Trade, Savings, and Economic Growth

by

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Abstract

This dissertation studies the issues of economic development in developing countries. There are three chapters in this thesis. The first chapter focuses on the relationship between foreign technology imports and economic growth in developing countries. Based on an intertemporal endogenous growth model that explicitly takes foreign technology imports as a factor of production, we establish an important theoretical link between growth rate of productivity in a developing country with the country's ability to import foreign technology. We formally show that a developing country's economic growth rate increases as the imports of foreign technology increases. Then, we use a sample of more than 50 developing countries to test the prediction of the model. Econometric issues related to panel data regressions are discussed. The empirical results strongly support the hypothesis that foreign capital import is the most important factor in economic growth in developing countries.

In the second chapter, we move on to discuss the relationship between different sectors of exports and economic growth in developing countries. We first develop a model which separates the impacts of manufacturing exports on economic growth from that of primary exports, and then applying the framework to a data set of over 50 developing countries. The evidence emerged from this study challenge the conventional wisdom that promoting manufacturing exports is always a better strategy than promoting primary exports. We find that for these 50 developing countries as a group, the growth of primary export had a greater impact on the rates of economic growth than that of manufacturing export for a long period of time until the beginning of 1980s, while the success of expanding manufacturing export in promoting economic growth has been only a recent phenomenon. Finally, sensitivity analysis shows that the empirical results are robust.

The third chapter is a case study on the savings rates in China. Given the apparent link between high savings rates and high economic growth rates in many Asian countries, it is very important to study the determinants of savings rates in those countries. The main question asked in this chapter is: what are the factors determining the widely different gross savings rates in China's provinces? We first develop an empirical framework based on discussions of relationships between savings rates and a group of economic, demographic, and institutional factors. Then using a panel data set of 28 provinces for 5 year time span, we cpnduct empirical tests to see which factors are significant in determining savings rates in China's provinces. Three findings emerge from this study: first, savings rates in China's provinces are determined by the degree of income disparity between rural and urban populations; second, the state sector's revenue has significant impact on the savings rates in China's provinces; and third, Life-Cycle Hypothesis seems not applicable in studying China's savings rates in 1980s and early 1990s.

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Contents

List of Tables

Chapter 1

Foreign Technology Imports and Economic Growth

1.1 Introduction

In this chapter, we discuss the relationship between the transfer of foreign technology and economic growth in developing countries. This topic has long been studied by economists. In the gap-model approach, Chenery and Bruno (1962), McKinnon (1964), Bacha (1984) and Taylor (1990, 1993) focus on foreign exchange resources as one of the most important constraints on economic growth in developing countries. Their argument is based on the idea that most developing countries cannot produce the technologically advanced capital goods domestically, they have to rely on importing foreign capital goods from advanced countries to obtain new technology. Thus, imported capital goods are indispensable inputs for these economies. If there is a shortage of foreign exchange to finance the desired technology-embodies foreign capital goods and intermediate goods, the economies in developing countries cannot operate properly, let alone achieving high growth rates.[1]

Some economists even claim that foreign technology import is the most important factor in explaining the rapid economic growth of Japan, Taiwan, South Korea,

[1]Bochove (1982) also argues that many foreign imports are indispensable inputs in developing economies, therefore imports should be treated explicitly as a factor of production in growth models.

and other newly industrialized countries. For example, Amsden (1989) argues that the common character in the economic development processes of all the "late industrializers" (i.e., developing countries) is industrialization based on learning foreign technology. Countries like Japan, South Korea, Brazil, Turkey, India, and Mexico "all industrialized by borrowing foreign technology rather than by generating new products or processes" (Amsden, 1989, p. 5). She suggests that a growth model appropriate for late industrializers should incorporate not technological innovation, but foreign technology imports.

While the idea of import as a factor of production has been put forward in some simple models, to my knowledge, there does not exist an intertemporal endogenous growth model incorporating this idea, nor is there any systematic studies to test this hypothesis. Although many New Growth models try to tackle the important issue of endogenous productivity growth, they fail to explain the important linkage between foreign technology transfer and phenomenal economic growth in countries like Japan, South Korea, Taiwan, and many other developing countries. These models are not very accurate in describing economic growth process in developing countries because they ignore the most important source of productivity increase in developing countries: borrowed foreign technology through import and transfer.

On the empirical side, there are a few studies based on the two-gap model approach in testing the linkage between imports and growth. For example, Esfahani (1991) conducted a simultaneous system analysis testing the relationship among export, intermediate imports, and economic growth using 31 semi-industrialized countries sample, and found that "export promotion policies in these countries can be quite valuable in supplying foreign exchange, which relieves import shortages and permits output expansion" (p. 114). However, there exists no empirical studies directly testing the hypothesis that foreign technology import is the most important factor in explaining economic growth process in developing countries.

In this paper, we first develop an intertemporal endogenous growth model that explicitly link foreign capital import to economic growth in developing countries. Then we conduct an empirical test on the model using a sample of 53 developing countries. The paper is organized as follows, in section 2, we present a two-goods model of optimal growth along the line of the technology argument by dividing capital accumulation in a typical developing country into two parts: the accumulation of traditionally, home-produced capital and the accumulation of imported foreign technology. Revenues from exports are used for foreign good consumption and foreign technology imports. We formally show that a developing country's economic growth rate increases as foreign technology imports increase. In section 3, we conduct empirical tests of the hypotheses generated by the model, using panel data from developing countries. Section 4 concludes.

1.2 An Endogenous Growth Model with Foreign Technology Imports

The model developed in this section has its origin in neoclassical growth model[2]. The standard version of the neoclassical growth model developed first by Solow (1956) has the property that the only potential sources of growth are sustained exogenous increases in factor supplies (e.g., population growth) and exogenously given technological change (see, for example, Jones & Manuelli 1989). Thus, except for the possibility of exogenous technical change, these models of growth lead on to the startling conclusion that there is no growth in per capita terms. Rather, depending on initial conditions, in simple versions there is growth until the capital stock reaches a steady state where things settle down permanently. The fundamental problem with the neoclassical growth model, as Solow (1970) acknowledged, is that it is not able to explain the wide differences in the rate of productivity growth across countries. Faced with the phenomenal sustained growth in per capita output that many developing countries have experienced, the only explanation the model has to offer is exogenous technical change, which sheds no new light on cross-country differences.

Since the mid-1980s, many economists have tried to endogenize the process of

[2]This section draws heavily on an un-published paper by Devarajan and Zou (1993).

technical change. Three different groups of models of capital formation have been proposed to deal with this problem. The first group relies on externality and increasing returns to scale (Romer 1986). The second group are the models of human capital formation pioneered by Lucas (1988). The third focus on new goods introduction with learning by doing, advanced by Grossman and Helpman (1990). However, all of these models fail to explain the important linkage between foreign technology transfer and phenomenal economic growth in countries such as Japan, South Korea, Taiwan, and many other developing countries. As Amsden (1989) points out, the conventional growth model is inappropriate for developing countries because it throws away valuable information on the source of productivity increase in these countries: borrowed foreign technology through capital imports and transfers.

