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George S. Chen

School of Business, Economics and Public Policy
Faculty of the Professions,
University of New England,

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School of Business, Economics and Public Policy
Faculty of the Professions
University of New England
Armidale NSW 2351
Tel: 02 6773 2432
Fax: 02 6773 3596
Email: beppwps@une.edu.au

AUTHOR CONTACT DETAILS:
George S. Chen, gchen2@une.edu.au
School of Business, Economics and Public Policy
Faculty of the Professions
University of New England
Armidale NSW 2351

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George S. Chen
gchen2@une.edu.au
Phone: (02) 6773 3595
School of Business, Economics and Public Policy
Faculty of the Professions
University of New England
Armidale NSW 2351

Tel: 02 6773 2432 • Fax: 02 6773 3596
Email: beppwps@une.edu.au

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ABSTRACT

We investigate the effects of provincial characteristics on the distribution of Taiwanese investment in China. For the period 1996-2005, we find that the distribution of this investment can be attributed to the effects of industrial linkages, labour-market pooling and monitoring costs. Furthermore, we find evidence that the determinants of this investment not only differ across regions, but also change over time. Importantly, we find mild evidence that this investment is adversely affected by a market-crowding effect.

Keywords Foreign-specific agglomeration; China; Taiwanese investment; location choice

Subject classification codes F23, R12, R30

1. INTRODUCTION

Following the normalization of the China-Taiwan (or cross-Strait) relation in 1989, one of the most striking developments has been the rise to prominence of Taiwanese investment in China. Since the formal record began in 1991, Taiwan has been consistently ranked as one of the leading source countries contributing to China's stock of foreign direct investment (FDI)[1]. From the outset, this development is not surprising given the close cultural and geographical ties between these two states. Undoubtedly, these non-economic factors are important, but they alone cannot compensate for the political risk facing Taiwanese investors in China[2]. For such an undertaking to be an economically viable proposition, there must be some other economic factors attracting these investors to "go west" across the Taiwan Strait rather than "go south" to the Southeast Asian countries sharing similar cultural and geographical ties with Taiwan. Therefore, the first motivation for this study is to explore the nature of this set of economic factors behind this development.

Another salient feature of Taiwanese investment in China is its regional distribution. Despite the relentless effort by local government officials from the interior provinces to attract this investment, it remains concentrated in the coastal provinces to date. This seems to contradict the popular belief that this investment simply occurs as a means of tapping into the huge pool of low-cost workers in China. Since if this were true, then we would expect to see Taiwanese investors, like migratory birds, flocking to these interior provinces where labour costs are substantially lower than their coastal counterparts. However, we have yet to see such a trend emerging. This brings the second motivation for this study; that is, why is it that this investment remains concentrated in the coastal provinces?

These two motivations have also marked the starting points for many studies on FDI in China. However, our study differs from those previously undertaken in two very important aspects. The first is that the current state of research on determinants of FDI in China often gives conflicting results. In part, this can be attributed to the fact that the

[1] For example, Yang and Tu (2004) and Zhu (2005) suggest that the true extent of Taiwanese investment in China is likely to be far greater than those officially reported figures due to deliberate non-reporting and under-reporting behaviors of Taiwanese investors.

[2] Tung (2003) identifies some of the political risks facing Taiwanese investors in China.

significance of a particular determinant is sensitive to sample selection, research design and methodology (Dunning, 1992; Caves, 1996). Without a coherent conceptual framework, many researchers have to rely on ex-post explanations in order to justify the inconsistent results in their studies (Chakrabarti, 2001, 2003). We avoid such ex-post rationalizations by deriving our a priori expectations on the determinants of Taiwanese investment in China from the new economic geography (NEG) literature. Secondly, despite its rise to prominence since 1991, there has been no systematic analysis into the determinants of this investment to date. Knowledge on this development is important, particularly if Chinese policymakers want to use it as a catalyst for economic development in the interior provinces.

This paper is structured as follows. Conceptual framework and hypotheses for exogenous variables are described in Section 2 and Section 3, respectively. Section 4 presents the data and econometric methods. The results are provided in Section 5, while the final section concludes.

2. CONCEPTUAL FRAMEWORK

The conceptual framework used in this study is derived from the NEG literature.[3] To see how various centripetal and centrifugal forces can shape the regional distribution capital stock, let us suppose that the world is consisted of two regions, two sectors and two factors of production. The two regions, home (H) and foreign (F), are assumed to be identical in every aspect, except that region F has a higher level of initial labour endowment. For ease of exposition, we will call one of these two sectors the manufacturing (M) sector, and let it produce differentiated goods under monopolistic competition and increasing returns to scale. In contrast, we will call the other sector the agricultural (A) sector and let it produce a homogeneous good under perfect competition and constant returns to scale[4]. To keep our discussion manageable, we assume that, in order to produce one M-sector variety, both capital (K) and labour (L) are required. Meanwhile, in terms of the A-sector variety, only L is required in the production process. For the purpose of this study, we will let K to be the only factor of production that is free

[3] Fujita et al. (1999) and Baldwin et al. (2003), among others, provide excellent theoretical expositions on the nature of centripetal and centrifugal forces driving the regional distribution of economic activities.

[4] The agricultural sector is simply used a reference; it can easily be any sector that produces a homogenous good and operates under constant return to scale (Krugman, 1991).

to move between regions[5]. Given this, we can infer the regional distribution of the M-sector by examining the pattern of interregional flow of K. In order to highlight the importance of location choices, we will let the interregional trade in A-sector output to be costless, while a similar trade in M-sector output incurs positive trade costs.

In this set up, the regional distribution of K is determined by interactions between centripetal forces and centrifugal forces in equilibrium. Consistent with the NEG literature, the first type of centripetal forces is related to our assumption about initial labour endowment. Recall that we have assumed this endowment is larger in region F than region H. If we also assume that all workers spend their income locally, then we expect the market size in region F to be larger than region H. Krugman (1991) shows that this difference in market size, coupled with increasing returns at the firm level, can generate pecuniary externalities that encourage some M-sector firms in region H to relocate to region F. This notion is also formalized by Ottaviano and Thisse (2004) as the market access effect. For purpose of this study, it can be stated as follows:

Hypothesis 1 (market access effect): A Chinese province with greater market potential is expected to host a higher level of Taiwanese investment.

The second type of centripetal forces is related to the production function of the M-sector. Recall that we have assumed both L and K are required to produce one M-sector variety. To make our model closer to reality, let us also assume that one unit of the M-sector composite good, which is comprised of all existing M-sector varieties, is also required as the intermediate input for producing one M-sector variety. Conceptually, Fujita et al. (1999) suggest that this good is introduced to capture the notion of industrial linkages, with more M-sector varieties included in this good indicating a more complex system of industrial linkages. The complexity of industrial linkages represents an important centripetal force because pecuniary externalities are closely related to the number of M-sector varieties in a region. Specifically, the procurement cost of the M-sector composite good is lower in a region with the a greater number of M-sector varieties due to lower trade costs associated with these varieties (Ottaviano and Puga, 1998). Consistent with

[5] This set up follows the footloose capital model presented in Baldwin et al. (2003).

Krugman and Venables (1995), if we assume that the number of M-sector varieties in a region increases proportionately with the number of workers in that region, and that these varieties are all used in the production of other M-sector varieties, then we expect the larger initial labour endowment to give rise to a more complex system of industrial linkages in region F. These linkages, in turn, generate further pecuniary externalities that attract still more M-sector firms to relocate from region H to region F (Fujita et al., 1999). Formally, Baldwin et al. (2003) refer to this logic as the vertical linkage effect. For the purpose of this study, it can be stated as follows:

Hypothesis 2 (industrial linkage effect): A Chinese province with complex industrial linkages is expected to host a higher level of Taiwanese investment.

The final type of centripetal forces is related to pecuniary externalities arising from the supply and demand of specialized workers. As Marshall (1898) points out, a higher probability of finding employment in related industries encourages specialized workers to congregate in regions with a large contingent of firms demanding their services[6]. Reciprocally, firms also benefit from locating in these highly congregated regions as it increases their probability of obtaining specialized services. Krugman (1991) shows that these two forces work in opposite directions due to specialized workers competing for the limited employment opportunity in these regions. This depresses the cost of specialized workers, which attracts still more firms to locate in these regions. Furthermore, Rotemberg and Saloner (2000) suggest that, in order to secure employment, specialized workers in these regions are more willing to invest in human capital at their own expense. This human capital formation, in effect, implies that firms in these regions are paying a lower wage rate for these specialized workers. In this study, it means that region F has a lower effective wage rate than region H, which attracts some M-sector firms in region H to region F. Formally, Dumais et al. (2002) refer to this line of reasoning as the labour-market pooling effect. For the purpose of this study, it can be stated as follows:

Hypothesis 3 (labour- market pooling effect): A Chinese province with more specialized workers is expected to host a higher level of Taiwanese investment.

