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The Paradox of Unequal Regional Investment and Equal Regional Economic Growth in China

Foreign Direct Investment and Unequal Regional Economic Growth in China

Jie Zhang
Research Center of Bornholm
Stenbrudsvej 55, 3730 Nexø,
Denmark
Tel: (45) 5644 1144;
Fax: (45) 5649 4624
Email: jie@rcb.dk

Gustav Kristensen
Institute of Economics
Odense University
DK-5230, Odense M, Denmark
Tel: (45) 6557 2114
Fax: (45) 6595 7766
Email: **guk@busieco.ou.dk**

Abstract:
China's policy on Special Economic Zones has attracted direct foreign investment to China. The investment is very unequally distributed on China's 30 regions.

The article focuses on the regional economic growth as a result of the direct foreign investment in the region and its spill-over effects on neighboring regions. The unequal distribution of foreign direct investment should in principle tends to enlarge the regional economic differences. The article, however, shows that this is not the result of the investment.

The empirical findings highlight the impact of foreign direct investment on the Chinese regional economies in transition.

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1. INTRODUCTION

China took an "*economic reform and open-door*" policy in 1978. In July 1979, at the first step, China created four special economic zones (SEZ) at Shenzhen, Zhuhai, and Shantou in the Guangdong province and at Xiamen in the Fujian province. Later in 1988, China separated Hainan from the Guangdong province and set up Hainan as the fifth special economic zone in China. The central government has further built up fourteen economic and technological development zones within the eleven provinces along the coastal area in 1984. Since then the Chinese economy has steadily grown and has experienced even faster growth rate during 1992-1996 partly as a result of direct foreign investments. However, the investments have been unequally distributed on the 30 Chinese regions (i.e. provinces in China).

The purpose of this article is to show the impact of the direct foreign investment on the regional economic growth rate and to discuss why unequal distributed investments will not necessarily lead to higher regional inequalities. This is done in a short run Keynesian model. The model is constructed with its variable coefficients inspired by the expansion method as stated by Casetti (1986).

The Chinese statistics use the expression "direct foreign investment, DFI". Therefore this expression is used here.

2. DIRECT FOREIGN INVESTMENT AND REGIONAL GROWTH

The thirty Chinese provinces are grouped into three economic belts according to openness and location: Coastal area, Central area, and Western area. The region of Tibet is omitted due to lack of data, therefore 29 regions are included in the data set for the time period 1988-1996. The average real growth rate in national income (1985-1991) and GDP (1992-1996) is shown in table 1 in the appendix l. From the table it is seen that the coastal area grew faster than the national average growth rate, while the average growth rates of both the central and western areas were below the national average.

The high growth rate in the coastal area was led by the large scale of direct foreign investment (DFI) followed by an export expansion. The average shares of DFI in the regions and export from each region during the period of 1988-1996, compared with their shares of population is shown in table 2 in the appendix 1. The coastal area accounted for 90% of DFI and 84% of export, while their population only accounted for 41%. The table shows quite low shares of DFI and export in both central and western areas. In recent years the direct foreign investment, specially the joint ventures, and external demand through export did play an important role in the Chinese regional development.

The large shares of DFI in the coastal area was partly stimulated by the central government's regional policy. The economic development zones and their special foreign investment policies have attracted quite many foreign-Chinese joint ventures and foreign sole-ownership companies, and brought large inflows of foreign capital to the coastal regions. The aim of economic and technological development zones was to set up new advanced technology industries, to develop export products and new materials and key parts of machinery needed for import substitution, and to increase the export earnings.

Growth in export is here seen as a direct result of DFI. “Export” is thus endogenous in the model, and not a direct (and as normal exogenous) source of growth. This point of view is supported by the data, see the appendix.

3. DATA

The purpose of the empirical analysis is to show the relations between regional income development and regional foreign direct investment. The data used in the analysis are the regional data published by the China Statistical Yearbook (1989-1997). The data for GDP and GDP per capita measured in yuan are adjusted for inflation and are expressed in 1990 price deflated by consumer price indices for China. The data for “direct foreign investment and other” measured in US dollar are deflated by US consumer price index. Both deflators are published by the IMF: “International Financial Statistics Yearbook, 1997”.

The model formulated for estimation is based on the following development of data

GDP - Gross Domestic Product for the region, measured in yuan

POP - Population of the region

DFI - Direct Foreign Investment in the region, measured in dollar

DFL - Deflator - Consumer price index for China

DFLUS - Deflator - Consumer price index for USA

FGDP = GDP/DFL - fixed price GDP of the region

FDFI = DFI/DFLUS - fixed price DFI in the region

FPCY = FGDP/POP - fixed price per capita income of the region

FDFIPC = FDFI/POP - fixed price per capita DFI in the region

Percentage change in fixed price per capita income (growth rate):

$$DFPCY = (FPCY - FPCY(-1))/(.5*(FPCY + FPCY(-1)))$$

Change in direct foreign investment in percentage of fixed price per capita income is defined as:

$$DFDFIPC = (FDFIPC - FDFIPC(-1))/(.5*(FPCY + FPCY(-1)))$$

In order to facilitate the intuitive understanding of the equations we will call

FPCY - for income indicated by: Y

DFPCY - for the *growth rate* in income indicated as: GY

DFDFIPC - for the *growth rate* in the investment level indicated as: GI

MY - the unweighted annual mean of Y for all regions

MGY - the unweighted annual mean of GY for all regions

MGI - the unweighted annual mean of GI for all regions

DY = Y- MY - the *deviation* of Y from the all region annual mean

DGY = GY- MGY - the *deviation* of the GY from all region annual mean

DGI = GI - MGI - the *deviation* of GI from the all region annual mean

WDY - value of DY weighted with the region's share of population

WDGY - value of DGY weighted with the region's share of population

WDGI - value of DGI weighted with the region's share of population

The last three (six) variables is the operationalization of the first 3 variables for the model building.

Note that DY^2 is defined as DY*ABS(DY), which means that it is **signed**.

4. THE MODEL FOR INVESTMENT AND GROWTH

A given level of investment in equilibrium with a level of saving will decide the equilibrium income of the economy considered. Economic *growth* is thus (e.g.) decided by the *change* in the level of investment. Thus *change* in direct foreign investments, DFI, gives a *change* in the equilibrium income - that is "growth".

A number of the Chinese provinces function as ports for DFI, and resent themselves as centers of growth when foreign direct investment rises. The economic growth in a region due to the change in the DFI is spread to the neighboring regions, through the economic interaction between them.

Out of 29 Chinese provinces (excl Tibet incl Hainan) only 6 provinces has 78.73% of the total DFI in the period 1988-1996.

4.1 The Paradox of Unequal Direct Foreign Investments and Equal Growth in China

Growth towards greater regional equilibrium can now, simplified, be written in the following way

$$DGY = -\beta DY \qquad (1)$$

Which means that if the income in a region is *above* the average (all region) income, the growth rate should be *below* the average growth rate in order to move the regions towards greater equality.

At increasing investment the income tend to increase too. Therefore

$$GY = \alpha_0 + \alpha_1 GI \qquad (2)$$

α_0 - the autonomous growth rate.

α_1 - the investment multiplier which is always supposed to be positive.