We construct a model that addresses this shortcoming. Two features distinguished our model from all the other growth models. First, we explicitly assume that foreign capital goods are indispensable inputs in developing countries' production. Foreign capital goods are not perfectly substitutable by home capital goods. Second, we build into the model a direct linkage between foreign technological imports and the productivity increase in developing by assume that the rate of technological growth is a positive function of foreign capital imports.

1.2.1 The Model

There are two economies in this model: the home country and the foreign country. The home country is a developing economy, and foreign country is a developed one. There are two goods — the home good and the foreign good; and the home good price in the foreign market is p_x, which, as will be discussed later, is a negative function of the quantity exported.

At time t there are N_t identical persons in home country producing the home good with a technology given by the production function,

$$Y_t = K_{ht}^{\alpha} K_{ft}^{\beta} [A_t N_t]^{1-(\alpha+\beta)}, \quad (\alpha + \beta < 1) \tag{1.1}$$

Where K_{ht} is home capital stock at time t, K_{ft} is foreign capital. While allowing substitution between home capital and foreign capital in production, in general, foreign capital through its embodiment of modern technology is more efficient than home capital. The idea of putting foreign capital into the production function as an input is taken from the paper by Devarajan and Zou (1993). N_t is the total population in the home country. The population is growing at a constant rate n, i.e., $\dot{N}/N = n$.

A_t is an index of the labor-augmenting technology at time t. A_t is growing at rate ϕ: $A_t = e^{\phi t}$. We can define $N_t e^{\phi t}$ as the effective labor force at time t, and denote it $\hat{N}$. Thus,[3]

$$\hat{N} = N(0)e^{(n+\phi)t}, \quad \text{because } N = N(0)e^{nt} \tag{1.2}$$

The effective labor force grows at rate of $n + \phi$. For a given size of physical population, there will be more effective units of labor as time passes by. But on the other hand, the number of physical bodies increases at the constant rate n. Now we can rewrite the production function as follows

$$Y = K_h^{\alpha} K_f^{\beta} \hat{N}^{1-(\alpha+\beta)} \tag{1.3}$$

Let's divide both sides of (1.3) by $\hat{N}$, define $y = Y/\hat{N}$, $k_h = K_h/\hat{N}$, and $k_f = K_f/\hat{N}$, the constant return assumption implies:

$$y = k_h^{\alpha} k_f^{\beta} \tag{1.4}$$

Note that here y, k_h, k_f are all variables measured in per effective unit of labor.

Now we need to further examine the technology index $A = e^{\phi t}$. In the standard neoclassical growth model, ϕ is assumed to be exogenously given. In our model, in order to capture the stylized fact of developing countries, we assume that the technological growth rate in the developing country is a function of imported foreign

[3]For notational simplicity, we will drop the time index for all the current variables from here on. So unless specified otherwise, N is equivalent to N_t.

capital stock, i.e.,

$$\phi_t = \begin{cases} \Phi(k_{f,t-1}) & \text{if } y_h < y_f \\ \phi_f & \text{if } y_h \geq y_f \end{cases} \tag{1.5}$$

where $k_{f,t-1}$ is foreign capital stock measured at per efficient unit of labor at time $t-1$, and $\Phi'(.) > 0$, $\Phi''(.) < 0$. ϕ_f is the developed country's technological growth rate, which is assumed to be exogenously given and constant for simplicity. Equation (1.5) says that the growth rate of the labor-augmenting technology in the developing country at time t is a positive function of the stock of imported foreign capital good at time $t-1$. We offer three reasons for the assumption on the rate of growth of productivity in developing countries in equation 1.5. First, foreign plant and equipment investments generally embodying advanced foreign technology, advanced design and advanced management method. More investment in importing foreign plant and equipment will raise home country's technology by having more embodied foreign technology. Further more, investment in foreign plant and equipment involves training technicians in foreign country, so a higher stock of foreign capital means a proportionally larger number of people being trained in foreign country. The second channel by which the stock of foreign capital affects the growth rate of technology is by economics of scale. A higher level of foreign capital imports makes it more likely for the home country to operate foreign technology on a scale sufficient to minimize unit costs. The third channel is through experience accumulation. How efficiently foreign technology is used will depend on the experience of the user. The higher foreign capital stock imports level is, the more intensively people have to learn to operate foreign equipment, hence the faster experience accumulates. That is to say, learning-by-doing, which is one critical aspect of learning in general, depends on accumulation of foreign capital stock.

The assumption in 1.5 that the growth rate of technology in developed country is exogenously fixed is for analytical simplicity. Alternatively, we could have used a endogenous growth formulation along the lines of Lucas (1988) or Grossman & Helpman (1991). However, the focus of this paper is on the developing country's "catching-up" process, what happens after the developing country becomes a developed one is not important here.

We assume that there is no foreign direct investment in the home country. To obtain foreign technology, the home country relies on its export earning. This assumption is for simplifying analytical exposition. It can be relaxed without changing our model results. The home country's foreign earning is $E = P_x X$, where P_x is the price of home good in the foreign market which is a function of the quantity exported given by

$$P_x = a - bX \tag{1.6}$$

As the quantity of export increase, the price of home good in foreign market will decrease. X is the home country's export, the demand of which is elastic.

Thus the home country's foreign earning is a quadratic function of X:[4]

$$E = P_x X = aX - bX^2 \tag{1.7}$$

Let C_h and C_f be the aggregate home good consumption and foreign good consumption at time t, respectively. Then dynamic equations for the accumulations of home capital and foreign capital are:

$$\dot{K}_h = K_h^{\alpha} K_f^{\beta} (e^{\phi t} N)^{1-(\alpha+\beta)} - C_h - K_h - X, \tag{1.8}$$

$$\dot{K}_f = P_x X - C_f - K_f = (aX - bX^2) - C_f - K_f. \tag{1.9}$$

Expressed in per effective unit of labor variables, the dynamic equations for the accumulations of home capital and foreign capital become

$$\dot{k}_h = k_h^{\alpha} k_f^{\beta} - c_h - (n + \phi) k_h - x, \tag{1.10}$$

$$\dot{k}_f = (ax - bx^2 e^{\phi t}) - c_f - (n + \phi) k_f. \tag{1.11}$$

[4] I thank Lance Taylor for his suggestion on using an export earnings function that is non-linear in X.

Note that we have assumed away capital depreciation for simplicity.

Consumers maximize an instantaneous utility function specified as:

$$\int_0^\infty [log(C_h/N) + \theta log(C_f/N)]e^{-\rho t}dt. \tag{1.12}$$

The separability of utility function is purely for analytical simplicity. The constant θ is positive and measures the preference for foreign good consumption.