[6] Implicitly, Marshall (1898) assumes that the demand for specialized workers is not perfectly correlated across location.

In theory, these aforementioned centripetal forces should lead to catastrophic agglomeration, or that all M-sector firms end up locating in one region only (Baldwin et al., 2003). However, such a view neglects the fact that there are also centrifugal forces working against economic agglomeration. For instance, some firms may not enter highly agglomerated regions because competition over limited supply of factors of production in that region can increase factor prices, which reduces pecuniary externalities from agglomeration (Fujita et al., 1999; Fujita and Krugman, 2004). Alternatively, negative externalities, such as congestion and pollution, in these regions may deter firms from entering there (Brakman et al., 1996). From another perspective, Johansson and Quigley (2004) suggest that research-intensive or large firms are reluctant to locate in these regions because they tend to be the contributors of knowledge spillover yet receive little monetary reward in return. These forces explain why, in reality, economic activities are dispersed across different locations rather than concentrated in a few locations.

In this study, one of the centrifugal forces preventing catastrophic agglomeration of the M-sector firms can be related the interregional trade in the M-sector output. Recall that we assume this trade entails positive trade costs. In the NEG literature, centrifugal forces such as this are often modelled by iceberg trade costs; that is, the physical quantity of the good arriving at the final destination decreases with the distance it has travel (Krugman, 1998). However, these costs make exporting the M-sector output from region F to region H more difficult, which leaves a niche market in region F for some local M-sector firms to serve. This explains why we do not explain expect all M-sector firms to locate in region H only. Formally, Fujita and Thisse (1996) refer to this logic as the trade cost effects. For the purpose of this study, it can be stated as follows:

Hypothesis 4 (trade cost effect): A Chinese province with low trade costs is expected to host a higher level of Taiwanese investment.

Another important centrifugal force pertinent to the regional distribution of K in our model is monitor costs, or the costs associated with maintaining production facilities in another region. These costs partly explain the stylized fact that, despite some regions with favourable factor endowment, they still fail to attract FDI because of the high costs of maintaining production facilities in these regions. In our model, this means that the presence of monitoring costs may deter some M-sector firms in region H from relocating to region F, since these costs could be so great that they more than offset any pecuniary externalities to be gained from such relocation. Formally, Robert-Nicoud (2002) refers to this logic as the monitoring cost effect. For the purpose of this study, it can be stated as follows:

Hypothesis 5 (monitoring cost effect): A Chinese province with low monitoring costs is expected to host a higher level of Taiwanese investment.

In summary, our conceptual framework suggests that the regional distribution of Taiwanese investment is positively influenced by the extent of market potential, complexity of industrial linkages and availability of specialized workers, but it is negatively influenced by the level of trade costs and the magnitude of monitoring costs.

3. HYPOTHESES FOR EXOGENEOUS VARIABLES

In general, there are five commonly proposed effects in relation to the distribution of economic activities in the NEG literature; namely, market access, industrial linkages, labour-market pooling, trade cost and monitoring cost effects. The variables that define the provincial characteristics with respect to each of the aforementioned effects and their expected signs on Taiwanese investment are summarized in Table 1.

3.1 Market Access Effect

Market access is an important determinant because it determines the extent of economies of scale and scope that Taiwanese firms can realize in the host province. Furthermore, it is critical for reaching new customers in largely untapped Chinese market. Therefore, all things being equal, Taiwanese investment is expected to increase with provincial market size.

In the literature, gross provincial product (GPP) is the most commonly used measure for market access for studying FDI in China. Chen (1997), Qu and Green (1997), Coughlin and Segev (2000), Zhang (2001) and Gao (2005) find that FDI increases with GPP. Furthermore, Fung et al. (2002), Fung et al. (2005) and Zhang (2005) find that GPP is also responsible for the uneven distribution of American, Japanese, Hong Kong, Korean and Taiwanese investment in China. To the extent, Sun et al. (2002) suggest that the importance of GPP as a FDI determinant has increased since 2000.

Table 1 Variables, by effect

Effect	Variables	Symbol	Expected Sign
Market Access	Gross provincial product (RMB billion)	GPP	+
	Gross provincial product per capita (RMB)	PGPP	+
	Provincial population density (person/km^2)	POPD	+
Industrial Linkages	Provincial manufacturing output (RMB billion)	MOUT	+
	Provincial number of manufacturing firms (count)	NMF	+
	Cumulative FDI (RMB 10,000)	CFDI	+
	Provincial number of foreign-invested enterprises (count)	NFDI	+
	Provincial cumulative TDI (RMB10,000)	CTDI	+
	Provincial number of Taiwanese enterprises (count)	NTDI	+
Labour-Market Pooling	Provincial average real wage rate (RMB)	AWAGE	-
	Provincial efficiency wage rate (RMB)	EWAGE	-
Trade Costs	Provincial railway density (km/km^2)	RWAY	+
	Provincial highway density (km/km^2)	HWAY	+
	Provincial combined railways and highways density (km/km^2)	WAY	+
Monitoring Costs	Provincial telephone density (Telephone set per 1,000 people)	TELD	+
	Provincial postal and telecommunication output (RMB billion)	TOUT	+
	Provincial number of postal and telecommunication workers (10,000 people)	TWKER	+

However, the use of the absolute level of GPP has been criticized for neglecting a province's growth potential. This is important because it is not uncommon for foreign investors in China to invest in smaller, but rapidly growing, provinces in order to benefit from milder competition in goods markets. Based on this, Wei et al. (1999), Wei and Liu

(2001) and Ljunwall and Linde-Rahr (2005) find that FDI increases with the growth rate of GPP.

The main drawback of using either the absolute level of GPP or its annual growth rate is that it implicitly assumes complete market segmentation; that is, the demand for a province's output does not stem from its neighboring provinces. However, as Gao (2005) points out, this is highly unlikely in China. As a consequence, Chen (1996) and Cheng and Kwan (2000) suggest that a better measure for market access should be GPP per capita, as this takes into account the purchasing power of local residents. They find that FDI increases with GPP per capita.

Finally, it is argued that provinces with a larger population size are expected to attract more FDI, on the basis that a more populated province means a higher availability of potential clients. This is especially important for foreign investors in service industries, such as retail and banking and finance. Using provincial population density as a measure for market access, He (2002) finds a positive relationship between it and FDI.

Based on the aforementioned literature, we include GPP, GPP per capita and provincial population density as potential variables for testing the impact of market access on Taiwanese investment in China.

3.2 Industrial Linkage Effect

Foreign investors consider local industrial linkages as an important provincial characteristic when investing in China. This is because by locating in a province with strong industrial linkages, they have better access to local networks of specialized intermediate inputs and services. Local procurement also has the added advantage of reducing transportation costs and ensuring timely delivery. Furthermore, because foreign investors of the same nationality tend to share similar business practices and values, it is common for them to co-locate in one province in order to reduce transaction costs associated with operating in an unfamiliar environment. Last, but not the least, co-location may occur as a result of supply chains and supporting networks among foreign investors.

Therefore, all things being equal, Taiwanese investment is expected to increase with a province's industrial linkages.

The extant literature employs a wide array of variables to test the impact of industrial linkages on FDI in China. Based on the notion that a higher ratio of industrial output to GPP implies better industrial linkages, Qu and Green (1997) find that FDI increases with a province's industrial output.

However, given the dominance of state-owned enterprises in China, the use of industrial output may bias the result. In order to rectify this, Head and Ries (1996), He (2002), Zhou et al. (2002) and Wakasugi (2005) suggest that the number of manufacturing firms should be used, on the basis that more of these firms generally mean more varieties of intermediate input being produced in the province. They find that FDI increases with the number of industrial firms established in the province.

Another aspect of the industrial linkage effect is related to the network effect in which foreign investors can extend their inter-personal and inter-firm networks from their home country to the host country. This is examined by Head and Ries (1996), Wakasugi (2005), Cheng and Stough (2006) and Cheng (2007), who use provincial cumulative stock of FDI and provincial cumulative stock of Japanese FDI, as well as provincial cumulative count of foreign firms and provincial cumulative count of Japanese firms.

Consistent with the extant literature, we include provincial manufacturing output, provincial number of manufacturing firms, provincial stock of cumulative FDI and provincial stock of cumulative Taiwanese investment, as well as provincial count of foreign firms and provincial counts of Taiwanese firms as potential variables for testing the impact of industrial linkages on Taiwanese investment in China.

