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

Chinchih Chen*
London School of Economics

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Abstract

Theoretical predictions on the impact of trade costs on FDI locations across regions remain inconclusive due to the multi-region modelling difficulties. This empirical paper 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 index 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.

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* Contact: Department of Geography and Environment, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, UK. E-mail: c.chen1@lse.ac.uk

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 paper, 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[2]. 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[3].

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 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 paper 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

[2] 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

[3] 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.

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 industries 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[4] 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 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

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

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[5]. 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[6]. 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 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[7]. 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

[5] 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.
[6] These 17 provinces are: Beijing, Chongqing, Fujian, Guangdong, Guangxi, Hainan, Hubei, Hunan, Jiangsu, Liaoning, Shanxi, Shandong, Shanghai, Sichuan, Tianjin, Yunnan and Zhejiang.
[7] 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.

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.

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[8]. 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.

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-

[8] 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.

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:

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

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

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

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[9]. Nunn (2007) also provides contract intensity for 29 3-digit ISIC Rev.2 manufacturing industries[10]. 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 contract intensity due to following reasons. First, the production processes in United States and China might exist huge differences 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.

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

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):

$$v_{ic} = \alpha_i + \beta d_c + other\ controls + \varepsilon_{ic} \quad (1)$$

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)[11]. The product fixed effects estimated specification is shown in equation (2):

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

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

[11] 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

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 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[12]. The distance is calculated by using Google Earth.

[12] 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.

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[13]. 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[14]. 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[15]. 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 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

[13] For examples, I use booking website such as Skyscanner (www.skyscanner.net) and airline companies' website: China Airline, Eva Airways, etc.
[14] Other alternative first stops include Macau, Cheju Island or Seoul.
[15] 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.

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):

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

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.[16] According to the estimate in column (3), increasing the distance between Taiwan and province p of 1 percent increases the FDI growth 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.

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

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).

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

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

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

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[17].

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 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

[17] 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.

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.[18] 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 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

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

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.[19]

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.

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

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.

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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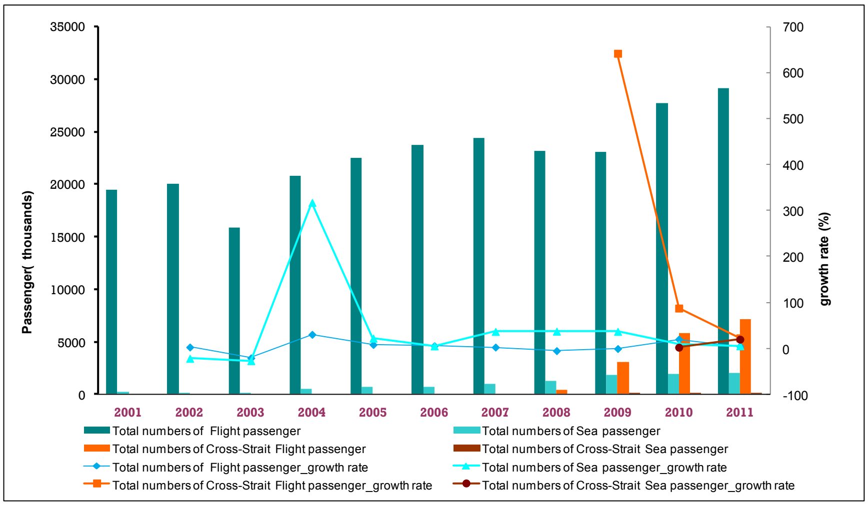
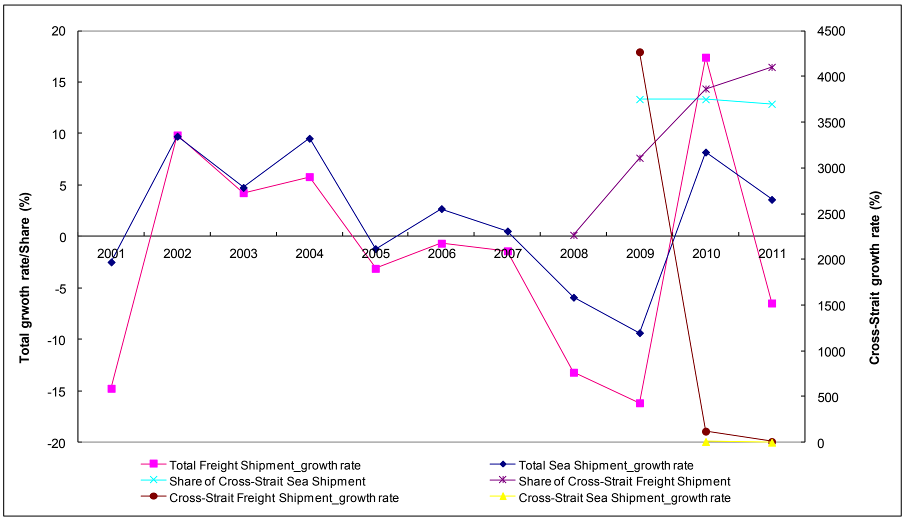


