

The Effect of Foreign Direct Investment on the Chinese Endogenous Economic Growth

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Abstract

As a result of the decentralization reforms introduced in China, local governments have become more important participants or commanders in regional economic development. In this paper, we examine a simple AK model with direct interference of local governments on the technology spillovers via FDI. We theoretically find that the economic growth shows convergence cross the economic areas when the relative ratio of FDI capital to the domestic capital changes with an equal unit. However, the convergence of economic growth take shorter time between the member areas in the same economic cluster than the members in the different level of economic growth group. The result for household's welfare issue is different. When the economic growth

changes, the convergence of household's welfare only happen to the members in the same economic cluster but no convergency exist between two clusters. In fact, the government subsidy rate on FDI capital to the industries determines the effect of tax policy changes on the local economic growth and agent welfare. It is possible to government to carry out a positive tax change and keep an increase of economic growth at same time.

1 Introduction

Following the economic reforms conducted since 1979, China has achieved a fast growth over the last two and half decades. Undeniably, foreign direct investment (FDI) has played a significant role in the opening economic reform. By 2002, cumulative FDI stock reached US\$448 billion in China and new FDI flow was US\$52.7 billion in 2002. For the first time China surpassed the USA to become the world's largest FDI recipient country. In earlier studies, recognition of the economic role of FDI can be seen as of two kinds: (i) it is a business operation strategy of the FDI host country to promote its export sector, (Sun 1999 and Chen 1999). (ii) FDI is a vehicle for technology spillover from the developed countries to the less developed countries, (Lo 2004, Berthelemy and Demurger 2000 and Borensztein et al.

1998). In case of China, some empirical works demonstrate the variety of effects of FDI on economic growth in 1990s. For instance, Lo (2004) has constructed two models representing the different economic roles of FDI in China: a capital-deepening model and an export-oriented model. The empirical results suggest two different types of FDI capital coexist in China, but each concentrates in the different economic areas. It is shown that FDI has more positive effect on economic growth in the former model than in the latter one and improves overall productivity growth by a cumulative causation effect rather than an immediate direct causation effect.

Borensztein et al. (1998) find that FDI contributes to economic growth only when a sufficient absorptive capability of the advanced technologies is available in the host country. Lheem and Guo (2004) empirically demonstrate that there is a ‘synergistic effect’ between local economic growth and FDI distribution on the provincial level in China, very little on national aggregate level. We consider FDI improves the economic growth by increasing the productivity of the industrial sector, as a vehicle for technology spillover from the FDI supply countries. Embracing the existing empirical results, we model that the productivity as a function of the relative ratio of the cumulative FDI capital to the domestic capital investment in this paper. We ignore the crowding out effect between FDI and domestic investment. We predict the ratio between two capitals has positive effect on local economic

growth, and an increase of domestic investment (such as investment in public infrastructure, or education) would enhance the ability of retaining high level of foreign investment.

In the western economies, the import of FDI is normally decided by each individual enterprise optimizing its target objective. However, we emphasize the FDI as the public investment, since all FDI projects have to be authorized a licence by central or local governments in China. For simplicity, we assume governments purchase FDI (e.g., a specific needed advanced technology) from the world market, and the domestic industries would rent such capital at a government fixed price (domestic interest rate). The capability of new FDI input is restricted by the local government budget constraint. Under such circumstance, the changes of fiscal policies, for instance, tax rates, would have an impact on local economic growth. Not any successful empirical research were seen on this topic in case of China, may for the difficulty of collecting good quality data (Sun et al. 2002). However, Sun et al. referred to Hines's (1996) study that in the USA, a higher state tax rate has a negative effect on investment. This gives us an incentive to carry out a further study on how local governments influence the economic growth by controlling the productivity capital. In this paper, with a single-agent model, we will first show the dynamic tax policy effect on the balanced economic growth, via its impact on a FDI measurement variable. Second, considering the heterogeneity on the

provincial level, the model enables us to examine the disparities of regional economic growth related to the same dynamic change of tax policy.

The rest of this paper is organized as follows. Section 2 presents two new characteristics of FDI distribution in China, based on the data from China Statistics Year Book (CSY 2003). Section 3 presents a representative agent economy model in interaction with government decision. The balanced economic growth system is depicted in that section. Section 4 presents the tax policy effect on balanced economic growth. Section 5 presents the tax policy effect on a representative household welfare. Section 6 presents the difference of economic development on provincial level. We also statistically show the advantage of dividing individual provinces into groups while we have the economic analysis. Section 7 presents the theoretical conclusions and possible research directions for future research. The tables, figures and proofs are presented in appendixes at the end.

2 New Characteristics of FDI in China

For empirical study, Broadman and Sun (1997) examined the development of FDI in China from the 1980s to 1995 and they demonstrate that the distribution of FDI is in positive correlation with the level of local economic development. First of all, they documented that FDI was heavily concen-

trated in those more open economic areas, namely the four initial Special Economic Zones (SEZs) and 14 open coastal cities and development zones, while the inland cities attracted relatively little foreign investment before 1996. During the same period, most FDI was in the real estate sector, rather than in manufacturing. Graham (2001) presented evidence that total factor of productivity (TFP) grew faster in the FDI intensive areas in the 1991–97 period, but not in the 1978–90 period. Those empirical results highlighten our research on how to structure the pattern of FDI distribution and relationship between economic growth and foreign investment in China. It says the type of FDI might have changed over time in Chinese economic reform and the FDI has a positive impact on economic growth mainly through promoting the productivity factors in production. As China experienced, a higher level of TFP is normally related to a higher local economic growth on provincial level, which consequentially brings more tax revenue to local government. Therefore, there is a strong incentive for local government to improve the capability of hosting more foreign investment. The statistics (CSY) show some new changes of FDI imports since 1996, a growing portion of FDI flow has come from Europe, North America, and Japan, rather than mostly from the non-Japanese Asian countries and areas in the earlier stage. This shift in suppliers marks new changes of FDI on the concentrated sectors and areas in China. We brief the new changes relating to our theoetical analysis in this

paper as follows:

- (i) *Geographic change of FDI distribution, from coastal areas to inland areas.*

At the beginning of open economic reform, FDI was only invested in the Guangdong and Fujian areas. The main foreign investors were from Hong Kong and Taiwan. The share of utilized FDI in Guangdong province was 46% in 1985, and 28% in 1995 (Sun et al., 2002), but only 21% in 2002. As the Chinese government started to address economic development in inland cities and western areas, in order to reduce the widely recognized inequality in economic growth over the country, domestic investment in fixed capital increased averagely in inland cities after the later 1990s. Those domestic investments were concentrated on local infrastructure development, building highway roads, renewing the train system and increasing investment in the education system, which all were intended to improve the investment environment for foreign investors.

We construct a new measurement of FDI distribution, the relative ratio of cumulative foreign investment to cumulative domestic loans across regions, which is supposed to be the determinant of the TFP of production.

Table 1 is Here.