3.3 Labour- market pooling effect

The level of the wage rate is negatively related to the number of workers in the province because competition among workers for a limited number of jobs depresses local wage rates. Therefore, an ample supply of low-cost workers is particularly important for Taiwanese investors wanting to reduce production costs, particularly those in labour-intensive industries. Therefore, all things being equal, Taiwanese investment is expected to decrease with labour costs in a province.

In testing the impact of labour-market pooling on FDI in China, most studies have used provincial average real wage rate. Chen (1996), Head and Ries (1996), Qu and Green (1997), Cheng and Kwan (2000) and Coughlin and Segev (2000) find a negative relationship between provincial average real wage rate and FDI.

However, critics have argued that these studies fail to control for the stylized fact that provinces with a higher stock of cumulative FDI also tend to have a higher average real wage rate because of the competition among foreign investors over a limited supply of workers. This concern is addressed by Sun et al. (2002), who use the lagged average real wage rate instead. They find a negative relationship between this variable and FDI. Furthermore, Fung et al. (2002), Fung et al. (2005) and Cassidy and Andreosso-O'Callaghan (2006) suggest that this variable affects the distribution of Hong Kong and Taiwanese investment more than Japanese investment in China. This is consistent with the fact that Hong Kong and Taiwanese investors tend to employ relatively labour-intensive technology, whereas Japanese investors tend to employ relatively capital-intensive technology that requires better quality, rather than low-cost, workers.

Another criticism attributed to the use of the average real wage rate relates to the unique wage structure in China. Sun et al. (2002) point out, because employees in China's state-owned enterprises receive fringe benefits, such as housing subsidies and health insurance, while employees in the private sector receive cash bonuses, not all of which are disclosed truthfully. These institutional features may have weakened the explanatory power of average real wage. In order to control for this, Chen (1997), Wei et al. (1999), Wei and Liu (2001), He (2002) and Ljunwall and Linde-Rahr (2005) use the efficiency wage rate; that is, average real wage rate adjusted for productivity. They find that a higher efficiency wage rate deters FDI.

Following on the aforementioned studies, we include both provincial average wage rate and provincial efficiency wage rate to test the effect of labour-market pooling on Taiwanese investment in China.

3.4 Trade cost effect

Sound transportation network coverage in a province reduces the level of trade costs through facilitating an efficient distribution of final goods to consumers and reducing transportation costs associated with shipping intermediate inputs in and out of production facilities. Therefore, all things being equal, Taiwanese investment is expected to decrease with trade costs in a province.

Most studies of FDI in China have examined the impact of trade costs using the length of transportation networks adjusted for landmass in the relevant province. Cheng and Kwan (2000) and Ljunwall and Linde-Rahr (2005) find that FDI increases with provincial highway density. The same conclusion is also reached by Chen (1996), Head and Ries (1996) and Sun et al. (2002) when provincial railway density is used instead.

However, Chen (1997), Zhang (2001) and Gao (2005) argue that a better proxy for trade costs should be the combined length of railways, highways and waterways in a province, as this captures the linkages between different modes of transportation. They find that provinces with a longer combined length of railways, highways and waterways attract more FDI. Meanwhile, given China's rise to prominence as the world's leading exporter, He (2002) and Ljunwall and Linde-Rahr (2005) find that the presence of sea berths partly explains the concentration of FDI in the coastal provinces. Furthermore, Fung et al. (2002), Fung et al. (2005) and Cassidy and Andreosso-O'Callaghan (2006) find trade costs are responsible for the uneven distribution of Japanese, Hong Kong, Korean and Taiwanese investment across China.

In this study, we include provincial railway density, provincial highway density and provincial combined railway and highway density as potential variables for testing the effects of trade costs on Taiwanese investment in China.

3.5 Monitoring cost effect

The availability of postal and telecommunication networks is expected to have an impact on the regional distribution of FDI in China because modern infrastructure helps to alleviate the monitoring costs associated with cross-border operations. For instance, a better telecommunication system help to reduce communication costs between parent companies and subsidiaries in China. Therefore, all things being equal, Taiwanese investment is expected to decrease with monitoring costs in the province.

Head and Ries (1996) investigate the impact of monitoring costs using the share of population in the province that has access to a telephone. Wei and Liu (2001) test the hypothesis that foreign investors prefer provinces with a low level of monitoring costs using the output of postal and telecommunication industries and the ratio of output of postal and telecommunication industries to GPP in the province.

Taken together, we include provincial telephone density, provincial postal and telecommunication output and provincial number of postal and telecommunication workers as potential variables for testing the effects of monitoring cost on Taiwanese investment in China.

4. DATA AND ESTIMATION PROCEDURE

4.1 Dependent Variable

The dependent variable in this study is the annual flow of Taiwanese investment to each Chinese province for the period 1996-2005[7]. The state of this investment is regularly reported by the Ministry of Economic Affairs (MOEA) in Taiwan and the Ministry of Commerce (MOFCOM) in China. However, as Yang and Tu (2004) point out, MOEA

[7] We exclude Xizang from the sample due to its unique political status. Meanwhile, Hong Kong and Macao are excluded from the sample because they are the leading contributors to the FDI stock in China.

consistently underestimates this investment due to non-reporting and under-reporting. As such, van Hoesel (1999) and Tung (2003) argue that figures from MOFCOM may be more reliable, since Taiwanese investors have to disclose information, such as country-of-origin and contracted amount of the investment project, to Chinese authorities in order to qualify for fiscal incentives and preferential treatment. Despite this, we use figures released by MOEA, on the basis that those registered investors generally operate genuine businesses on both sides of the Taiwan Strait and active in cross-Strait economic exchanges. Furthermore, we do not use MOFCOM figures as they may contain many dubious investment projects financed by roundabout Chinese capital rather than capital originated from Taiwan (Pomfret, 1994).

In terms of the sample period, we choose the period 1996-2005 on two grounds. Firstly, it is related to the availability of data as MOEA only started to compile and report on the state of Taiwanese investment at the provincial level in 1996. Secondly, this sample period contains year 2000; a year in which the government on both sides of the Strait changed their regulatory framework governing this investment.

The figures for the annual flow of Taiwanese investment to each Chinese province investment are compiled from various issues of *Statistics on Approved Indirect Mainland Investment by Year and Area* published by MOEA. Since these figures are stated in terms of US dollars, they are converted into the Chinese currency, Renminbi (RMB), using the yearly average US dollar/RMB exchange rate, before deflating them to 1990 prices using the GDP deflator for the relevant provinces.

4.2 Description of Exogenous Variables

From our discussion in Section 2, there are a total of 17 commonly proposed measures for the five effects identified in the NEG literature. Table 2 provides summary statistics of these measures. In the table, GPP, GPP per capita, provincial manufacturing output and provincial output of postal and telecommunication industries into 1990 prices using the gross domestic product deflator for the relevant province. Similarly, provincial wage rates are converted into 1990 prices using the consumer price index for the relevant province. In order to obtain the respective densities, population size, total length of railways and highways sets are adjusted for the relevant province’s landmass and the number of telephone set for the relevant province's population. In terms of the figures for provincial cumulative FDI and provincial cumulative Taiwanese investment, we make 1996 as our reference point and use the GDP deflator for the relevant province to deflate the stock of these investments. Finally, provincial cumulative count of foreign-invested firms and provincial cumulative count of Taiwanese firms are year-end figure.

4.3 Factor Analysis

In Table 2, we have listed 17 variables that are commonly used in studying FDI in China. However, the main problem associated with these variables is that they tend to overlap with one another, which gives rise to potential multicollinearity. Therefore, it is important to retain only variables that are pertinent to the distribution of Taiwanese investment in China.

