates, the increase of the distance by 10 percent will lead to an average 0.31 percent change for the FDI growth rate and 0.51 percent change for the number of new FDI projects during the period 2008-2011. Moreover, the estimated coefficients of both transaction and transport costs channel are statistically significant with expected signs. With a 10 percentage points higher in the transaction intensity, an increase in distance by 10 percent will result in average 0.24 percent decrease for the number of new FDI projects in the industry with relatively higher transaction costs. For the transport costs channel, the result is weaker. With 10 percentage points higher in the unit value intensity, an increase in distance by 10 percent will result in a relative higher number of new FDI projects by 0.0049 percent. After the direct flight shock, there is no clear impact through the transaction costs channel, while firms in the more unit value intensive industries will choose to invest in relative closer locations than less intensive ones.

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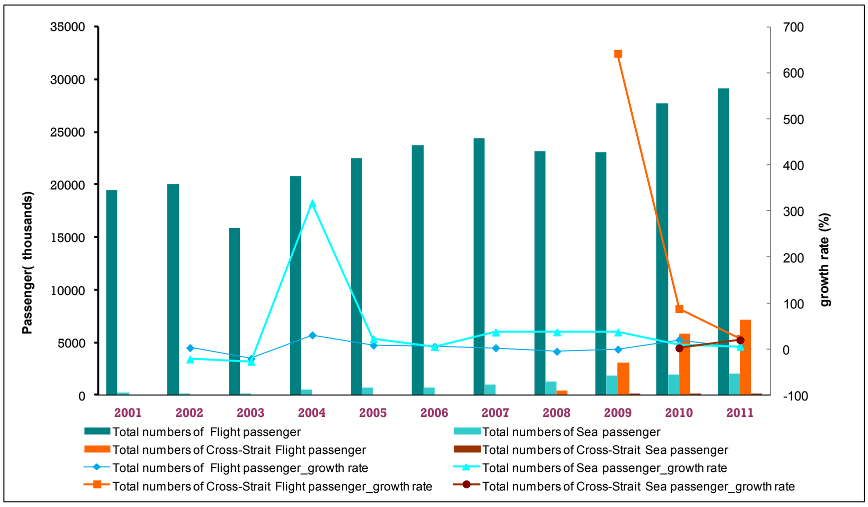
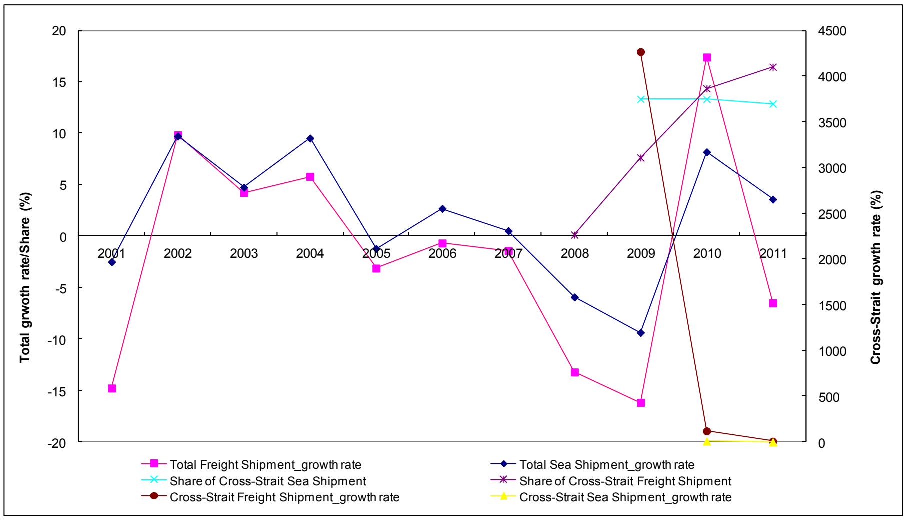


Source: Ministry of Transportation and Communication, Taiwan, 2012

Figure 1

Number and Growth Rate of Taiwan Air and Ocean Passengers



Source: Ministry of Transportation and Communication, Taiwan, 2012

Figure 2

Growth Rate and Share of Taiwan Air and Ocean Shipments

Source: CAA, 2011

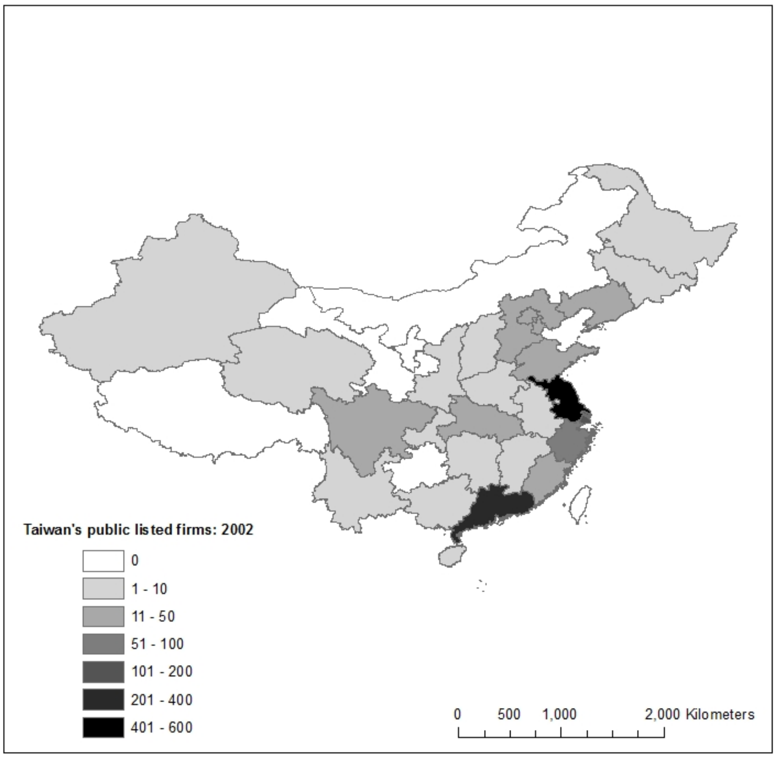
Figure 3-1

Taiwan-China Air Transportations, via Hong Kong, before 2008

Source: CAA, 2011

Figure 3-2

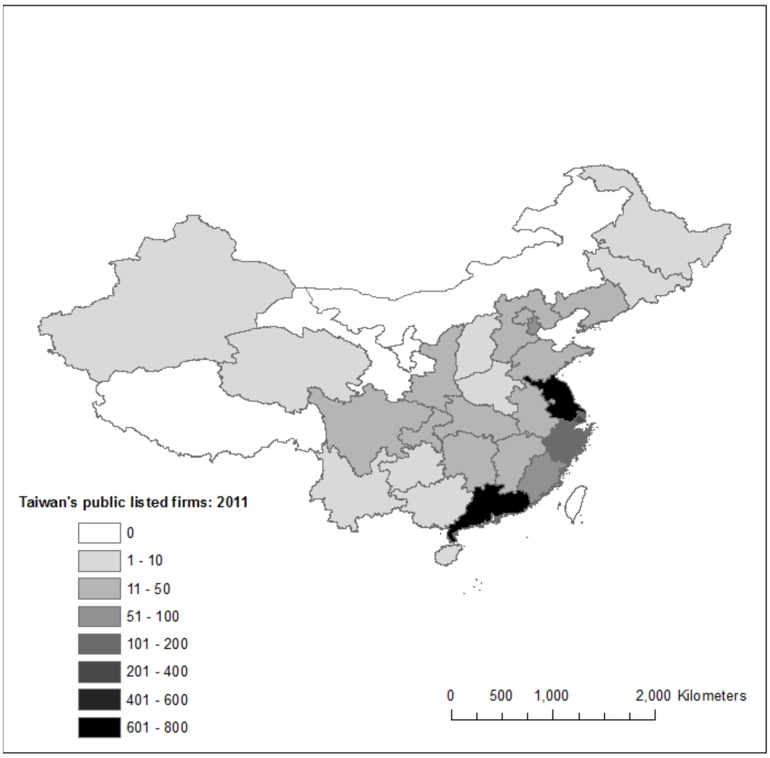
Taiwan-China Air Transportations, Direct Flights After 2008



Source: TEJ, 2012

Figure 4-1

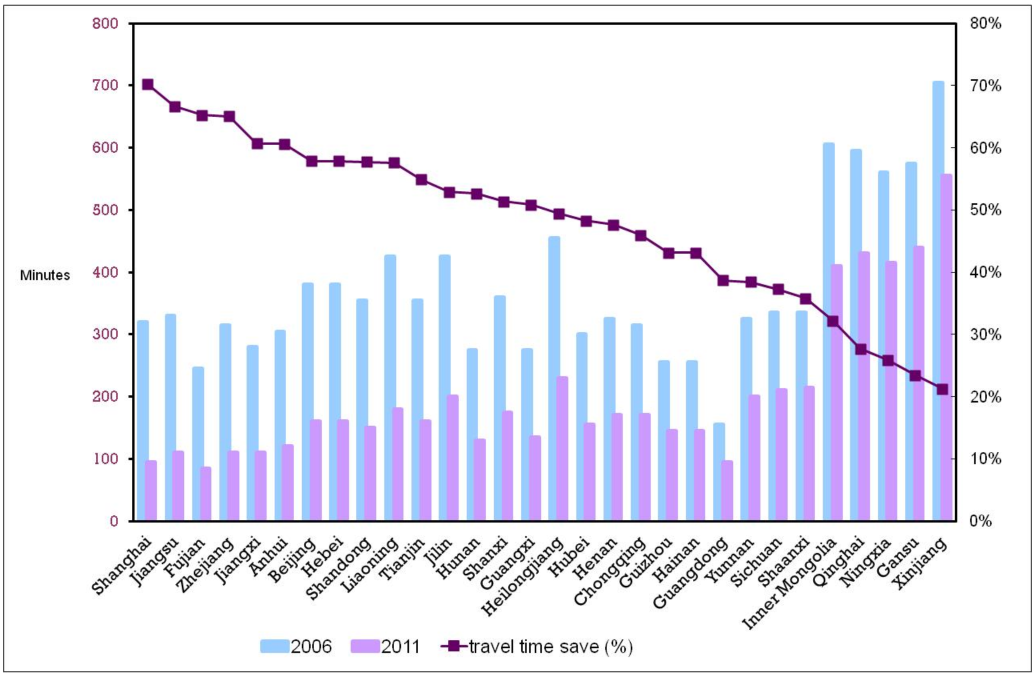
Number of Taiwanese Public Listed Firms in China, 2002



Source: TEJ, 2012

Figure 4-2

Number of Taiwanese Public Listed Firms in China, 2011



Source: author estimations

Figure 5

Estimated Air Travelling Time Between Taiwan and Chinese Provinces, 2006 & 2011

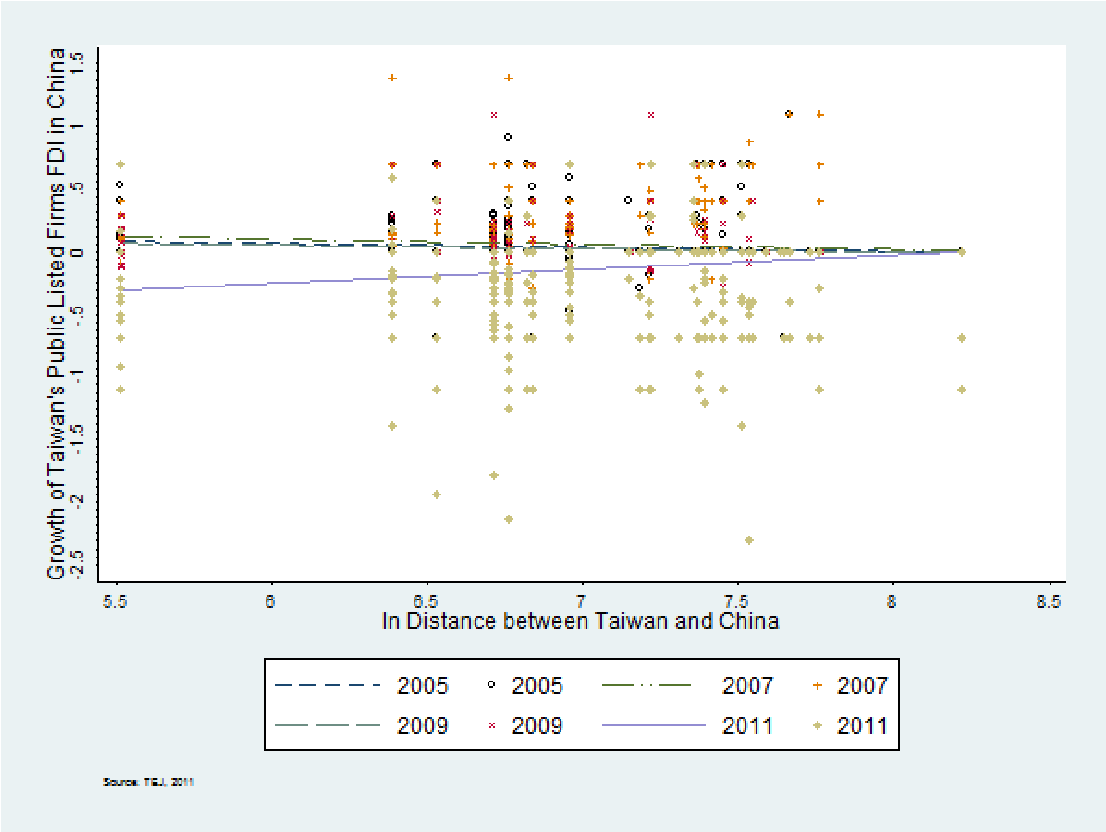


Figure 6-1

Growth of Taiwan's FDI and Distance between Taiwan and Chinese Provinces, 2005, 2007, 2009 and 2011