Source: Ministry of Transportation and Communication, Taiwan, 2012

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

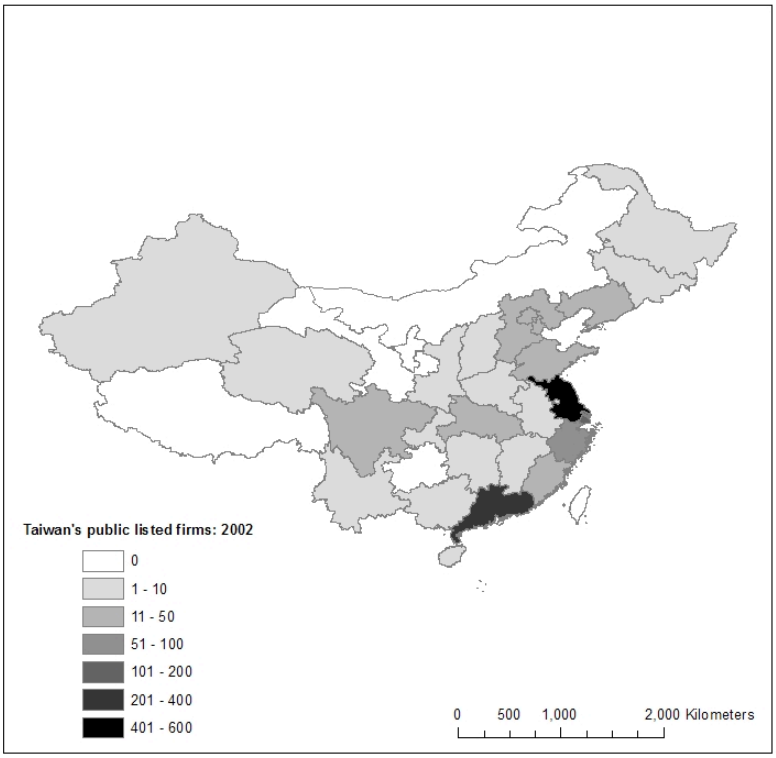
Figure 3-1

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

Source: CAA, 2011

Figure 3-2

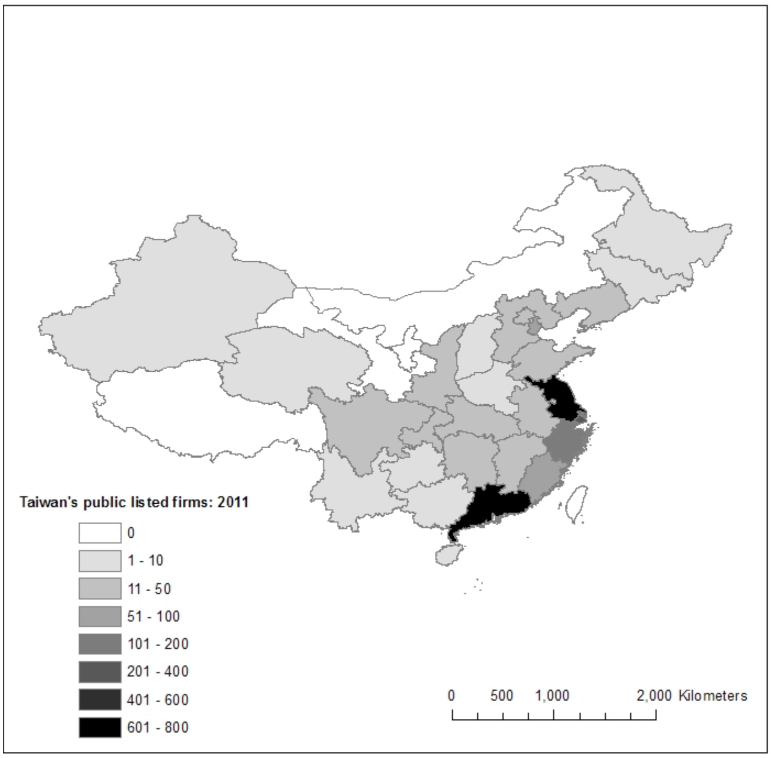
Taiwan-China Air Transportations, Direct Flights After 2008