Table 2 Summary statistics, by variable

Variables	Symbol	Mean	Std. Dev.	Min.	Max.	Source
Gross provincial product (RMB billion)	GPP	4.404	2.920	0.588	6.159	CSY
Gross provincial product per capita (RMB)	PGPP	3.665	3.044	0.271	4.440	CSY
Provincial population density (person/km^2)	POPD	1.455	0.259	0.402	2.554	CSY
Provincial manufacturing output (RMB billion)	MOUT	4.404	2.920	0.588	6.159	CSY
Provincial number of manufacturing firms (count)	NMF	3.661	4.605	0.435	2.790	CSY
Cumulative FDI (RMB 10,000)	CFDI	9.762	8.802	0.498	10.909	CSY
Provincial number of foreign-invested enterprises (count)	NFDI	3.694	2.775	0.481	4.782	CSY
Provincial cumulative TDI (RMB10,000)	CTDI	5.512	3.320	0.818	7.510	IDIC
Provincial number of Taiwanese enterprises (count)	NTDI	3.694	2.775	0.481	4.782	IDIC
Provincial average real wage rate (RMB)	AWAGE	3.674	3.281	0.174	4.159	CSY
Provincial efficiency wage rate (RMB)	EWAGE	2.649	2.206	0.207	3.220	CSY
Provincial railway density (km/km^2)	RWAY	-1.867	-2.409	-1.161	0.301	CSY
Provincial highway density (km/km^2)	HWAY	4.644	3.589	0.337	5.224	CSY
Provincial combined railways and highways density (km/km^2)	WAY	-0.457	-1.367	0.121	0.263	CSY
Provincial telephone density (Telephone set per 1,000 people)	TELD	0.990	-0.042	0.406	1.772	CSY
Provincial postal and telecommunication output (RMB billion)	TOUT	3.255	1.848	0.600	4.963	CSY
Provincial number of postal and telecommunication workers (10,000 people)	TWKER	5.348	4.542	0.236	5.750	CSY

Note: These summary statistics are based on the logged value and since log 0 is undefined, 10^{-4} is used to replace the zero whenever it occurs in the dataset. The panel data comprises observations of 29 provinces across the period 1996-2005. CSY denotes *China Statistical Yearbook*. IDIC denotes Statistics on Approved Indirect Mainland Investment by Year and Area published by Taiwan's Industrial Development and Investment Commission. Efficiency wage rate is the ratio of the average real wage rate to manufacturing output divided by the number of workers in the manufacturing industries.

To achieve that end, we calculate the Pearson correlation coefficient matrix by transforming these variables into their natural logarithm and stacking them across provinces. Gujarati (1995) suggests that, as a rule of thumb, multicollinearity poses a serious problem if the Pearson pair-wise correlation exceeds 0.6. A visual inspection examination of Table 3 reveals that there is a high degree of correlation among some of the proposed variables (as highlighted in bold).

Table 3 Pearson pair- wise correlation coefficient matrix, by variable

	1	2								10	11	12	13	14	15	16	17
1. PGRP	1,00																
2. POPD	0.59	1.00															
3. GRP	**0.83**	**0.90**	1.00														
4. HWAY	-0.45	-0.52	-0.54	1.00													
5. LWAY	0.62	**0.86**	**0.85**	-0.38	1.00												
6. RWAY	0.59	0.65	0.69	-0.60	0.59	1.00											
7. INDOUT	0.18	0.31	0.31	0.21	0.08	0.17	1.00										
8. TELD	**0.83**	**0.93**	**1.00**	-0.54	**0.85**	0.69	0.31	1.00									
9. TELOUT	**0.86**	0.39	0.65	-0.26	0.56	0.50	0.01	0.65	1.00								
10. TWORKER	**0.85**	**0.89**	**0.98**	-0.55	**0.85**	0.69	0.26	**0.98**	0.69	1.00							
11. CNFDI	0.12	0.16	0.18	0.28	-0.08	0.11	**0.84**	0.18	-0.07	0.12	1.00						
12. CNTDI	0.67	0.63	**0.72**	-0.24	0.58	0.25	0.47	**0.72**	0.43	**0.72**	0.35	1.00					
13. CFDI	0.39	0.05	0.21	0.21	0.26	0.15	-0.19	0.21	0.68	0.24	-0.22	-0.06	1.00				
14. CTDI	**0.76**	0.66	**0.78**	-0.22	0.64	0.31	0.44	**0.78**	0.56	**0.79**	0.34	**0.97**	0.09	1.00			
15. EWAGE	**0.77**	0.60	**0.75**	-0.15	0.65	0.26	0.26	**0.75**	**0.73**	**0.76**	0.12	**0.78**	0.47	**0.84**	1.00		
16. AWAGE	-0.01	0.08	0.04	-0.42	0.11	0.22	0.11	0.04	-0.06	0.06	-0.16	0.03	-0.31	-0.02	-0.07	1.00	
17. NMF	**0.77**	0.41	0.62	-0.19	0.59	0.37	-0.10	0.62	**0.86**	0.63	-0.17	0.35	**0.74**	0.49	**0.73**	-0.05	1.00

In order to select the best variables for the forces attracting Taiwanese investment in China, we perform factor analysis. According to Cramer (2003), factor analysis is the simplest and most widely used approach in data reduction.8 However, before we perform factor analysis, it is useful to standardize the variables for two reasons. Firstly, standardization controls for substantial inter-provincial differences in locational attributes, such as population and landmass, by removing the unit of measurement from the variables. Secondly, the standardized variables can be expressed exactly as a linear combination of common factor scores of the principal components.

Factor analysis using Varimax with Kaiser Normalization is conducted on the data matrix of the 17 variables listed in Table 4.9 After seven iterations, we removed items that are highly loaded on more than one factor and ended up with the five factors shown in the table.

Table 4 Principal component analysis

Variable	Market access	Trade costs	Industrial linkage	Labour-market pooling	Monitoring costs
GPP	**0.841**	0.335	0.380	0.148	0.048
PGPP	**0.461**	0.194	0.805	-0.019	0.046
POPD	**0.885**	0.331	0.118	0.205	0.030
RWAY	0.848	**0.125**	0.135	0.105	-0.079
HWAY	-0.560	**0.477**	-0.101	0.480	0.291
WAY	0.817	**0.189**	0.241	0.365	0.013
MOUT	0.841	0.335	**0.380**	0.148	0.048
NMF	0.344	0.677	**0.272**	0.117	0.217
CFDI	0.583	0.550	**-0.077**	0.258	0.062
NFDI	0.594	0.578	**0.277**	0.239	0.014
CTDI	0.529	0.353	**0.200**	0.699	0.114
NTDI	0.444	0.258	**0.071**	0.808	0.152
AWAGE	0.159	-0.086	0.927	**-0.140**	0.047
EWAGE	0.012	-0.078	-0.064	**-0.102**	-0.979
TELD	0.230	-0.001	0.924	0.057	**0.099**
TOUT	0.835	0.307	0.407	0.158	**0.010**
TWKER	0.210	0.889	-0.102	0.182	**0.030**
Eigenvalue	6.297	3.659	3.285	1.854	1.168
Cumulative variance	34.986	55.314	73.566	83.865	90.355

Note: Varimax with Kaiser Normalization. Rotation converged in seven iterations.

[8] This is also the approach adopted by Zhou et al. (2002) in their study of Japanese investors' locational choice in China.

[9] We also used Quartimax rotation with Kaiser Normalization. After five iterations, we reached the same qualitative conclusion as those shown in Table 3.

In this solution, factor retention is based on scree plots and eigenvalues. These five factors account for approximately 90 percent of the variance in the 17 variables identified. Specifically, market access indicates the market potential in a province via GPP, GPP per capita (PGPP) and population density (POPD). The length of railways (RWAY), highways (HWAY) and the combined length of railways and highways (WAY) adjusted for the landmass indicate transportation network coverage in a province, hence the label trade costs. Industrial linkages comprise manufacturing output (MOUT) and the number of manufacturing firms (NMF), as well as the cumulative stock of foreign capital (CFDI) and Taiwanese capital (CTDI) and the number of registered projects affiliated with foreign capital (NFDI) and Taiwanese capital (NTDI). Average wage rate (AWAGE) and efficiency wage rate (EWAGE) are variables measuring the impact of labour-market pooling. Telephone density (TELD) and the output of postal and telecommunication industries (TOUT) and number of postal and telecommunication employees (TWKER) are potential proxies for monitoring costs.

As Table 4 shows, POPD is the best proxy for market access. Trade costs are best captured by HWAY. NMF explains most of the variations in industrial linkages. We select EWAGE and TELD to measure the impacts of labour-market pooling and monitoring costs, respectively. These results are consistent with the discussion in Section 2; namely, the annual inflow of Taiwanese investment to a Chinese province increases with POPD, HWAY, NMF and TELD, while it decreases with EWAGE.

In order to ensure that there is no multicollinearity between these variables, we reconstruct the Pearson pair-wise correlation coefficient matrix. As expected, Table 5 indicates that there is no significant degree of correlation among the five selected variables; one for each effect.

4.4 Panel Unit Root Tests

The main purpose of this study is to assess the determinants of the annual inflow of Taiwanese investment to a Chinese province from 1996 to 2005. Since our panel data include time-series observations, it is important to check for the order of integration of the variables listed in Table 5.