Note that the utility function is defined in consumption per capita (per physical body) while the dynamic equations are defined in terms of consumption per effective labor unit. We can transform the utility function using the equality $C/N = Ce^{\phi t}/Ne^{\phi t} = e^{\phi t}c$.

$$\int_0^\infty [logc_h + \theta logc_f + (1+\theta)\phi t]e^{-\rho t}dt \tag{1.13}$$

The representative agent in the home country chooses c_h and c_f so as to maximize (1.13) subject to the dynamic constraints (1.10) and (1.11), and the initial values of home capital and foreign capital ($k_h(0)$, $k_f(0)$).

The current value Hamiltonian function is

$$\begin{aligned} H &= e^{-\rho t}\{logc_h + \theta logc_f + \lambda_h[k_h^\alpha k_f^\beta - c_h - x - (n+\phi)k_h] \\ &\quad +\lambda_f[(ax + bx^2e^{\phi t}) - c_f - (n+\phi)k_f]\} \end{aligned} \tag{1.14}$$

Note that although ϕ changes in each period, the representative agent takes ϕ as given because it is determined by the last period's foreign capital stock.

The necessary conditions for maximization are

$$c_f = \theta(a - 2bxe^{\phi t})c_h, \tag{1.15}$$

$$\frac{\dot{c}_h}{c_h} = \alpha k_f^\beta k_h^{\alpha-1} - (n+\phi+\rho), \tag{1.16}$$

$$\frac{\dot{c}_f}{c_f} = \frac{C_f}{\theta C_h}\beta k_f^{\beta-1}k_h^\alpha - (n+\phi+\rho), \tag{1.17}$$

$$\dot{k}_h = k_f^\beta k_h^\alpha - c_h - (n+\phi)k_h - x, \tag{1.18}$$

$$\dot{k}_f = (ax - bx^2 e^{\phi t}) - c_f - (n+\phi)k_f. \tag{1.19}$$

In the steady state, $\dot{c}_h = \dot{c}_f = \dot{k}_d = \dot{k}_f = 0$. So the necessary conditions for optimization in equilibrium are

$$\bar{c}_f - \theta(a - 2b\bar{x}e^{\phi t})\bar{c}_h = 0 \tag{1.20}$$

$$\alpha \bar{k}_f^{\beta} \bar{k}_h^{\alpha-1} - (n+\phi+\rho) = 0 \tag{1.21}$$

$$\frac{C_f}{\theta C_h}\beta \bar{k}_f^{\beta-1}\bar{k}_h^{\alpha} - (n+\phi+\rho) = 0 \tag{1.22}$$

$$\bar{k}_h^{\alpha}\bar{k}_f^{\beta} - \bar{c}_h - (n+\phi)\bar{k}_h - x = 0 \tag{1.23}$$

$$(a\bar{x} - b\bar{x}^2 e^{\phi t}) - \bar{c}_f - (n+\phi)\bar{k}_f = 0 \tag{1.24}$$

where a bar over a variable denotes its steady state value, and all derivatives are evaluated at the steady state.

Condition (1.20) gives the steady state relationship between the amount of good to be exported and the ratio of home good consumption to foreign good consumption. Conditions (1.21) and (1.22) are the modified golden rule. Condition (1.23) gives the steady state level of per effective unit of labor consumption of home good. Condition (1.24) says that total export are the only income for purchasing foreign consumption goods and foreign capital goods.

1.2.2 Growth Rate at the Steady State

We define steady state (or balanced growth path) as the state where all the variables grow at a constant rate. Thus we rule out paths with ever increasing growth rates, but we allow for the possibility of zero steady state growth rates.

Equations (1.21), (1.22), (1.23), and (1.24) tell us that in the steady state, the consumption of home good and foreign good, and the home capital stock and foreign capital stock measured at per effective labor unit are constant, i.e.,

$$c_h = \bar{c}_h, \quad c_f = \bar{c}_f, \quad k_h = \bar{k}_h, \quad k_f = \bar{k}_f$$

Hence the growth rate of all per effective unit of labor variables is zero. Knowing this, we can find the growth rate of all the variables measured in per capita (i.e., per physical body) from the relation between per capita variables and per effective unit variables. For example, the relationship between the per capita home good consumption and per effective unit of labor home good consumption is given by

$$\bar{c}_h = \frac{C_h}{e^{\phi t} N}$$

i.e.,

$$\frac{C_h}{N} = \bar{c}_h e^{\phi t} \tag{1.25}$$

Take time derivative of both sides of equation (1.25) and then divide the result by (1.25), we get the growth rate of per capita home good consumption at steady state:

$$\frac{d(C_h/N)/dt}{C_h/N} = \phi = \Phi(\bar{k}_f) \tag{1.26}$$

Similarly, we can show that all the per capita variables grow at the same rate when the economy is at the steady state:

$$\frac{d(C_f/N)/dt}{C_f/N} = \frac{d(K_h/N)/dt}{K_h/N} = \frac{d(K_f/N)/dt}{K_f/N} = \frac{d(Y/N)/dt}{Y/N} = \phi = \Phi(\bar{k}_f) \tag{1.27}$$

Equation (1.26) and (1.27) say that at steady state, per capita consumption of home good and foreign good, and per capita home and capital stocks, and thus per capita income, are growing at the same rate ϕ ($\phi = \Phi(\bar{k}_f)$), which is determined by the steady state foreign capital stock per effective labor unit. If a country has a higher steady state per effective labor unit foreign capital stock, its per capita income growth rate in steady state is higher. It is conceivable that given right parameters the home country's growth rate can be higher than that in the developed country, i.e., $\Phi(\bar{k}_f) > \phi_f$. Then the income gap between the two countries will decrease until the home country's per capita income level is equal to that of the foreign country at which point there will be no particular advantage of importing foreign technology and the growth rate of the home economy will be the same as the foreign country

($\phi = \phi_f$). This scenario captures the essence of catching-up experience of many late industrializers (Japan, South Korea, Turkey, Taiwan, Singapore, China), which was based on learning and borrowing foreign technology from developed countries.

The aggregate variables of the home economy—aggregate income Y, total consumption of home good C_h and foreign good C_f, and total home capital stock K_h and foreign capital stock K_f—are all growing at the rate of $\phi + n$, until the home country's aggregate income level reaches that of the foreign country, at which point the growth rates of the two economies will converge.

Thus, our model links a developing country's long-run economic growth rate with its efforts in learning advanced technology from foreign technological imports. The model explains why some developing countries succeeded in catching up with the developed countries while some others lagged behind.