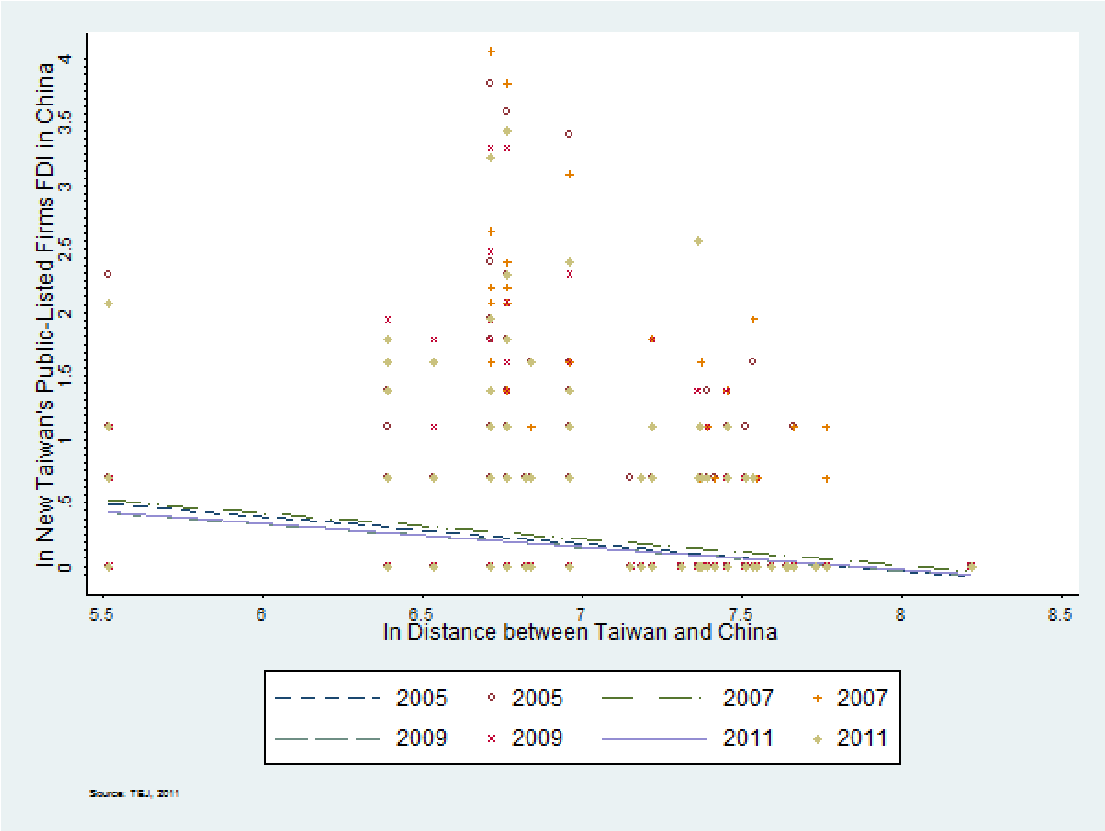


Figure 6-2

New Taiwan's FDI and Distance Between Taiwan and Chinese Provinces, 2005, 2007, 2009 and 2011

Table 1-1

Descriptive Statistics of Contract and Unit Value Intensity

Contract Intensity		Unit Value Intensity	
	Industry description		Industry description
0.859	Moto vehicles, trailers and semi-trailers	15.279	Pharmaceutical products
0.855	Other transport equipment	5.825	Basic metals
0.785	Computer, electronic and optical products	3.245	Other manufactured products
0.764	Machinery and equipment	3.245	Repair and installation of machinery and equipment
0.745	Wearing apparel	2.768	Chemicals and chemical products
0.740	Electrical equipment	-0.275	Moto vehicles, trailers and semi-trailers
0.713	Beverages	-0.275	Other transport equipment
0.713	Printing and publishing	-0.369	Computer, electronic and optical products
0.611	Leather and related products	-0.724	Electrical equipment
0.568	Furniture	-0.857	Printing and publishing
0.547	Other manufactured products	-1.676	Coke and petroleum refineries
0.547	Repair and installation of machinery and equipment	-1.698	Other non-metallic mineral products
0.516	Wood products, except furniture	-1.743	Machinery and equipment
0.490	Pharmaceutical products	-1.944	Textiles
0.435	Fabricated metal products	-2.006	Fabricated metal products
0.421	Other non-metallic mineral products	-2.074	Paper and products
0.408	Rubber and plastic products	-2.105	Wearing apparel
0.376	Textiles	-2.279	Food products
0.365	Chemicals and chemical products	-2.479	Leather and related products
0.348	Paper and products	-2.520	Tobacco
0.317	Tobacco	-2.555	Rubber and plastic products
0.305	Food products	-2.654	Wood products, except furniture
0.226	Coke and petroleum refineries	-2.837	Beverages
0.201	Basic metals	-3.089	Furniture

The tow intensities measures reported are rounded from 7 digits to 3 digits.

Table 1-2

Descriptive Statistics for Main Variables

	Mean	Std. Dev.	Min	Max
Distance	7.21849	0.510864	5.517734	8.215991
No. of Taiwan FDI	0.4516016	0.8705551	0	6.240276
No. of Total Firms	4.802671	1.732966	0	9.400217
Wage	9.85519	0.4690574	8.97563	11.18269
Market Access	4.517039	0.5629486	2.710821	5.947222
Contract Intensity	0.5451921	0.194357	0.201311	0.8587404
Unit Value Intensity	-0.0556142	3.985771	-3.089045	15.27882

Table 2

The Impact of The Direct Flight Policy Shock: Baseline Estimates

	Dependent variable							
	Taiwanese FDI growth rate				Taiwanese new FDI projects			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Distance_p$ x Post	0.0511***	0.0435***	0.0315***	0.0276***	0.00871	0.0755***	0.0521***	0.0439**
	(0.01000)	(0.00965)	(0.0094)	(0.00979)	(0.0145)	(0.0188)	(0.0176)	(0.0178)
Baseline Controls								
# of Taiwan FDI_{ipt-1}	N	Y	Y	Y	N	Y	Y	Y
# of Total $Firms_{ipt-1}$	N	Y	Y	Y	N	Y	Y	Y
$Wage_{pt-1}$	N	N	Y	Y	N	N	Y	Y
Market $Access_{pt-1}$	N	N	Y	Y	N	N	Y	Y
Other Controls								
Rail $Density_{pt-1}$	N	N	N	Y	N	N	N	Y
# of SEZ_{pt-1}	N	N	N	Y	N	N	N	Y
D_Air $Freight_{pt-1}$	N	N	N	Y	N	N	N	Y
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	6900	6900	6900	6900	6900	6900	6900	6900
R_squared	0.177	0.192	0.194	0.196	0.423	0.573	0.575	0.575

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of a control variable; N indicates that the control is not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.

* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 3

Alternative Variable of Interest (Flight time) and Post Policy Shock Time Period

	Dependent Variable											
	Taiwanese FDI growth rate						Taiwanese new FDI projects					
	Distance between Taiwan and Chinese Provinces			*Traveltime* between Taiwan and Chinese Provinces			*Distance* between Taiwan and Chinese Provinces			*Traveltime* between Taiwan and Chinese Provinces		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Post=2008, 2009, 2010, 2011	0.0511***	0.0435***	0.0315***	0.0696***	0.062***	0.052***	0.00871	0.0755***	0.0521***	0.0317**	0.0988***	0.0780***
	(0.010)	(0.0096)	(0.0094)	(0.0086)	(0.0083)	(0.0079)	(0.0145)	(0.0188)	(0.0176)	(0.0130)	(0.0167)	(0.0148)
Post=2009, 2010, 2011	0.0597***	0.0522***	0.0417***	0.0692***	0.0621***	0.0531***	0.00763	0.0718***	0.0496***	0.0326**	0.0946***	0.0761***
	(0.011)	(0.011)	(0.011)	(0.0089)	(0.0086)	(0.0082)	(0.0149)	(0.0189)	(0.0175)	(0.0131)	(0.0166)	(0.0148)
Baseline Controls												
# of Taiwan FDI$_{ipt-1}$	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
# of Total Firms $_{ipt-1}$	N	Y	Y	N	Y	Y	N	Y	Y	N	Y	Y
Wage $_{pt-1}$	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Market Access $_{pt-1}$	N	N	Y	N	N	Y	N	N	Y	N	N	Y
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of a control variable; N indicates that the control is not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.

* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 4

Transaction and Transport Costs

	Dependent Variable: Taiwanese new FDI projects					
	(1)	(2)	(3)	(4)	(5)	(6)
$Distance_p \times CI_i$	-0.258***	-0.235***			-0.249***	-0.227***
	(0.0408)	(0.0413)			(0.0412)	(0.0417)
$Distance_p \times UVI_i$			0.00485**	0.00425**	0.003	0.00268
			(0.002)	(0.00199)	(0.00201)	(0.00201)
Control Variables						
# of Total Firms $_{ipt-1}$	N	Y	Y	N	Y	Y
Wage $_{pt-1}$	N	Y	Y	N	Y	Y
Fixed effects	Y	Y	Y	Y	Y	Y
Observations	6900	6900	6900	6900	6900	6900
R_squared	0.303	0.305	0.305	0.299	0.302	0.302

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of a control variable; N indicates that the control is not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.

* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 5

Transaction and Transport Costs: Direct Flight Policy Shock

Dependent Variable: Taiwanese new FDI projects						
	(1)	(2)	(3)	(4)	(5)	(6)
$Distance_p \times CI_i$	-0.239***		-0.254***	-0.229***	-0.244***	-0.225***
	(0.0427)		(0.0427)	(0.0431)	(0.0532)	(0.0535)
$Distance_p \times CI_i \times Post$	0.0101		0.0122	0.00628	-0.012	-0.00424
	(0.0289)		(0.0280)	(0.0290)	(0.0842)	(0.0841)
$Distance_p \times UVI_i$		0.00747***	0.00611**	0.00586**	0.00618**	0.00589**
		(0.00257)	(0.00259)	(0.00258)	(0.00260)	(0.00259)
$Distance_p \times UVI_i \times Post$		-0.00806**	-0.00777*	-0.00796**	-0.00794*	-0.00804**
		(0.00406)	(0.00406)	(0.00406)	(0.00410)	(0.00410)
$Distance_p \times Post$					0.0148	0.0065
					(0.0486)	(0.0488)
Control Variables						
# of Total Firms $_{ipt-1}$	N	Y	N	Y	N	Y
Wage $_{pt-1}$	N	Y	N	Y	N	Y
Fixed effects	Y	Y	Y	Y	Y	Y
Observations	6900	6900	6900	6900	6900	6900
R_squared	0.303	0.305	0.303	0.305	0.303	0.305

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of a control variable; N indicates that the control is not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.
* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 6

Flexible Estimates: The Relationship between Taiwan-China Distance and Taiwan FDI Growth Rate or Taiwan New FDI Plants in China: By Time Period

	Dependent variable			
	Taiwanese FDI growth rate		Taiwanese new FDI plants	
	(1)	(2)	(3)	(4)
$Distance_p$ × 2003	0.0275	0.0244	0.0516**	0.0716**
	(0.0188)	(0.0182)	(0.0250)	(0.0286)
$Distance_p$ × 2004	0.0108	0.00649	-0.00828	0.0238
	(0.0181)	(0.0176)	(0.0309)	(0.0348)
$Distance_p$ × 2005	0.0315**	0.0238	0.0124	0.0597**
	(0.0152)	(0.0147)	(0.0238)	(0.0273)
$Distance_p$ × 2006	0.0103	0.000809	-0.00443	0.0524
	(0.0205)	(0.0199)	(0.0281)	(0.0330)
$Distance_p$ × 2007	0.0222	0.00746	0.0213	0.0901**
	(0.0206)	(0.0200)	(0.0325)	(0.0370)
$Distance_p$ × 2008	0.0348**	0.0163	0.0205	0.0989***
	(0.0156)	(0.0148)	(0.0241)	(0.0302)
$Distance_p$ × 2009	0.0351**	0.0126	0.0454	0.128***
	(0.0172)	(0.0164)	(0.0294)	(0.0378)
$Distance_p$ × 2010	0.0259	0.00226	-0.031	0.0614*
	(0.0182)	(0.0176)	(0.0340)	(0.0371)
$Distance_p$ × 2011	0.177***	0.152***	0.0483*	0.154***
	(0.0339)	(0.0323)	(0.0288)	(0.0380)
Control variables	N	Y	N	Y
Fixed effects	Y	Y	Y	Y
Observations	6900	6900	6900	6900
R_squared	0.112	0.131	0.409	0.558

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. All regressions include province, industry and year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of control variables; N indicates that the controls are not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.