In Table 1(the data from the year of 2002 in the CYS 2003, Table 8-21), from the column of Foreign Investment, we see only Tibet has no foreign investment, otherwise FI exists in all the other 30 cities and economic areas.¹ From the column of the relative capital ratio, we see there are only three cities with outstandingly high relative level of foreign investment: Shanghai, Guangdong and Hainan. As known, Guangdong was the earliest open economic area in China, and Shanghai aims to be the national financial centre. Hainan was appointed as economic testing area in the early 1990s, and attracted FI mostly in the hotel and tourism development business due to its beautiful natural setting. Thus there is a historical reason why these three areas have very high foreign investment stock level. The relative capital ratios are on the similar level in the other areas, except in the west: for example, Inner Mongolia, Guizhou, Yunnan, Tibet, Gansu and Ningxia. In this paper, first we will analyse the relationship between the relative capital ratio and the balanced economic growth in a homogeneous model. Second, we extend the representative agent model to a heterogenous economic regions model, in which we categorize the economic regions to three different clusters according to the new FDI measurement: namely, high, medium and low areas, written as the subscript $j = h, m, l$, where j represents economic area (or

¹Commonly, the foreign investment includes FDI and foreign borrowing but in CSY, the value of foreign borrowing is always set in an different table. Here FI is the equal value as FDI.

province). We model the effect on the local economic growth is determined by both the level and growth of relative capital ratio. Hu and Owen (2005) empirically show that the growth of FDI converges within coastal areas but widens between coast and the inland cities. Later in this paper, we will do a theoretical discussion on convergence possibility for economic growth and welfare growth cross different economic clusters.

(ii) *The change of FDI-concentrated sectors, from competitive industrial sector to monopoly industrial sector.*

At the early stage of open economic reform in China, most FDI was used in Joint Ventures or Cooperative Operation Enterprises, in which a Chinese partner supplied a cheaper labour force and land rent, but most machinery and working capital and managerial skill was imported from the foreign partner, and all products were exported to the world market, whereby the enterprises gain competitive profit from the lower production costs. Such a model of FDI is known as the export-oriented FDI model, and is popular in the early economic period in Guangdong area (Lo 2004). In addition, major donors of foreign investment concentrated on tourism and the hotel business at the beginning of the economic opening stage, in which sectors no domestic investors were interested or had enough experience of. Thus, the pattern of FDI in the primary stage in China was that most foreign

investment concentrated on labour-intensive industries and cooperated with local small private sectors, as well as being focused on the coastal areas with their beautiful natural resources which make them suitable for tourism.

China has now passed the primary stage of FDI utilization. Currently, the share of FDI from OECD investors is growing. OECD investors prefer a big lump-sum capital investment in non-opened or less-opened industries, which are mostly located in inland areas in China. They seek the non-competitive sector in order to gain monopoly profit with their more advanced technology in a specific industrial sector. In such case, FDI flows to technology-intensive industries, such as the auto industry, chemical industry, and coal-related industry. A recent event of FDI in China, which has surprised the world, is that Beijing has given the green light to BP (British Petroleum) to make a joint venture with Sinopec, the foreign-listed arm of China Petroleum Chemical Cooperation, which is China's biggest oil producer and refiner (*The Observer*, 26 February 2006). BP will benefit from the size of Chinese domestic market demand, and Sinopec hope that the link with BP will provide the opportunity of integration with global production structures in the western world. Figure 1 and Table 2 show the change of FDI in terms of types of cooperation and the change of concentrated industrial sectors since the later 1990s.

FDI is usually viewed as a channel for technology to spread from the economic developed countries to the developing countries (Borensztein, 1998).

In China, there are five main channels for FDI inflow: (i) Joint Venture Enterprises (JV), (ii) Cooperative Operation Enterprises (Co-Op), (iii) Foreign Investment Enterprises (FIE), (iv) Foreign Investment Share Enterprises, (v) Cooperative Development.²

Figure 1 is Here.

Figure 1 shows that JV was the top main channel for FDI inflow by 1996 in China. However, the FIE (also named the wholly foreign owned foreign enterprise) has much more rapid growth than the other channels do, and, by 2000, FIE had become the top main channel. As is known, the major providers of FDI are currently attracted to the high value-added financial service sectors in the near future, many of which, such as banking, insurance and informatics, are areas currently still restricted to FDI. Thus there still exist excess opportunities for foreign investors to invest in China. In the short term, China has no problem of FDI saturation on the national level, but some FDI intensively endowed areas may face such a problem in the future. However, we ignore the crowding effect of FDI import between economic areas in this paper. Suppose each area demands different technology capital

²Statistical work is found in Broadman and Sun (1997, Table 4), about the contracted value of each foreign investment involving enterprises from 1995 to 1999. In this work, our study is based on similar data but for 1996 to 2003. We explain the scenario with a graph instead of a table.

according to the local economic structure and natural resource.

Table 2 is here.

From Table 2, we find that there are several sectors growing fast in terms of utilized value of FDI, namely Farming, Manufacturing, Banking and Insurance, as well as the non-named sectors (i.e., Others). This implies that FDI flows to the manufacturing sector more and more and that major Chinese manufacturing is located mostly in inland areas. The value of foreign project in manufacturing sector is statistically larger than those in trading or financial service sectors. It cause difficulty to individual manufacturing enterprise finance the project without government help.

3 One-Sector Economy

3.1 Representative Agent

First of all, we consider a representative agent (or household) economy. The representative household owns the production sector, which has only one output. The output can either be consumed as private goods or be reinvested as domestic capital. We normalize population, which corresponds to the number of labour force, as unity (i.e., $L = 1$) in this model. Each household

works a given amount of time, so there is no labour–leisure choice. A feasible production frontier is depicted with a Cobb–Douglas function,

$$Y = AK_w^\alpha K_D^{1-\alpha} \quad (0 < \alpha < 1) \quad (1)$$

where A represents an exogenous coefficient of productivity, which takes account of all other observable elements related to technology change, apart from the influence from the change of relative capital ratio. Let K_D denote a broad concept of domestic capital, which encompasses human and physical working capital and here it is the cumulative stock of capital invested by the domestic agent. K_w symbolizes the cumulative stock of foreign investment in the recipient economy, which can only be used for improving productivity, for instance, advanced technology or advanced managerial skills, rather than for consumption. Previous research also proved the fact that it is cheaper to imitate products already in existence for some time than to create new products at the frontier of innovation (see Borensztein, 1998). Thus we ignore the substitution effect from the domestic research improvement on the same technology. In order to stress the separation of productivity capital investment from the normal working capital, we transform the above production function to the following simple AK style:

$$Y = A(K_w/K_D)^\alpha K_D = \tilde{A}K_D \quad (2)$$

$$k = \frac{K_w}{K_D} \quad (3)$$

$$\tilde{A} = Ak^\alpha \quad (0 < \alpha < 1). \quad (4)$$

In contrast to the exogenous variable A , \tilde{A} is defined as an endogenous technology coefficient of production, which embraces the effect of capital investments and of the exogenous elements. We theoretically build a measurement of FDI distribution, that is the relative ratio of cumulative FDI to cumulative domestic capital investment, i.e. k , which is the determinant of endogenous productivity³. The value of k has to be constant on the balanced economic growth path, which ensures that the growth rate of FDI has to be in the same as that of domestic capital. In this model, the change of domestic capital is endogenously decided by the private agent but the change of FDI is an exogenous variable to the agent, which is restricted by government budget constraint, because FDI is bought by government. Within this frame-

³The increase of relative capital ratio k could be from an increase of FDI capital or an decrease of domestic investment. However, the Chinese domestic cumulative investment has gone up over last two decades. Thus, we refer an increase of relative capital ratio to an increase of FDI distribution in this paper.

work, the ratio k is the instrumental variable bridging the government policy change to the long-run economic growth. In addition, within a heterogenous economic growth model, k_j characterizes the different economic regions with the distinguishable relative capital ratio, i.e., the local economic growth rate, g_{k_j} , and $j = l, m, h$.