Source: TEJ, 2012

Figure 4-1

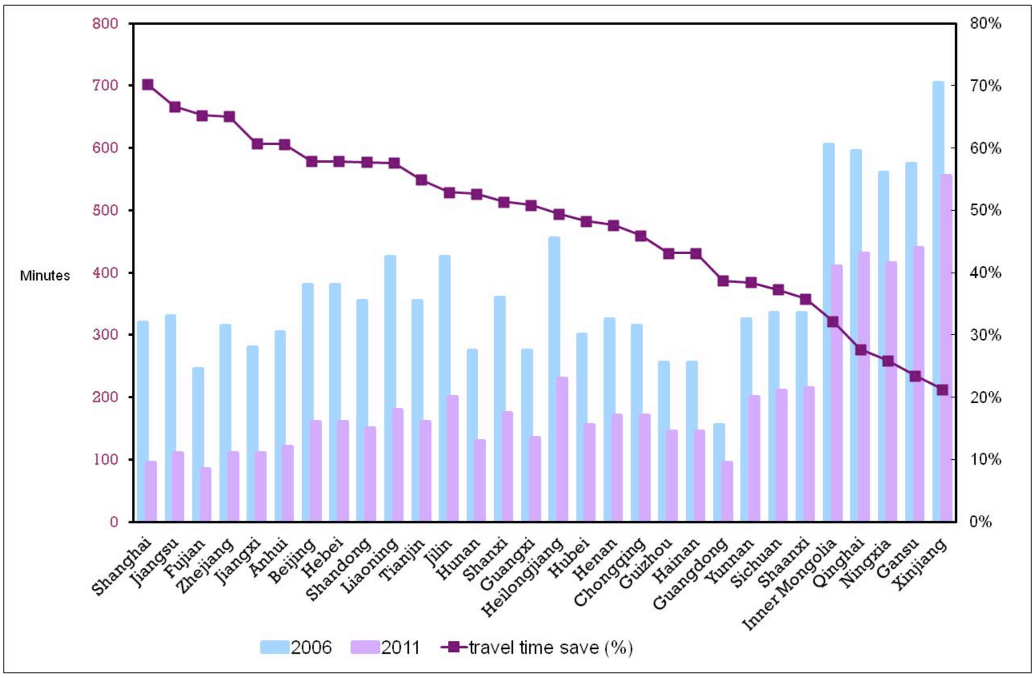
Number of Taiwanese Public Listed Firms in China, 2002