We pose for a moment and compare the model constructed here with existing growth models. Several distinctive features set this model apart from other growth theory models. As mentioned in the beginning, in the existing growth theory literature, the growth rate of technology is either assumed to be exogenously determined (Solow, 1956), or to be determined endogenously by postulating some externality effects (Lucas 1988, Romer 1986). All of them have one thing in common: they assume away the important fact that developing countries usually can take advantages of the existing advanced technology in the developed countries by intensive learning, instead of by investing in R&D and innovation. Although in the models developed by Grossman and Helpman (1991), the technological difference between North and South is a central focus, they model the learning process as a rather mechanic one: the North always creates new products and the South always imitates. In this pattern, the developing countries can never catch up and surpass the income and technological level of the developed ones. Our model is a departure from growth models on technological progress. In our model, it is the quality gap between the developing country's home technology and imported foreign technology that propels the former to catch up with the latter. Through active learning, the developing country can reduce the technological lag and eventually become a developed country. By explicitly linking productivity growth with increase in output, our model is a distant descendant of models developed by Kaldor (1967, 1978).

Another important feature of this model is that the steady state is given a new meaning here. In most growth models, the steady state means an ideal state existing only in the future. All the developing countries are usually assumed to be not in such a state, as if the long histories of these countries do not count. In our model, we do not assume the economic growth starts from the beginning of 20th century or the end of World War II or some arbitrary date. After all, most developing countries have several hundred years of history, many even have several thousand years of civilization. If after such a long history a country is still in some mid-way from the steady state, then what is the usefulness of studying the steady state? In our model, we postulate that all the developing countries are in their steady state development. Each country's steady state per capita income is growing at a rate determined within the economic system. The different growth rates we observe are the results of each nation's different preferences and tastes (which are related to culture and history), different natural endowment, and different foreign exchange resources.

1.3 Empirical Tests of the Relationship Between Foreign Technology Imports and Economic Growth

In this part, we conduct empirical tests on the predictions generated by the model in the previous section. We test the relationship between the economic growth rate and foreign technology imports. We first develop statistical specifications, then discuss the data and the empirical result, and then discuss policy implications and suggestions for future research.

1.3.1 Statistical Specification

Our empirical model specification follows the general approach used in the study by Mankiw, Romer, and Weil (M-R-W thereafter) (1992), although we do not adopt many of their assumptions that we consider not reasonable.

Let production function be

$$Y_t = K_{ht}^{\alpha} K_{ft}^{\beta} (A_t N_t)^{1-\alpha-\beta} \tag{1.28}$$

Let S_k be the fraction of income invested in foreign capital imports. The dynamics of the economy is given by

$$\dot{K}_{ht} = S_{ht} Y_t - \delta K_{ht} \tag{1.29}$$

$$\dot{K}_{ft} = S_{ht} Y_t - \delta K_{ft} \tag{1.30}$$

Equations (1.29) and (1.30) imply that the economy converges to a steady state given by

$$\bar{K}_{ht} = A_t N_t \left(\frac{S_{ht}^{1-\beta} S_{ft}^{\beta}}{\delta}\right)^{\frac{1}{1-\alpha-\beta}} \tag{1.31}$$

$$\bar{K}_{ft} = A_t N_t \left(\frac{S_{ht}^{\alpha} S_{ft}^{1-\alpha}}{\delta}\right)^{\frac{1}{1-\alpha-\beta}} \tag{1.32}$$

Substituting (1.31) and (1.32) into the production function, and taking logs, we get an equation for per capita income:

$$\ln Y_t = \ln A_t + \ln N_t - \frac{\alpha+\beta}{1-\alpha-\beta} \ln \delta + \frac{\alpha}{1-\alpha-\beta} \ln S_h + \frac{\beta}{1-\alpha-\beta} \ln S_f \tag{1.33}$$

Equation (1.33) relates a country's level of income with the rate of home capital investment and that of foreign capital investment, and its population. This equation will be the basis of our empirical study. Our model predicts that the coefficients on home capital investment and on foreign capital import are positive, and the latter should be bigger than the former in magnitude. We have to first make some assumptions on the parameters before we can test the model. We assume that δ be country specific but are constant over time within the same country. Thus by taking first difference of individual country observations over time we can eliminate the δ:

$$\begin{aligned}\ln Y_t - \ln Y_{t-1} &= [\ln A_t - \ln A_{t-1}] + \frac{\alpha}{1-\alpha-\beta}(\ln S_{h,t} - \ln S_{h,t-1}) \\ &+ \frac{\beta}{1-\alpha-\beta}(\ln S_{f,t} - \ln S_{f,t-1}) + [\ln N_t - \ln N_{t-1}] \end{aligned} \tag{1.34}$$

i.e.,

$$\frac{\dot{Y}}{Y} = [\ln A_t - \ln A_{t-1}] + \frac{\alpha}{1-\alpha-\beta}(\frac{\dot{S}_h}{S_h}) + \frac{\beta}{1-\alpha-\beta}(\frac{\dot{S}_f}{S_f}) + \frac{\dot{N}}{N} \tag{1.35}$$

The term $A(.)$ in equation (1.35) is in fact an all encompassing variable. It reflects not only technology, but also many unobservable factors. These include resource endowments, climates, social institutions, and other random effects. In M-R-W's study, they assume that

$$\ln A_t = a + \epsilon \tag{1.36}$$

where a is assumed to be a constant both cross-country and over time, and ϵ is a random shock includes all country-specific factors that are independent of the rate of investment and population growth. In growth form, their assumption means

$$\ln A_t - \ln A_{t-1} = \epsilon_t - \epsilon_{t-1} \tag{1.37}$$

This is to say, all the unobserved institutional variables are assumed away in this formulation. This assumption allows them to proceed with the simple OLS estimation.

M-R-W provide three reasons for this assumption. First, this assumption is made not only by Solow, but also in many other growth model studies. They also argue that in models where investment is endogenous but preferences are isoelastic, S_h and S_f are independent of ϵ. Second, this assumption is necessary for testing different hypothesis in their paper. Third, because the model predications are very precise, they can use the result to test whether OLS is a mis-specification.

Many economists have questioned this assumption and the three supporting arguments. For example, Islam (1992) argues that investment and fertility behavior is apparently affected by the variables included in the A_t.

Indeed a theoretical case can be made against M-R-W's assumption. By standard formulation, $\ln A_t - \ln A_{t-1}$ is the technical growth rate ϕ, which is country specific. In fact, ϕ can be decomposed into

$$\phi_i = \lambda C_i + \mu_{it} \tag{1.38}$$

Where i denotes countries in the sample, t is index for time. C_i is a country-specific constant, and μ_{it} is all the unobserved variables that are not correlated with the explanatory variables, and is i.i.d. with variance equal to σ_μ^2. Substituting (1.37) and (1.38) into equation (1.35), we have

$$(\frac{\dot{Y}}{Y})_{it} = \lambda C_i + \frac{\alpha}{1-\alpha-\beta}(\frac{\dot{S}_h}{S_h})_{it} + \frac{\beta}{1-\alpha-\beta}(\frac{\dot{S}_f}{S_f})_{it} + (\frac{\dot{N}}{N})_{it} + \mu_{it} \tag{1.39}$$

Equation (1.39) specifies a model with heterogeneous intercepts, homogeneous slopes. Apparently, if this specification is true, then M-R-W's specification of an independent ϵ is equivalent to a restriction that all intercepts for different countries are the same. And their estimates would be biased.