We assume that the representative agent chooses the time path for private consumption and the benefit of accumulation of domestic capital. The agent's utility is written with an isoelastic intertemporal utility function: ⁴

$$U = \int_0^{\infty} \frac{1}{\gamma} (CG_c^\beta)^\gamma e^{-\rho t} dt \quad \beta > 0, \gamma < 1; \quad \beta\gamma < 1; 1 > \gamma(1 + \beta) \quad (5)$$

where G_c denotes the public service goods supplied by government, which is exogenous to the agent. The parameter β measures the impact of public consumption on the welfare of the agent. C denotes the agent's private consumption, which is assumed to be a constant proportion of national income:

for instance, $C = cY$. We assume that both private and public consumption

⁴The basic model for this work is highlighted by Bruce and Turnovsky (1999). They bridged the government policy change to long-run economic growth by the variable of government spending on the economy's infrastructure. We could also argue that the FDI designed in this work is an external fund for government spending on proving TFP for local economy, which is borrowed from foreign investors by local governments. However, the tailored assumption that new FDI is determined by government budget constraint to China has important implications for the effect of change of government spending on economic growth.

yield positive marginal utility, so that $\beta > 0$. The remaining constraints on the coefficients appearing in (5) ensure that the utility function is concave in quantities C and G_c . The parameter γ is related to the intertemporal elasticity of substitution (IES), which is $\frac{1}{1-\gamma}$. Where ρ is the agent's time preference, $\rho > 0$. Assume that the representative agent chooses the optimal time path by accumulating capital, so its income budget constraint is written as

$$\dot{K}_D = (1 - \tau)Y - (1 + \omega)C - \delta K_D - r_d K_w \quad (6)$$

where τ and ω denote income tax rate and consumption tax, respectively ⁵. δ is the depreciation rate of domestic capital, $0 < \delta < 1$, and r_d represents the interest rate of new foreign investment capital, paid by the agent to the government, which is an exogenous variable to the agent. \dot{K}_D represents the new domestic investment done by the private agent. Since the FDI is determined by government policy, the variable K_w is given to the representative agent. The interest payment of borrowing FDI capital from government is an exogenous cost to the agent.

⁵Here and throughout, terms with overdot are time derivatives

3.2 Government Budget Constraint

We assume that government plays as the FDI buyer and public service supplier in this framework. The fiscal budget constraint is defined as

$$\dot{K}_w = \tau Y + \omega C + (r_d - r^*)K_w - G_C \quad (7)$$

where r^* denotes the world price of FDI. As we consider the FDI receipt economy as world price taker in the world market, r^* is exogenously given. r_d is the rent rate charged by government for renting the FDI capital. If $r_d > r^*$, government earns interest. However, we mainly focus on the case that $r_d < r^*$, which implies government subsidizing the local agent in order to promote a particular FDI capital in the local economy. This is consistent with the Chinese recent scenario; even though a specific technology may definitely improve the productivity, it is too expensive to an individual enterprise to afford. In fact, such proposal is likely to be supported by the local government as strategic development project, instead of borrowing money from the commercial banks. As assuming $r_d < r^*$, we implicitly rule out the situation that enterprise directly imports similar FDI capital goods from the world market since the renting cost is lower than buying.

Equation (7) shows that the new FDI is bound by the government tax revenue and fiscal expenditure plan. For simplicity, we assume that private

goods consumption is a constant proportion of GDP, such as $C = cY$, and $0 < c < 1$. Since private consumption and public service supplied by government have the same expansion magnitude in the balanced economic growth path, in a simple case we take the public service supplied by government to be also a constant proportion of GDP, the ratio given as b ($0 < b < 1$) and $0 < (b + c) < 1$, i.e. $G_C = bY$. Dividing both sides of Eq.(7) by K_w , we derive the growth rate of FDI as

$$g_w = \frac{\dot{K}_w}{K_w} = (\tau + \omega c - b)Ak^{\alpha-1} + (r_d - r^*). \quad (8)$$

If government earns profit by owning FDI capital, that is $r_d > r^*$, the local economy has a definite positive economic growth. However, if government subsidizes local agents to spread FDI capital goods, that is $r_d < r^*$, the local economy may have negative economic growth. Consistent with the reality in China, we need to prove it is possible that local government promote its local economic growth by supply subsidy to the production sector. From Eq.(8), we derive the necessary condition for having a positive growth of FDI capital in the latter case:

$$\text{if } 0 < k < \left[\frac{(\tau + \omega c - b)A}{r^* - r_d} \right]^{\frac{1}{1-\alpha}}, \text{ given } r_d < r^*, \text{ then } g_w > 0. \quad (9)$$

It indicates that the local government could have an increasing FDI capital, even though no interest gains from renting such capital, as long as the level of relative capital ratio is conditionally small. Since $\alpha - 1 < 0$, Eq.(8) shows that the speed of growth rate of FDI is negatively related to the relative ratio k . This is empirically demonstrated by Sun et al. (2002), that is the cumulative FDI relative to cumulative domestic investment has a negative impact on the new FDI across provinces in China.

3.3 The Balanced Economic Growth

The household chooses the time path of private consumption, and the accumulation of domestic capital, so as to maximize its intertemporal utility function Eq.(5), subject to the production function Eq.(1), and his income budget constraint Eq.(6). To the private agent, the fiscal variables, such as income and consumption tax rates, as well as the public service, are exogenously given.

The following first-order conditions give us the relationship between optimal private consumption and the growth rate of shadow price of domestic capital:

$$\left(CG_C^\beta\right)^{\gamma-1} G_C^\beta = \lambda(1 + \omega) \quad (10)$$

and

$$\frac{\dot{\lambda}}{\lambda} = \rho + \delta - (1 - \alpha)[(1 - \tau) - (1 + \omega)c]Ak^\alpha. \quad (11)$$

In addition, the domestic capital accumulation must satisfy the following transversality condition:

$$\lim_{t \rightarrow \infty} \lambda K_D e^{-\rho t} = 0. \quad (12)$$

Differentiating both sides of Eq.(10) with respect to time, we get a dynamic equation, which gives the dynamic relationship between consumption and the shadow price of domestic capital:

$$(\gamma - 1)\frac{\dot{C}}{C} + \beta\gamma\frac{\dot{G}_C}{G_C} = \frac{\dot{\lambda}}{\lambda}. \quad (13)$$

Let g denote the balanced growth rate, so that the following condition is satisfied on the balanced economic growth path:

$$\frac{\dot{C}}{C} = \frac{\dot{K}_D}{K_D} = \frac{\dot{G}_C}{G_C} = \frac{\dot{K}_w}{K_w} = \frac{\dot{Y}}{Y} = g. \quad (14)$$

Combining Eq.(13) and Eq.(14), the balance growth rate is written as

$$g = \left(\frac{1}{1 - \gamma - \beta\gamma} \right) \{ (1 - \alpha)[(1 - \tau) - (1 + \omega)c]Ak^\alpha - (\rho + \delta) \}. \quad (15)$$

The above equation tells that the balanced economic growth rate is determined by the productivity factor, such as the relative capital ratio k , as the income tax and consumption tax rates, as well as other systematic parameters are given. Nevertheless, the direct effect of increasing tax rates on economic growth is negative, though we need have a careful calibration on how tax policy change affect the relative capital ratio k , which causes an indirect affect on balanced economic growth too. With the hypothesis of homogeneity of the regional economy, Eq.(15) gives the balanced economic growth rate for the whole economy. We say that the agent's time preference and the depreciation rate of domestic capital both have negative impact on economic growth. When an economy has a larger share of FDI capital in production technology, that is α is bigger, then its economic growth rate is lower. This implies that an increasing dependence on FDI in production can slows the economic growth of an economy.