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

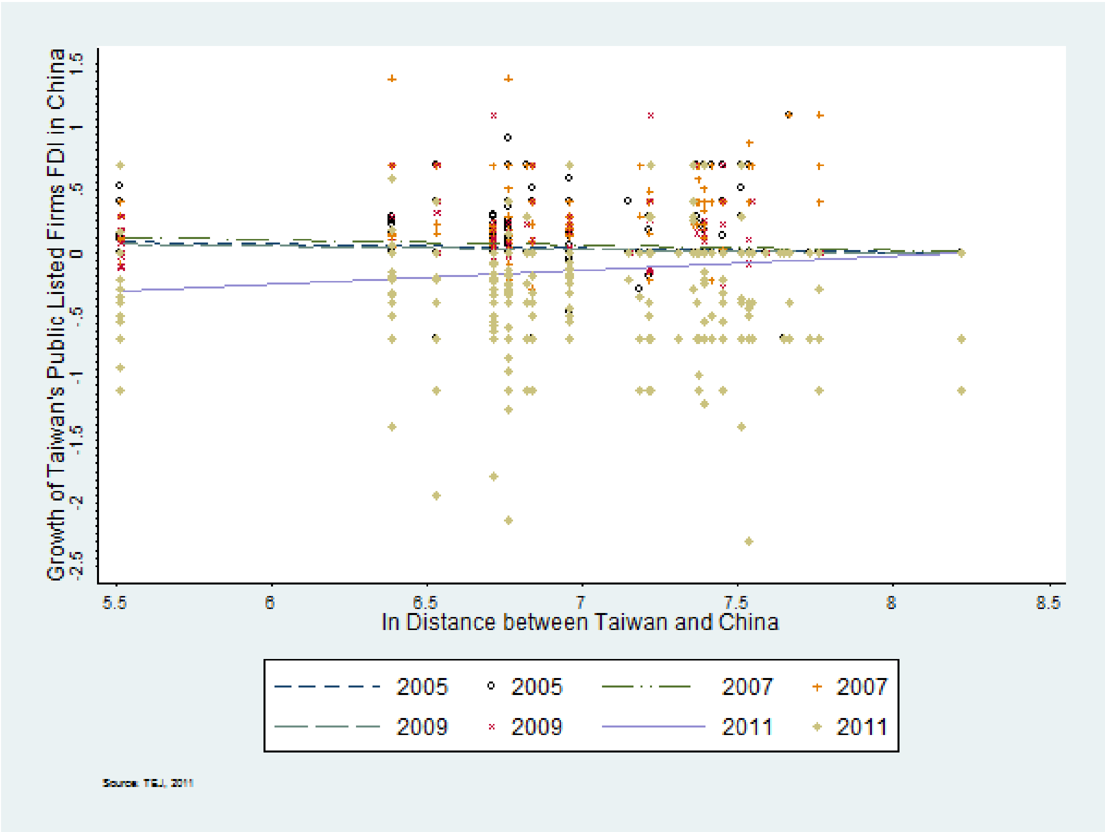


Figure 6-1

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

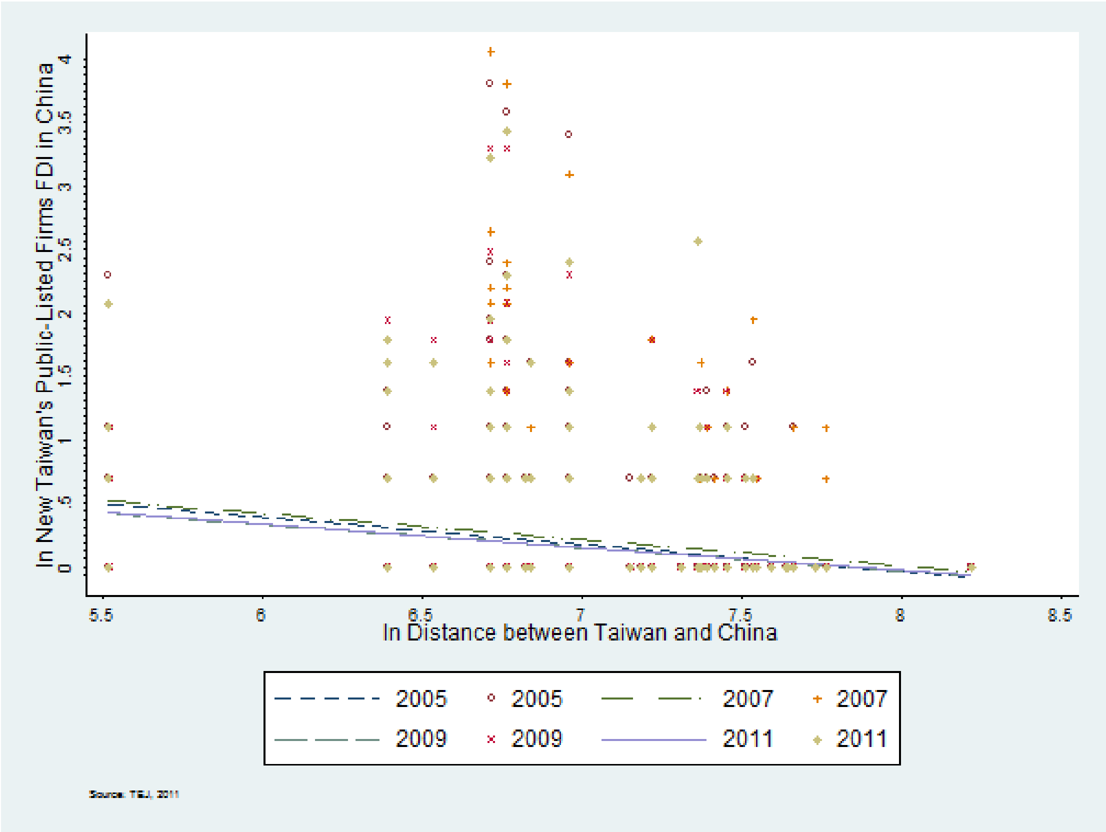


Figure 6-2

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	0.00395	-0.00245	0.0144	-0.0161	0.029	0.00305	0.0475**	0.0250**	0.0532**	-0.000291	-0.00067
	(0.0120)	(0.0249)	(0.0121)	(0.0232)	(0.0144)	(0.0240)	(0.0118)	(0.0202)	(0.0109)	(0.0237)	(0.0108)	(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)
$Distance_p \times Post$	0.0315***	0.0199*	0.0154	0.0521***	-0.0164	0.0294*
	(0.0094)	(0.0105)	(0.0100)	(0.0176)	(0.0147)	(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)
$Distance_p$×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.