Now let us assume that the investments are attracted by rich areas then

$$GI = \gamma_0 + \gamma_1 DY \qquad (3)$$

where

γ_0 - is the autonomous (foreign) investment growth for DY = 0, or at MGI

γ_1 - indicates the distributions of DFI due to the deviation of the region's income from the average income, or the region's ability to attract increasing investments at an increasing income level

We can now (see appendix 3) derive

$$DGY = \alpha_1\gamma_1 DY \qquad (4)$$

where

$$\beta = \alpha_1\gamma_1 > 0 \quad \text{for} \quad \gamma_1 > 0 \qquad (5)$$

which (when γ_1 is positive) means that when investment growth is higher in rich region's than in poor regions then we expect growth against greater inequality, because β will be positive.

We can now estimate (1) and (3) by Weighted Least Square where the weights are the regions share of the total population (the prefix W in variable names is omitted to facilitate readings.

$$DGI = .0000004893{*}DY \qquad R^2 = .2045 \quad Obs = 232$$

(7.74)

Empirical evidence for the Chinese regions 1989-1996 thus shows that the rich regions attract the highest growth in investments. Using the same simple approach for regional growth rates we get

$$DGY = .000001525*DY \qquad R^2 = -.0172 \qquad Obs = 232$$
$$(0.53)$$

where the parenthesis indicate t-values.

Although there is unequal investments and the rich regions tend to attract the highest growth in foreign direct investment there is no obvious unequal growth after the above used definition as β is insignificant.

Other definitions of equal growth give a result that the actual income has been developed towards more equal income distribution measured by the following commonly used methods[1]: (1) A simple dispersion indices, based on standard deviation; (2) Gini coefficients and the dissimilarity index; (3) the Shannon entropy measure; (4) the rank-size function.

The general trend in the *standard deviation* of relative per capita income among 29 provinces is shown declining, except slightly rising in the years of 1992, 1993 and 1994. (See table 3, column 2, in the appendix 2 which reports the development in income inequality among the regions in China). The *index for dissimilarity* among all regions in China is likewise declining during 1988-1996, see column 3. The total inequality measured by *Shannon entropy* declines. Column (5) shows the total inequality (4) as a percentage of maximum inequality which equal to *log* N, (i.e. *log*(29) = 3.3673). Column (6) and (7) present respectively the coefficient b and R^2 value in the rank-size function as shown in appendix 2, formula (3). The trend of b coefficient is same as for the I-value.

The over-all picture is thus that the Chinese regions over the considered period became more equal. In general during the economic boom years in 1992-1994, the total inequality among all regions in China has been increased, but this does not destroy the picture of growing inter-regional equality.

We, here, have a *paradox that unequal investments might lead to equal growth*. The explanation is partly found in equation (2), which in a more developed form transform change in investment level to economic growth. Therefore, we shall now develop equation (2) a little further.

4.2 The Income Dependent Multiplier Effects

The basic (annual) growth model is the Keynesian inspired. When the investment multiplier is dependent on the income level we will have

$$\alpha_1 = 1/(1 - c(Y)) \qquad (6)$$

where

c(Y) - the marginal propensity to consume is a function of the real per capita income

Other variables could be included to explain the investment multiplier, e.g. the marginal (inland) propensity to invest, the marginal propensity to import etc. Therefore c is here an “aggregate” marginal propensity to consume. The functional form for estimation of the investment multiplier was, after relative and absolute income

$$\alpha_1 = \alpha_{10} - \alpha_{11}DY \qquad (7)$$

$$\alpha_1 = \beta_0 - \beta_1 Y_1 \qquad (7a)$$

where the expected sign of β_1 is negative while β_0 is positive.

The point of departure for discussing β now becomes

$$GI = \gamma_0 + \gamma_1 DY \qquad (8)$$

$$GY = \alpha_0 + \alpha_1 GI \qquad (9)$$

$$\alpha_1 = \alpha_{10} - \alpha_{11}DY \qquad (10)$$

Now the distribution of growth on regions is described by a second degree polynomial

$$DGY = (\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0)DY - \alpha_{11}\gamma_1 DY^2 \qquad (11)$$

The coefficient γ_1 is here crucial because it indicates to which degree the investment growth is unequally distributed in relation to the income distribution

Equal growth as a function of γ_1 is found by solving

$$(\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0)DY - \alpha_{11}\gamma_1 DY^2 = 0 \qquad (12)$$

The condition for an equal regional growth at an unequal distributed DFI is for a given “aggregate” consumption function is now given by

$$\gamma_1 = \alpha_{11}\gamma_0/(\alpha_{10} - \alpha_{11}DY) \qquad (13)$$

The ability to attract increasing investment to the region thus must increase at an increasing rate of DY in order to maintain equal growth rates over the regions. Equation (13) thus can explain the paradox of unequal investment growth and equal growth rate.

4.3 The Spill-Over Effect

The spill-over effect is indicated in the following way

$$GY = \alpha_0 + \alpha_1 GI + \alpha_2 GI_2 \tag{14}$$

where

GI_2 - the growth in investments in the neighbor regions

The spill-over-multiplier is based on empirical evidence formed as

$$\alpha_2 = \beta_{10} (\alpha_{10} - \alpha_{11} DY)(\alpha_{10} - \alpha_{11} DY_2) \tag{15}$$

β_{10} expresses the effect of the distance to the neighbor region. Because the regions in China are quite similar in geographical and population size (compared to e.g. the European countries) all distances to neighbor regions (considered as points) are here assumed to be the same. The term

$$(\alpha_{10} - \alpha_{11} DY)(\alpha_{10} - \alpha_{11} DY_2) \tag{16}$$

indicate that the multiplier effect from the neighbor region depends on the income in the region who receive the investments and the income in the region who receive the spill-over effect.

The model for calculating β is now

$$GY = \alpha_0 + \alpha_1 GI + \alpha_2 GI_2 \tag{17}$$

$$GI = \gamma_0 + \gamma_1 DY \tag{18}$$

$$\alpha_1 = \alpha_{10} - \alpha_{11} DY \tag{19}$$

$$\alpha_2 = \beta_{10} (\alpha_{10} - \alpha_{11} DY)(\alpha_{10} - \alpha_{11} DY_2) \tag{20}$$

If the neighbor income is assumed to be the average income $DY_2 = 0$ we have

$$DGY = (\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0 - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0)DY - \alpha_{11}\gamma_1 DY^2 \qquad (21)$$

Equal growth as a function of γ_1 is found by solving

$$(\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0 - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0)DY - \alpha_{11}\gamma_1 DY^2 = 0 \qquad (22)$$

The condition for the equal regional growth at an unequal distributed DFI for the given "aggregate" consumption function is now given by

$$\gamma_1 = (\alpha_{11}\gamma_0 + \beta_{10}\alpha_{11}\alpha_{10}\gamma_0)/(\alpha_{10} - \alpha_{11}DY) \qquad (23)$$

The ability to attract increasing investment to the region thus also here must increase at an increasing rate of DY in order to maintain equal growth rates over the regions, however, when the spill-over effect is included the level of ability to attract increasing investment must be even higher in the richer regions. Equation (23) is thus more strongly than (13) in underlining the possibility of unequal investment growth and equal growth rate.

The Chinese growth process was heavily disturbed in 1988 and 1989, due to the political instability coming from the transformation process in the Soviet Union and Eastern Europe and internal instability from the Tien-An-Min event. Therefore a dummy was introduced to catch this depression, DUM89.