There are three commonly used procedures for testing for a unit root in a panel data setting; namely, the Maddala and Wu (1999) Augmented Dickey-Fuller (ADF) Fisher Chi-square test, the Breitung (2000) t-test and the Im et al. (2003) IPS t-bar test. Specifically, Breitung develops a panel version of the Augmented Dickey-Fuller (ADF) unit root test, where appropriate variable transformations are used to correct for cross-sectionally heterogeneous variances that allows for efficient pooled ordinary least squares (OLS) estimation. However, in the present context, it suffers from the implicit assumption that all provinces converge towards the equilibrium value at the same speed under the alternative hypothesis, which is highly restrictive (Narayan and Smyth, 2007). In contrast, the IPS t-bar test is more flexible as it does not require all provinces to converge towards the equilibrium value at the same speed. There are two stages in constructing the IPS t-bar test statistic. Specifically, the first step is to evaluate the average of the individual ADF t-statistics for each province in the panel. The second step is to calculate the standardized t-bar statistic:

$$\bar{t} = \frac{\sqrt{N}(t_\alpha - \kappa_t)}{\sqrt{v_t}} \qquad (1)$$

where *N* is the size of the panel, t_α is the average of the individual ADF t-statistics for each of the provinces and κ_t and v_t are estimates of the mean and variance of each $t_{\alpha i}$, respectively. Im et al. provide Monte Carlo simulations of κ_t and v_t and tabulate exact critical values for the t-bar statistic for various combinations of *N* and *T*.

A potential problem with the IPS t-bar test involves cross-sectional dependence. When this is present in the disturbances, the t-bar test is no longer applicable. Im et al. suggest that, in the presence of cross-sectional dependence, the data can be adjusted by subtracting the cross-sectional means and then applying the t-bar statistic to the transform data. The standardized demeaned t-bar statistic converges to a standard normal in the limit. The existing evidence suggests that this demeaning procedure dramatically reduces cross-sectional dependence, even in instances where the observed data are highly correlated (Smyth, 2003).

Maddala and Wu argue that the demeaning procedure suggested by IPS t-bar test may not completely eradicate the cross-sectional dependence in the disturbance terms. Instead, they propose a panel unit root test that is based on Fisher (1932). Specifically, the Maddala-Wu test combines the p-values of the test statistic for a unit root in each residual cross-sectional unit. The test is non-parametric and has a chi-square distribution with 2N degrees of freedom, where N is the number of cross-sectional units or, in the present context, provinces. Using the additive property of the chi-squared variable the following test statistic can be derived:

$$\lambda = -2\sum_{i=1}^{N} \log_e \pi_i \qquad (2)$$

where π_i is the p-value of the test statistic for unit *i*. An important advantage of the Maddala-Wu test is that it can be used regardless of whether the null is one of integration or stationarity.

The results for the three panel unit root tests are reported in Table 6. All three tests reach the same conclusion; namely, that all variables are stationary at the 10 per cent level of significance. This result means that we can proceed to panel data testing without examining panel co-integration. In addition, given that all variables are stationary, we can assess the significance of a variable using the level series.

Table 5 Panel unit root tests

Variable	Breitung (2000)	Im et al. (2003)	Maddala-Wu (1999)
TDI	-4.791	-2.797	82.324
	(0.000) ***	(0.002) ***	(0.002) **
POPD	-1.926	-2.797	243.930
	(0.027) **	(0.000) ***	(0.000) ***
HWAY	-3.297	-7.179	60.670
	(0.038)	(0.000) ***	(0.000) *
NMF	-2.411**	-7.179	60.670
	(0.002) **	(0.000) ***	(0.000) *
EWAGE	-2.411	-9.549	127.499
	(0.000) **	(0.001) ***	(0.000) ***
TELD	-7.882	-2.240	145.963
	(0.000) ***	(0.013) **	(0.557) ***

Note: Asterisks denote the rejection of the null hypothesis: unit root at the 1%(***), 5%(**), and 10%(*) level of significance. Test equations include individual effects and individual linear trends, automatic selection of lags based on AIC:0-2.

4.6 Estimation Procedure

We start with a basic model derived from a reduced-form specification of the annual flow of Taiwanese investment across China from 1996 to 2000. Let TDI_{it} be the annual inflow of Taiwanese investment to Chinese province i at time t. The relationship between TDI and the selected variables can be written as $TDI_{it} = f(X_{it})$, where X_{it} is a vector of the variables identified in Table 6. Specifically, we select POPD, HWAY, NMF, EWAGE and TELD as the proxies for the impact of market access, trade costs, industrial linkages, labour-market pooling and monitoring costs, on the annual flow of Taiwanese investment to a Chinese province, respectively.

As discussed in Section 1, the attitude toward Taiwanese investment in China has significantly changed on both sides of Taiwan Strait since 2000. From 1996 to 2000, the Taiwanese government imposed severe restrictions on the activities of Taiwanese investors in China. However, after the presidential election in 2000, it adopted a more pragmatic and liberal approach in managing Taiwanese investment in China. In order to capture this, we include a policy dummy variable (POLICY) in addition to the exogenous variables. Specifically, we assign a value of zero to this variable for the period 1996-2000 and a value of one for the period 2001-2005. This variable is expected to have a positive sign, on the basis that relaxations in laws and regulations encourage Taiwanese investment in China, all things being equal. Taken together, the annual flow of Taiwanese investment to Chinese province i at time t can be written as follows:

$$\text{TDI}_{it} = f(\text{POPD}_{it}, \text{HWAY}_{it}, \text{MMF}_{it}, \text{EWAGE}_{it}, \text{TELD}_{it}, \text{POLICY}) \qquad (3)$$

We have shown in Section 3 that POPD, HWAY, NMF, EWAGE and TELD are not highly correlated and that each of them is panel stationary. These results indicate that equation (3) can be estimated with all variables in levels. It is also worth noting that both random-effect model and fixed-effect model were considered, but since the Hausman test ($\chi^2 = 0.002$) rejected the random-effect model, only the results of the fixed-effect model are reported here; that is,

$$\begin{aligned} \ln(\text{TDI}_{it}) = \alpha_i + \beta_1 \ln(\text{POPD}_{it}) + \beta_2 \ln(\text{HWAY}_{it}) + \beta_3 \ln(\text{NMF}_{it}) \\ + \beta_4 \ln(\text{EWAGE}_{it}) + \beta_5 \ln(\text{TELD}_{it}) + \beta_6 (\text{POLICY}) + \varepsilon_{it} \qquad (4) \end{aligned}$$

We select panel data analysis, on the basis that it is appropriate for studying the dynamics of changes such as the annual inflow of Taiwanese investment across China. Specifically, it has the advantage of taking into account heterogeneity of cross-sectional observations by allowing for individual-specific effects (Davidson and MacKinnon, 2004). Furthermore, it gives more variability, degrees of freedom and efficiency, as well as less collinearity among variables (Hsiao, 1989).

In equation (4), we realize these objectives by allowing the intercepts to vary across provinces. In other words, we control for potential omitted variable bias in the fixed effect model by allowing the intercepts to capture unique, but missing or unobserved, factors affecting Taiwanese investment in China. Indeed, two types of possible omitted variables are of particular concern in estimating equation (4); namely, the individual time-invariant variables and period individual-invariant variables. The individual time-invariant variables are variables that remain unchanged for a given province through time, but vary across provinces. Examples include a province's cultural affinity with Taiwan, treatment under the Open Door policy and geographic proximity to the world market.

In contrast, the period individual-invariant variables are variables that remain unchanged across all provinces in China at a given point in time, but vary through time. Examples include changes in macroeconomic conditions, FDI laws and regulations and investor sentiment. These omitted variables, however, may be correlated with the independent variables included in equation (4). In order to control for potential omitted period individual-invariant and provincial-specific omitted variables, we include the POLICY variable and intercepts in equation (4), respectively.

Possible cross-sectional heteroskedasticity in provincial-specific characteristics is another concern that needs to be addressed when estimating equation (4). As a result, the initial estimation of equation (4) is done using the OLS method with the standard White (1980) heteroskedasticity-consistent standard errors and covariance matrix correction procedure.

In order to check the robustness of the OLS estimates, we re-estimate equation (4) using the generalized least square (GLS) method proposed in Greene (2000). Specifically, GLS estimators are computed by first running OLS on the entire sample for each province. Then the variance components are estimated by using the residuals from the OLS estimates. These estimated variances are used in the second step to compute the parameters of the model. The significance of GLS coefficients is also adjusted by the White-correction for heteroskedasticity. While it is common for time-series analysis to control for autocorrelation, we do not think autocorrelation poses a serious problem in estimating equation (4) given the short time series and the long time interval of the data; that is, the annual observations from 1996 to 2005 (Gujarati, 1995).

We also perform regressions on the first-differenced data. The rationale for this procedure is so that we can examine the impact of the growth rate of a variable on Taiwanese investment in China.