Control variables include: *# of Taiwan FDI_{ipt-1}, # of Total $Firms_{ipt-1}$, $Wage_{pt-1}$*

* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 7

Impact of Direct Flight Policy Shock with Alternative Cut-offs

	Placebo Treatment Periods											
	2002-2005; Post=2004, 2005		2003-2006; Post=2005, 2006		2004-2007; Post=2006, 2007		2005-2008; Post=2007, 2008		2006-2009; Post=2008, 2009		2007-2010; Post=2009, 2010	
	Growth Rate	New FDI	Growth Rate	New FDI	Growth Rate	New FDI	Growth Rate	New FDI	Growth Rate	New FDI	Growth Rate	New FDI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$Distance_p \times Post$	0.00345 (0.0120)	0.00395 (0.0249)	-0.00245 (0.0121)	0.0144 (0.0232)	-0.0161 (0.0144)	0.029 (0.0240)	0.00305 (0.0118)	0.0475** (0.0202)	0.0250** (0.0109)	0.0532** (0.0237)	-0.000291 (0.0108)	-0.00067 (0.0224)
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2760	2760	2760	2760	2760	2760	2760	2760	2760	2760	2760	2760
R_squared	0.156	0.621	0.121	0.605	0.116	0.598	0.11	0.593	0.113	0.571	0.134	0.569

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of a control variable; N indicates that the control is not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.

Baseline controls include: *# of Taiwan* FDI_{ipt-1}, *# of Total Firms* $_{ipt-1}$, $Wage_{pt-1}$, *Market Access* $_{pt-1}$

* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 8

Robustness to Using Within-Region Variation Only

	Dependent variable					
	Taiwanese FDI growth rate			Taiwanese new FDI plants		
	(1)	(2)	(3)	(4)	(5)	(6)
Distance$_p$×Post	0.0315*** (0.0094)	0.0199* (0.0105)	0.0154 (0.0100)	0.0521*** (0.0176)	-0.0164 (0.0147)	0.0294* (0.0176)
Controls variables	Y	N	Y	Y	N	Y
Coastal Province Fixed Effects	N	Y	Y	N	Y	Y
Observations	6900	6900	6900	6900	6900	6900
R_squared	0.194	0.187	0.2	0.575	0.424	0.577

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion control variables; N indicates that the controls are not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.
Control variables include: *# of Taiwan FDI$_{ipt-1}$, # of Total Firms $_{ipt-1}$*
* indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

Table 9

Robustness to Controlling for Lagged Dependent Variable

	Dependent Variable							
	Taiwanese FDI growth rate				Taiwanese new FDI plants			
	Distance between Taiwan and Chinese Province				*Distance* between Taiwan and Chinese Province			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Distance_p \times Post$	0.0513***	0.0431***	0.0314***	0.0305***	0.0133	0.0454***	0.0296**	0.00745
	(0.010)	(0.010)	(0.0093)	(0.00866)	(0.011)	(0.013)	(0.013)	(0.0142)
Lagged D.V.	-0.0163	0.0016	0.0013	0.0237	0.561***	0.397***	0.394***	0.442***
	(0.0174)	(0.018)	(0.018)	(0.0190)	(0.0539)	(0.0553)	(0.0554)	(0.0147)
Lagged D.V. ×Post				-0.0253				-0.131***
				(0.0288)				(0.0178)
Baseline Controls								
$\#\ of\ Taiwan\ FDI_{ipt-1}$	N	Y	Y	Y	N	Y	Y	Y
$\#\ of\ Total\ Firms_{ipt-1}$	N	Y	Y	Y	N	Y	Y	Y
$Wage_{pt-1}$	N	N	Y	Y	N	N	Y	Y
$Market\ Access_{pt-1}$	N	N	Y	Y	N	N	Y	Y
Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y
Observations	6900	6900	6900	6900	6900	6900	6900	6900
R_squared	0.178	0.192	0.194	0.195	0.604	0.624	0.625	0.628

Note: Observations are at industry-province level. All regressions use a baseline sample of 30 provinces and 23 ISIC Rev.4 2-digit industries. The periods are from 2002 to 2011. The dependent variable is either Taiwanese FDI growth rate or natural log of Taiwanese new FDI projects. *Distance* is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The Post indicator variable equals zero for the periods 2002-2007 and one for the periods 2008-2011. All regressions include province and industry-year fixed effects. Each control variable listed is either provincial or industrial time variant. A Y indicates the inclusion of a control variable; N indicates that the control is not included in the specification. Coefficients are reported with standard errors, clustered at the province-industry level, in parentheses.

* Indicates significance at the 10 percent level; ** indicates significance at the 5 percent level; *** indicates significance at the 1 percent level.

CHAPTER 3

THE IMPACT OF TRADE COSTS ON HORIZONTAL AND VERTICAL FDI—EVIDENCE FROM TAIWANESE FDI IN CHINA

1. Introduction

What are the motivations that drive firms to establish their production facilities in foreign countries? Is it to save trade costs by serving the foreign market locally, or to take advantage of factor-price differentials, or both? The abundant theoretical literature studying the patterns of foreign direct investment (FDI) has identified two main types of FDI: horizontal and vertical FDI. With horizontal FDI, firms serve the foreign market by producing the final products locally to avoid trade costs, whereas with vertical FDI firms take advantage of cross-country factor cost differentials. Hence, the patterns of FDI have often been predicted on the basis of industry and country characteristics in which the affiliates are in operation. However, the main challenge in examining the casual relationship between the locations of FDI and the motivations explained by the theoretical models is to find an identification strategy that allows one to distinguish between horizontal and vertical FDI.

In this paper, I aim at investigating the relative impact of trade costs on horizontal and vertical FDI across industries. Since trade costs are recognized as one of the determinants in both horizontal and vertical FDI theoretical models, the understanding of their impact on different type of FDI is empirically relevant. Although there are abundant empirical studies on the impacts of other determinants, such as market access or factor cost differentials, on the patterns of FDI since 1990s, there are fewer studies on the relative impact of trade costs on the distribution of horizontal and vertical FDI activities. This might be due to limitations on data availability and methods to classify horizontal and vertical FDI. By exploiting unique firm-level data on Taiwanese public listed firms' affiliate in China during the period 2001 to 2011, I aim at providing solid empirical evidence to identify the causal effect of trade costs on the distribution of horizontal and vertical FDI across space.

Alfaro and Charlton (2009) point out that the challenges are mainly related to the need for high quality data. The data should include information on location, ownership, and intra-firm trade flows within multinational firms at the plant level. Due to data limitation, many empirical studies instead employ information on multinational activities at the industry level, such as the share of the affiliates' exports to the parent firm to total affiliates output, or aggregated FDI flows from balance-of–payments statistics as a proxy for foreign affiliate's activity. Empirical findings generally support the market access motive (horizontal FDI) while rejecting the low transport and factor costs motives (vertical FDI). For example, Brainard (1997) assessed the motivations of horizontal FDI by using U.S. trade data and affiliate sales data and found that higher trade costs reduce the affiliate's exports in favour of affiliate sales at the foreign market.

As the theoretical literature predicts (see Markusen, 1984; Helpman, 1984; Markusen & Venables, 2000; etc.), trade costs have different impacts on horizontal and vertical FDI locations. In the horizontal FDI model, given foreign market size, as trade costs between the host and home country increase, firms will prefer to establish foreign production facilities rather than exporting, with the aim of reducing trade costs. Instead, in the vertical FDI model, given the factor cost differentials, firms will chose to locate the production affiliates, which is part of the production processes, in the closer destinations in order to reduce the trade costs resulting from intra-firm trade. However, in the empirical literature, the use of bilateral geographical distance as a proxy for trade costs seems to provide inconclusive predictions on the patterns of FDI. For instance, Fajgelbaum et al. (2013) find that the estimates of trade costs have a significantly negative impact on horizontal FDI activities, which goes against the predictions of the horizontal FDI model[30]. The first contribution of this paper is to shed light on the role of trade costs on horizontal and vertical FDI locations by using panel data on Taiwanese firm-level FDI in Chinese provinces during the period from 2001 to 2011. The findings show that as the distance between Taiwan and the Chinese provinces increases, vertical FDI affiliates tend to locate relatively closer to the home country in comparison to the horizontal ones. These results provide solid support for theoretical predictions on the patterns of horizontal and vertical FDI locations.

Carr et al. (2001) examine the cross-country trade cost effects on the patterns of FDI[31]. Their empirical specification, however, separates the distance effect from the overall trade costs. This is because the sign of the distance

[30] Fajgelbaum et al. (2013) argue that these results could be rationalized in an extended version of the model with intermediate inputs. Irarrazabal et al. (2013) show that a negative coefficient on distance is consistent with a model of horizontal FDI when allowing for trade in intermediates goods.

[31] They assess the impact of bilateral trade costs between the host and home country on foreign affiliates sales. The trade costs effects include three estimates: host country trade costs, home country trade costs and the interaction between the host country trade costs and the endowment difference between home and host country.

variable is ambiguous due to the fact that distance is an element of both exports costs and investment and monitor costs (Carr et al., 2001). Recently, the empirical trade literature also suggests that geographical distance has cross-industry effects and can be at least decomposed into transaction and transport costs. For example, Cristea (2010) indicates that an industry with more relationship-specific investments tends to incur higher transaction costs than industries with few specific-relationship investments. Besides, Horrigan (2010) suggests that industries with higher value-weight ratio in air shipments can afford to trade goods in distant countries. This implies that the distance effect can be further decomposed to exploit the cross-industry variation on the patterns of FDI.

Since Taiwan and China share a common culture and the data on Taiwanese affiliates provides information at provincial level, I can eliminate country-invariant tariff as well as other intangible trade costs such as language or institutions, which are commonly considered as distance correlated costs. Hence, I can better identify the cross-industry distance effects on horizontal and vertical FDI locations. To the best of my knowledge, this has not been fully investigated in the literature. Based on the transaction and transport costs channels identified in Chapter 2 of this thesis, the second contribution of this paper is to provide solid empirical evidence of heterogeneous trade costs effects on the patterns of FDI across industries. The results show that vertical FDI affiliates are more sensitive to both transaction and transport costs channels than horizontal FDI.

The Taiwanese firm-level dataset provided by Taiwan Economics Journal (TEJ) is on the basis of Taiwanese public-listed firms' direct investments in China. It enables me to investigate the effect of trade costs on multinational activities comprehensively at a more disaggregated industry level. The TEJ dataset includes information on location, ownership, primary products and the parent firm's information for each affiliate. By employing this information, I identify more than 3,000 new multinational affiliates in 87 industries and 29 provinces during the period 2001-2011. This unique panel dataset on new FDI affiliates allows me not only to use fixed effects estimators to reduce industrial selection biases or control for unobserved provincial characteristics, but also to clearly assess the effect of trade costs on the new foreign affiliates. Thus, the potential biases resulting from the exit of foreign affiliates in the stock level data can be controlled for. In the data section, I also produce a number of checks to ensure that the data is representative of the full sample.

A limitation of this dataset is that it does not provide the affiliates' sales and intra-firm trade within multinational firms, which is a common way to distinguish horizontal and vertical FDI affiliates in the empirical literature (Brainard, 1997; Yeaple, 2003; Carr et al., 2001; etc.). Following Alfaro and Charlton (2009) and Fajgelbaum et al. (2013), I use a combination of four-digit International Standard Industrial Classification Rev. 4 (ISIC Rev.4) industry-level information and U.S. Bureau Economic Analysis (BEA) 2002 Benchmark Input-Output Tables to distinguish horizontal and vertical FDI affiliates. In this paper I further break down vertical FDI into inter-and intra-industry vertical FDI based on Alfaro and Charlton's (2009) method. Inter-industry vertical FDI is defined when the parent firm and affiliate have different two-digit ISIC Rev. 4 code, while intra-industry vertical FDI pairs share the same two-digit but different three or four-digit codes.

Although both inter- and intra-industry affiliates are vertical in the sense that they are in industries that provide inputs to their parents firm, Alfaro and Charlton (2009) indicate that their findings derived from intra-industry FDI are not closely consistent with the standard vertical FDI theories, which emphasizes the factor cost differentials motive. They find that intra-industry vertical affiliates, which are mostly located in rich countries and in industries with proximate stage of production process to the parent firm, are less attracted by the host country's comparative advantage. Since trade costs are another important motive in the vertical FDI models, it is worth assessing whether trade costs have a different impact across inter-and intra-industry vertical FDI affiliates. Hence, the third contribution of this paper is to provide the empirical evidence of impact of the trade costs on the intra-industry vertical FDI for theoretical considerations.

The paper is organised as follows: Section 2 provides a discussion of the related theoretical and empirical literature on patterns of FDI. Section 3 describes the data and patterns of horizontal and vertical FDI. Section 4 presents the horizontal and vertical FDI patterns. Section 5 presents the empirical strategy and results. Section 6 offers concluding remarks.

2. Related Literature

A multinational firm is defined as "…an enterprise that controls and manages production establishments-plants-located in at least two countries establishes business enterprises in two or more countries." (Caves, 2007) Although the corporate structure of a multinational firm might be complex, it is generally defined by two types of entities, the parent and the affiliate. According to Antras and Yeaple (2013), parent firms are entities located in one country that control productive facilities, while affiliates are located in other countries. The control between the parent and the affiliate is associated with the ownership resulting from foreign direct investments.