In what follows, we will use the specification in equation (1.39) to study the relationship between a country's level of income and its foreign capital import share in GDP, albeit expressed in growth rate form. The dependent variable is income growth rate, the independent variables are growth rate of the share of foreign capital imports in GDP, growth rate of home investment share in GDP, and population growth rate. The term C_t is an unobservable constant for each country. We will use variable-intercept models with panel data to deal with this issue. By assuming that the effects of the numerous omitted country-specific variables are each individually unimportant but are collectively significant and possess the property of a random variable that is uncorrelated with all other included and excluded variables, we can specify our model as having common slopes for all the counties but the intercept varies over individual countries. This method is called variable-intercept method. [5]

We will also run simple OLS regressions based on M-R-W's assumption and compare the results from the different methods, which would provide a test on their assumption.

1.3.2 The Data and Samples

The data are assembled from the publications from United Nations, from the World Bank. I also use the panel data set by Summers and Heston (1991). The Summers-Heston data have been widely used in growth empirical studies. In this study, whenever possible, we always try to use direct national income account assembled and published by the UN or the World Bank.

The reasons to choose national account data instead of Summers-Heston data are: (1) Summers-Heston data are extrapolations from benchmark studies. For many developing countries, it is more likely to be subject to measurement error than the World Bank data which is directly based on the national income accounts. Specifically, a third of the developing countries have not participated in even one round of the International Comparison Program, on which Summers and Heston extrapolate their data set. Thus, for these countries, every real income figure is estimated by their relationships with participating countries found. Even if the extrapolation method is the best possible, the analysis of the data is in a danger of extracting the extrapolation formula rather than any independent knowledge. On the other hand, although the national account data also have measurement problems, it is likely to be better since it went through less human manipulation. (2) The main advantage of using Summers-Heston data is for cross- country comparison of the levels of the variables, because all the variables are measured in a single "international price". But for calculating each country's growth rates, there is no apparent advantage of using "international price". (3) many researchers have noted the poor quality of Summers-Heston data. For example, Fischer (1993) find that some estimate results are more plausible based

[5]See Hsiao (1986) for the details of the variable-intercept method in panel regression.

on growth rates computed from World Bank income data than on that from the Summers-Heston data. Blomstrom et al (1992) also express their doubts about the quality of the data.

In this study, the income growth rates and population growth rates are calculated from World Bank data. Values of import commodities are from UN's International Statistical Yearbook. However, for some variables in our study, Summers and Heston data set has to be used, since it is the only source we can find information on these particular variables. For the definitions of all variables and data sources please see Appendix 1. The data do not include OECD countries, since many development economists argue that the development process in developing countries are different from that of developed countries. We also exclude major oil producers from our sample (as defined by World Bank in World Development Report). Countries with a population less than 1 million in early 1980s are excluded from the sample because the determination of their real income may be dominated by idiosyncratic factors.

The data include annual variables and cover the period of 1965-1988. The panel data allow us to conduct tests based on variable-intercept models, which can control the unobserved country-specific effects. We measure S_f as the share of current foreign capital goods import in current GDP. The data on foreign capital imports are calculated from the International Trade Statistics.[6] S_h is calculated as the difference between the share of current total investment in current GDP minus S_f. The data on current total investment share in GDP are from Summers and Heston data set. We measure $\dot{S}_f/S_f$ as changes in the share of foreign capital import in GDP, $\dot{S}_h/S_h$ the change in the share of home investment in GDP. $\dot{Y}/Y$ is real annual growth rate of GDP, and $\dot{N}/N$ is population growth rate. Table 1.1 lists mean values of $\dot{S}_f/S_f$, $\dot{S}_h/S_h$, $\dot{Y}/Y$, and $\dot{N}/N$ for all the countries in our sample. We also list the quality rating of the data by Summers and Heston according to the number of benchmark studies a country participated. This information on data quality of Summers-Heston

[6]We divide the SITC two digit level import commodity data into three main categories: capital equipment imports (including SITC commodities 71, 72, 73, part of 86, 87, and part of 9), intermediate good import (including SITC commodities 2, 3, 4, 5, 6, and part of 9), and final consumption good import (including commodities in the SITC groups 0, 1, 81-85, part of 86, 89, and part of 9).

Table 1.1: Summary Statistics of Main Variables

Country	Share of Foreign Capital Imports in GDP	Share of Home Investment in GDP	Growth Rate of GDP	Growth Rate of Population	Data Quality
Greece	0.071	0.186	0.041	0.007	a-
Portugal	0.065	0.176	0.043	0.004	a-
Israel	0.098	0.152	0.052	0.024	b
Hong Kong	0.144	0.060	0.079	0.020	b-
South Korea	0.051	0.223	0.086	0.018	b-
Kenya	0.043	0.101	0.052	0.038	c
Costa Rica	0.050	0.097	0.045	0.026	c
Domini. Rep.	0.036	0.138	0.014	0.025	c
El Salvador	0.031	0.045	0.021	0.023	c
Guatemala	0.027	0.059	0.035	0.028	c
Honduras	0.058	0.077	0.016	0.033	c
Jamaica	0.051	0.106	-0.002	0.014	c
Mexico	0.023	0.178	0.046	0.027	c
Panama	0.060	0.176	0.050	0.024	c
Argentina	0.021	0.097	0.021	0.015	c
Bolivia	0.049	0.119	0.023	0.025	c
Chile	0.038	0.089	0.024	0.017	c
Colombia	0.023	0.143	0.045	0.022	c
Ecuador	0.045	0.205	0.025	0.028	c
Paraguay	0.043	0.081	0.027	0.029	c
Peru	0.034	0.124	0.028	0.026	c
India	0.007	0.163	0.037	0.022	c
Indonesia	0.027	0.195	0.060	0.022	c
Malaysia	0.075	0.227	0.064	0.025	c
Philippines	0.025	0.171	0.042	0.027	c
Singapore	0.179	0.105	0.109	0.019	c
Turkey	0.019	0.201	0.051	0.024	c

[Please turn to next page for the rest of the list]

Note: All the variables are averages over the period 1965-1988

Table 1.1 [Continue from previous page]