Apart from estimating the full sample period, we also use 2000 as our reference year to divide the full sample period into two sub-sample periods; 1996-2000 and 2001-2005. By splitting the full sample period into two sub-samples, we are able to investigate the impact of policy changes since 2000 on the nature of agglomeration forces drawing Taiwanese investment. We drop the POLICY variable from equation (4) when estimating these sub-sample periods. Similarly, there is also a concern that the eastern area had hosted more than two-thirds of the stock of Taiwanese investment in China, which could bias the estimated results. To address this issue, we run a separate set of tests that exclude the eastern area and compare their results with the full sample.

5. RESULTS

5.1 Full Sample Period: 1996- 2005

Table 7 reports both the OLS and GLS results for equation (4) for all provinces and interior provinces. Column (1) and column (2) are the fixed-effect regressions allowing a different intercept for each province. Column (3) and column (4) are the fixed-effect regression on the first-differenced data. The OLS estimates for Column (1), except for POPD, are consistent with our a priori expectation. In general, the OLS estimate is statistically significant for NMF and TELD at the 10 and 5 per cent level of significance, respectively. These findings lend support to our hypothesis that both industrial linkages and monitoring costs are important factors giving rise to the uneven distribution of Taiwanese investment in China. They are also consistent with previous findings by Wei and Liu (2001) and He (2002). In contrast, the coefficients on POPD, HWAY, EWAGE and POLICY are not statistically significant at any conventional level. To put these results differently, market access, trade costs and labour-market pooling, as well as changes in policy do not contribute to the uneven distribution of this investment. One of the reasons for these results could be that the White-correction for heteroskedasticity cannot control for group-wise heteroskedasticity (Wooldridge, 2000). Indeed, a standard Lagrange multiplier (LM) test reveals that homoskedasticity across provinces can be easily rejected at the 1 per cent level of significance.

Table 6 Regression results, 1996- 2005, by all provinces and interior provinces

	All Provinces				Interior Provinces			
	Fixed effect		First-differenced		Fixed effect		First-differenced	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
POPD	-1.962 (-1.088)	-1.593 (-2.210)**	1.605 (0.523)	0.900 (0.892)	-2.981 (-1.154)	-4.371 (-1.908)*	0.944 (0.170)	-0.746 (-0.368)
HWAY	0.618 (1.509)	0.200 (0.817)	0.153 (0.260)	-0.820 (-2.375)**	0.884 (0.840)	-0.110 (-0.170)	-0.835 (-0.574)	-1.744 (-0.697)
NMF	3.307 (1.781)*	2.166 (2.890)***	5.366 (2.554)***	4.928 (4.570)***	5.140 (2.076)**	5.097 (3.366)***	6.066 (2.074)**	5.338 (3.148)***
EWAGE	-2.550 (-1.620)	-1.680 (-2.391)**	-4.560 (-2.248)**	-4.201 (-4.063)***	-4.417 (-2.144)**	-4.768 (-3.488)***	-5.446 (-1.953)*	-5.157 (-3.149)***
TELD	0.931 (2.101)**	0.504 (2.132)**	2.860 (3.831)***	2.357 (4.510)***	0.962 (1.468)	0.683 (1.799)*	2.653 (2.776)***	2.019 (4.547)***
POLICY	0.114 (0.330)	0.298 (2.194)**	0.606 (1.691)*	0.480 (4.443)***	0.284 (0.535)	0.508 (1.433)	1.079 (1.568)	1.341 (3.234)***
Adjusted R^2	0.685	0.853	-0.121	0.201	0.465	0.571	0.110	0.065
F-statistic	18.940***	48.843***	0.879	2.861***	7.094***	10.346***	0.657	1.439
D-W	1.986	1.880	2.660	2.570	2.006	1.954	2.660	2.583
N	240	240	216	216	130	130	117	117

Note: t-statistics are in parenthesis. ***, ** and * denote the 1, 5 and 10 per cent level of significance, respectively. The All Provinces sample includes Beijing, Tianjin, Hebei, Shanxi, Neimengu, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou and Yunnan. The Interior Provinces sample includes Hebei, Shanxi, Neimenggu, Jilin, Heilongjian, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Guizhou and Yunnan.

In order to obtain more robust results, we re-estimate equation (4) using the GLS procedure. Column (2) in Table 7 reveals that, except for HWAY, all estimates become highly significant. For instance, a 1 per cent increase in NMF leads to a 2.17 per cent increase in TDI, which is significant at any conventional level. Similarly, a 1 per cent increase in TELD leads to a 0.50 per cent increases in TDI, which is significant at the 5 per cent level of significance. Moreover, the change in policy leads to a 0.30 per cent increase in TDI, which is significant at the 5 per cent level of significance. Importantly, EWAGE now enters significantly with a negative sign into the GLS regression at the 5 per cent level of significance. Specifically, a 1 per cent increase in EWAGE leads to a 1.68 per cent decrease in TDI. This is consistent with previous findings by Chen (1997), Wei et al. (1999), Wei and Liu (2001) and Ljunwall and Linde-Rahr (2005).

Another notable result is that POPD enters significantly with a negative sign into the GLS regression. Specifically, a 1 per cent increase in POPD leads to a 1.59 per cent decrease in TDI. From the outset, this finding seems to contradict the existing literature that finds a positive market-access effect for the provincial distribution of FDI in China (Chen, 1997;

Wei et al., 1999; Wei and Liu, 2001; Fung et al., 2002; Sun et al., 2002; Fung et al., 2005; Ljunwall and Linde-Rahr, 2005). However, this result needs to be interpreted with caution. This is because, after its accession to the World Trade Organization (WTO) in 2000, the Chinese government has allowed foreign investors greater access to its domestic market. Many market-seeking foreign investors, particularly those originating from service industries, have entered highly populated provinces, on the basis that more populated provinces represent greater market potential. This, however, creates excess demands for productive factors, such as land and labour, and puts upward pressure on factor prices (Qu and Green, 1997). This surge in production costs discourages many export-orientated Taiwanese investors as it restricts their ability to supply competitively priced goods in the world market. In addition, negative externalities such as pollution, congestion and high crime rates associated with densely populated provinces may further discourage these investors (Zhu, 2005). Finally, strict restrictions imposed by the Taiwanese government imposed on these investors in service industries may have marginalized the importance of the market-access effect (Tung, 2003). These reasons explain why some of these investors prefer to produce in, and export from, less densely populated provinces; that is, factor prices associated with these provinces are lower. In short, the finding of a negative market-access effect needs not to be inconsistent with the NEG literature, which suggests that the market-crowding effect will set in once the market size surpasses a critical threshold (Baldwin et al., 2003).

Column (3) and column (4) in Table 7 examine whether Taiwanese investment in China is affected by the growth rate. For the GLS results, except for POPD, all variables entered significantly into the regression at the 5 per cent level of significance. These results indicate that this investment is higher in provinces with a higher growth rate of HWAY, NMF and TELD, but slower in provinces with a higher growth rate of EWAGE. These results are consistent with our earlier findings for fixed-effect models; namely, this investment is positively affected by industrial linkages and monitoring costs, while it is negatively affected by labour-market pooling.

Since Taiwanese investment is concentrated in China’s coastal provinces, this may be the reasons for the results obtained so far. Indeed, as Ljunwall and Linde-Rahr (2005) point out, the locational determinants of FDI in China vary between the coastal provinces and the interior provinces. In order to test that hypothesis, we perform regressions excluding coastal provinces. Column (6) in Table 7 shows that the fixed-effect GLS estimates are qualitatively the same as those obtained in Model (2) in the same table. Specifically, column (6) shows that TDI is positively affected by MMF and TELD, while it is negatively affected by EWAGE and POPD.

Finally, it is worth noting that, although the adjusted R-square for the GLS estimate of column (6) has decreased in Table 7, it still explains more than half of the variation in the annual inflow of Taiwanese investment to the interior provinces in China. In other words, proximity to the coastline, as captured by the intercepts of individual provinces, is another factor explaining the concentration of this investment in the coastal provinces. This is also consistent with Ljunwall and Linde-Rahr's (2005) finding; namely, the nature of the determinants of this investment differs between the coastal provinces and the interior provinces in China.

In short, these findings suggest that industrial linkages, labour-market pooling and monitoring costs affect the provincial distribution of Taiwanese investment in China for the period 1996-2005. Furthermore, the large magnitude of the coefficient on NMF suggests that industrial linkages are by far the most important location determinant of this investment.

5.2 Sub- sample period: 1996- 2000

As discussed earlier, the nature and source of Taiwanese investment in China significantly changed in recent years. At the turn of the century, the Taiwanese government relaxed laws and regulation governing Taiwanese investment in China. Furthermore, as point out by Sun et al. (2002), determinants of FDI in China have also changed following the introduction of the Open Door policy in 1978. In order to take these considerations into account, we split the entire sample period into the pre- and post-2000 periods. The results of the earlier period from 1996 to 2000 are shown in Table 8.