The pattern of multinational activities has long been recognized to be complex, and there was no formal theory about the relationship between multinational firms' activities and host and home country characteristics until the 1980s. The very first general equilibrium model of FDI locations was built by embedding multinational firms' activities in trade theory. This theoretical framework focused on two types of multinationals' investments: horizontal FDI and vertical FDI.

According to the horizontal FDI model, multinationals arise because of the potential to save on transaction and trade costs, as a substitute for exports. When trade costs in the host country are low, a firm can undertake production at home and serve the host country market through exports. However, when trade costs are high, a firm becomes a multinational to undertake the same production both at home and abroad, and serve the foreign market by producing locally instead of exporting to it. This type of FDI is called horizontal because the multinational replicates a subset of its activities or production processes in another country. Hence, the arm's-length exports and horizontal FDI are two alternative ways to serve a foreign market. Firms with headquarters in the home country produce final goods in plants located in the home and host country to serve each market separately (see Markusen, 1984 and Markusen & Venables, 2000)

Firms engage in vertical FDI when they break the value-added chain in order to take advantage of international factor-price differentials. Firms engage in two activities: headquarter services and plants production. Headquarter activities are physical or human capital intensive, while plant activities are manual labour intensive. When there are no factor-price differences across countries, the activities of both the headquarters and plants are carried out in the domestic market. When factor prices differ across countries, firms become multinationals and split the activities of headquarters and plants. Firms locate their headquarters in a country that is relatively abundant in skilled labour and production plants in countries where unskilled labour is relatively abundant. Hence, intra-firm trade of inputs and FDI are complements. Helpman's (1984) model of multinational firms predicts that vertical multinational activities, i.e. maintain their headquarters in the home country and establish production plants in other countries, will increase as the relative factor endowment differences between the home and host countries increase.

The empirical evidence on patterns of FDI activity generally gives strong support to the predictions of the horizontal model. For example, Brainnard (1997) and Carr et al. (2001) show that FDI is high in countries with higher trade costs and low plant economies of scale, while the factor abundance has little impact on FDI locations. Their results support the horizontal investment model along with the market access motive, but reject the vertical FDI, which is motived by low trade costs and comparative advantage across countries.

In recent empirical investigations of vertical FDI, however, the comparative advantages considerations on multinational firms' location decisions are supported by, for example, Yeaple (2003) and Hanson et al. (2005). Alfaro and Charlton's (2009) findings, based on global firm-level data, show that in the more aggregated industrial level, vertical FDI will arise in countries where production factors are relatively cheap.

In the empirical literature on FDI location, it has been well documented that bilateral distance, as a proxy for trade costs, has consistent and negative effect on FDI location (Egger and Pfaffermayr, 2001; Keller & Yeaple, 2009; Mayer et al., 2010; etc.). However, there are only few further investigations on the relative distance effect on vertical and horizontal FDI. This is because the firm-level FDI data with detailed product information, production locations and intra-firm trade flows are difficult to acquire. Hence, the identification strategy to define vertical and horizontal FDI becomes the crucial empirical challenge. Egger (2008) employs US bilateral FDI stocks panel data at industry level to examine the distance-related effects on the distribution of US horizontal and vertical FDI. The results provide strong support for horizontal FDI models. However, in the empirical specification, the use of total FDI stocks as the outcome of interest cannot distinguish the horizontal and vertical FDI. Hence, it is not possible to identify the relative distance effect on horizontal and vertical FDI.

Alfaro and Charlton (2009) exploited the firm-level dataset provided by Dun & Bradstreet on global multinational activities. They establish a method to classify the relationship between the parent and the foreign affiliates into horizontal and vertical FDI by inferring from their products' input-output linkage. They also further define two sub-categories of the vertical FDI: inter- and intra-industry vertical FDI. Inter-industry vertical FDI is defined when the parent and affiliates are in different two-digit Standard Industrial Classification (SIC) codes, while intra-industry vertical FDI is defined when the parent and affiliates are in the same two-digit SIC codes but have different 3 or 4 digit codes. Their findings generally support the trade costs motive on vertical FDI locations, i.e., the negative coefficient on the bilateral distance variable. It is worth noticing that they present the results that intra-industry vertical affiliates tend to locate in richer countries, which contradict to theoretical predictions on factor price differentials. The findings indicate that not only the factor costs comparative advantage become insignificant, but also the magnitude of the coefficient on trade costs decreases. The explanations could be that intra-vertical FDI affiliates, which is in the same proximate production stage as the parent firm, are more likely to establish in the countries with better governance or better quality of contracting institutions[32]. However, they did not provide further results of the relative effect of trade costs on the inter- and intra-industry vertical FDI locations.

Even though trade costs are of theoretical importance, the empirical specification of trade costs is far from being direct and quantifiable. Bilateral distance is commonly used as a proxy for trade costs. The inverse distance is employed as a discount factor to measure region or country market access (Redding & Veneables, 2004; Amiti & Javorcik, 2008). Distance is also the important determinant of transport costs of goods shipments (Hummels, 2007). Moreover, in Mayer et al (2010), transaction costs, which are approximated by

[32] Nunn (2007) shows that countries with a poor contractual environment tend to specialize in industries in which relationship-specific investments are not important. The contracting institutions affect the patterns of trade through comparative advantage channel.

bilateral distances, languages and law origins, can be taken as one of the determinants of firms' choice of location. Fujita and Mori (2005) summarized that it is important to distinguish the two different types of impediment to trade in space, i.e. transport costs for goods, and communication costs for doing business over space. In Chapter 2, based on the literature discussed above, I have identified transaction and transport costs channels of the trade costs by employing two intensity measures: contract intensity and unit value intensity.

It has been argued that trade costs have heterogeneous effects on the distribution of economic activities across industries. Cristea (2011) indicates that exporting firms in the industry requiring specific-relationship investment, i.e. higher contract intensity, will face higher transaction costs. On the other hand, Harrigan (2010) claims that exporting firms in the industry with higher value-weight air shipments ratio, i.e. higher unit value intensity, will bear relative smaller ad-valorem transport costs than those in the lower value-weight ratio industry. Hence, in Chapter 2, I created the contract intensity and the unit value intensity to measure the relative distance effect on FDI locations across industries. The empirical findings from Chapter 2 suggest that the higher the contract intensity (the higher requirement for relationship-specific investments), the higher the transaction costs. The parent firms tend to establish the foreign affiliate in the higher contract intensity industry in a closer location. On the other hand, the higher the unit value intensity (the higher value-weight ratio of air shipments), the lower the ad-valorem cost premium for the transport cost. Thus, the parent firms can afford to establish the foreign affiliates in the higher unit value intensity industries in the locations further away from the home country than lower ones.

In sum, the horizontal FDI model predicts that market access and trade costs are two major host country characteristics affecting horizontal FDI locations. The larger the market access, the stronger incentive the parent firm has to establish the foreign affiliate in order to serve the local market. Also, if the trade costs become higher, the parent firm will not serve foreign markets through exports but through local affiliates. On the other hand, the location characteristics conducive for vertical FDI differ from those for horizontal FDI and principally concentrate on factor price differentials and low trade costs. As the differences in factor prices increase between the home and host country, the parent firm is motivated to divide production into discrete processes and locate individual process in the country that provides the most favorable environment. Production fragmentation leads to intra-firm trade between headquarters and foreign affiliates. Hence, as trade costs decrease, the intra-firm trade flows increase. Therefore, based on the theoretical literature, this paper aims at providing empirical evidence on the relative importance of trade costs on the pattern of FDI locations by testing the following three hypotheses of related trade costs effects:

1) Trade costs – approximated by bilateral distance - have a negative impact on the formation of new vertical FDI affiliates in comparison to the horizontal FDI;
2) With the same transaction or transport costs intensities, vertical FDI affiliates will be affected relatively more than horizontal FDI as the trade costs increase;
3) The negative impact of trade costs on intra-industry vertical FDI affiliates is smaller than inter-industry vertical FDI.

3. Data

3.1 Data sources

In this paper, I use three sources of data. In the first place, I use data on Taiwanese public listed firms' FDI in China, collected from the Taiwan Economic Journal (TEJ). TEJ collects the FDI information from firms' annual financial statements as well as FDI registration data from the Ministry of Economic Affairs (MOEA). The unit of foreign affiliates in TEJ dataset is the firm. It provides the business names, addresses, investment types, ownership, primary products, and the capital flow of these affiliates in China. Parent's primary industry code is recoded using Taiwanese industrial classification, which is based on four-digit ISIC Rev. 4 system. The affiliate's code is not reported, but can be filled in by using the information of affiliate's primary products. To be consistent with the empirical literature, I construct the dataset with both parent and affiliate being in the manufacturing sector during the period between 2001 and 2011. Combining the affiliate's name and location in China and MOEA's registration date, it is possible to identify the 3,023 new FDI affiliates spanning cross 87 four-digit ISIC Rev. 4 industries. This paper will use the number of new FDI affiliates as the dependent variable to investigate the impact of the distance at the extensive margin, i.e., more firms participate in multinational activities.

To validate the representative of TEJ data, I compare the number of new TEJ affiliates aggregated by year and province with information on Taiwanese FDI projects by the MOEA (see Figure 1-1 and 1-2). According to Taiwan's FDI regulations, both individuals' and firms' FDI projects in China have to be approved by MOEA, or register in MOEA if the amount of investment is under \$200,000. Complete firm-level data is not available, but the MOEA provides monthly and annual reports on all registered/approved FDI projects in China with information covering 25 provinces/regions with two-digit ISIC Rev. 4 codes. However, MOEA's data is based on projects not affiliates. Figure 1 plots total number of FDI projects (by year and province) from the MOEA against total new affiliates (by year and province) in the TEJ data. The correlation between the two datasets is 0.81, suggesting that the cross-province and year distribution of Taiwanese multination activity in the TEJ data matches that in the MOEA registered data. Moreover, Figure 1-2 demonstrates that the two datasets are highly correlated in the cross year-province-two digit ISIC industry level.

In this paper, I include as main control variables, factor prices and agglomeration externalities at the Chinese provincial level. Data on wages and gross industry output are collected from the Chinese Statistical Yearbook. The market access of province j is the summation of: 1) distance discounted final consumption of all other provinces i, i ≠ j, and 2) province j's final consumption discounted by the radius of area. I also construct the market access with zero trade costs within province, i.e. the inversed intra-province distance equals to 1. Two market access measurements are highly correlated (0.71). Hence, considering the huge variation in the size of Chinese provinces (the standard deviation is 118,630.4), the radius intra-province distance is better to account for the ease of the access within each province by controlling the impact of geographic unit.). In the regression analysis, I also use the market access measurement with the zero trade costs (D_{ii}=1) intra-province distance as a sensitivity check. The estimated results are qualitatively consistent with signs and significance as the market access variable with the radius intra-province distance.

Finally, the Taiwanese industrial agglomeration data is collected from the MOEA's annual FDI reports. They provide the number of projects and amounts of FDI in twenty-five Chinese provinces/regions in twenty-three two-digit ISIC Rev.4 industries. I use the cumulated industrial FDI projects as the proxy for Taiwanese agglomeration in each province.

The major variables of interest are the trade costs between Taiwan and China. Due to data constraints on calculating precise cost measures, I employ the distance between Taiwan and capital city of each Chinese province as a proxy for trade costs[33]. The distance is calculated by using Google Earth.

Based on the methods established in Chapter 2, I reconstruct contract and unit value intensities for three-digit ISIC Rev. 4 codes to investigate the relative impact of transaction and transport costs on horizontal and vertical FDI locations. As for contract intensity, the top five contract intensive industries are: Manufacture of motor vehicles (ISIC 291), Manufacture of parts and accessories for motor vehicles (ISIC 293), Manufacture of bodies (coachwork) for motor

[33] Distance is commonly used as a proxy for trade costs in the new economy geography or international trade literature. Disdier and Head (2008) provide a thorough evaluation of the distance effect on trades.

vehicles, Manufacture of trailers and semi-trailers (ISIC 292), Manufacture of measuring, testing, navigating and control equipment, watches and clocks (ISIC 265) and Manufacture of irradiation, electromedical and electrotherapeutic equipment (ISIC 266). The least five intensive industries are: Manufacture of refined petroleum products (ISIC 192), Manufacture of basic precious and other non-ferrous metals (ISIC 242), Manufacture of basic chemicals, fertilizers and nitrogen compounds, plastics and synthetic rubber in primary forms (ISIC 201), Casting of metal (ISIC 243) and Manufacture of other food products (ISIC 107).

As for the unit value intensity, the top five unit value intense industries are: Manufacture of pharmaceuticals, medicinal chemical and botanical products (ISIC 210), Manufacture of other chemical products (ISIC 202), Manufacture of basic precious and other non-ferrous metals (ISIC 242), Manufacture of medical and dental instruments and supplies (ISIC 325), and Manufacture of man-made fibres (ISIC 203). The five least intensive industries are: Manufacture of furniture (ISIC 310), Manufacture of beverages (ISIC 110), Manufacture of plastics products (ISIC 222), Manufacture of products of wood, cork, straw and plaiting materials (ISIC 162), and Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing and dyeing of fur (ISIC 151). In short, these two intensity measurements can reflect heterogeneous industrial characteristics on transaction and transports costs.