However, if we consider the heterogeneity characteristic of economic areas, then we have

$$g_{k_j} = \left(\frac{1}{1 - \gamma - \beta\gamma} \right) \{ (1 - \alpha)[(1 - \tau) - (1 + \omega)c]Ak_j^\alpha - (\rho + \delta) \} \quad (16)$$

$$j = l, m, h.$$

As we assume that the agent's time preference parameter ρ and the depreciation rate of domestic capital δ are the same in different economic areas, given the tax rates determined by central government, the above equation implies that local economic growth is endogenously determined by the relative ratio of FDI distribution in areas. The economic area with higher relative ratio of FDI distribution has a better economic growth, i.e. $g_{k_l} < g_{k_m} < g_{k_h}$. This is consistent with the statistical evidence of Chinese economic growth, that the economic areas with intensive FDI grow better than the ones with poor FDI distribution. Does this mean that local economy could grow infinitely with a growing of FDI stock in the area? According to Eq.(16), when we differentiate the function of local economic growth with respect to the relative capital ratio k_j , we get the following:

$$G'_{k_j} = \frac{\partial g_{k_j}}{\partial k_j} = B \cdot \frac{1}{k_j^{1-\alpha}} > 0, \quad (17)$$

$$\text{and } B = \left(\frac{\alpha}{1 - \gamma - \beta\gamma} \right) \{ (1 - \alpha)[(1 - \tau) - (1 + \omega)c]A$$

$$G''_{k_j} = (\alpha - 1) B \frac{1}{k_j^{2-\alpha}} < 0. \quad (j = l, m, h) \quad (18)$$

The quick answer is 'no'. As the coefficient before the k_j item, named as B , in the right-hand side of the above equations is positive, the first-order derivative function, change of k_j , is positively related to the economic growth. But

the second-order derivative function, G''_{k_j} , becomes negative, which implies that the derivative function of economic growth is concave on the level of relative ratio of FDI distribution.

Figure 2 is here.

- *If the FDI distribution in local economic areas is homogeneous, i.e. $k_l = k_m = k_h$, then the concavity of economic growth function with respect to the relative capital ratio implies that the FDI host economy benefits from a faster economic growth by attracting more FDI—however, the magnitude of growth change gradually reduces.*
- *If we consider the heterogeneity between local economic areas in one FDI host country, i.e. $k_l < k_m < k_h$, Figure 2 suggests that the economic area with higher level of the ratio of relative capital has higher economic growth rate. And when the relative capital ratio increase an equal unit cross the different economic areas, the convergence of economic growth could happen, since the speed of economic growth with lower level of the lower speed of k_j is faster, i.e., $G''_{k_l} > G''_{k_m} > G''_{k_h}$. However, if the areas with higher level of the relative capital ratio get more FDI distribution, i.e., $\Delta k_l < \Delta k_h$, then the discrepancy of economic growth between two economic cluster could be worsen.*

- *If the ratio k changes with an equal unit between the members in one economic cluster, i.e., k_h^{-1} and k_h^{+1} , the convergence of economic growth may take much shorter time happen, by contrast to the above case.*

The above discussion is about the transitional dynamic change of economic growth when the relative capital ratio changes. As a further step, it is interesting to know what determinants affect the relative ratio of FDI distribution, k , in a subeconomy, which may highlight how government influences local economic growth via control of the relevant economic determinants in practice. Given that Chinese economy growth has big disparity between provinces, we are also keen to know if the same dynamic fiscal policy change necessarily brings the same economic effects in different economic areas.

As is known for the balanced growth path, the relative ratio of cumulative FDI to cumulative domestic capital has to be constant, which implies that the growth rates of the two kinds of capital are the same. This is an additional restriction on the variable k , which gives us all the determinants of the relative ratio. Differentiating both of sides of the agent's budget constraint Eq.(6) with respect to domestic capital stock, K_D , we obtain the growth rate of domestic capital,

$$\frac{\dot{K}_D}{K_D} = [(1 - \tau) - (1 + \omega)c]Ak^\alpha - r_d k - \delta. \quad (19)$$

From the condition $\frac{\dot{K}_w}{K_w} = \frac{\dot{K}_D}{K_D}$ on the balance growth path, we derive an equation determining the relative ratio of FDI distribution as follows:

$$(\tau + \omega \cdot c - b)Ak^{\alpha-1} + (r_d - r^*) = [(1 - \tau) - (1 + \omega)c]Ak^\alpha - r_d k - \delta. \quad (20)$$

Equation (20) is a polynomial equation with respect to the variable k . It is difficult to derive k as a direct function of policy variables from the above equation. Nevertheless, we can work out the derivatives of k with respect to tax policy variables from Eq.(20), to implement our discussion of how tax policy changes affect the relative ratio, k .

To ensure that the growth rates of FDI and of domestic investment are both positive, the following two conditions on the tax rates and ratio of consumption and government spending on public service must hold:

$$(\tau + \omega c - b) > 0,$$

$$(1 - \tau) - (1 + \omega)c > 0.$$

As $(\tau + \omega c - b) > 0$, therefore $\tau + \omega c > b$. Combining $\tau + \omega c > b$ and $b + c < 1$, so the inequality condition $(1 - \tau) - (1 + \omega)c = [1 - c - (\tau + \omega c)] > 0$ must be

true. Therefore, the sufficient condition for having positive growth rates of domestic capital investment and of FDI is that the total sum of tax revenue is big enough to cover government spending on public services.

4 The Effect of Tax Policy Change on Balanced Economic Growth

Now, we come to study the dynamic effect of tax policy change on the balanced economic growth. From optimization analysis of the agent, we have a determined balanced economic growth path, derived in Eq.(15),

$$g = \left(\frac{1}{1 - \gamma - \beta\gamma} \right) \{ (1 - \alpha)[(1 - \tau) - (1 + \omega)c]Ak^\alpha - (\rho + \delta) \}.$$

From the above equation, we find that the effect of tax policy on economic growth can be decomposed into two parts: the direct impact from income tax and consumption tax and the indirect impact via the taxes effect on the relative ratio of FDI distribution, k . In addition, the indirect impact on economic growth from the policy effect on the relative ratio k can be derived from Eq.(20):

$$(\tau + \omega \cdot c - b)Ak^{\alpha-1} + (r_d - r^*) = [(1 - \tau) - (1 + \omega)c]Ak^\alpha - r_d k - \delta$$

where k is a function of the tax rates, as the world interest rate and depreciation rate of domestic capital are exogenous in the model. ⁶

We consider a case with a ceteris paribus change in consumption tax firstly, and we examine how the policy change affects the balanced economic growth rate. Differentiating both sides of Eq.(15) with respect to the tax rate of consumption, ω , we get the following expression:

$$\frac{\partial g}{\partial \omega} = \left(\frac{1 - \alpha}{1 - \gamma - \beta\gamma} \right) Ak^{\alpha-1} \left\{ [(1 - \tau) - (1 + \omega)c] \alpha \frac{\partial k}{\partial \omega} - ck \right\}. \quad (21)$$

This equation shows that there is a direct effect of consumption tax change on the balanced economic growth, but also an indirect impact via k . Nevertheless, the following proposition holds.