Table 7 Regression results, 1996- 2000, by all provinces and interior provinces

	All Provinces				Interior Provinces			
	Fixed effect		First-differenced		Fixed effect		First-differenced	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
POPD	-7.527 (-1.190)	-4.789 (-1.962)*	-0.319 (-0.022)	3.756 (2.898)***	-12.227 (-1.641)	-10.360 (-3.648)***	-6.879 (-0.380)	-9.089 (-2.122)**
HWAY	-0.400 (-0.292)	0.713 (1.361)	-0.327 (-0.195)	-1.083 (-1.731)*	-1.699 (-0.544)	-3.609 (-0.992)	1.188 (0.131)	-4.109 (-1.858)*
NMF	7.216 (1.547)	6.295 (3.787)***	11.062 (1.556)	10.058 (18.576)***	10.081 (1.808)*	9.375 (2.731)***	13.139 (1.249)	11.296 (4.353)***
EWAGE	-8.810 (-2.388)**	-7.968 (-4.957)***	-8.912 (-1.133)	-8.204 (-9.560)***	-10.58 (-1.791)*	-8.84 (-2.270)**	-8.834 (-0.807)	-7.925 (-2.289)**
TELD	0.604 (0.422)	0.544 (1.453)	4.343 (2.391)**	4.440 (10.515)***	1.949 (0.968)	1.557 (0.970)	5.171 (2.293)**	6.29 (5.858)***
Adjusted R^2	0.572	0.805	-0.171	0.705	0.230	0.548	-0.286	0.258
F-statistic	6.702***	18.635***	0.502	9.129***	2.104**	5.473***	0.346	2.023**
D-W	2.373	1.961	2.487	2.515	2.464	2.182	2.541	2.502
N	120	120	96	96	120	120	96	96

Note: t-statistics are in parenthesis. ***, ** and * denote the 1, 5 and 10 per cent level of significance, respectively. The All Provinces sample includes Beijing, Tianjin, Hebei, Shanxi, Neimengu, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou and Yunnan. The Interior Provinces sample includes Hebei, Shanxi, Neimenggu, Jilin, Heilongjian, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Guizhou and Yunnan.

Column (1) and column (2) in Table 8 indicate that EWAGE still enters significantly with a negative sign. For column (1), EWAGE estimate is -8.81 with a t-value of -2.39. For column (2), the same estimate is -7.97 with a t-value of -5.00. These estimates are significantly higher than those obtained for the full sample period. In contrast, HWAY and TELD now enter insignificantly. This result differs to those obtained for the full sample period. One way to interpret these results is to recall that, for the period 1996-2000, the majority of Taiwanese investment in China originated from export-orientated, manufacturing industries, reflecting partly worsening production conditions in Taiwan (Tung, 2000; Zhang, 2005). For these investors, the importance of labour-market pooling (as measured by EWAGE) outweighs other considerations such as trade costs (as measured by HWAY) and monitoring costs (as measured by TELD).

Column (5) to column (8) in Table 8 reports the results excluding China's coastal provinces. The results are similar to those presented in column (1) and column (4) in Table 8. In general, Taiwanese investment is concentrated in provinces with a higher level of NMF and a lower level of EWAGE. That is to say, Taiwanese investors prefer central and western provinces that have more of low-cost industrial workers and a smaller population in order to avoid competition against other foreign investors over a limited supply of productive factors.

In short, for the period 1996-2000, the distribution of Taiwanese investment in China is predominantly driven by industrial linkages and labour-market pooling. Furthermore, the baseline fixed-effects GLS model seems to a better candidate for explaining this investment in China's coastal provinces vis-à-vis interior provinces.

5.3 Sub- sample period: 2001- 2005

We examine the impact of changes in the cross-Strait policy by studying the distribution of Taiwanese investment across China for the period 2001-2005. The OLS and GLS regressions in equation (4) are re-estimated for the fixed-effect model (column (1)-(2)) and the first-differenced data (column (3)-(4)) in Table 9.

Table 8 Regression results, 2001- 2005, by all provinces and interior provinces

	All Provinces				Interior Provinces			
	Fixed effect		First-differenced		Fixed effect		First-differenced	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
POPD	0.471 (0.448)	0.330 (0.750)	0.065 (0.448)	0.844 (2.223)**	-0.109 (-0.103)	-0.680 (-1.038)	-1.607 (-0.917)	-0.642 (-2.605)**
HWAY	1.950 (1.531)	2.024 (3.136)***	2.508 (3.684)***	0.659 (1.486)	3.245 (0.951)	5.522 (3.707)***	3.039 (1.848)*	2.299 (1.884)*
NMF	-0.147 (-0.163)	-0.350 (-0.595)	-1.812 (-0.548)	-1.483 (-1.510)	3.245 (0.951)	0.965 (1.201)	-3.446 (-0.719)	-1.279 (-0.616)
EWAGE	0.785 (0.935)	0.805 (1.468)	2.378 (0.739)	2.034 (2.147)**	-0.676 (-0.561)	-0.514 (-0.680)	3.929 (0.754)	1.841 (0.901)
TELD	1.738 (10.255)***	1.335 (9.402)***	1.614 (2.907)***	1.409 (5.329)***	1.335 (4.526)***	1.130 (7.056)***	0.694 (0.754)	1.071 (3.561)***
Adjusted R^2	0.849	0.956	-0.038	0.422	0.786	0.9	-0.108	0.186
F-statistic	25.004***	94.583***	0.843	4.115***	14.625***	43.745***	0.640	1.843*
D-W	2.357	2.05	3.018	2.9	2.674	2.274	2.909	2.804
N	120	120	96	96	120	120	96	96

Note: t-statistics are in parenthesis. ***, ** and * denote the 1, 5 and 10 per cent level of significance, respectively. The All Provinces sample includes Beijing, Tianjin, Hebei, Shanxi, Neimengu, Liaoning, Jilin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Guangdong, Guangxi, Hainan, Sichuan, Guizhou and Yunnan. The Interior Provinces sample includes Hebei, Shanxi, Neimenggu, Jilin, Heilongjian, Anhui, Jiangxi, Henan, Hubei, Hunan, Sichuan, Guizhou and Yunnan.

Specifically, column (1) and column (2) provide some interesting results. First, consistent with our a priori expectations, HWAY enters significantly in the GLS regression at any conventional level of significance. For the GLS estimate, a 1 per cent increase in HWAY leads to a 2.02 per cent increase in TDI. A similar result is also found for TELD. For the GLS estimate, a 1 per cent increases in TELD increases TDI by 1.34 per cent. These results can be explained by the fact that the adaptation of just-in-time logistic management and decentralized production systems by Taiwanese investors in China since 2000 (Ohmae, 2002; Zhu, 2005). To achieve these ends, an extensive coverage of highway and telecommunication networks is necessary. As such, the increase in importance of trade and monitoring costs on this investment since 2000 can be attributed to changes in business strategies and practices.

Column (3) and column (4) in Table 9 reach similar results to column (1) and column (2) in the same table. Specifically, for the GLS results, a province with a higher growth rate of TELD, EWAGE and POPD attracts more annual inflow of Taiwanese investment. This is consistent with our findings so far; namely, both trade and monitoring costs are the main determinants of distribution of Taiwanese investment in China for the period 2000-2005.

Finally, results excluding the coastal provinces in China, as shown in column (5) to column (8), are qualitatively the same as those for column (1) to column (4) in Table 9. Specifically, for the period 2000-2005, a 1 per cent increase in HWAY leads to a 5.52 per cent increase in TDI. The large magnitude of the HWAY coefficient is consistent with the hypothesis that extensive transportation network coverage is needed in order to reduce trade costs in shipping goods from the central and western provinces to the world market. This findings is also consistent with the experience of Korean investors in China, as the majority of Korean investment is driven by vertical integration, transportation costs in shipping intermediate inputs from China back to Korea is an important consideration (Kang and Lee, 2007). Similarly, because it is relatively more difficult for head offices in Taiwan to monitor their subsidiaries in China located in the interior provinces compared to those in the coastal provinces, a sound telecommunication network effectively reduces monitoring costs; that is, a 1 per cent increase in TELD leads to a 1.13 per cent increase in TDI (Belderbos and Carree, 2002; He, 2002).

Overall, for the period 2001-2005, trade and monitoring costs are important determinants of the distribution of Taiwanese investment across China. Furthermore, the baseline fixed-effects GLS model explains this investment across the coastal provinces better than the interior provinces.