The final model for the impact of direct foreign investment in China on the growth rate became

$$\begin{aligned} GY_1 &= \alpha_{00} + (\alpha_{10} - \alpha_{11}DY)GI_1 \\ &+ \beta_{10}(\alpha_{10} - \alpha_{11}DY)(\alpha_{10} - \alpha_{11}DY_2)GI_2 + \alpha_3 DUM89 \qquad (24) \end{aligned}$$

4.4 Alternative Growth Models

If the multiplier is decided by the absolute income instead of the relative income we will have

$$\begin{aligned} GY_1 &= \beta_{00} + (\beta_{01} + \beta_{11}Y_1)GI_1 \\ &+ \beta_{10}(\beta_{01} + \beta_{11}Y_1)(\beta_{01} + \beta_{11}Y_2)GI_2 + \beta_3 DUM89 \qquad (24a) \end{aligned}$$

where Y_1 and Y_2 are the absolute income in the region and in the neighbor region respectively.

It is of cause the total growth rate in the neighbor region which through the multiplier effect is transformed to the growth in the region considered. Therefore a model in the form where GY_2 replace GI_2 and form the equation

$$GY_1 = \beta_{00} + (\beta_{01} + \beta_{11} Y_1)GI_1 + \beta_{10} (\beta_{01} + \beta_{11} Y_1)GY_2 + \beta_3 \, DUM89 \quad (24b)$$

must be assumed to give a better fit. However, this article focus on DFI as the driving force in the growth process.

5. THE CYCLICAL ATTRACTION OF INVESTMENTS

As mentioned above a group of regions will develop towards equality when the growth rate is high for regions below the average income and low for regions above the average income. Therefore it is an important question for the regional equality whether it is the rich or the poor regions who attract most direct foreign investments.

It was argued above that the regional growth rate is a function of the change in foreign direct investment.

The role of FDI in the development of income equality is therefore decided partly by the individual region's ability to attract an increasing amounts of investment.

As mentioned above as the first the regions Guangdong and Fujian opened three and one SEZ's. Because Hainan first was nominated as a SEZ in 1988 it is here calculated as just a coastal area.

The basic model of attraction of *additional* investments after income level is for the empirical estimation formed as

$$GI = \gamma_0 + \gamma_1 \, DY + \gamma_2 \, SEZ \quad (25)$$

Where

SEZ - dummy, 3 for Guangdong, 1 for Fujian and 0 for others

DSEZ - deviation from average all region SEZ value

If the ability of attracting investments among the regions change over the years the coefficient can change over the years after the pattern

$$GY = \alpha_0 + \alpha_1 GI + \alpha_2 GI_2 \quad (26)$$

$$GI = \gamma_0 + \gamma_1 \, DY + \gamma_2 SEZ \quad (27)$$

$$\alpha_1 = \alpha_{10} - \alpha_{11} DY \quad (28)$$

$$\alpha_2 = \beta_{10} (\alpha_{10} - \alpha_{11} DY)(\alpha_{10} - \alpha_{11} DY_2) \quad (29)$$

$$\gamma = \beta_0 + \beta_1 * Y + \beta_2 * Y^2 + \beta_3 * Y^3 + \beta_4 * Y^4 + \beta_5 * Y^5 \qquad (30)$$

$$\begin{aligned} GI = \; & \gamma_{00} + \gamma_{10} * Y + \gamma_{20} * Y^2 + \gamma_{30} * Y^3 + \gamma_{40} * Y^4 + \gamma_{50} * Y^5 \\ & + (\gamma_{01} + \gamma_{11} * Y + \gamma_{21} * Y^2 + \gamma_{30} * Y^3 + \gamma_{40} * Y^4 + \gamma_{50} * Y^5) DY \\ & + (\gamma_{02} + \gamma_{12} * Y + \gamma_{22} * Y^2 + \gamma_{30} * Y^3 + \gamma_{40} * Y^4 + \gamma_{50} * Y^5) DSEZ \qquad (31) \end{aligned}$$

If the neighbor income again is assumed to be the average income $DY_2 = 0$, and following $DY_2^2 = 0$, we have the distribution of growth on income groups described by a third degree polynomial which gives the final expanded form for attracting more investments, and the final form for distribution and growth.

If

$$MGI = \gamma_{00} + \gamma_{10} * Y + \gamma_{20} * Y^2 + \gamma_{30} * Y^3 + \gamma_{40} * Y^4 + \gamma_{50} * Y^5 \qquad (32)$$

that is the investments for $DY_1 = DY_2 = 0$.

Then

$$\begin{aligned} & DGY_1 = \alpha_{00} + (\alpha_{10} - \alpha_{11} DY) GI_1 \\ & + \beta_{10} (\alpha_{10} - \alpha_{11} DY)(\alpha_{10} - \alpha_{11} DY_2) GI_2 \\ & - (\alpha_{00} + (\alpha_{10} - \alpha_{11} * 0) MGI \\ & + \beta_{10} (\alpha_{10} - \alpha_{11} * 0)(\alpha_{10} - \alpha_{11} * 0) MGI) \qquad (33) \end{aligned}$$

Inserting (31) in (26) we have

$$\begin{aligned} GY = \; & \kappa_{00} + \kappa_{10} * Y + \kappa_{20} * Y^2 + \kappa_{30} * Y^3 + \kappa_{40} * Y^4 + \kappa_{50} * Y^5 \\ & + (\kappa_{01} + \kappa_{11} * Y + \kappa_{21} * Y^2 + \kappa_{31} * Y^3 + \kappa_{41} * Y^4 + \kappa_{51} * Y^5) DSEZ \\ & - ((\kappa_{02} + \kappa_{12} * Y + \kappa_{22} * Y^2 + \kappa_{32} * Y^3 + \kappa_{42} * Y^4 + \kappa_{52} * Y^5) \\ & + (\kappa_{03} + \kappa_{13} * Y + \kappa_{23} * Y^2 + \kappa_{33} * Y^3 + \kappa_{43} * Y^4 + \kappa_{53} * Y^5) DSEZ) * DY \\ & + (\kappa_{04} + \kappa_{14} * Y + \kappa_{24} * Y^2 + \kappa_{34} * Y^3 + \kappa_{44} * Y^4 + \kappa_{54} * Y^5) DY^2 \qquad (34) \end{aligned}$$

and

$$\begin{aligned} DGY = \; & (\kappa_{01} + \kappa_{11} * Y + \kappa_{21} * Y^2 + \kappa_{31} * Y^3 + \kappa_{41} * Y^4 + \kappa_{51} * Y^5) DSEZ \\ & - ((\kappa_{02} + \kappa_{12} * Y + \kappa_{22} * Y^2 + \kappa_{32} * Y^3 + \kappa_{42} * Y^4 + \kappa_{52} * Y^5) \\ & + (\kappa_{03} + \kappa_{13} * Y + \kappa_{23} * Y^2 + \kappa_{33} * Y^3 + \kappa_{43} * Y^4 + \kappa_{53} * Y^5) DSEZ) * DY \\ & + (\kappa_{04} + \kappa_{14} * Y + \kappa_{24} * Y^2 + \kappa_{34} * Y^3 + \kappa_{44} * Y^4 + \kappa_{54} * Y^5) DY^2 \qquad (35) \end{aligned}$$

The relationship between the relative growth rate and relative income can thus be calculated in two ways: by estimating (24) and (31) and using equation (33) or by estimating (35) directly.