Country	Share of Foreign Capital Imports in GDP	Share of Home Investment in GDP	Growth Rate of GDP	Growth Rate of Population	Data Quality
Cameroon	0.047	0.059	0.052	0.027	c-
Ivory Coast	0.063	0.044	0.049	0.040	c-
Morocco	0.034	0.060	0.043	0.025	c-
Senegal	0.045	0.028	0.021	0.026	c-
South Africa	0.084	0.192	0.008	0.022	c-
Tanzania	0.067	0.156	0.033	0.033	c-
Brazil	0.011	0.179	0.059	0.024	c-
Uruguay	0.024	0.146	0.011	0.004	c-
Pakistan	0.016	0.119	0.056	0.030	c-
Sri Lanka	0.015	0.202	0.044	0.018	c-
Thailand	0.028	0.129	0.065	0.025	c-
Egypt	0.041	0.022	0.055	0.024	d+
Ethiopia	0.023	0.023	0.024	0.026	d+
Madacascar	0.030	0.057	0.012	0.027	d+
Malawi	0.038	0.092	0.045	0.032	d+
Mali	0.035	0.035	0.038	0.022	d+
Mauritius	0.037	0.094	0.052	0.014	d+
Sierra Leon	0.017	0.001	-0.031	0.021	d+
Zambia	0.106	0.240	0.013	0.030	d+
Ghana	0.042	0.029	0.007	0.024	d
Sudan	0.026	-0.008	0.028	0.027	d
Uganda	0.112	-0.072	0.003	0.026	d
Zaire	0.063	0.030	0.001	0.029	d
Haiti	0.014	0.063	0.035	0.018	d
Nicaragua	0.031	0.146	0.009	0.030	d

Note: All the variables are averages over the period 1965-1988 data should be useful in assessing the reliability of the statistical inferences based on the data.

The number of developing countries included in our empirical study varies among different model specifications, depending on the variables included in a specification. Some countries may not have information on certain important variables so we have to exclude them from a particular equation.

1.3.3 The Result

Initial Regressions

Table 1.2 presents three different regressions of the growth rate of income on the growth rate of foreign capital import, growth rate of home investment, and growth rate of population. Before we discuss empirical findings, let's first explain the different econometric methods used in the three regressions. The first column is the result from simple OLS regression using pooled data. The second and third columns are results from panel data regressions using variable-intercepts method. The difference between the second column and the third column is that we use fixed-effects model for the regression in the second column, and use random-effects model in the third. That is, in the second column, we assume that the omitted country-specific variables (C_i) are fixed over time, while in the third column regression we treat the country-specific effects, like the error term, as random variables. Generally the two types of specifications produce quite different results.[7]

On the bottom of the third column, we provide the chi-square statistic which can be used to test whether the data favor a fixed-effect model or a random-effects one. The null hypothesis is that the true model is a random-effects model and if the computed chi-square statistic is larger than the critical value at a predetermined significance level, the null hypothesis should be rejected. From Table 1.2 we see the computed Chi-square statistic is 17.0, well exceeding the critical value for the

[7]For a detailed discussion about the difference between fixed effects and random effects models, see Hsiao 1986.

Table 1.2: Panel Data Regressions (Annual Data)

Dependent variable: annual growth rate of income			
	(1)	(2)	(3)
Method of Est.	Pooled OLS	Fixed-effects	Random-effects
Countries:	53	53	53
Observations:	989	989	989
$\dot{S}_f/S_f$	0.059 (0.007)	0.051 (0.006)	0.053 (0.006)
$\dot{S}_h/S_h$	0.012 (0.004)	0.013 (0.004)	0.013 (0.004)
$\dot{N}/N$	0.421 (0.169)	0.529 (0.311)	0.430 (0.240)
C	0.033 (0.004)		0.032 (0.006)
R^2	0.090	0.088	0.085
$\bar{R}^2$	0.087	0.034	0.031
Test of Restrictions:		$F(52,933) = 4.33$	$\chi^2(3) = 17.00$

Note: Standard errors are in parenthesis.

1 percent significance level at 3 degrees of freedom, which is 11.34. Thus we should reject the random-effects specification in the third column and accept the fixed-effects model in the second column. At the bottom of the second column, we also provide the F-statistic for testing the hypothesis that the intercepts for different countries are different (i.e., the pooled OLS model is mis-specified). The computed F value is 4.33, which is much larger than the 1 percent critical value. This indicates that the pooled OLS regression, which is based on the M-R-W's assumption, is indeed mis-specified. We should reject the result in column one and accept the result from the second column. However, if we look at the estimated coefficients across Table 1.2, we find that, apart from econometric theory, the results from all the three different regression are very similar. That, is to say, the pooled regression produces results similar to the panel data regression.

Now we look at the estimated coefficients. Both estimated coefficients on foreign capital import and home investment are positive and statistically very significant. Furthermore, the estimated coefficient on foreign capital import is indeed much higher than the one domestic capital investment, as is predicted by our model. Thus the empirical data from 53 countries shows that the growth rate of foreign capital imports has a strong and positive impact on the growth rate of income. The estimated coefficient on the population growth rate is positive but not statistically significant in the fixed-effects model (the second column of Table 1.2), which is the favored model.

Thus, although the results from Table 1.2 produce the right signs for the coefficients on the investment of foreign capital equipment and that of home capital, there are several problems. First, as mentioned above, the estimated coefficient on population growth turns out to be insignificant. Second, the magnitudes of the estimated coefficients on the three variables $(\dot{S}_f/S_f, \dot{S}_h/S_h, and \dot{N}/N)$ are too small. The implied α and β, which are the relative shares of home capital and imported capital in production, are smaller than 0.02 and 0.06 respectively. And the estimated coefficient on population growth is also much smaller than 1, as the model predicted. The third problem is that the independent variables in all three regressions only explain very little of the variation of the dependent variable, as indicated by the extremely low

$\bar{R}^2$s.[8]

Omitted Variable Problem

We suspect that the above problems may arise from many omitted variables. As mentioned in last section, our model specification are based on many strong neoclassical assumptions that are not true in the real world. In reality, the economic development process in developing countries is affected not onlv by factors of production, but also by many social, institutional factors. These omitted variables many cause biased estimates in our model.

Thus, in Table 1.3, we present the regression results with more exogenous variables included in the model. The new variables introduced into the regressions are: annual inflation rate (INFLAT), black market foreign exchange rate premium (EXCHPREM), changes in the terms of trade (TOT), primary school enrollment rate in the population (SCHOOL), growth rate of export (EXPORT).

All these variables are widely used by other economists in growth empirical studies. Fischer (1993) has argued that the inflation rate is a good measure of long-run economic growth rate, because it is the best indicator of the overall ability of the government to manage and stabilize the economy. If macroeconomic stability is good for growth, then high inflation rate tends to lower growth rate. Levine and Renelt (1992) show that high growth countries are also lower inflation countries, and have lower black market exchange rate premium. The negative impacts of adverse terms of trade shocks on developing countries' economic growth have been a widely accepted fact. The inclusion of the SCHOOL variable is introduced first by M-R-W (1992), and has become a standard variable in growth study ever since. Many studies have also found the positive relationship between the growth rate of export and economic growth.

Now we look at the results in Table 1.3. It once again contains three regressions. The first one is the simple OLS regression, and the last two are panel data regressions.

[8]Please note that the smaller $\bar{R}^2$s in the variable-intercept models are due to the fact that a large number of constants are included in these models.