3.2 Horizontal and Vertical FDI

To investigate the patterns and the determinants of FDI locations, the ideal data should be able to distinguish horizontal and vertical FDI. However, it is difficult to have a clear-cut distinction. First of all, not all divisions of production stages can be neatly classified as horizontal or vertical. Secondly, the empirical study requires firm-level information on the sales and purchases of inputs by foreign affiliates. Furthermore, foreign affiliates' sales have to be categorised according to their destination: sales to local market, exports to home country, or exports to the third country. And the imported inputs of foreign affiliates need to be classified based on whether they are used for further reprocessing or for resale in the local market. However, detailed firm-level data with which to analyse the activities of multinational firms are not generally available.

Since the Taiwanese dataset does not provide intra-firm trade flows, which is used in the trade literature to identify the vertical FDI, Alfaro and Charlton's (2009) method is a feasible identification strategy to distinguish horizontal and vertical FDI affiliates by using firm ownership data and an input-output matrix. In Alfaro and Charlton's (2009) data, there was no intra-firm trade information to identify vertical and horizontal FDI. They solved this issue by inferring the intra-firm trade from information about the goods produced in the parent firm and foreign affiliates and the aggregate input-output linkage between these goods. As their dataset covered many countries and industries, they argued that this method should not cause concerns about the value of intra-firm trade being affected by transfer pricing. In addition, this method avoids the arbitrariness of classifications of products for the "intermediate" inputs or others. Therefore, this input-output linkage method is employed for the Taiwanese FDI data, which is disaggregated in finer industry level across Chinese provinces and years. Since Taiwanese FDI data is a panel dataset, I can even better control for other unobserved and time invariant provincial, industrial and province-industry characteristics in this empirical study.

According to U.S. input-output tables, horizontal FDI is defined when the activity of foreign affiliates is in the same industry of their parent, and vertical FDI when the activity of foreign affiliates is in the industries upstream from the parent industry. Foreign affiliates are neither vertical nor horizontal if they satisfy neither of these criteria, and if they satisfy both, they will be called complex FDI[34]. In this paper, I characterize the input-output links among industries using the direct requirements table from U.S. Bureau Economic Analysis (BEA) 2002 Benchmark Input-Output Tables. The observation in the table is a commodity-industry pair, and the direct requirements coefficient, d_{ij}, specifies the value of inputs from industry i needed to produce one dollar of output in industry j. The commodities and industries are defined using the BEA six-digit industry codes, which I can map into the 2007 NAICS classification. And then they are matched to the four-digit ISIC Rev. 4 assigned in the TEJ dataset by using the BEA concordances[35]. There are 130 manufacturing industries

[34] Please see Alfaro and Charlton (2009) for detailed information.

[35] The BEA provides following concordances tables: 2002 I-O industry code to 2002 NAICS, 2002 NAICS to NAICS 2007, and ISIC Rev. 4 to NAICS 2007. Based on the industry descriptions, the direct requirement coefficient is allocated to ISIC Rev. 4 from 2002 I-O industry code.

in the four-digit ISIC Rev. 4 classification. In this paper, as the literature suggested (Alfaro and Charlton, 2009 and Ramondo et al., 2012), the threshold of $d_{ij} > 0$ is selected to determine the strength of the relationship required to assume that an affiliate is a supplier to this parent[36].

[36] I also use the BEA 2002 Total Requirement Table and choose various thresholds: 0.01, 0.001 and 0.005. Those results are qualitatively consistent across different thresholds.

4. Patterns of Horizontal and Vertical FDI

By using the direct requirement coefficient matrix with the Taiwanese parent-affiliate industry pairs, I can describe the most frequent manufacturing parent-affiliate combinations. Table 1 shows that, out of all the manufacturing FDI affiliates in the data, 1,361 are vertical and 1,599 are horizontal at four-digit ISIC Rev. 4 level. In Table 2, the most common horizontal pair is Manufacturing Computer Components and Boards (ISIC 2610), and the second is Manufacture of Computers and Peripheral Equipment (ISIC 2620). On the other hand, Table 3 demonstrates that the most common vertical industry pair is Manufacturing of Computers and Peripheral Equipment (ISIC 2620) affiliates supplied by the Manufacturing of Computer Components and Boards (ISIC 2610). The second most common pair is Manufacturing of Computer Components and Boards (ISIC 2610) supplied by Manufacturing of Computers and Peripheral Equipment (ISIC 2620). The third most common pair is Manufacturing of Computer Components and Boards (ISIC 2610) supplied by Plastics Packaging Materials and Unlamented Film and Sheet Manufacturing (ISIC 2220). Those observations suggest that this approach captures supply chain relationships.

The average value of the direct requirements coefficients in the I-O matrix is only 0.001, and 70 percent of the industry pairs do not have an input-output relationship. The direct requirements I-O table also shows that most industries require inputs from similar industries: the entries in the direct requirements matrix tend to be the largest on or near the diagonal. In the Taiwanese parent-affiliate data, the average direct requirements coefficients jump to 0.009 when the affiliate is upstream. This suggests that in the Taiwanese parent-affiliate data, the parent owns affiliates in similar industries and that these industries are important producers of intermediate inputs for each other.

A large share of these production chains linkages is unreported when the data are aggregated at the two-digit ISIC rather than the four-digit ISIC industry. That is, many parent-affiliate pairs operate in industries that share the same two-digit ISIC industry, but have different three and/or four-digit ISIC industries. Table 1 shows that, in two-digit aggregation level, only 780 affiliates are allocated as vertical FDI, while in four-digit level, there are 1,361 vertical FDI affiliates. About 40 percent of the vertical FDI observed is not visible at the two-digit level because only at finer levels of disaggregation it is clear that these foreign affiliates are in industries that produce inputs to their parents' products. Alfaro and Charlton (2009) argue that the distinction between vertical investments visible at the two- and four-digit level is more than of labeling: there are in fact different products, one being an input to the other. Hence, in this paper, the main results are made from using 4-digit ISIC Rev. 4 code to reduce the measurement bias.

Moreover, based on Alfaro and Charlton (2009) definition, I further distinguish the vertical FDI into inter-and intra-industry vertical FDI. Inter-industry vertical FDI is labeled when the parent and affiliate operate across two-digit ISIC codes, and intra-industry vertical when the parent and affiliate operate cross four-digit industry codes. According to the input-output linkages, I argue that the inter-industry vertical FDI has different motivations, product characteristics, and location determinants from intra-industry vertical FDI. This provides the opportunity for further investigations on the relative distance effect on inter-industry and intra-industry vertical FDI. For example, Manufacturing of Computers and Peripheral Equipment (ISIC 2620) affiliates supplied by the Manufacturing of Computer Components and Boards (ISIC 2610) are classified as intra-industry vertical FDI, while Manufacturing of Computer Components and Boards (ISIC 2610) supplied by Plastics Packaging Materials and Unlamented Film and Sheet Manufacturing (ISIC 2220) are as inter-industry vertical FDI. Figure 2 shows the parent-affiliate industry combinations for both inter- and inter-industry vertical FDI in the manufacturing sector (ISIC, 1010-3290). We can observe that intra-industry affiliates are, by construction, close to the diagonal line, whereas inter-industry FDI is more widely spread.

Industry characteristics differ among horizontal, inter-industry and intra-industry FDI. Table 4 shows that horizontal FDI affiliates are in industries with higher contract intensity than vertical ones, whereas there is no significant difference in unit value intensity between horizontal and vertical FDI. Host country characteristics of horizontal and vertical FDI also differ. Horizontal FDI, on average, are more likely to be found in distant locations. In Table 5, the average distance is still significantly different between inter-and intra-industry vertical FDI affiliates, while there is no significant difference in the factor costs motive (wages) and market access motive. It suggests that trade costs might still be a dominant determinate of vertical FDI locations. Figure 3-1 and 3-2 demonstrate that the bilateral distance has general negative effect on FDI locations.

5. Empirical Strategies and Results

5.1 Baseline Estimates

Following the empirical literature on FDI location (Egger 2008, Alfaro and Charlton, 2009, Mayer et al., 2010, etc.), I assess the importance of trade costs in the determination of horizontal and vertical patterns by running the following equation (1):

$$\begin{aligned} FDI_{spjt} = {} & \beta_0 + \beta_1 Distance_j \\ & + \beta_2 D\_VFDI_{sp} + \beta_3 Distance_j \times D\_VFDI_{sp} \\ & + \beta_4 Wage_{jt-1} + \beta_5 MarketAccess_{jt-1} \\ & + \beta_6 IndAgglomeration_{jt-1} + \beta_7 TaiAgglomeration_{jt-1} \\ & + \Theta \boldsymbol{X}_{jt\text{-}1} \boldsymbol{D\_VFDI}_{sp} + \varepsilon_{spjt} \end{aligned} \tag{1}$$

where the subscript s indexes the industry of foreign affiliate, the subscript p indexes the industry of the parent firm, the subscript j indexes the Chinese province, and the subscript t indexes the time periods, which are from 2002 to 2011. The outcome of interest, FDI_{spjt}, is the measure of the multinational activities either classified as the logarithm of the number of new horizontal affiliates or vertical FDI affiliates in an affiliate-parent industry pair, s-p, in province j at year t. To examine the first hypothesis based on the vertical and horizontal FDI models, trade costs, market access motive and provincial factor prices are included. First, $Distance_j$, used as a proxy for the trade costs, is the logarithm of bilateral distance between Taipei (Taiwan) and the capital city of Chinese province j. $Wage_{jt-1}$ is the logarithm of average salaries of workers and staff in province j at year t-1. This is used to approximate the factor price differentials between Taiwan and Chinese provinces. $MarketAccess_{jt-1}$ is the logarithm of measure of local market size in province j at year t-1, defined in the previous section.

In addition, empirical evidence suggests that agglomeration externalities have significant impact on FDI location in Chinese provinces (e.g., Amiti and Javorcik, 2008, Debaere et al., 2010; Chang et al., 2011). Two agglomeration variables are included in order to control for these time varying provincial characteristics. $IndustryAgglomeration_{jt-1}$ is the logarithm of total gross industry outputs in province j at year t-1. This accounts for the positive externalities that an affiliate can benefit from locating in the province where it has larger supplier access. $TaiAgglomeration_{jt-1}$ is the logarithm of total cumulated FDI projects in province j at year t-1. Taiwanese agglomeration is likely to be a favorable factor in Taiwanese firms' location choices. The findings in Chapter 1 suggest that for a newly entering firm, the agglomeration of Taiwanese affiliates in the host province demonstrates that the investment environment is favorable because of local information spillovers and lower investment risk.

D_VFDI_{sp} is the vertical FDI indicator, which equals one for the observations that are aggregated from vertical FDI affiliates, and zero for horizontal FDI. The interaction term, $Distance_j \times D\_VFDI_{sp}$, is the interaction of distance and an indicator variable. $\boldsymbol{X}_{jt-1}$ is the vector of provincial control variables in equation (1): $Wage_{jt-1}$, $MarketAccess_{jt-1}$, $IndustryAgglomeration_{jt-1}$, and $TaiAgglomeration_{jt-1}$. $\boldsymbol{X}_{jt-1} \times \boldsymbol{D\_VFDI_{sp}}$, which is the vector of interactions between control variables and the vertical FDI indicator, is included to control for all the additional effects of control variables on the patterns of vertical FDI.

The theoretical predictions suggest that in the vertical FDI sub-sample, a negative coefficient of the distance variable is expected. As provinces are closer to Taiwan, they will attract more vertical FDI projects because of lower trade costs given the similar provincial comparative advantage. On the other hand, in the horizontal FDI sub-sample, a positive coefficient is expected. As provinces are further away from Taiwan, they will attract more horizontal FDI projects because of higher trade costs given the similar size of market access.

Table 6 presents the main results of equation (1) using the ordinary least squares (OLS) estimator. In columns (1) and (2), I present the results using data at the four-digit level of aggregation (58 four-digit manufacturing industries) and information on the number of new horizontal FDI affiliates only. Columns (3) and (4), present the results for aggregated vertical FDI affiliates (63 four-digit manufacturing industries). Two specifications for each outcomes of interest are reported. The first specification regress the distance variable only, reported in columns (1) and (3). Columns (2) and (4) report the estimates from equation (1) including all controls. Overall, the coefficients of the variable of interest, $Distance_j$, show that trade costs have no expected impacts on horizontal and vertical FDI in both specifications. Since the distance variable is likely to be correlated with other unobserved provincial characteristics, such as cultures or institutions, the coefficient of distance variable might be biased. Also, the unobserved time and industrial characteristics are not controlled for. For example, some industries with highly fragmented production processes or higher share of intermediate inputs for producing final goods, such as computer, electronic and optical products or motor vehicles, may incline to agglomerate to benefit from better market or supply access than other industries in which raw materials are major inputs.

Columns (5) and (6) report the results for total FDI affiliates. To estimate the relative effect in trade costs on horizontal and vertical FDI affiliates' location decisions in the full FDI sample, vertical indicator and all its interaction terms with other repressors are included. The estimated coefficient of the distance interaction term, $Distance_j \times D\_VFDI_{sp}$, reveals the average change in the outcomes of interest arising from the types of FDI. With or without control variables, the estimates are positive but not significant, which is not in line with the theoretical predictions. This can be resulted from the same omitted variable bias faced in columns (1) to (4).