6. THE ESTIMATIONS AND SCENARIOS

6.1 The Model for the Attraction of Investments

The above model (31) for change in investment level is now estimated by WLS as

$$
\begin{aligned}
GI = {} & \underset{(4.21)}{.0040914} - \underset{(-6.07)}{.0027593}Y^2 - \underset{(-6.89)}{.0011928}Y^3 - \underset{(-7.33)}{.0001704}Y^4 + \underset{(7.52)}{7.927e\text{-}06}Y^5 \\
& + (\underset{(2.49)}{3.41e\text{-}05} - \underset{(-2.54)}{3.92e\text{-}05}Y + \underset{(2.52)}{1.62e\text{-}05}Y^2 - \underset{(-2.44)}{3.07e\text{-}06}Y^3 + \underset{(2.33)}{2.72e\text{-}07}Y^4 - \underset{(-2.23)}{9.21e\text{-}09}Y^5)DY \\
& - (\underset{(-1.77)}{.004091} + \underset{(2.01)}{.032782}Y - \underset{(-2.30)}{.016265}Y^2 + \underset{(2.62)}{.003758}Y^3 - \underset{(-2.92)}{.000400}Y^4 + \underset{(3.18)}{1.588e\text{-}05}Y^5)DY^2
\end{aligned}
$$

$R^2 = .6863 \quad Adj.R^2 = .6630 \quad Obs = 232$

Year, Y, takes the values 1 - 9 for the years 1988-1996.

The estimated GI-function is shown in figure 1.

6.2 The Investment-Growth Model

The equation for the growth rate as a function of the growth in direct foreign investments is estimated to

$$
\begin{aligned}
GY_1 = {} & \underset{(21.61)}{.09117} + (\underset{(5.09)}{8.3743} - \underset{(-1.97)}{.0008348}DY_1)*GI_1 \\
& + \underset{(1.24)}{.0367}* (\underset{(5.09)}{8.3742} - \underset{(-1.97)}{.0008348}DY_1)*(\underset{(5.09)}{8.3742} - \underset{(-1.97)}{.0008348}DY_2)*GI_2 \\
& - \underset{(-15.20)}{.1606}*DUM89
\end{aligned}
$$

$R^2 = .6046 \quad Adj.R^2 = .5976$

All signs are as theoretically expected. The coefficients of the neighbor regions are insignificant, however, highly plausible (see also appendix 4 for alternative estimations).

The change in investment level will change the equilibrium income. Normally it is expected to happen over more than one year. The data, however, showed no time lag in the adaption. This could indicate that the friction in the regions is close to zero possibly due to “unlimited” accession to qualified labor force.

In principle all neighboring regions should be included. In the empirical estimations, however, it was only possible to trace the effect, of the neighbor, with the highest level of foreign direct investments. The neighbor is therefore selected as the neighbor having the highest DFI.

The estimated equation shows that the poorest regions have the highest investment multipliers. A given investment thus has higher effects on the growth rate in a poor region than in a rich region.

The alternative model where the total growth rate was used instead of the annual growth rate created by the DFI is shown in the appendix 4. The general picture is the same as above

The high investment areas of Guangdong and Fijian are close to the mean income of the regions, which implies that their contributions to unequal growth are relative low.

We shall now calculate the DFIs contribution to the distribution of growth on the Chinese provinces, when the DFI are distributed after the calculations made by the WLS estimated model (31), where the weights are the regions share of population.

Combined the two estimated models (24) and (31) can now describe the pattern of converging/diverging growth over the period 1989-1996 by the use of formula (33).

6.3 The Relative Income and the Growth Rate Estimated Directly

The distribution of growth rates after relative income as shown in figure 2 can also as mentioned be estimated directly by formula (34). This equation was estimated to

$$\begin{aligned}
DGY = (&\underset{(1.47)}{.0731887} - \underset{(-1.36)}{.0297396Y} + \underset{(1.73)}{.0016699Y^3} - \underset{(-1.70)}{.0001556Y^4})DSEZ \\
&(- \underset{(-3.03)}{3.444e\text{-}05Y} + \underset{(2.94)}{1.759e\text{-}05Y^2} - \underset{(-2.68)}{2.672e\text{-}06Y^3} + \underset{(2.36)}{1.258e\text{-}07Y^4} \\
&+ (- \underset{(-2.20)}{2.610e\text{-}06Y^2} + \underset{(1.45)}{2.841e\text{-}07Y^3})DSEZ)DY \\
&(- \underset{(-2.20)}{1.978e\text{-}10Y^2} + \underset{(1.45)}{2.335e\text{-}11Y^3})DY^2
\end{aligned}$$

$R^2 = .1149$ Adj.$R^2 = .0706$ Obs = 232

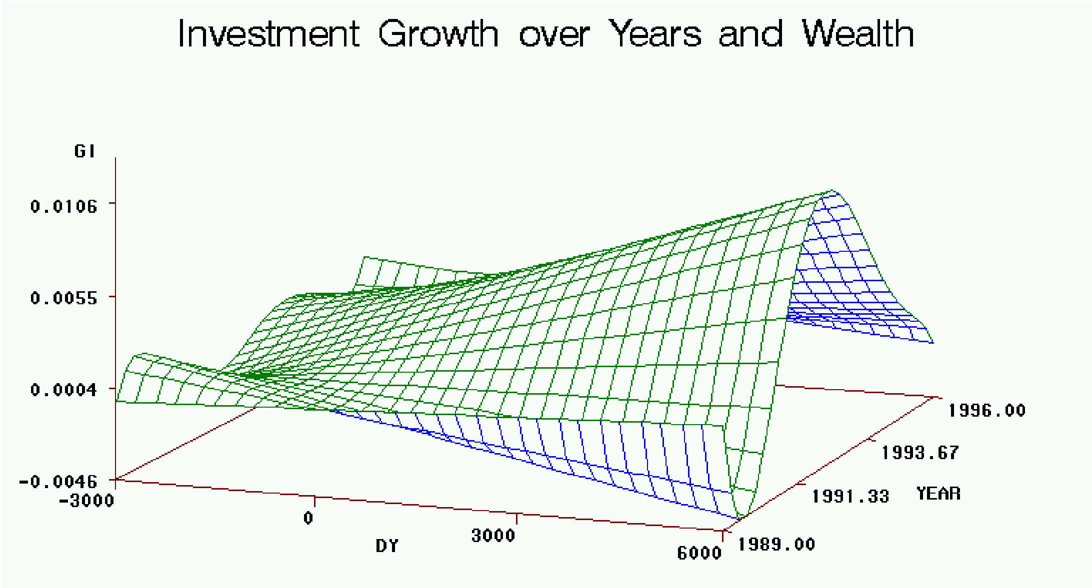

FIGURE 1. Distribution of change in investments, GI, versus YEAR and relative income, DY.