Proposition 1 *The effect of consumption tax rate change on balanced economic growth can be decomposed into two parts: direct impact and indirect*

⁶In theory, an change of public service could also affect the value of relative ratio of capital k . However, in this work, we take the propensity of public service to GDP as a fixed constant, b .

impact via its effect on k . The dynamic effect of consumption tax rate change on the economic growth is determined by the value of domestic interest rate of renting FDI capital . If $e_2^ \leq r_d < e_1^*$, then $\frac{\partial g}{\partial \omega} \geq 0$. But if $r_d < e_2^*$ or $r_d > e_1^*$, then $\frac{\partial g}{\partial \omega} < 0$, where e_2^* and e_1^* are exogenously determined.*

The effect of consumption tax rate change on balanced economic growth varies with the different value of domestic interest rate of renting FDI capital, which is controlled by government. Proposition 1 indicates that it is possible for local government to have a positive economic growth by changing the consumption tax rate. If the domestic interest rate of renting FDI capital has been set at too high or too low a band (i.e., $r_d > e_1^*$ or $r_d < e_2^*$), an increase of consumption tax rate will harm local economic growth, versa vice. But if the domestic interest rate of renting FDI capital is set within the range of the determined boundry, (i.e., $e_2^* \leq r_d < e_1^*$), government can achieve a positive effect on economic growth by even enlarging its consumption tax revenue. This implies that local government should set the value of its controlling variable according to the real situation of the local economy (i.e., the propensity of consumption to income, the tax revenue, and the relative capital ratio of FDI distribution in local economy), in order to benefit most from a economic growth. In the other word, a samiliar tax policy change could bring the different impact on the local economic growth cross country.

Secondly, we consider a ceteris paribus change in income tax and examine the effect on balanced economic growth. Differentiating both sides of Eq.(15) with respect to income tax rate, τ , we derive the following expression:

$$\frac{\partial g}{\partial \tau} = \left(\frac{1 - \alpha}{1 - \gamma - \beta\gamma} \right) Ak^{\alpha-1} \left\{ [(1 - \tau) - (1 + \omega)c]\alpha \cdot \frac{\partial k}{\partial \tau} - k \right\}. \quad (22)$$

Proposition 2 *In this framework, the design of income tax rate is same to that of consumption tax so the effects on economic growth from both tax policy changes are similar. If $e_2^* \leq r_d < e_1^*$, then $\frac{\partial g}{\partial \tau} \geq 0$ but if $r_d < e_2^*$ or $r_d > e_1^*$, then $\frac{\partial g}{\partial \tau} < 0$. However, the magnitudes of the effects are different by changing two tax policies.*

From the above analysis, we also find there is an optimal value for the controlling variable, i.e. $r_d = e_2^*$, with which the local economy reaches its optimal static economic growth, so that there is no transitional fiscal effect on the balanced economic growth.

5 The Effect of Tax Policy Change on Welfare of the Representative Agent

In the previous section, we discussed the effects of fiscal policy changes on balanced economic growth. We are also interested in examining how fiscal policy affects the household's welfare. As assumed earlier, the private goods consumption is a constant proportion of domestic output, $C = cY$. In addition, we assert that public services supplied by government growth is also a constant proportion of domestic output in this model: e.g., $G_c = bY$. The growth of FDI keeps equal pace with the growth of domestic capital, which ensures that the relative ratio k is a constant on the balanced economic growth path. First, we transform the consumption time path in the utility function to a function of domestic capital stock:

$$CG_C^\beta = b^\beta c^{\beta+1} (Ak^\alpha)^{(\beta+1)} K_D^{\beta+1}. \quad (23)$$

As the initial stock of domestic capital is given, $K_D(0) > 0$, the time accumulation path of domestic capital accumulation is determined:

$$K_D = K_D(0)e^{gt}. \quad (24)$$

Substituting Eq.(23) and Eq.(24) into Eq.(5), we have

$$U = \int_0^{\infty} \frac{1}{\gamma} b^{\beta\gamma} c^{\gamma(\beta+1)} (Ak^\alpha)^{\beta\gamma} [K_D(0)]^{\gamma(\beta+1)} e^{[g\gamma(\beta+1)-\rho]t} dt \quad (25)$$

and the transversality condition is transformed to the following condition:

$$g\gamma(\beta + 1) - \rho < 0. \quad (26)$$

This implies that there is an additional condition for the balanced growth rate, which is determined by the agent's time preference, the elasticity of intertemporal substitution and the marginal share of utility of public service supplied by government. As the transformed transversality condition holds, we derive the utility of household on balanced growth path as

$$U_j = \frac{1}{\gamma} b^{\beta\gamma} c^{\gamma(\beta+1)} (Ak_j^\alpha)^{(\beta+1)\gamma} \frac{[K_D(0)]^{\gamma(\beta+1)}}{\rho - g\gamma(\beta + 1)}. \quad (27)$$

From the above equation, we have

$$U'_{k_j} = \frac{\partial U}{\partial k_j} = B_u k_j^{\alpha(\beta+1)\gamma-1} > 0 \quad (28)$$

$$\text{but } U''_{k_j} < 0.$$

This implies that the change of welfare is positive by an increase of the relative capital ratio but the magnitude is decreasing, as B_u is given, which indicate the economic areas are in the same growth cluster. However, $U''_{k_j} < 0$ implies the capability of welfare increase is lower in the area with higher level of the relative capital ratio, which shows the convergence of household's welfare exists between the members in the same economic cluster.

By differentiating both sides of Eq.(27) with respect to the economic growth, we have the following results:

$$U'_g = \frac{\partial U}{\partial g} > 0$$

and $U''_g > 0$.

This indicates that the economic growth has a positive impact on the household's welfare. Even further, the convexity of welfare to economic growth implies the household's welfare increases bigger in the area with a faster economic growth.

- *Under our theoretical analysis, the convergence of household's welfare dose not happen between the different economic cluster when the local economies grow with an equal pace. It implies the poor areas get poorer and the rich areas get richer, in terms of household's welfare.*

The dynamic effect of tax policy changes on agent's welfare can be decomposed into two forces: the dynamic effect on the economic growth and on the relative ratio of FDI distribution. Differentiating Eq.(27) with respect to consumption tax, we obtain

$$\frac{\partial U}{\partial \omega} = U \left[\frac{1}{k} \frac{\partial k}{\partial \omega} + \frac{\gamma(\beta + 1)}{\rho - g\gamma(\beta + 1)} \frac{\partial g}{\partial \omega} \right]. \quad (29)$$

Similarly, differentiating Eq.(27) with respect to income tax rate, we have

$$\frac{\partial U}{\partial \tau} = U \left[\frac{1}{k} \frac{\partial k}{\partial \tau} + \frac{\gamma(\beta + 1)}{\rho - g\gamma(\beta + 1)} \frac{\partial g}{\partial \tau} \right]. \quad (30)$$

By contrasting the above two partial derivative equations, we find that the ceteris paribus effect of two tax rates on the agent's welfare are symmetric. Then we take one case to represent the dynamic effect on agent's welfare.