5.2 Horizontal vs. Vertical FDI

To reduce omitted variable as well as selection biases, I estimate equation (2) with industry and province-industry fixed effect estimators. The industry here is referred to affiliate's industry. There are two main unobserved affiliate's industry characteristics to control for. First, the cross-industry agglomerations effects have been considered as major determinants of FDI locations in China (see Chapter 1; Amiti & Javorcik, 2008; Debaere et al., 2010). However, due to the data limitation, these agglomeration variables in 4-digit ISIC industry level are not available. In order to uncover their impacts on affiliate's locations, the 4-didgt ISIC industry fixed effects are at play.

Second, the unobserved specific industry-province characteristics, such as comparative advantages, might bias the estimation on vertical FDI location choices. For example, the interactions between the relative difference in skilled-labour intensity or knowledge capital across affiliate's industry and provincial factor endowments might affect the patterns of vertical FDI locations. Yeaple's

(2003) and Alfaro and Charlton's (2009) results show that a skilled-labour intensive affiliate industry tends to be located more in the destinations with a relative abundant skilled labour force. Because of the data constraints on factor endowments in provincial level, the industry-province fixed effects estimator is used to reduce the omitted variables bias.

$$\begin{aligned} FDI_{spjt} &= \beta_0 + \beta_1 D\_VFDI_{sp} + \beta_2 Distance_j \times D\_VFDI_{sp} \\ &+ \boldsymbol{\Phi X_{jt\text{-}1}} + \boldsymbol{\Theta X_{jt\text{-}1} D\_VFDI_{sp}} \\ &+ v_{sj} \times D\_VFDI_{sp} + v_t \times D\_VFDI_{sp} + v_{sj} + v_t + \varepsilon_{spjt} \end{aligned} \quad (2)$$

Columns (1) and (2) in Table 7 report the results estimated by using industry fixed effects estimator. Province and time dummies are also included. The estimate of interest in column (1) is not significant and with the positive sign. In column (2), after including additional time-varying provincial control variables, the estimate of interest is significant with the expected negative sign.

Columns (3) and (4) in Table 7 report respectively the results of estimated coefficients from equation (2) by running industry-province fixed effects estimator. The coefficient of distance interaction term in column (3) is negative but not significant. In column (4), the result shows that trade costs have an addition negative impact on vertical FDI locations in comparison to Horizontal FDI. Quantitatively, according to the estimates in column (4), if the distance between Taiwan and Chinese provinces increase by 10 percentage, the number of new vertical FDI decreases by 2.48 percentage comparing to horizontal FDI. This result supports the first hypothesis that vertical FDI affiliates locate in the destinations that are closer to the parent firm to save trade costs.

5.3 Transaction and Transport costs and Patterns of FDI locations

In this section, I further examine the impact of transaction and transport costs on locations of new FDI affiliates. According to the findings in Chapter 2, in the transaction costs channel, as bilateral distances increase, the contract intensive industries will invest less than less intensive ones. On the other hand, in the transport costs channel, industries with higher unit value intensity will tend to invest in locations relatively further away than less intensive ones. In equation (3), the estimated coefficients of the distance interaction terms, *Ln* $Distance_j \times Contract\ intensity_s$ and $Ln\ Distance_j \times Unit\ value\ intensity_s$, reveal the relative effects of distance on the location choices through transaction and transport cost channels across industries.

$$\begin{aligned} FDI_{spjt} = {} & \beta_0 + \beta_1 D\_VFDI_{sp} \\ & + \beta_2 Distance_j \times CI_s \times D\_VFDI_{sp} \\ & + \beta_3 Distance_j \times UVI_s \times D\_VFDI_{sp} \\ & + \boldsymbol{\Phi X_{jt\text{-}1}} + \boldsymbol{\Theta X_{jt\text{-}1} D\_VFDI_{sp}} \\ & + v_{sj} \times D\_VFDI_{sp} + v_t \times D\_VFDI_{sp} + v_{sj} + v_t + \mu_{sjt} \end{aligned} \tag{3}$$

In Table 8, I use the Taiwanese FDI affiliates' data aggregated to three-digit ISIC Rev. 4 level. Columns (1) and (2) report the results for horizontal FDI affiliates and vertical FDI respectively. As for vertical FDI, although the estimated coefficient of transaction costs channel has the expected negative sign and the estimate of the transport costs channel has the positive sign, there is no clear significant impact of transaction and transport costs on vertical FDI locations. In the horizontal sub-sample, the estimated coefficients of transaction costs channel is significant with a negative sign, and the coefficient of transport costs channel is with a positive sign but insignificant. The results are in contrast to the theoretical predictions that horizontal FDI affiliates in relative high contract intensity industry will tend to be located more in the further away destination to save trade costs. Similarly, the locations of horizontal affiliates being in the relative low unit value industry will tend to be further away from the parent frim. In general, we cannot distinguish the relative effects of trade costs on the patterns of FDI.

Next, I examine the relative impact of trade costs through these two channels on horizontal and vertical FDI affiliates. In equation (3), the estimated coefficients of the interaction terms with vertical FDI, $Distance_j \times CI_s \times D\_VFDI_{sp}$ and $Distance_j \times UVI_s \times D\_VFDI_{sp}$, reveal the average additional effects of being vertical FDI affiliates through each specific channel. Column (3) in Table 8 shows that, if vertical affiliates are in the contract intensive industries, the parent firms tend to choose the locations relatively closer in comparison to horizontal FDI affiliates with the same intensity. If horizontal and vertical FDI affiliate are in the same contract intensive industry, a 10 percent increase in the distance reduces the number of vertical FDI affiliates by an additional 4.43 percent than horizontal FDI. The result in column (3) also indicates that, through the transport costs channel, if vertical affiliates are in the unit value intensive industries, parent firms choose locations that are relatively further away in comparison to horizontal FDI locations with the same intensity. If a horizontal and a vertical FDI affiliates are in the same unit value intensive industry, a 10 percent increase in the distance will result in an additional 0.15 percent increase in the number of the vertical FDI affiliate. In column (4), with all control variables, the coefficient of transaction costs is still significant with similar magnitude, while the significance of transport costs drops with the expected positive sign. In short, the empirical findings suggest that vertical FDI locations are much more sensitive to trade costs through both transaction and transport costs channels.

5.4 Patterns of Inter- and Intra-industry FDI

In this section, I further investigate the relative importance of trade costs on inter- and intra-industry vertical FDI by estimating the following equation:

$$\begin{aligned} VFDI_{spjt} = {} & \beta_0 + \beta_1 D\_IntraV_{sp} \\ & + \beta_2 Distance_j \times D\_IntraV_{sp} \\ & + \beta_3 Closeness_{sp} + \beta_4 Closeness_{sp} \times D\_IntraV_{sp} \\ & + \boldsymbol{\Phi X_{jt\text{-}1}} + \boldsymbol{\Theta X_{jt\text{-}1} D\_IntraV_{sp}} \\ & + v_{sj} \times D\_IntraV_{sp} + v_t \times D\_IntraV_{sp} + v_{sj} + v_t + \varepsilon_{spjt} \end{aligned} \tag{4}$$

where the outcome of interest is $VFDI_{spjt,}$, the logarithm of new vertical FDI affiliates in affiliate-parent industry pair, sp, in province j at year t. $Distance_j \times D\_intraV_{sp}$ is the variable of interest, which is the interaction between the distance and the intra-industry vertical FDI indicator. D_intraV_{sp} equals one if the observation is intra-industry vertical FDI, and zero for inter-industry vertical FDI.

Alfaro and Charlton (2009) and Ramondo et al. (2012) show that multinational firms are more likely to own the stages of production closest to the final good they supply. To control for the industrial proximity impact on the patterns of vertical FDI, I introduce a variable, $Closeness_{sp}$, which measures the proximity of two industries in a vertical production chain established by Alfaro and Charlton (2009). $Closeness_{sp}$ is simply the logarithm of absolute difference between the four-digit ISIC Rev. 4 codes of two industries, where subscript s indexes the industry of foreign affiliate and subscript p indexes the industry of parent firm. For example, Manufacturing of Computers and Peripheral Equipment (ISIC 2620) have a closeness of 10 to Manufacturing of Computer Components and Boards (ISIC 2610) and a closeness of 400 to Plastics Packaging Materials and Unlamented Film and Sheet Manufacturing (ISIC 2220). This closeness variable takes advantage of the fact that the ISIC Rev.4 categorizes similar industries together.

Table 9 presents the results of equation (4). The estimates of distance interaction in columns (1) and (2) are not significant, but in column (2), the estimate of distance interaction term is with positive sign. In columns (3) and (4), I further control for the production proximity effect. The estimated coefficient of distance interaction is with positive sign but not significant in column (4). In short, the results suggest that trade costs might affect less negatively on intra-industry vertical FDI than inter-industry vertical FDI, but this difference is not significant.

The estimated coefficients of the proximity variable are with the expected negative sign as the literature suggests (Alfaro and Charlton, 2009). The results imply that the farther apart two ISIC codes, the less vertical multinational activity is observed between them. Hence, the parent firms tend to invest in the stages of production proximate to their final production, giving rise to a class of similar factor inputs, intra-industry vertical FDI. Columns (3) and (4) also report the results of the estimates of interaction terms of the intra-industry indicator and the proximate variable. The negative and statistically significant coefficients indicate that parent firms tend to own more intra-industry affiliates which are in the similar production stages in comparison to inter-industry vertical FDI. The rationales for why firms choose to own these proximate stages of production might result from information advantages associated with co-ownership of the similar production stage, intellectual property concern or product quality control[37].

[37] Alfaro and Charlton (2009) provide detail discussion based on the existing trade literature.

5.5 Robustness Check

According to Hummels (2007), air and sea transportation costs have declined since 1970s. Although the distance is still a major part of the costs, it may not catch the change in trade costs over time. Alternatively, it has been suggested that transportation time can be taken as a type of trade costs (Hummels and Schaur, 2013). To provide a more practical measure to catch the time variation for the trade costs in this paper, I construct the estimated passenger air traveling time between Taiwan and each Chinese provincial capital. As discussed in Chapter 2, the passenger air travelling time has two components: actual flight time and estimated transfer time. These are calculated through the flight booking systems of both airlines and flight search engines[38]. This measure takes into account the change in travelling time costs over the period 2001 to 2011. For example, the open of direct flights between Taiwan and Chinese provinces dramatically change the travelling time after 2008.

Following previous specifications, $Distance_j$ is replaced with the passenger's flight time, $Flight\ time_{jt}$, which is a time varying measure of trade costs. Columns (1) and (2) in Table 10 report the results of the relative importance of trade costs on horizontal and vertical FDI. In column (1), without including provincial control variables, the estimate of flight time interaction term is positive. It reflects the similar omitted variables bias discussed in section 5.1. In column (2), once control variables are included, the coefficient of flight time interaction term has expected negative sign but not significant. Columns (3) and (4) report the results of transaction and transport costs channels. The results show that both transaction and transport cost channels are significant with the expected signs. Overall, the travelling time variable gives better results on the two trade costs channels but weaker in the baseline specification. For the transaction and transport costs channels, the robustness check further supports the findings in the previous sections that trade costs have heterogeneous impacts on the patterns of horizontal and vertical FDI across industries and provinces.

[38] For example, I use booking websites such as Skyscanner (www.skyscanner.net) and airline companies' website, such as China Airline and Eva Airways.

6. Conclusions

In this paper, I aim at investigating the relative impact of trade costs on horizontal and vertical FDI across industries. Since trade costs are recognized as one of the determinants in both horizontal and vertical FDI theoretical models, the understanding of their impact on different type of FDI is empirical relevant. Although there are abundant empirical studies on the impacts of other determinants, such as market access or factor cost differentials, on the patterns of FDI since 1990s, there are fewer studies on the relative impact of trade costs on the distribution of horizontal and vertical FDI activities. This might be due to limitations on data availability and methods to classify horizontal and vertical FDI. By exploiting unique firm-level data on Taiwanese public listed firms' affiliates in China during the period 2001 to 2011, I aim at providing solid empirical evidence to identify the causal effect of trade costs on the distribution of horizontal and vertical FDI across space.

Based on horizontal and vertical FDI theoretical models, I test three hypotheses: 1) trade costs – approximated by bilateral distance - have a negative impact on the formation of new vertical FDI affiliates in comparison to the horizontal FDI; 2) with the same transaction or transport costs intensities, vertical FDI affiliates will be affected relatively more than horizontal FDI as the trade costs increase; and 3) the negative impact of trade costs on intra-industry vertical FDI formation is smaller than inter-industry vertical FDI.

The paper exploits a novel source of data, a panel dataset of Taiwanese public-listed firms' affiliates in Chinese provinces with detail information on location, ownership, and four-digit ISIC Rev.4 between 2001 and 2011. As Alfaro and Charlton (2009), I identify each affiliates as a horizontal or vertical FDI on the basis of the input-output linkage of each parent-affiliate industry pair. I estimate the impact of trade costs on the number of new vertical and horizontal FDI affiliates by using the fixed effects estimator. This controls for unobserved industrial and provincial characteristics in order to eliminate omitted variables problems or selection issues that might cause biased estimates.

My findings indicate that the increase in distance between Taiwan and province j of 10 percent reduces the number of new vertical FDI affiliates by 2.48

percent in comparison to horizontal FDI. In addition, if both vertical and horizontal FDI affiliates are in the same industry, as the distance increases by 10 percent, the number of the vertical FDI affiliates reduces average additional 4.43 percent than horizontal FDI through the transaction costs channel, while the number increases by 0.15 percent through the transport costs channel. Finally, trade costs have no significantly relative impact on inter-and intra-industry vertical FDI.