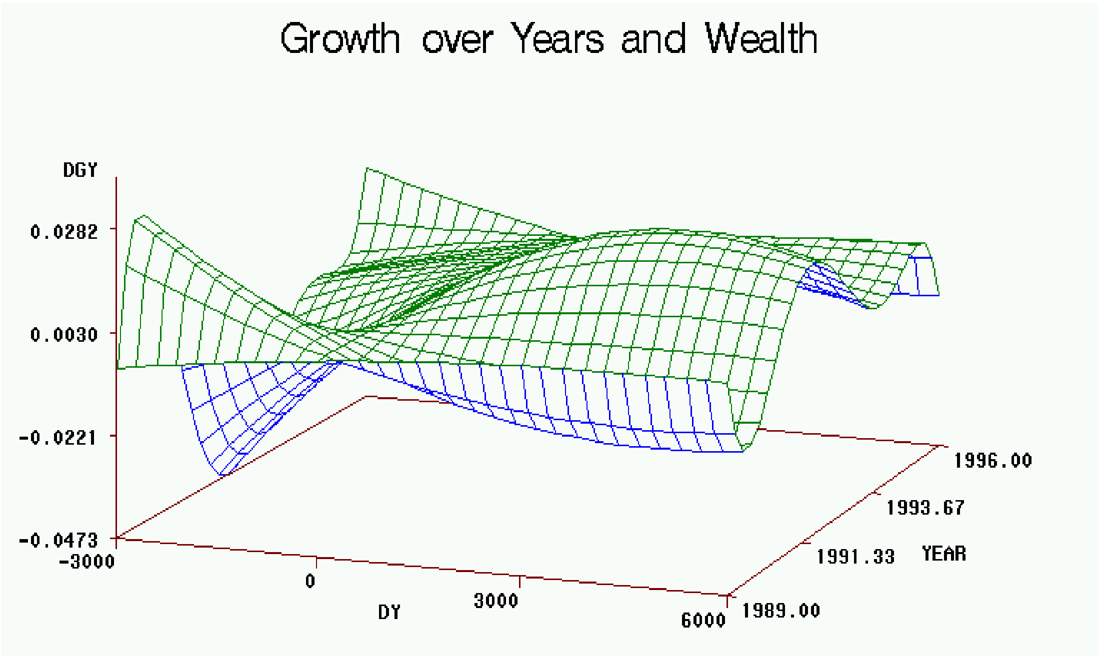

FIGURE 2. Distribution of relative growth rate, DGY, versus YEAR and level of relative income DY, calculated by the equations (24) and (31) and using equation (33). (Sample conditions: DSEZ = 0, $GI_1 = GI_2$, $DY_2 = 0$)..

Figure 2 shows converging growth at the start and end of the period and diverging growth in the middle that is 1992-1994.

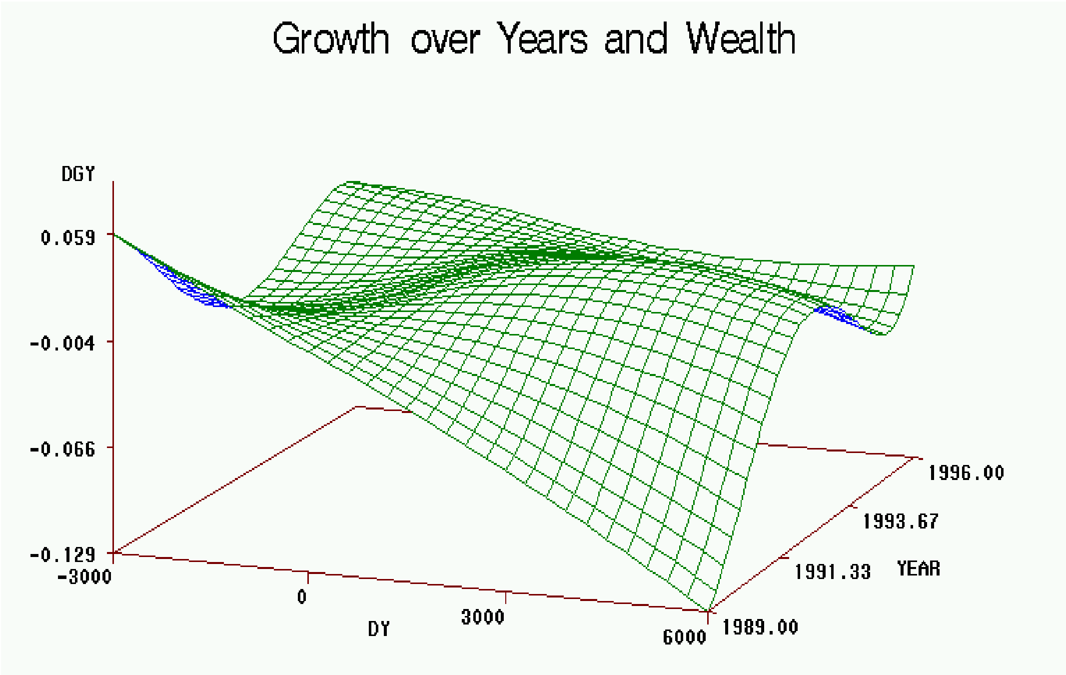

FIGURE 3. The distribution of the relative growth rate, DGY, versus YEAR and level of relative income DY, calculated by the estimated equation (42). (Sample conditions: DSEZ = 0, $GI_1 = GI_2$, $DY_2 = 0$).

As seen the R^2 is very low this is, however, in accordance with the above discussed aspect that investments positively distributed after relative income level will not give a significant positively distributed growth.

The picture connected to the estimated formula is shown in figure 3. The figure shows as figure 2 that the growth is converging in the start and end of the period and diverging in the middle of the period when the investments boomed and concentrated relatively on rich areas. As figure 2 figure 3 shows that a given distribution of investment growth will result in a distribution of growth rates modified by a multiplier which declines at increasing income.

7. GROWTH IN SUBREGIONS

The regional income inequality changes in the three economic belts, i.e. the coastal area, the central area and the western area. The income inequality among the provinces within the region (or area) is calculated by using the same formulae above, but the country data is replaced by the regional data. For example, in formula (1) in the appendix2, *Y* will change to be the per capita income in the region and *P* will be the population in the region; in formula (2) $\sum y_i$ will be the sum of per capita income in the region and *n* will be the number of provinces in the region; and in formula (3), rank will be re-arranged according to the size of per capita income in the region.

Tables 4-6 in the appendix 2 show the income inequality within the region in the three economic areas in China. The names of variable are changed to such as D1, D2 and D3, etc. in which 1 indicates the coastal area, 2 the central area and 3 the western area.

Comparing the figures in the three economic area, we find that the regional income inequality in the coastal area has been declining in the whole period, while both the central and western areas have frustrated in the same period. An increase in the dissimilarity in the central area during 1990-1992 is caused by flood catastrophes happened in Jilin province in 1989 and Anhui province in 1991. This natural disaster has brought these two province drop in relative per capita income to a quite low level, specially for Anhui province, it did not totally recover until 1994. However, the total inequality in the western area has been continued in the period, because a few province, such as Xingjiang, are rich in petroleum or other natural resources, therefore they could benefit from the economic boom of the coastal area. For some provinces in the western area, such as Guizhou, have not superior geographical condition and suffered from stagnation and are left behind. Therefore the gap between these province and others both within the region and the country has been enlarged.

8.CONCLUSION

This article is based on a data bank covering 29 regions over 9 years of which two years were ”unusual” due to political instability. The data material must therefore be considered as weak, with only limited possibilities to extract effects. Some main features can, however, be derived.