Proposition 3 *If government sets the control variable, domestic interest rate at a high band, i.e. $r_d > e_1^*$, an increase of tax rates reduces the welfare of agent, i.e., $\frac{\partial U}{\partial \omega} < 0$ or $\frac{\partial U}{\partial \tau} < 0$. But if the control variable is set in a sensible regime, i.e. $e_2^* \leq r_d < e_1^*$, an increase of tax rates even brings a positive impact on the agent's welfare, i.e., $\frac{\partial U}{\partial \omega} > 0$ or $\frac{\partial U}{\partial \tau} > 0$.*

Setting a high value of domestic interest rate of FDI capital means that government gives less subsidy on promoting of the new technology. This

bring an instant effect as that an increase in growth of the FDI capital but a decrease in growth of domestic capital. The relative capital ratio increases as a consequence. Under this circumstance, an increase of tax rates has harm on the household's welfare. By contrast, if the domestic interest rate of FDI renting is set as $e_2^* \leq r_d < e_1^*$, local household's welfare increases while the local government benefit from more tax revenue by increasing the tax rates.⁷

6 Statistical Explanation of Chinese Provincial Economic Development

According to our theoretical analysis in last few sections, we have the following general statement: that the relative capital ratio has a positive relationship to the balanced economic growth rate of local economy. In addition, the incentive for local governments to improve local economic growth is to obtain more tax revenues. Therefore, comparing the economic development of provinces, the province with the higher relative FDI capital ratio has the faster economic growth and local government has more tax revenues. We present the relevant economic variables in Table 3.

Consistent with Table 1, we represent the measure variable of FDI distri-

⁷It is impossible to us to collect the data delegating the local interest rate on strategic proposal from each province. Since the local financial agents are permitted to charge interest rate with a wide range ($\pm 20\%$) around the base rate given by the central bank in China.

bution as the relative ratio of cumulative FDI stock to cumulative domestic capital stock in each province in the second column in Table 3. There are a total of 32 provinces presented.⁸ We also use the data of the total tax revenues to represent benefit of the government. Since we have discussed the dynamic effect on economic growth of changing consumption tax and income tax, so we also include two such tax items in the table. The sixth column is a proxy variable for the local economic size, which is calibrated as the percentage of GDP of each province to the total country GDP. The seventh column, the economic growth rate, is calibrated from the percentage change of total output of each province in 2002. Finally, we add a proxy variable for local household's welfare with the average per-urban household's consumption in each province.⁹

We reorganize the economic development information in Table 3 by grouping the provinces into three economic clusters according to the relative capital ratio. The high level cluster (i.e., $k_h > 20$), includes six economic areas (but excludes Hainan area). The medium level cluster (i.e., $10 < k_m < 20$), comprises 11 economic areas and the low level cluster (i.e., $k_l < 10$) comprises

⁸Here the data collection has not embraced the Hong Kong and Macau economic areas, which are statistically accounted as FDI supply areas to the mainland of China.

⁹All data are collected and reconstructed from the data collection of China Statistic Yearbook 2003. For the data for Government Taxation see Table 8-17, Final Statement of Government Revenue by Region (p.293); for the data for Economic Growth see Table 3-8, Gross Domestic Product and Its Indices by Region (p.62), and for Urban Household Consumption see Table 3-16, Household Consumption (p.72), in CSY (2003).

another 12 economic areas (excluding Tibet).

Table 3 is here.

We calibrated the weighted mean of economic variables for each group, by setting the weight with the local economic size. But the mean of per-urban household consumption is represented by the normal average value. Comparing the mean values of each group, we can see clearly that economic growth has a positive relationship with the relative FDI capital ratio. The cluster with faster economic growth have more local tax revenues on average. The mean of relative FDI capital ratio occurs quite different between clusters, which represents an different strength of FDI distribution. In brief, with the Table 3, we statistically demonstrate that higher level of the relative capital ratio promotes local economic growth and local government benefits more from tax revenues, as well as the household welfare is also better off. Under the decentralized government reform in China, local governments have more power on its retained finance resource. More financial resources may bring more political power, it drives local governments carry out more productive public investments.

The nominal interest rate on loans is set up by central government but the actual charge can float around a large range. For example, the lending rate

could be 10% higher or lower than nominal interest rate for local state-owned financial institutions; for rural credit cooperatives, the lending rate could be 40% higher or 10% lower than nominal interest rates. The percentage of float range could vary according to the economic development in each year. As of November 1998, the lending rate for small-size enterprises could be 20% higher than nominal interest rates, and for medium and large-size enterprises could be 10% higher. As of September 1999, the lending rate for medium and small-sized enterprises could 30% higher than nominal interest rate, for large-sized enterprises, it could be 10% higher. (CSY 2003, p707.) All point out the local governments have quite large freedom to decide the loan interests in China. According to the above analysis, it is very important to local government choose a right level of lending rate, in order to keep a positive influence on local economic growth by having a positive taxation change.

7 Conclusion

We have built a representative agent model representing a small local economy. Direct government interference in the production sector is in terms of direct financial subsidy to the agents applying FDI productivity capital. Agents make production plan which determines the local economic growth. With such joint operation, we aim to find the government policy impacts on

the local economic growth. Theoretically, we prove that government policy impact on local economies vary according to how much subsidy government allocates to private agents, which is measured by the government control variable, the domestic interest rate of FDI capital in FDI host areas. According to the chosen economic variables on the balanced economic growth path, we have upper and lower criterion boundry for the domestic interest rate. If the governments set the value in between the upper and lower boundry, changing tax rates has a positive effect on the economic growth, otherwise the result is negative. This implies that if governments set a sensible target for subsidy to the private sector, they can benefit by collecting more tax revenue without harming local economic growth. Similarly, we show that it is possible that the agent's welfare is enhanced while government benefits from more tax revenue.

A more striking results from our theoretical model come out of the comparison of economic growth between economic cluster. We characterize the economic regions by the values for the relative ratio of cumulative FDI to cumulative domestic capital. We find that the economic growth function is concave with respect to the relative capital ratio. This indicates that an increase of relative capital ratio will improve the local economic growth in any region. However, the speed of economic growth is lower in the areas with the higher relative capital ratio than that in the areas with the lower

relative capital ratio. We say the convergence of economic growth could occur between the different economic areas when the relative capital ratio changes with an equal unit. Hu and Owen (2005), have empirically demonstrated that the FDI distribution has converged within the coastal region but has further widened between the coast and the interior. This is a good support for clustering the economic areas by the relative capital ratio in our model. We assume the member provinces in the same economic cluster has very similar level of relative capital ratio and economic growth. We find the convergence of economic growth could happen between the economic cluster when the relative ratio changes an equal unit. However, the results on household's welfare are different with the existing empirical work, such as Hale and Long (2006), they prove that economic growth and regional income both have convergence between economic areas in China. We find the convergence of household's welfare could only happen between the member areas in the same economic cluster, but the discrepancy of household's welfare would be widen up between the different economic clusters.

Although we have defined the public capital investment as FDI in this paper, but we take it as lump-sum of government spending, rather than international trading business. So we are unable to show the economic impact of changes of the economic variables in international business, such as exchange rate or marginal cost of foreign capital in world market. However,

we integrate government interest subsidy policy into our theoretical work. It implies the different setting bill of government interest subsidy has influence the local economic growth differently. For future research, we should carefully calibrate an economic system according to Chinese economy and numerically demonstrate the possible impacts on economic growth by changing the government tax policy or the spending policy or interest subsidy policy.