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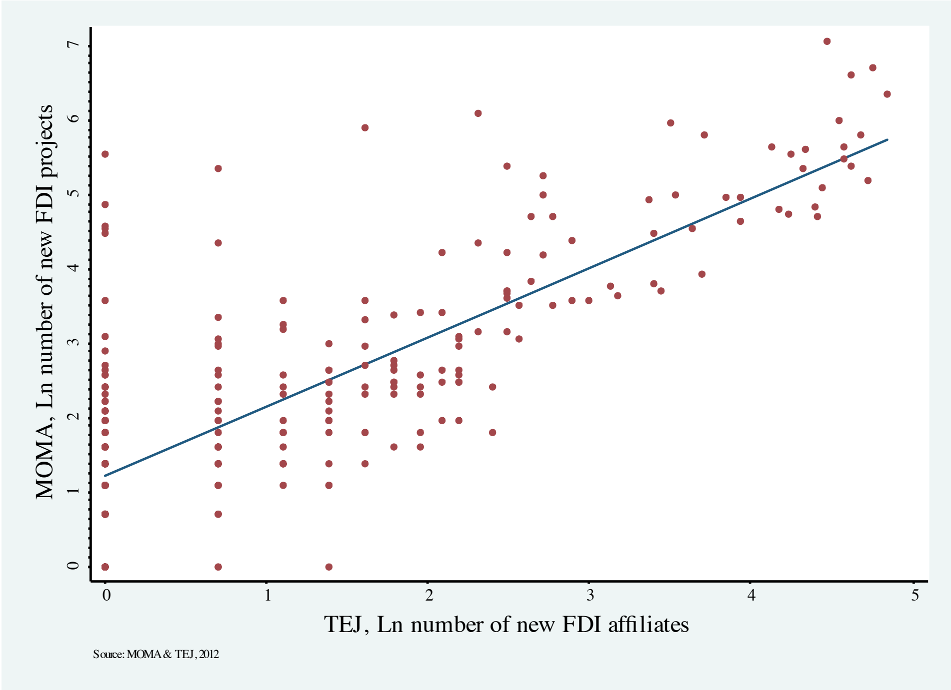

Figure 1-1

Comparison of Cross-year and province Taiwanese FDI in China:

TEJ vs. MOEA, 2001-2011

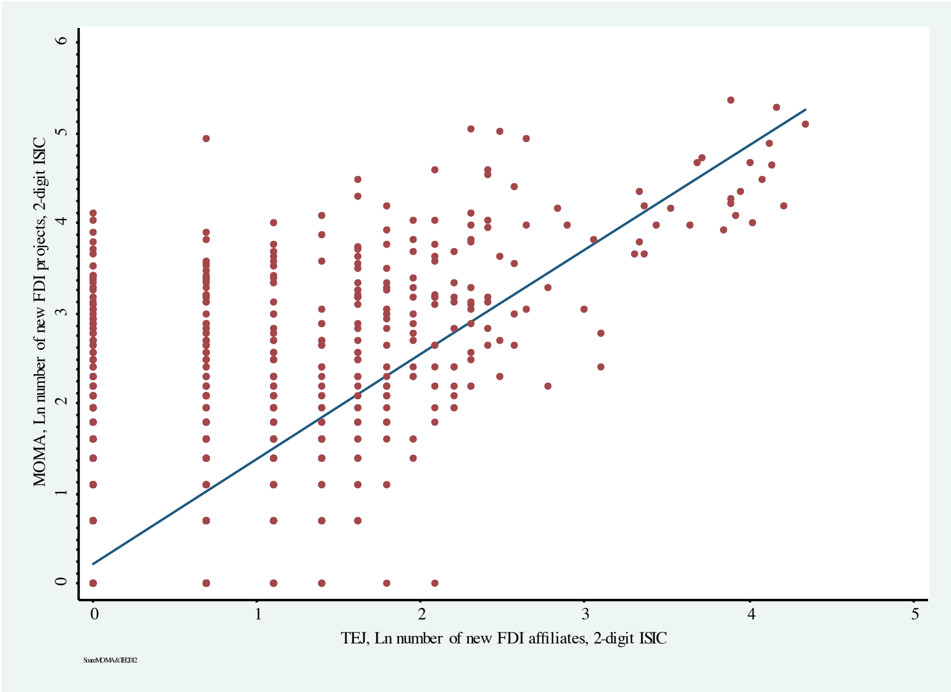

Figure 1-2

Comparison of Cross-year, province and industry Taiwanese FDI in China: TEJ vs. MOEA, 2001-2011

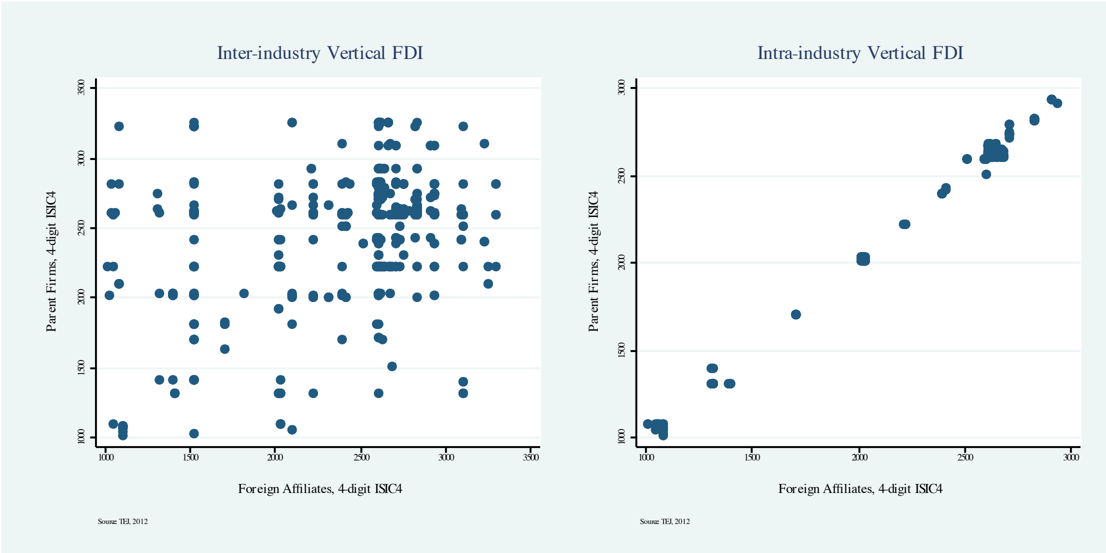

Figure 2

Taiwanese Inter- and Intra-industry Vertical FDI, 2001-2011

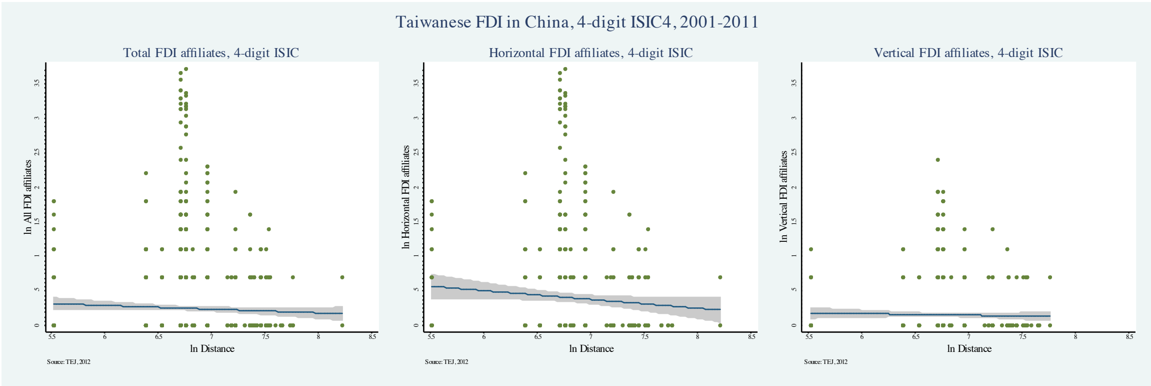

Figure 3-1

Taiwanese Total, Horizontal and Vertical FDI in China, four-digit ISIC4, 2001-2011

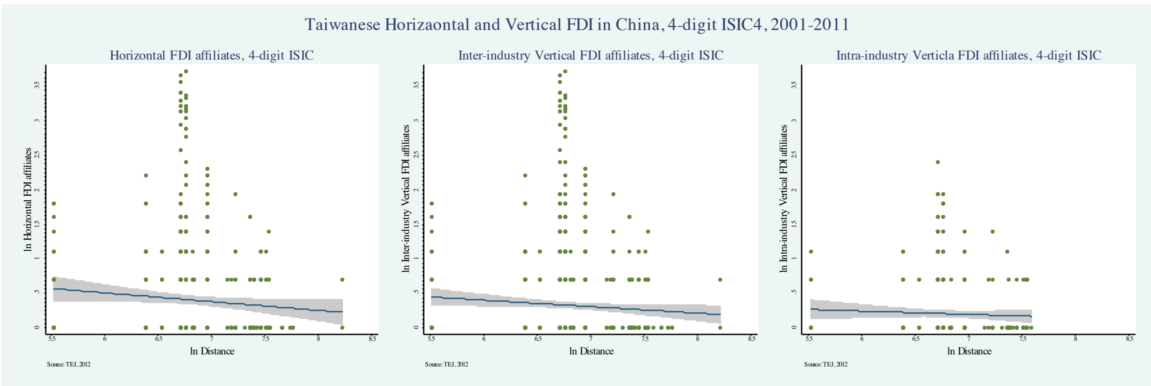

Figure 3-2

Taiwanese Horizontal, Inter-and Intra-Industry Vertical FDI in China, four-digit ISIC4, 2001-2011

Table 1

Patterns of Taiwanese FDI Affiliates in China

	Four-digit	Three-digit	Two-digit
Total	2960	2960	2960
Horizontal	1599	1723	2180
Vertical	1361	1237	780
Vertical inter	780	780	780
Vertical intra	581	457	
Percentage			
Horizontal	54%	58%	74%
Vertical	46%	42%	26%
Vertical inter	26%	26%	26%
Vertical intra	20%	15%	

Source: Authors' calculation using TEJ data.

Table 2

Most Frequent Parent-Affiliate Horizontal Industry Pairs

Parent Industry	Parent ISIC code	No. of Affiliates
Electronic components and boards	2610	820
Computers and peripheral equipment	2620	181
Electric motors, generators, transformers, and electricity distribution and control apparatus	2710	75
Communications equipment	2630	60
Footwear	1520	37
Plastics products	2220	31
Optical instruments and photographic equipment	2670	27
Parts and accessories for motor vehicles	2930	25
Wearing apparel, except fur apparel	1410	22
Plastics and synthetic rubber in primary forms	2013	22
Pharmaceuticals, medicinal chemical and botanical products	2100	22
Other special-purpose machinery	2829	21
Prepared animal feeds	1080	16
Pulp, paper and paperboard	1701	14
Glass and glass products	2310	14
Other fabricated metal products	2599	14
Batteries and accumulators	2720	13
Soft drinks; production of mineral waters and other bottled waters	1104	12
Rubber tyres and tubes; retreading and rebuilding of rubber tyres	2211	12
Medical and dental instruments and supplies	3250	12
Consumer electronics	2640	11
Basic iron and steel	2410	10
Bicycles and invalid carriages	3092	10
Magnetic and optical media	2680	8
Other chemical products	2029	7
Irradiation, electromedical and electrotherapeutic equipment	2660	7
Sports goods	3230	7
Made-up textile articles, except apparel	1392	6
Corrugated paper and paperboard and of containers of paper and paperboard	1702	6
Articles of concrete, cement and plaster	2395	6

Source: TEJ, 2012

Table 3

Most Frequent Parent-Affiliate Upstream Vertical Industry Pairs

Parent Industry	Affiliate Industry	Parent ISIC code	Affiliate ISIC code	No. of firms
Computers and peripheral equipment	Electronic components and boards	2620	2610	127
Electronic components and boards	Computers and peripheral equipment	2610	2620	58
Electronic components and boards	Plastics products	2610	2220	54
Cement, lime and plaster	Articles of concrete, cement and plaster	2394	2395	45
Electronic components and boards	Optical instruments and photographic equipment	2610	2670	30
Computers and peripheral equipment	Communications equipment	2620	2630	28
Computers and peripheral equipment	Plastics products	2620	2220	27
Electronic components and boards	Other fabricated metal products	2610	2599	26
Electronic components and boards	Cutlery, hand tools and general hardware	2610	2593	25
Electronic components and boards	Other electronic and electric wires and cables	2610	2732	23
Communications equipment	Electronic components and boards	2630	2610	22
Communications equipment	Computers and peripheral equipment	2630	2620	21
Pulp, paper and paperboard	Corrugated paper and paperboard and of containers of paper and paperboard	1701	1702	18
Other special-purpose machinery	Electronic components and boards	2829	2610	18
Electronic components and boards	Forging, pressing, stamping and roll-forming or metal; powder metallurgy	2610	2591	17
Electronic components and boards	Electric lighting equipment	2610	2740	17
Computers and peripheral equipment	Electric motors, generators, transformers, and electricity distribution and control apparatus	2620	2710	17
Basic iron and steel	Treatment and coating of metals; machining	2410	2592	16
Electric motors, generators, transformers, and electricity distribution and control apparatus	Electronic components and boards	2710	2610	16
Plastics and synthetic rubber in primary forms	Plastics products	2013	2220	15
Electronic components and boards	Communications equipment	2610	2630	15
Electronic components and boards	Treatment and coating of metals; machining	2610	2592	14
Electronic components and boards	Electric motors, generators, transformers, and electricity distribution and control apparatus	2610	2710	14
Electronic components and boards	Wiring devices	2610	2733	12
Electronic components and boards	Wiring devices	2620	2733	12
Other electronic and electric wires and cables	Electronic components and boards	2732	2610	12
Parts and accessories for motor vehicles	Electric lighting equipment	2930	2740	12
Electronic components and boards	Other special-purpose machinery	2610	2829	11
Computers and peripheral equipment	Basic precious and other non-ferrous metals	2620	2420	11
Other special-purpose machinery	Treatment and coating of metals; machining	2829	2592	11