The direct foreign investments is highly unequal distributed on the Chinese regions. The unequal distribution of DFI does not, however, influens the economic growth towards a more unequal income distribution among the Chinese regions over the period 1988-1996 for several reasons:

The growth rate is not decided by the investment *level* but by the *change* in the investment level.

The investment multiplier declines at increasing income making the benefit of a given investment grater in poor regions than in rich regions.

The Special Economic Zones who attract the greatest DFI are middle income regions and the effect on the income distribution is thus close to neutral.

The effect of the DFI is spread to the neighboring regions, and the poorest regions also here gets the highest growth rate for a given investment in the neighbor region.

The adaption to new investment level seems to happen (according to our tiny data set) within the year which gives the impression that the Chinese economy is frictionless.

Keynesian economic modelbuilding seems still to be appropriate in a short run model like this.

APPENDIX 1. Chinese Growth Rates

Table 1. Regional economic growth in China, grouped in three economic belts of average real growth rate of national income (1985-1991) and GDP (1992-1996)

(%)

Coastal area			Central area			Western area		
Names of province	**1985-1991**	**1992-1996**	**Names of province**	**1985-1991**	**1992-1996**	**Names of province**	**1985-1991**	**1992-1996**
1. Beijing	7.3	11.8	4. Shanxi	5.1	11.3	21.Sichuan	7.0	11.4
2. Tianjin	6.1	13.5	5. Mongolia	7.3	10.7	22.Guizhou	7.1	8.8
3. Hebei	8.0	14.5	7. Jilin	6.7	12.7	23.Yunnan	9.3	10.9
6. Liaoning	6.6	10.7	8. H.L.J.	5.5	8.6	25.Shaanxi	8.4	9.9
9. Shanghai	6.9	14.2	12.Anhui	6.6	17.6	26.Gansu	9.4	10.6
10.Jiangsu	9.6	18.2	14.Jiangxi	8.5	14.7	27.Qinghai	7.4	8.4
11.Zhejiang	11.8	18.1	16.Henan	7.8	14.4	28.Ningxia	8.1	9.1
13.Fujian	11.7	19.7	17.Hubei	6.1	13.9	29.Xinjiang	10.0	9.9
15.Shandong	10.0	16.1	18.Hunan	7.0	12.0			
19.Guangdong	13.7	17.8						
20.Guangxi	7.8	16.2						
30. Hainan	*	13.0						
Coastal total average:	**9.4**	**15.9**	**Central total average:**	**6.7**	**13.1**	**Western total average:**	**8.0**	**10.6**
National total average:	**8.3**	**14.3**	**National total average:**	**8.3**	**14.3**	**National total average:**	**8.3**	**14.3**

Note: The numbers used to identify the regions correspond to the numbers in the map of Fig. 2. In the coastal area, Hainan is included in Guangdong province during the period 1985-1991 and it shows separately in the period 1992-1996. In the western area, Tibet (i.e. number 24) is omitted. The average growth rates for the three areas and the whole China are calculated by using shares of national income in 1985 for the period 1985-1991 and shares of GDP in 1992 for the period of 1992-1996 as weights.

Table 2. The average shares of direct foreign investment (DFI), export and population in Chinese regions grouped in the three economic belts, 1988-1996.

(%, national total=100%)

Name of region FPCY	Share of DFI	Share of export	Share of population
Coastal area:			
1. Beijing ***	6.69	3.70	0.97
2. Tianjin ***	2.41	3.12	0.78
3. Hebei ***	1.28	2.80	5.37
6. Liaoning ***	5.09	8.12	3.46
9. Shanghai	8.02	9.66	1.16
10.Jiangsu	8.58	6.10	5.92
11.Zhejiang	2.54	4.88	3.67
13.Fujian	10.08	5.05	2.67
15.Shandong	5.86	6.23	7.37
19.Guangdong	34.41	32.31	5.60
20.Guangxi	1.64	1.24	3.77
30. Hainan	3.21	0.73	0.59
Coastal area total:	*89.81*	*83.94*	*41.33*
Central area:			
4. Shanxi	0.24	0.73	2.55
5. Mongolia	0.15	0.60	1.91
7. Jilin	0.69	1.32	2.17
8. Heilongjiang	0.98	1.86	3.11
12.Anhui	0.69	1.10	5.00
14.Jiangxi	0.55	0.92	3.37
16.Henan	1.15	1.36	7.57
17.Hubei	1.39	1.78	4.79
18.Hunan	0.93	1.42	5.38
Central area Total:	*6.77*	*11.09*	*35.85*
Western area:			
21.Sichuan	1.32	1.74	9.52
22.Guizhou	0.18	0.28	2.89
23.Yunnan	0.19	0.97	3.31
25.Shaanxi	1.46	0.84	2.92
26.Gansu	0.11	0.33	2.00
27.Qinghai	0.02	0.11	0.40
28.Ningxia	0.01	0.13	0.42
29.Xinjiang	0.12	0.57	1.36
Western area Total:	*3.41*	*4.97*	*22.82*

Source: China Statistical Yearbook, various years.

APPENDIX 2: REGIONAL INCOME INEQUALITY INDEXES

The measures of income inequality follow the commonly used methods: (1) A simple dispersion indices, based on standard deviation; (2) Gini coefficients and the dissimilarity index; (3) the Shannon entropy measure; (4) the rank-size function.

The *dissimilarity* is measured by the following index:

$$D = \frac{1}{2}\Sigma_{i=1}^{n}\left|\frac{y_i}{Y} - \frac{POP_i}{POP}\right| \qquad (1)$$

where y_i = per capita income in region *i*;

Y = per capita income in the country;

POP_i = population in region *i*;

POP = total population in the country;

The dissimilarity index evaluates the maximum vertical deviation between the Lorenz Curve and the diagonal. When measuring in a time period, a descending trend shows that the dissimilarity in income among the regions is reduced.

The modified *Shannon entropy* measure is also called the total inequality measured by:

$$I = \sum_{i=1}^{n} z_i \log n z_i \qquad (2)$$

where $z_i = y_i / \sum y_i$, in which the value z_i shows the fraction of region *i*'s per capita income, while *n* is the total number of regions.

From this formula complete inequality exists when the per capita income of one region is equal to the sum, i.e. $z_i = 1$, in which case *I* would be as its maximum, log *n*.

Conversely, complete equality is achieved when all regions have the same per capita income, so that $z_1 = z_2 = \ldots = z_n$, and *I* is at 0, which is also its minimum. When *I* tends to decrease, it means income inequality is reduced, when *I* tends to increase, the income gap is enlarged.

The *rank-size function* describes the relations between the size and rank of observations when they are arranged in the descending order according to size. The logarithmic form is applied:

$$\ln y = a + b \ln r \qquad (3)$$

where y is size, expressed by the size of per capita income, r is rank arranged from the largest per capita income of the region to the smallest one.