Table 1.3: Panel Data Regressions (Annual Data) With Added Variables

Dependent variable: annual growth rate of income

Method of Est.	(4) Pooled OLS	(5) Fixed-effects	(6) Random-effects
$\dot{S}_f/S_f$	0.058	0.058	0.058
	(0.007)	(0.007)	(0.007)
$\dot{S}_f/S_f(t-1)$	0.024	0.023	0.024
	(0.007)	(0.007)	(0.007)
$\dot{S}_f/S_f(t-2)$	0.017	0.016	0.016
	(0.007)	(0.007)	(0.007)
$\dot{S}_f/S_f(t-3)$	0.011	0.007	0.010
	(0.007)	(0.007)	(0.007)
$\dot{S}_h/S_f$	0.017	0.016	0.016
	(0.004)	(0.004)	(0.004)
$\dot{N}/N$	0.901	1.170	0.908
	(0.2176)	(0.510)	(0.271)
INFLAT	-0.023	-0.023	-0.024
	(0.005)	(0.006)	(0.005)
EXCHPREM	-0.022	-0.010	-0.014
	(0.005)	(0.004)	(0.004)
TOT	0.030	0.028	0.030
	(0.011)	(0.011)	(0.011)
SCHOOL	0.00008	-0.00027	-0.00004
	(0.00008)	(0.0002)	(0.0001)
EXPORT	0.056	0.045	0.051
	(0.009)	(0.009)	(0.009)
DEASIA	0.005		0.006
	(0.006)		(0.008)
DSASIA	0.0006		0.0005
	(0.007)		(0.010)
DLATIN	-0.0097		-0.009
	(0.0052)		(0.007)
DSAFRIC	-0.017		-0.018
	(0.006)		(0.008)
C	0.025		0.028
	(0.010)		(0.013)
R^2	0.325	0.262	0.286
$\bar{R}^2$	0.310	0.192	0.218
Countries:	44	44	44
Observations:	772	772	772
Test of Restrictions:		$F(43,614) = 1.96$	$\chi^2(16) = 28.37$

Note: Standard errors are in parenthesis.

Notice that the sample size of regressions in Table 1.3 are smaller than these in Table 1.2. Nine countries which were in the Table 1.2 sample do not have information on some of the new variables, so they are excluded in Table 1.3 regressions.

The F and chi-square statistics are shown at the bottom of the table. The F-test once again rejects the pooled OLS regression in favor of variable-intercept models. The chi-square statistic again rejects random-effects model, in favor of fixed-effects model.

Results in Table 1.3 show several improvements over the regressions in Table 1.2. First, after introducing new explanatory variables, both R^2 and $\bar{R}^2$ are indeed much higher than the corresponding regressions excluding new variables. Second, the estimated coefficients on population growth ($\dot{N}/N$) are very significant and close to 1 in magnitude in all three regressions. The estimated coefficients on the other key variables — foreign capital imports and home investment — are again positive and very significant, and are larger than those in Table 1.2 in magnitude.

All the newly added variables except the SCHOOL variable have the expected signs and are statistically significant. The SCHOOL variable is a proxy for human capital, which should be positively contributing to growth. But in Table 1.3, the SCHOOL variable is either insignificant (first column), or have wrong signs (in the second and third columns). One possible reason for this result is that primary-school enrollment rate in a country is not a good proxy for the measurement of human capital.

We also include several lagged foreign capital imports as exogenous variables in the Table 1.3 regressions. The estimated coefficients for these lagged foreign capital imports provide a very interesting result. They show that the current year change in foreign capital import has the strongest positive impact on the income growth, and the impacts become weaker as one goes back further. This can also serve as a test on the causal relationship between income growth and foreign capital imports. Since both one-year and two-year lagged foreign capital investment have positive impacts on income growth, the causal relationship is likely to be from the former to the latter, rather than the other way around.

Finally, notice that we have also included regional dummy variables for different regions in the equation (East Asia, South Asia, Latin America, and Sub-Saharan Africa).[9] The countries in the base group are non-OECD European countries (Greece, Portugal, Turkey), North African countries (Egypt, Morocco), and South Africa and Israel. Table 1.3 shows that only the coefficient for Sub-Saharan Region are significantly negative.

Annual Data vs. Longer Time Span

Although Table 1.3 results show a significant improvement compared to those in Table 1.2, there remains the problem that the estimated coefficients on the growth rate of foreign capital imports and on that of home capital investment are too small in magnitude. Furthermore, the reported R^2 are still not very high relative to other similar studies (for example, see Levin and Renelt 1992).

We suspect that the problem may arise from our using of the annual data, which contain too many noises and short term disturbances which do not reflect long-run trend. One way to smooth out these short term disturbances is to use longer time span. We thus divide the total period of 1965-88 into several 5-year time intervals. More specifically, we will have four observations for each country, i.e., 1970, 1975, 1980, and 1985. When $t = 1985, t-1$ is 1980. All the growth rates variables are averages over the five year time span. This set-up would also reduce the serial correlation between the μ_{it}'s, and they would also be less affected by business cycle fluctuations than they were in the annual data set-up, because now the μ_{it}'s are five years apart.

We show the regression results using 5-year time interval data in Table 1.4. By comparing Table 1.4 with table 1.2, it is apparent that regressions with 5-year time interval produce much better estimations. Both the R^2's and $\bar{R}^2$'s are much higher in Table 1.4. That is to say, when the data are in 5 year interval, the three exogenous variable can better explain the variations in the growth rate of GDP.

We focus our attention on regression No.8, the fixed effects panel regression.. The

[9]The fixed-effects model does not provide estimates for regional dummies because the fixed individual country-specific intercepts have already accounted for these individual country effects.

Table 1.4: Panel Data Regressions (5-Year Time Interval)

Dependent variable: 5-year average growth rate of income

	(7)	(8)	(9)
Method of Est.	Pooled OLS	Fixed-effects	Random-effects
$\dot{S}_f/S_f$	0.128 (0.018)	0.129 (0.018)	0.127 (0.017)
$\dot{S}_h/S_h$	0.024 (0.019)	0.013 (0.021)	0.023 (0.019)
$\dot{N}/N$	1.200 (0.245)	1.444 (0.554)	1.223 (0.267)
East Asia	0.009 (0.007)		0.010 (0.008)
South Asia	-0.004 (0.008)		-0.003 (0.009)
Latin America	-0.018 (0.005)		-0.018 (0.006)
South Africa	-0.026 (0.006)		-0.026 (0.007)
C	0.027 (0.006)		0.026 (0.007)
R^2	0.446	0.385	0.428
$\bar{R}^2$	0.422	0.057	0.123
Countries:	51	51	51
Observations:	165	165	165
Test of Restrictions:		$F(50,107) = 1.38$	$\chi^2(7) = 1.136$

Note: Standard errors are in parenthesis.