Source: TEJ, 2012

Table 4

Characteristics of Horizontal and Vertical FDI

	Horizontal FDI	Vertical FDI	Difference
Average log distance between Taiwan and Chinese provinces	6.84 (6.80-6.88)	6.78 (6.76-6.80)	0.06***
Average industry-contract intensity of subsidiary	0.64 (0.63-0.65)	0.56 (0.55-0.57)	0.08***
Average industry-unit value intensity of subsidiary	0.98 (0.91-1.05)	0.96 (0.89-1.02)	0.02
Average log wage of subsidiary province	9.95 (9.92-9.99)	10.02 (9.99-10.04)	-0.07***
Average log market access of subsidiary province	4.70 (4.66-4.74)	4.75 (4.72-4.78)	-0.05**
Average log gross industry output of subsidiary province	9.51 (9.43-9.59)	9.88 (9.83-9.94)	-0.37***
Average log Taiwanese FDI stock of subsidiary province	11.90 (11.69-12.12)	12.97 (12.85-13.09)	-1.07***

Note: 95% confidence interval in brackets.

*** Significant at the 1 percent level, ** Significant at the 5 percent level, and * Significant at the 10 percent level

Table 5

Characteristics of Inter- and Intra-industry Vertical FDI

	Inter-industry FDI	Intra-industry FDI	Difference
Average log distance between Taiwan and Chinese provinces	6.76 (6.74-6.79)	6.81 (6.76-6.85)	-0.05*
Average log wage of subsidiary province	10.03 (9.99-10.06)	10.02 (9.97-10.06)	0.01
Average log market access of subsidiary province	4.76 (4.72-4.80)	4.73 (4.68-4.78)	0.03
Average log gross industry output of subsidiary province	9.97 (9.91-10.04)	9.74 (9.65-9.83)	0.23***
Average log Taiwanese FDI stock of subsidiary province	12.87 (12.72-13.02)	13.13 (12.93-13.33)	-0.26**

Note: 95% confidence interval in brackets.
*** Significant at the 1 percent level, ** Significant at the 5 percent level, and * Significant at the 10 percent level

Table 6

Baseline Estimates: Horizontal and Vertical FDI

	Dependent Variable: Ln New Taiwanese Vertical FDI Affiliates$_{spit}$, 4-digit ISIC4					
	Horizontal FDI		Vertical FDI		Total FDI	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Distance$_i$	-0.127*	0.0234	-0.0222	0.0520**	-0.127*	0.0234
	(0.0765)	(0.0826)	(0.0232)	(0.0221)	(0.0764)	(0.0825)
Ln Distance$_i$× D_VFDI$_{sp}$					0.104	0.0286
					(0.0805)	(0.0864)
D_VFDI$_{sp}$					-0.960*	2.228*
					(0.577)	(1.246)
Control variables						
Ln Wage$_{it-1}$		0.169		-0.108**		0.169
		(0.238)		(0.0520)		(0.238)
Ln Market Access $_{it-1}$		-0.133		0.00781		-0.133
		(0.260)		(0.0519)		(0.259)
Ln Industrial		0.0176		0.0262		0.0176
Agglomeration $_{it-1}$		(0.0759)		(0.0179)		(0.0757)
Ln TAI FDI		0.0933***		0.0356***		0.0933***
Agglomeration $_{it-1}$		(0.0291)		(0.00958)		(0.0291)
Ln Wage$_{it-1}$ ×D_VFDI$_{sp}$						-0.278
						(0.213)
Ln Market Access$_{it-1}$						0.141
×D_VFDI$_{sp}$						(0.233)
Ln Industrial						0.00861
Agglomeration$_{it-1}$×D_VFDI$_{sp}$						(0.0772)
Ln TAI Agglomeration$_{it-1}$						-0.0577**
×D_VFDI$_{sp}$						(0.0248)
Observations	651	651	1,059	1,059	1710	1710
Within R-squared	0.007	0.142	0.001	0.042	0.05	0.153

Note: Observations are at industry-province-year level. The periods are from 2002 to 2011. The dependent variable is natural log of Taiwanese new FDI affiliates. Ln Distance is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The vertical FDI dummy variable, D_VFDI, equals one for the industrial pairs with direct input requirements greater than zero in the IO table, and zero otherwise. Control variables are one year lagged. OLS estimator is used for 4 specifications and standard errors are in parentheses. Industry-province cluster Standard errors are reported.
* Significant at the 10 percent level; ** Significant at the 5 percent level; ***Significant at the 1 percent level

Table 7

The Relative Impact of Trade Costs on Horizontal and Vertical FDI

Dependent variable: Ln New Taiwanese FDI Affiliates$_{spjt}$, 4-digit ISIC4				
	(1)	(2)	(3)	(4)
Ln Distance$_j$× D_VFDI$_{sp}$	0.0697	-0.125*	-0.028	-0.248***
	(0.0615)	(0.0645)	(0.0887)	(0.0917)
D_VFDI$_{sp}$	-2.376	-19.33	6.099	41.84
	(16.91)	(41.83)	(20.16)	(54.52)
Control variables				
Ln Wage$_{jt-1}$		-0.0719		0.0134
		(0.246)		(0.314)
Ln Market Access$_{jt-1}$		-1.098		-1.265
		(0.772)		(0.939)
Ln Industrial Agglomeration$_{jt-1}$		-0.0373		0.0434
		(0.145)		(0.194)
Ln TAI Agglomeration $_{jt-1}$		0.151***		0.137**
		(0.0204)		(0.0542)
Ln Wage$_{jt-1}$×D_VFDI$_{sp}$		-0.125		0.211
		(0.119)		(0.176)
Ln Market Access$_{jt-1}$×D_VFDI$_{sp}$		0.0385		-0.0166
		(0.122)		(0.144)
Ln Industrial Agglomeration$_{jt-1}$		0.111**		0.247***
×D_VFDI$_{sp}$		(0.0480)		(0.0726)
Ln TAI Agglomeration$_{jt-1}$		-0.173***		-0.338***
×D_VFDI$_{sp}$		(0.0208)		(0.0324)
Time Dummy	Y	Y	Y	Y
Province Dummy	Y	Y	N	N
Fixed Effects	Industry	Industry	Industry-Province	Industry-Province
Observations	1,710	1,710	1,710	1,710
Within R-squared	0.158	0.235	0.159	0.254

Note: Observations are at industry-province-year level. The periods are from 2002 to 2011. The dependent variable is natural log of Taiwanese new FDI affiliates. Ln Distance is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The vertical FDI dummy variable, D_VFDI, equals one for the industrial pairs with direct input requirements greater than zero in the IO table, and zero otherwise. Control variables are one year lagged. Coefficients are reported from the fixed effect estimators and standard errors are in parentheses.
* Significant at the 10 percent level; ** Significant at the 5 percent level; ***Significant at the 1 percent level

Table 8

Transaction and Transport Costs Channels

Dependent variable: Ln New Taiwanese FDI Affiliates$_{spjt}$, 3-digit ISIC4				
	Horizontal FDI	Vertical FDI	Total FDI	
	(1)	(2)	(3)	(4)
Ln Distance$_j$×Contract Intensity	-0.609**	-0.0258		
	(0.250)	(0.190)		
Ln Distance$_j$×Unit Value Intensity	0.00728	0.00489		
	(0.0435)	(0.0408)		
Ln Distance$_j$×CI$_s$×D_VFDI$_{sp}$			-0.399***	-0.443***
			(0.0457)	(0.0448)
Ln Distance$_j$×UVI$_s$×D_VFDI$_{sp}$			0.0144**	0.0148**
			(0.00585)	(0.00603)
Control variables	Y	Y	N	Y
Time Dummy	Y	Y	Y	Y
Province Dummy	Y	Y	N	N
Fixed Effects	Industry	Industry	Industry-Province	Industry-Province
Observations	723	952	1,691	1,691
Within R-squared	0.33	0.068	0.173	0.239

Note: Observations are at industry-province-year level. The periods are from 2002 to 2011. The dependent variable is natural log of Taiwanese new FDI affiliates. Ln Distance is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The vertical FDI dummy variable, D_VFDI, equals one for the industrial pairs with direct input requirements greater than zero in the IO table, and zero otherwise. Control variables are one year lagged. Coefficients are reported from the fixed effect estimators and standard errors are in parentheses.
Control variables include: Ln Wage, Ln Market access, Ln Industrial agglomeration, and Ln Taiwanese agglomeration in the 2-digit ISIC4 level. Controls*D_VFDI are included as well.
* Significant at the 10 percent level; ** Significant at the 5 percent level; ***Significant at the 1 percent level

Table 9

Trade Costs on Inter-and Intra-industry Vertical FDI

Dependent variable: Ln New Taiwanese Vertical FDI Affiliates$_{spjt}$, 4-digit ISIC4				
	(1)	(2)	(3)	(4)
Ln Distance$_j$×*D_IntraV*$_{sp}$	-0.0148	0.197	-0.0121	0.208
	(0.138)	(0.158)	(0.137)	(0.157)
Ln Closeness$_{sp}$			-0.0258	-0.0215
			(0.0187)	(0.0186)
Ln Closeness$_{sp}$×*D_IntraV*$_{sp}$			-0.0756*	-0.101**
			(0.0388)	(0.0390)
Control variables	N	Y	N	Y
Time Dummy	Y	Y	Y	Y
Fixed Effects	Industry-Province	Industry-Province	Industry-Province	Industry-Province
Observations	1,059	1,059	1,059	1,059
Within R-squared	0.031	0.059	0.046	0.077

Note: Observations are at industry-province-year level. The periods are from 2002 to 2011. The dependent variable is natural log of Taiwanese new FDI affiliates. Ln Distance is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The intra-industry vertical FDI dummy variable, D_IntraV, equals one for the industrial pairs in the same 2-digit ISIC4 code and zero otherwise. Control variables are one year lagged. Coefficients are reported from the fixed effect estimators and standard errors are in parentheses.

Control variables include: Ln Wage, Ln Market access, Ln Industrial agglomeration, and Ln Taiwanese agglomeration in the 2-digit ISIC4 level. Controls*D_IntraV are included as well.

* Significant at the 10 percent level; ** Significant at the 5 percent level; ***Significant at the 1 percent level

Table 10

Alternative Measure of Trade Costs: Air Travelling Time

	DV: Ln New Taiwanese FDI Affiliates$_{spjt}$, 4-digit ISIC4		DV: Ln New Taiwanese FDI Affiliates$_{spjt}$, 3_digit ISIC4	
	(1)	(2)	(3)	(4)
Ln Flight time$_{jt}$	-0.0842	0.0637	0.265**	0.275***
	(0.118)	(0.125)	(0.109)	(0.101)
Ln Flight time$_{jt}$×D_VFDI$_{sp}$	0.233***	-0.0262		
	(0.0877)	(0.100)		
Ln Flight time$_{jt}$ ×CI$_s$×D_VFDI$_{sp}$			-0.447***	-0.456***
			(0.0562)	(0.0541)
Ln Flight time$_{jt}$ ×UVI$_s$×D_VFDI$_{sp}$			0.0157**	0.0167**
			(0.00723)	(0.00749)
Control variables	N	Y	N	Y
Time Dummy	Y	Y	Y	Y
Fixed Effects	Industry-Province	Industry-Province	Industry-Province	Industry-Province
Observations	1,710	1,710	1,675	1,675
Within R-squared	0.15	0.25	0.169	0.235

Note: Observations are at industry-province-year level. The periods are from 2002 to 2011. The dependent variable is Taiwanese new FDI affiliates. Ln Distance is the natural log of the distance between Taiwan and Chinese provincial capital that is defined as a proxy for transaction costs and transport costs. The vertical FDI dummy variable, D_VFDI, equals one for the industrial pairs with direct input requirements greater than zero in the IO table, and zero otherwise. Control variables are one year lagged. Coefficients are reported from the fixed effect estimators and standard errors are in parentheses.

Control variables include: Ln Wage, Ln Market access, Ln Industrial agglomeration, and Ln Taiwanese agglomeration in the 2-digit ISIC4 level. Controls*D_VFDI are included as well.

* Significant at the 10 percent level; ** Significant at the 5 percent level; ***Significant at the 1 percent level