Table 3. Income Inequality among all Regions in China

(29 regions and 9 years time series)

YEAR	S. V.	D	I	% of Max	b	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1988	0.80258	16.4742	0.16775	4.982	-0.56934	0.97881
1989	0.75381	16.3594	0.15353	4.559	-0.55237	0.97955
1990	0.71918	16.2519	0.14328	4.255	-0.53591	0.97607
1991	0.70448	16.1290	0.14118	4.193	-0.54294	0.98173
1992	0.71803	16.1068	0.14762	4.384	-0.56011	0.97902
1993	0.72454	15.9476	0.15508	4.605	-0.58546	0.97364
1994	0.71616	15.7848	0.15686	4.658	-0.59445	0.96106
1995	0.67848	15.3833	0.15037	4.465	-0.58659	0.95145
1996	0.67417	15.2920	0.14887	4.421	-0.57888	0.95277

Table 4. Income Inequality within the Region in the Coastal Area of China

YEAR	S. V. 1	D1	I1	% of Max1	b1	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1988	0.81337	7.11161	0.16475	6.630	-0.73933	0.95095
1989	0.74797	6.98378	0.14627	5.886	-0.69981	0.94873
1990	0.72376	6.93410	0.13943	5.611	-0.68238	0.94993
1991	0.67604	6.79207	0.12556	5.053	-0.64506	0.95628
1992	0.64899	6.77167	0.11655	4.690	-0.61952	0.93605
1993	0.61182	6.67402	0.10580	4.258	-0.58795	0.93288
1994	0.58132	6.59486	0.09776	3.934	-0.56142	0.91993
1995	0.54212	6.38962	0.09125	3.672	-0.54877	0.93152
1996	0.55244	6.38335	0.09460	3.808	-0.55718	0.92868

Table 5. Income Inequality within the Region in the Central Area of China

YEAR	S. V. 2	D2	I2	% of Max2	b2	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1988	0.21293	4.20265	0.01783	0.812	-0.26526	0.95672
1989	0.19958	4.19218	0.01581	0.719	-0.25263	0.97056
1990	0.21768	4.23090	0.01845	0.840	-0.27248	0.96714
1991	0.25396	4.27189	0.02450	1.115	-0.31005	0.94758
1992	0.20957	4.24449	0.01743	0.793	-0.26071	0.89573
1993	0.22986	4.23093	0.02053	0.934	-0.28627	0.96229
1994	0.23087	4.19354	0.02060	0.938	-0.28615	0.99795
1995	0.19944	4.13129	0.01568	0.713	-0.24538	0.98187
1996	0.19740	4.11153	0.01553	0.707	-0.24250	0.96519

Table 6. Income Inequality within the Region in the Western Area of China

YEAR	S. V. 3	D3	I3	% of Max3	b3	R^2
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1988	0.25671	3.93295	0.02332	1.121	-0.31408	0.90579
1989	0.26571	3.99706	0.02418	1.163	-0.32195	0.92403
1990	0.25636	3.90454	0.02351	1.131	-0.31259	0.88481
1991	0.28414	3.86453	0.02882	1.386	-0.34346	0.88934
1992	0.29295	3.85143	0.03071	1.477	-0.35153	0.87515
1993	0.29933	3.79964	0.03302	1.588	-0.36493	0.86524
1994	0.32334	3.75886	0.03871	1.862	-0.39310	0.87430
1995	0.32182	3.70308	0.04006	1.927	-0.39917	0.83579
1996	0.27488	3.61372	0.03128	1.504	-0.33823	0.73498

APPENDIX 3. MODEL DEVELOPMENT

When the right side values are measured as deviations from the mean (indicated by the prefix D) the mean of the dependent left side variable is equal to the constant element.

Model 1. A fixed Coefficient Model

$$GY = \alpha_0 + \alpha_1 GI \quad (1)$$

$$GI = \gamma_0 + \gamma_1 DY \quad (2)$$

where

α_0 - is the autonomous growth rate.
α_1 - the investment multiplier

γ_0 - is the (general) investment growth for DY = 0, or MGI
γ_1 - indicate the distributions of DFI due to the level of Y

$$GY = \alpha_0 + \alpha_1(\gamma_0 + \gamma_1 DY) \quad (3)$$

$$GY = \alpha_0 + \alpha_1\gamma_0 + \alpha_1\gamma_1 DY \quad (4)$$

$$DGY = \alpha_1\gamma_1 DY \quad (5)$$

$$\beta = \alpha_1\gamma_1 > 0 \quad \text{for} \quad \gamma_1 > 0 \quad (6)$$

Model 2. The Multiplier is Included

$$GY = \alpha_0 + \alpha_1 GI \quad (7)$$
$$GI = \gamma_0 + \gamma_1 DY \quad (8)$$

$$\alpha_1 = \alpha_{10} - \alpha_{11} DY$$

$$GY = \alpha_0 + (\alpha_{10} - \alpha_{11}DY)(\gamma_0 + \gamma_1 DY) \quad (9)$$

$$GY = \alpha_0 + \alpha_{10}\gamma_0 + \alpha_{10}\gamma_1 DY - \alpha_{11}\gamma_0 DY - \alpha_{11}\gamma_1 DY^2 \quad (10)$$

$$DGY = \alpha_{10}\gamma_1 DY - \alpha_{11}\gamma_0 DY - \alpha_{11}\gamma_1 DY^2 \quad (11)$$

Now the distribution of growth on income groups is described by a second degree polynomial

$$DGY = (\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0)DY - \alpha_{11}\gamma_1 DY^2 \quad (12)$$

Model 3. The Spill-Over Effect

$$GY = \alpha_0 + \alpha_1 GI + \alpha_2 GI_2 \tag{13}$$
$$GI = \gamma_0 + \gamma_1 DY \tag{14}$$

$$\alpha_1 = \alpha_{10} - \alpha_{11} DY \tag{15}$$

$$\alpha_2 = \beta_{10} (\alpha_{10} + \alpha_{11} DY)(\alpha_{10} + \alpha_{11} DY_2) \tag{16}$$

The point of departure for calculating β is now

$$GY = \alpha_0 + (\alpha_{10} - \alpha_{11} DY)GI + \beta_{10} (\alpha_{10} + \alpha_{11} DY)(\alpha_{10} + \alpha_{11} DY_2)GI_2 \tag{17}$$

$$GY = \alpha_0 + (\alpha_{10} - \alpha_{11} DY)(\gamma_0 + \gamma_1 DY)$$

$$+ \beta_{10} (\alpha_{10} + \alpha_{11} DY)(\alpha_{10} + \alpha_{11} DY_2)(\gamma_0 + \gamma_1 DY_2) \tag{18}$$

$$\begin{aligned} GY = {} & \alpha_0 + \alpha_{10}\gamma_0 + \alpha_{10}\gamma_1 DY - \alpha_{11}\gamma_0 DY - \alpha_{11}\gamma_1 DY^2 \\ & + \beta_{10} (\alpha_{10} - \alpha_{11} DY_1)(\alpha_{10} - \alpha_{11} DY_2)(\gamma_0 + \gamma_1 DY_2) \end{aligned} \tag{19}$$