To summarize this section, determinants relating to market access, industrial linkages, labour-market pooling, trade costs and monitoring costs are important to the distribution of Taiwanese investment in China from 1996 to 2005. However, for the period 1996-2000, both industrial linkages and labour-market pooling have sizeable effects on the distribution of this investment. For the period 2001-2005, both trade and monitoring costs have grown in importance. Furthermore, the identified determinants feature more prominently in explaining this investment across China's interior provinces, as evident by the larger magnitude of the estimates obtained. In other words, the determinants of this investment differ across provinces and change over time.

5.4 Model Fitness

Given the high explanatory power of the baseline fixed-effects GLS model, it is informative to also examine its predictive power. To achieve that end, we examine the residuals generated by the baseline model for the full sample period 1996-2005. A standardized residual exceeding a t-statistic value of 1.65 is regarded as a significant outlier. In general, a positive outlier indicates that a province receives more than the predicted amount of annual inflow of Taiwanese investment in a particular year. Similarly, a negative outlier indicates that a province receives less than the predicted amount of this investment. In addition, we calculate the standard deviation of time-series residuals for each province to assess the performance of the baseline model. Consistent with the conventional interpretation, a smaller standard deviation of time-series residual indicates a better performance of the baseline model in that province.

Table 9 Standardized difference between actual and predicted FDI (based on the fixed effect model), 1996- 2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	σ
Coastal											
Beijing	2.43***	-1.25	-0.74	0.71	-0.20	-1.44	-1.76*	-0.87	1.98**	1.13	1.48
Tianjin	-1.70*	-1.46	-0.47	1.50	0.13	0.96	0.01	-0.37	1.30	0.11	1.07
Liaoning	-1.55	-1.28	1.26	3.49***	0.15	-0.05	-1.40	-1.78	0.81	0.36	1.62
Shandong	-1.30	-1.53	-1.03	1.28	0.47	0.10	0.72	0.25	0.61	0.44	0.95
Jiangsu	0.04	-0.26	-0.12	0.27	-0.77	-0.16	0.23	-0.14	0.57	0.34	0.38
Shanghai	-0.49	0.19	-0.67	-1.06	-0.92	-0.96	1.41	0.70	1.70*	0.09	1.00
Zhejiang	0.61	-0.62	-0.01	0.12	0.09	-0.77	0.34	-0.34	0.32	0.28	0.45
Fujian	-1.34	-0.85	-0.81	-0.67	-0.60	-0.15	0.97	1.03	1.42	0.99	1.00
Guangdong	-1.03	-0.60	-0.73	-0.69	-0.81	-0.70	0.96	0.99	1.54	1.07	1.00
Guangxi	0.94	-2.82***	-2.78***	2.60***	0.42	1.84*	-3.94***	-3.55***	-2.02**	0.30	4.39
Hainan	-0.63	-3.28***	-2.92***	0.78	-1.05	-0.67	-0.21	-0.89	0.90	0.80	1.45
Interior											
Neimenggu	0.62	-6.47***	-7.69***	0.79	0.76	1.34	2.17**	2.53***	3.15***	2.81***	3.85
Jilin	8.54***	-3.79***	-2.62***	8.04***	1.15	0.54	-2.35***	-2.67***	-2.80***	-4.02***	4.68
Heilongjiang	8.46***	-2.82***	-2.23**	-5.56***	7.28***	-0.77	3.81***	-4.24***	-3.42***	-0.52	4.87
Anhui	-0.19	-0.83	-2.56***	1.98**	-3.17***	2.31***	-2.14**	-1.09	-2.15**	-2.16**	4.49
Jiangxi	7.44***	-3.07***	-0.06	0.57	-0.11	-0.45	-0.93	-2.05**	-0.19	-1.15	2.82
Henan	0.09	-1.93	-1.37	2.25**	1.37	2.31**	-0.11	-1.27	-0.71	-0.66	1.51
Hubei	1.25	-1.76	-1.42	-0.14	4.03***	-0.18	2.05**	-1.26	-1.12	-1.45	1.89
Hunan	-2.07**	-1.92*	-0.38	1.61	3.82***	-1.22	0.95	-0.20	-0.45	-0.12	1.76
Sichuan	1.01	-1.37	-0.01	-0.78	-0.83	-0.04	0.58	0.37	0.23	0.85	0.78
Guizhou	2.70***	-4.92***	-3.50***	3.16***	2.94***	0.31	-2.12**	-1.91*	5.22***	-1.89**	3.36
Yunnan	-0.88	-3.78***	-1.96*	1.16	3.58***	-1.13	0.60	0.12	2.06**	0.23	2.08
Shanxi	4.33***	-2.08**	-1.78*	-2.15**	4.62***	1.23	-0.34	-0.06	-2.00**	-1.78*	2.60

Note: ***, **, and * denote 1%, 5%, and 10% level of significance.

Table 10 presents the standardized residuals of individual provinces across time, as well as the time-series standard deviation of residuals, σ. Specifically, standard deviations are markedly smaller for the coastal provinces vis-à-vis interior provinces in China. These results suggest that the baseline model performs better for the coastal provinces, which is consistent with our earlier finding that determinants of this investment differ across provinces. However, this result needs to be interpreted with caution. The main reason for the significant outliers obtained for the interior provinces can be attributed to the fact that some of these provinces received no such investment in some years. These zero observations have the potential to bias the predictive power of our baseline model.

In short, a longer history of hosting Taiwanese investment, more stable production conditions and a more transparent policy in dealing with specific issues related to this investment explain the good performance of our baseline model in predicting the distribution of this investment across the coastal provinces in China.

6. CONCLUSION

The annual flow of Taiwanese investment to China has increased substantially during the period 1996-2006. In general, its provincial distribution can be attributed to industrial linkages, labour-market pooling and monitoring costs. Specifically, it is higher in provinces with sound industrial linkages, lower labour costs and better telecommunication coverage. Importantly, using provincial population density as a proxy for market access, we find evidence that it has a negative impact on this investment, which contradicts the majority of the existing literature that finds a positive relationship between FDI and market access. However, we have argued that this finding needs not imply that our baseline model is erroneous. Instead, we suggest that this may be evidence that a market-crowding effect is in play. This is consistent with the NEG literature, which predicts that FDI may actually decrease if market size exceeds a critical threshold due to competition among foreign investors for a limited supply of productive factors. In addition, we find evidence that the changes to the laws and regulations by the Taiwanese government are responsible for the systematic increase of this investment since 2000.

We also provide evidence that the nature of the determinants of Taiwanese investment in China changed over time. The level of labour costs and the number of manufacturing firms attract this investment before 2000, but bear no significant relationship after that. We suggest that these findings partly reflect the fact that, before 2000, this investment mostly originated from exported-orientated manufacturing industries. Clearly, for these investors, investing in provinces with an ample supply of cheap intermediate inputs is indispensible to enhancing international competitiveness.

Furthermore, we find that the length of highway and the availability of telephone sets have become important factors considered by Taiwanese investors since 2000. In general, provinces with better transportation and telecommunication networks are associated with lower trade and monitoring costs. We argue that these changes partly reflect the changing management philosophy and business practice of these investors. We also have mild evidence that market-seeking has become an important motivation for this investment during this period, as captured by the growth rate of provincial population density being a significant predictor of the growth rate of this investment.

There is clear evidence suggesting that the nature of determinants differ distinctly between Taiwanese investment in China's eastern provinces and their interior counterparts. This divergence can be partly explained by the Open Door policy that favours the development of FDI in the eastern provinces. As a result, this investment in the interior provinces has experienced extreme fluctuations, with some years during which no such investment occurred. In contrast, this investment in the coastal provinces has remained steady throughout the period 1996-2005, as evident by the smaller value of the standard deviation of residuals found for these provinces.

In sum, several policy implications can be drawn from our findings. Firstly, in order to attract more Taiwanese investment, the Chinese government should improve infrastructure, such as transportation and telecommunication networks, rather than relying solely on fiscal incentives and preferential treatment. As this study shows, both trade costs and monitoring costs have gained in importance in recent years. In fact, their importance is likely to be reinforced by globalization. Secondly, China should not rely on low labour costs as the source of its international competitiveness. Our finding suggests that, from 2000 onwards, industrial upgrading of this investment has rendered labour costs less of a concern. This means that the Chinese government should improve labour quality in the long run. Thirdly, the Chinese government should strengthen industrial base in order to cater for the development of decentralized production systems. This is important because weak industrial linkages can be detrimental to the productivity of the entire decentralized production network with increasing degrees of specialization and division of labour. Last, but not the least, the Chinese government should continue to pursue economic reforms. Our finding indicates that the growth rate of a market does have a positive impact on the growth rate of this investment. Indeed, market access could become the most important determinant as China continues to open up its domestic market to the rest of the world.

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