8 Appendix A: Proofs

Proposition 1:

Let F_1 and F_2 replace the parameter coefficient item in Eq.(20), that is

$$F_1 = \tau + \omega \cdot c - b > 0$$

$$F_2 = [(1 - \tau) - (1 + \omega)c] > 0.$$

Differentiating both sides of Eq.(20) with respect to ω , we get the following expression:

$$\frac{\partial F_1}{\partial \omega} Ak^{\alpha-1} + F_1 A(\alpha - 1)k^{\alpha-2} \frac{\partial k}{\partial \omega} = \frac{\partial F_2}{\partial \omega} Ak^\alpha + F_2 A\alpha k^{\alpha-1} \frac{\partial k}{\partial \omega} - r_d \frac{\partial k}{\partial \omega}.$$

Since the partial derivatives of parameter coefficients with respect to consumption rate are written as

$$\frac{\partial F_1}{\partial \omega} = c \text{ and } \frac{\partial F_2}{\partial \omega} = -c.$$

We have

$$\frac{\partial k}{\partial \omega} = \frac{Ak^{\alpha-1}c(1+k)}{Ak^{\alpha-2}[\alpha F_2 k + (1-\alpha)F_1] - r_d}.$$

Since r_d is policy variable which can be adjusted by the local government.

$$\text{If } r_d < e_1^*, \text{ then } \frac{\partial k}{\partial \omega} > 0,$$

$$\text{and } e_1^* = Ak^{\alpha-2}[\alpha F_2 k + (1 - \alpha)F_1]$$

where e_1^* denotes a computable variable representing the economic situation, which is determined by all observable economic variables, such as A, k, α, c, τ and ω . According to the derivative equation of economic growth with respect to ω , we find that

$$r_d > e_1^* \Leftrightarrow \frac{\partial k}{\partial \omega} < 0 \Leftrightarrow \frac{\partial g}{\partial \omega} < 0.$$

But if $\frac{\partial k}{\partial \omega} > 0$, we cannot easily sign $\frac{\partial g}{\partial \omega}$. However, if we substitute the expression of $\frac{\partial k}{\partial \omega}$ back into Eq.(21), then we can derive the following conditions:

$$\text{if } r_d \geq e_2^*, \text{ then } \frac{\partial g}{\partial \omega} \geq 0,$$

$$\text{and } e_2^* = Ak^{\alpha-2}[(1 - \alpha)F_1 - \alpha F_2]$$

and

$$\text{if } r_d < e_2^*, \text{ then } \frac{\partial g}{\partial \omega} < 0.$$

From the expressions for two optimal values, $e_1^* = Ak^{\alpha-2}[(1 - \alpha)F_1 + \alpha F_2 k]$ and

$e_2^* = Ak^{\alpha-2}[(1-\alpha)F_1 - \alpha F_2]$, and $F_1 > 0$, $F_2 > 0$ both hold, thus we have

$$e_1^* > e_2^*.$$

Therefore, we conclude that the conditions for the dynamic effect of changing consumption tax rate on the balance economic growth as follows:

$$\text{if } e_2^* \leq r_d < e_1^*, \text{ then } \frac{\partial g}{\partial \omega} \geq 0.$$

$$\text{But if } r_d < e_2^* \text{ or } r_d > e_1^*, \text{ then } \frac{\partial g}{\partial \omega} < 0.$$

Proposition 2:

Differentiating both sides of Eq.(20) with respect to τ , we obtain the following equation:

$$\frac{\partial F_1}{\partial \tau} Ak^{\alpha-1} + F_1 A(\alpha-1)k^{\alpha-2} \frac{\partial k}{\partial \tau} = \frac{\partial F_2}{\partial \tau} Ak^\alpha + F_2 A \alpha k^{\alpha-1} \frac{\partial k}{\partial \tau}.$$

Similarly, we have

$$\frac{\partial F_1}{\partial \tau} = 1 \text{ and } \frac{\partial F_2}{\partial \tau} = -1.$$

Then we have:

$$\frac{\partial k}{\partial \tau} = \frac{Ak^{\alpha-1}(1+k)}{Ak^{\alpha-2}[\alpha F_2 k + (1-\alpha)F_1] - r_d}.$$

So

$$\text{If } r_d > e_1^* \Leftrightarrow \frac{\partial k}{\partial \tau} < 0 \Leftrightarrow \frac{\partial g}{\partial \tau} < 0$$

$$\text{and } e_1^* = Ak^{\alpha-2}[\alpha F_2 k + (1 - \alpha)F_1].$$

But if $r_d < e_1^*$, then $\frac{\partial k}{\partial \tau} > 0$. Combining with Eq.(22), we cannot directly sign $\frac{\partial g}{\partial \tau}$. Similar to the last proof, we substitute the expression of $\frac{\partial k}{\partial \tau}$ back into Eq.(22), then we derive the conditions as follows:

$$\text{if } r_d \geq e_2^*, \text{ then } \frac{\partial g}{\partial \tau} \geq 0,$$

$$\text{and } e_2^* = Ak^{\alpha-2}[(1 - \alpha)F_1 - \alpha F_2]$$

and

$$\text{if } r_d < e_2^*, \text{ then } \frac{\partial g}{\partial \tau} < 0.$$

Similarly, we get the conditions for the dynamic effect of changing income tax on the balanced economic growth as follows:

$$\text{if } e_2^* \leq r_d < e_1^*, \text{ then } \frac{\partial g}{\partial \tau} \geq 0$$

$$\text{but if } r_d < e_2^* \text{ or } r_d > e_1^*, \text{ then } \frac{\partial g}{\partial \tau} < 0.$$

Proof for the Proposition 3:

From the proof for Propositions 1 and 2, we have the following:

$$\begin{aligned}
r_d > e_1^* &\Rightarrow \frac{\partial k}{\partial \omega} < 0, \quad \frac{\partial g}{\partial \omega} < 0, \\
e_2^* \leq r_d < e_1^* &\Rightarrow \frac{\partial k}{\partial \omega} > 0, \quad \frac{\partial g}{\partial \omega} \geq 0, \\
r_d < e_2^* &\Rightarrow \frac{\partial k}{\partial \omega} > 0, \quad \frac{\partial g}{\partial \omega} < 0.
\end{aligned}$$

Combining with Eq.(29), we have the following result:

$$\begin{aligned}
r_d > e_1^* &\Rightarrow \frac{\partial U}{\partial \omega} < 0, \\
e_2^* \leq r_d < e_1^* &\Rightarrow \frac{\partial U}{\partial \omega} > 0, \\
r_d < e_2^* &\Rightarrow \frac{\partial U}{\partial \omega} \text{ cannot be signed.}
\end{aligned}$$

9 Appendix B: Tables and Figures

City/Area (100 million yuan)	Domestic Loans -2002	Foreign Investment -2002	Ratio between two resources (FI/DL)
Beijing	155.8916	16.0218	10.28
Tianjing	185.6884	24.1234	12.99
Hebei	149.6717	23.6094	15.77
Shanxi	146.7893	17.3301	11.81
Inner Mongolia	166.6993	6.1276	3.68
Liaoning	150.6872	27.7227	18.40
Jilin	59.814	6.1121	10.22
Heilongjiang	79.3641	9.559	12.04
Shanghai	248.0693	138.0913	55.67
Jiangsu	564.7124	156.2863	27.68
Zhejiang	523.6652	89.7162	17.13
Anhui	131.6794	13.5992	10.33
Fujian	136.8516	39.472	28.84
Jiangxi	181.3343	33.8296	18.66
Shandong	297.8971	90.5602	30.40
Henan	336.6233	20.3601	6.05
Hubei	184.1138	53.5186	29.07
Hunan	157.6593	26.773	16.98
Guangdong	420.4559	260.869	62.04
Guangxi	164.1472	14.5683	8.88
Hainan	34.5567	41.1895	119.19
Congqing	164.8893	8.8841	5.39
Sichuan	300.25	28.815	9.60
Guizhou	135.1571	5.8217	4.31
Yunnan	188.98	9.7847	5.18
Tibet	5.3065		0.00
Shaanxi	150.0443	18.4358	12.29
Gansu	88.2385	3.8897	4.41
Qinghai	16.1208	1.5286	9.48
Ningxia	56.4019	1.0364	1.84
Xinjiang	121.9741	8.2028	6.73
Not Classified	437.2248	41.0236	9.38