If the neighbour income is assumed to be the average income $DY_2 = 0$ we have

$$\begin{aligned} GY = {} & \alpha_0 + \alpha_{10}\gamma_0 + \alpha_{10}\gamma_1 DY - \alpha_{11}\gamma_0 DY - \alpha_{11}\gamma_1 DY^2 \\ & + \beta_{10} (\alpha_{10} - \alpha_{11} DY_1)\alpha_{10}\gamma_0 \end{aligned} \tag{20}$$

$$\begin{aligned} GY - (\alpha_0 + \alpha_{10}\gamma_0) - \beta_{10}\alpha_{10}\alpha_{10}\gamma_0 = {} & \alpha_{10}\gamma_1 DY - \alpha_{11}\gamma_0 DY - \alpha_{11}\gamma_1 DY^2 \\ & - \beta_{10} \alpha_{11}\alpha_{10}\gamma_0 DY \end{aligned} \tag{21}$$

$$DGY = (\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0 - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0)DY - \alpha_{11}\gamma_1 DY^2 \tag{22}$$

Model 4. Attraction with Declining Force and Other Factors

$$GY = \alpha_0 + \alpha_1 GI + \alpha_2 GI_2 \tag{23}$$

$$GI = \gamma_0 + (\gamma_{10} + \gamma_{11} DY)DY + \gamma_3 DOPEN \tag{24}$$

$$\alpha_1 = \alpha_{10} - \alpha_{11} DY \tag{25}$$

$$\alpha_2 = \beta_{10} (\alpha_{10} - \alpha_{11} DY)(\alpha_{10} - \alpha_{11} DY_2) \tag{26}$$

$$\gamma_1 = \gamma_{10} + \gamma_{11} DY \tag{27}$$

If the neighbour income again is assumed to be the average income $DY_2 = 0$, and following $DY_2^2 = 0$ we have

$$GY = (\alpha_0 + \alpha_{10}\gamma_0) - \alpha_{11}\gamma_0 DY + (\alpha_{10} - \alpha_{11}DY)(\gamma_1 DY + \gamma_2 DY^2 + \gamma_3 DOPEN) + \beta_{10}(\alpha_{10} - \alpha_{11}DY)\alpha_{10}\gamma_0 \qquad (28)$$

$$GY = (\alpha_0 + \alpha_{10}\gamma_0) - \alpha_{11}\gamma_0 DY + (\alpha_{10} - \alpha_{11}DY)(\gamma_1 DY + \gamma_2 DY^2 + \gamma_3 DOPEN) + \beta_{10}\alpha_{10}\alpha_{10}\gamma_0 - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0 DY \qquad (29)$$

$$DGY = - \alpha_{11}\gamma_0 DY + (\alpha_{10} - \alpha_{11}DY)(\gamma_1 DY + \gamma_2 DY^2 + \gamma_3 DOPEN) - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0 DY \qquad (30)$$

$$DGY = - \alpha_{11}\gamma_0 DY + \alpha_{10}\gamma_1 DY + \alpha_{10}\gamma_2 DY^2 - \alpha_{11}\gamma_1 DY^2 - \alpha_{11}\gamma_2 DY^3 - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0 DY + \alpha_{10}\gamma_3 DOPEN + \alpha_{11}\gamma_3 DY*DOPEN \qquad (31)$$

Now the distribution of growth on income groups is described by a third degree polynomial

$$DGY = (\alpha_{10}\gamma_1 - \alpha_{11}\gamma_0 - \beta_{10}\alpha_{11}\alpha_{10}\gamma_0 + \alpha_{11}\gamma_3 DOPEN)DY + (\alpha_{10}\gamma_2 - \alpha_{11}\gamma_1)DY^2 - \alpha_{11}\gamma_2 DY^3 + \alpha_{10}\gamma_3 DOPEN \qquad (32)$$

Model 5. The Investment Cycle

If the ability of attracting investments among the regions change over the years the coefficient can change over the years after the pattern

$$GY = \alpha_0 + \alpha_1 GI + \alpha_2 GI_2 \qquad (33)$$

$$GI = \gamma_0 + \gamma_1 DY + \gamma_2 DY^2 + \gamma_3 DOPEN \qquad (34)$$

$$\alpha_1 = \alpha_{10} - \alpha_{11}DY \qquad (35)$$

$$\alpha_2 = \beta_{10} (\alpha_{10} + \alpha_{11}DY)(\alpha_{10} + \alpha_{11}DY_2) \qquad (36)$$

$$\gamma = \beta_0 + \beta_1 *YEAR + \beta_2 *YEAR^2 \qquad (37)$$

which gives the final expanded form for attracting more investments

$$GI = \beta_{00} + \beta_{10}*YEAR + \beta_{20}*YEAR^2 + (\beta_{01} + \beta_{11}*YEAR + \beta_{21}*YEAR^2)DY + (\beta_{02} + \beta_{12}*YEAR + \beta_{22}*YEAR^2)DY^2 + (\beta_{03} + \beta_{13}*YEAR + \beta_{23}*YEAR^2)DOPEN \qquad (38)$$

and the final form for distribution and growth.

$$\begin{aligned}
DAY = (&\beta_{00} + \beta_{10}*YEAR + \beta_{20}*YEAR^2 \\
&+ (\beta_{01} + \beta_{11}*YEAR + \beta_{21}*YEAR^2)DOPEN)DY \\
&+ (\beta_{02} + \beta_{12}*YEAR + \beta_{22}*YEAR^2)DY^2 \\
&+ (\beta_{02} + \beta_{12}*YEAR + \beta_{22}*YEAR^2)DY^3 \\
&+ (\beta_{03} + \beta_{13}*YEAR + \beta_{23}*YEAR^2)DOPEN
\end{aligned} \tag{39}$$

APPENDIX 4. Alternative Model Estimations

The growth model when the multiplier depends on the *actual* income is as follows:

$$\underset{(20.57)}{GY_1 = .08929} + (\underset{(4.23)}{8.6602} \underset{(-2.21)}{-.0007297Y_1})*GI_1$$

$$+\underset{(1.31)}{.05341}* (\underset{(4.23)}{8.6602} \underset{(-2.21)}{-.0007297Y_1})*(\underset{(4.23)}{8.6602} \underset{(-2.21)}{- .0007297Y_2})*GI_2$$

$$\underset{(-15.40)}{- .1613}*DUM89$$

$R^2 = .6077$ Adj.$R^2 = .6008$

The alternative model where the *total growth rate* of the neighbour was used instead of the growth in DAI was estimated to

$$\underset{(8.31)}{GY_1 = .05782} + (\underset{(4.41)}{6.6010} \underset{(-1.60)}{-.0003139Y_1})*GI_1$$

$$+\underset{(3.40)}{.05837}* (\underset{(4.41)}{6.6010} \underset{(-1.60)}{-.0003139Y_1})*GY_2$$

$$\underset{(-7.79)}{- .1063}*DUM89$$

$R^2 = .6530$ Adj.$R^2 = .6469$

Without explicit neighbor effect

$$\underset{(23.82)}{GY_1 = .09405} + (\underset{(7.08)}{9.9485} \underset{(-2.47)}{-.0010719Y_1})*GI_1 \underset{(-15.60)}{- .1637}*DUM89$$

$R^2 = .5984$ Adj.$R^2 = .5931$

Export as endogenous (and therefore not included) variable in the data for China is supported by the following estimated equation:

$$FEXPPC = .02674 + .006470*FDFIPC + .8852FEXPPC(-1) + .1579SEZ$$
$$\quad (.88) \qquad (5.47) \qquad (24.72) \qquad (3.13)$$

$R^2 = .9165$ Adj.R^2 = .9154 Obs. = 232

Where

FEXPPC - fixed price export per capita

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