Table 1: The Relative Capital Ratio of Each Province in China 2002

Unit (100 million USD)					
Sectors	1999	2000	2001	2002	2003
National Total	403.2	407.1	468.8	527.4	535.0
Farming, Forestry, Animal Husbandry and Fishery	7.10	6.76	8.99	10.28	10.01
Mining and Quarrying	5.57	5.83	8.11	5.81	3.36
Manufacturing	226.03	258.44	309.07	368.00	369.36
Electric Power, Gas and Water Production and Supply	37.03	22.42	22.73	13.75	12.95
Construction	9.17	9.05	8.07	7.09	6.12
Geological Prospecting and Water Conservancy	n/a	0.05	0.10	0.07	1.78
Transport, Storage, Post and Telecommunication service	15.51	10.12	9.09	9.13	8.67
Wholesale & Retail Trade and Catering Services	9.65	8.58	11.69	9.33	11.16
Banking and Insurance	n/a	0.76	0.35	1.07	2.32
Real Estate Management	55.88	46.58	51.37	56.63	52.36
Social Services	25.51	21.85	25.95	29.43	31.61
Health Care, Sports and Social Welfare	1.48	1.06	1.19	1.28	1.27
Education, Culture and Arts, Radio, Film and Television	0.61	0.54	0.36	0.38	0.58
Scientific Research and Polytechnic Services	n/a	0.57	1.20	1.98	2.59
Other sectors	9.65	14.52	10.51	13.21	22.51

Table 2: The Actual Utilized Value of FDI by Sectors

City/Area (by group)	Relative Capital ratio (FI/DL)	Total Tax (100 million yuan)			Economic Scale wj	Economic Growth	Household Consumption (1000 yuan)
		Value-added Tax	Individual Income Tax				
(High Level)							
Shanghai	55.67	708.95	136.83	67.08	0.046	10.9	16.46
Jiangsu	27.68	643.7	153.23	40.93	0.090	11.6	7.74
Fujian	28.84	272.89	47.43	23.54	0.040	10.5	7.78
Shandong	30.40	610.22	111.23	31.09	0.089	11.6	7.15
Hubei	29.07	243.44	39.97	13.08	0.042	9.1	7.21
Guangdong	62.04	1201.61	205.79	100.43	0.100	11.7	10.89
Weighted Mean	40.14	703.08	133.02	51.77		11.18	9.54
(Medium Level)							
Beijing	10.28	533.99	66.67	61.29	0.027	10.4	11.37
Tianjing	12.99	171.83	38.73	13.2	0.017	12.5	9.4
Hebei	15.77	302.31	55.3	21.57	0.052	9.6	6.6
Shanxi	11.81	150.82	38.11	9.99	0.017	11.7	4.76
Liaoning	18.40	399.69	74.27	28.35	0.046	10.2	7.88
Jilin	10.22	131.49	27.44	8.99	0.019	9.5	6.15
Heilongjiang	12.04	231.89	55.85	12.58	0.033	10.3	7.48
Zhejiang	17.13	566.85	129.72	43.55	0.066	12.5	10.48
Anhui	10.33	200.22	32.51	9.43	0.030	8.9	6.35
Jiangxi	18.66	140.55	18.72	7.68	0.021	10.5	5.14
Hunan	16.98	231.15	31.9	13.93	0.037	9	6.35
Shaanxi	12.29	150.29	26.47	7.41	0.017	9.7	5.84
Weighted Mean	14.73	318.42	61.06	23.61		10.45	7.32
(Low level)							
Inner Mongolia	3.68	112.85	17.43	5.71	0.015	12.1	5.61
Henan	6.05	296.72	49.25	17.82	0.052	9.5	5.92
Guangxi	8.88	186.73	26.34	11.6	0.021	10.5	5.94
Congqing	5.39	126.07	208	8.35	0.017	10.3	7.27
Sichuan	9.60	291.87	41.86	15.39	0.041	10.6	6.03
Guizhou	4.31	108.28	17.02	5.56	0.010	9.1	4.69
Yunnan	5.18	206.76	34.42	9.45	0.019	8.2	5.54
Gansu	4.41	76.24	15.07	4.09	0.010	9.4	5.34
Qinghai	9.48	21.1	4.61	0.87	0.003	12.4	5.56
Ningxia	1.84	26.47	4.39	1.45	0.003	10.2	5.426
Xinjiang	6.73	116.47	21.16	7.87	0.014	8.1	6.26
Weighted Mean	6.61	208.29	48.42	11.81		9.89	5.78

* of this variable, the average value is not weighted by economic scale.

Table 3: Economic Development in Each Economic Cluster

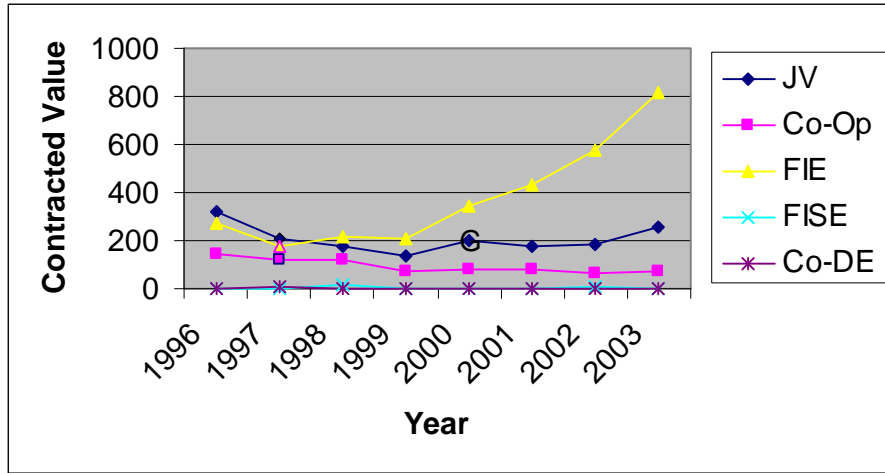


Figure 1: The Growth of Contracted Value for Each Type of FDI in China

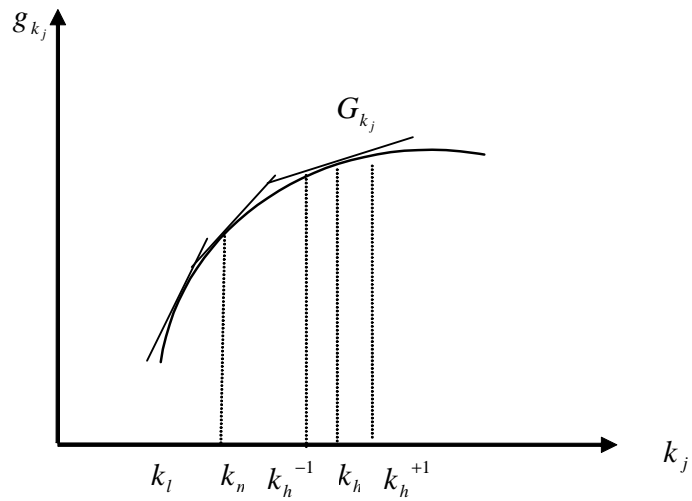


Figure 2: Transitional Change of the Local Economic Growth

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