Table 1.5: Random-Effects Panel Data Regressions (5-Year Time Interval)

Dependent variable: 5-year average growth rate of income

	(10)	(11)	(12)	(13)	(14)
$\dot{S}_f/S_f$	0.115	0.106	0.110	0.091	0.115
	(0.016)	(0.021)	(0.017)	(0.021)	(0.020)
$\dot{S}_h/S_h$	0.003	0.001	0.037	0.023	0.025
	(0.019)	(0.019)	(0.019)	(0.020)	(0.018)
$\dot{N}/N$	0.679	0.629	0.958	0.534	0.528
	(0.274)	(0.348)	(0.307)	(1.775)	(0.337)
INFLAT	-0.034	-0.031		-0.031	0.033
	(0.007)	(0.008)		(0.008)	(0.007)
EXCHPREM	-0.022	-0.024		-0.017	-0.014
	(0.006)	(0.006)		(0.006)	(0.006)
TOT	0.040			0.027	0.001
	(0.037)			(0.036)	(0.037)
F.CONSUM		0.013		0.013	0.014
		(0.021)		(0.021)	(0.019)
GDP$(t-1)$		-0.000002	-0.00001	-0.000004	-0.000003
		(0.000002)	(0.000009)	(0.000003)	0.000003
SCHOOL			-0.0001	-0.00015	-0.00019
			(0.0001)	(0.00011)	(0.00013)
EXPORT			0.133	0.117	0.091
			(0.027)	(0.027)	(0.024)
$\dot{S}_f/S_f(t-1)$					0.062
					(0.020)
R^2	0.487	0.495	0.415	0.570	0.626
$\bar{R}^2$	0.191	0.188	0.114	0.281	0.229
Countries:	44	42	48	42	39
Observations:	135	128	157	128	96
Test of Restrictions:	$\chi^2(6)$ =4.27	$\chi^2(7)$ =10.69	$\chi^2(6)$ =22.21	$\chi^2(10)$ =20.78	$\chi^2(11)$ =3.31

Note: Standard errors are in parenthesis.

Table 1.6: Pooled OLS Regressions (5-Year Time Interval)

Dependent variable: 5-year average growth rate of income

	(15)	(16)	(17)	(18)	(19)
$\dot{S}_f/S_f$	0.137	0.135	0.126	0.113	0.145
	(0.018)	(0.020)	(0.019)	(0.017)	(0.021)
$\dot{S}_h/S_h$	0.047	0.032	0.050	0.039	0.028
	(0.029)	(0.020)	(0.019)	(0.017)	(0.016)
$\dot{N}/N$	0.717	0.805	1.076	0.948	.998
	(0.250)	(0.265)	(0.282)	(0.287)	(0.338)
INFLAT	-0.027	-0.031		-0.025	-0.022
	(0.009)	(0.010)		(0.009)	(0.009)
EXCHPREM	-0.028	-0.028		-0.014	-0.014
	(0.008)	(0.009)		(0.009)	(0.010)
TOT	-0.013			-0.0003	-0.018
	(0.044)			(0.039)	(0.050)
F.CONSUM		0.019		-0.0003	-0.036
		(0.018)		(0.016)	(0.020)
GDP$(t-1)$		0.000002	-0.000002	-0.000006	- 0.000004
		(0.000002)	(0.000002)	(0.000002)	(0.000003)
SCHOOL			0.0002	-0.0002	-0.00009
			(0.00009)	(0.00010)	(0.0001)
EXPORT			0.150	0.124	0.146
			(0.028)	(0.027)	(0.038)
$\dot{S}_f/S_f(t-1)$					0.054
					(0.024)
East Asia				0.0016	-0.0003
				(0.0067)	(0.007)
South Asia				-0.0027	-0.010
				(0.0076)	(0.008)
Latin America				-0.0022	-0.012
				(0.0057)	(0.006)
South Africa				-0.0149	-0.022
				(0.0067)	(0.007)
C	0.036	0.033	-0.0056	0.022	0.026
	(0.007)	(0.009)	(0.011)	(0.013)	(0.015)
R^2	0.582	0.579	0.563	0.744	0.842
$\bar{R}^2$	0.557	0.550	0.540	0.703	0.793
Countries:	42	44	46	40	37
Observations:	106	112	119	101	65

Note: Standard errors are in parenthesis.

estimated coefficient on foreign capital imports is 0.147 in value and is statistically very significant (with the value of t-statistics larger than regression No. 9). It means that a one percentage point increase in the change of foreign capital imports is associated with a 0.15 percentage point increase in the growth rate of GDP. The estimated coefficient on home investment is also very significant but is about one third of the magnitude of the coefficient on foreign capital imports. This result shows that investment using foreign capital goods is a much more effective in generating economic growth than using home capital goods. We consider this result as a strong evidence supporting our model of "growth through borrowing foreign technology." Furthermore, the estimated coefficients on the population growth rate is 1.2, considering our data quality, this is close enough to 1, which is suggested by our model.

Table 1.5 shows the fixed-effect panel data regressions using 5-year time interval data with different groups of added explanatory variables. These regressions are comparable to regression No. 8 in Table 1.4. Again, all the estimated coefficients on foreign capital imports are positive and significant. This result strongly support our model prediction that foreign technology transfer is one of the most important factors in explaining the different economic growth rates among developing countries.

For comparison, in Table 1.6, we present the pooled OLS regressions with the same exogenous variables as in Table 1.5. One can see that the results in Table 1.6 are very similar in those in Table 1.5. Thus we have demonstrated that for practical purpose, pooled regression produces results similar to results from panel regressions.

In summary, several conclusions can be drawn from the results of our empirical tests. First, our empirical tests confirm our theoretical model prediction that foreign technology transfer have a positive impact on income growth rate in developing countries. All the results confirm the hypothesis that foreign technology import is a key element in explaining the differences in the growth rates of income among developing countries. The economic development process in developing countries is different from that in developed countries. More specifically, the increases of productivity in developing countries do not rely on innovation but on importing foreign plant and equipment and on borrowing foreign technology. Second, although econometric theory shows that M-R-W's OLS assumption would produce biased result, for all practical purpose, OLS regression results are as good as panel regression results. However, one thing to note is that in all our regressions, the F-tests demonstrate that although the heterogeneous intercept and homogeneous slopes specification is a better model than the simple OLS, it should be rejected in favor of models allow for heterogenourity for intercept and slopes. That is, the data call for individual country regressions. However, in this study, we do not have enough observations for each country to allow individual country regressions. This should be a direction to go for future studies on the relationship between income growth and foreign technology imports.

1.4 Conclusion

Many development economists have long argued that foreign technology imports is the most important factor in explaining different economic growth rates of developing countries. However, there are neither any existing growth models explicitly studying the role of foreign technology imports in economic development process, nor any systematic empirical studies to verify the above observations. In this paper, we have first developed a model that is appropriate for studying developing countries growth issues. Two features distinguish this model from other growth models. First, we explicitly assume that foreign capital imports a factor of production. Second, we build a direct linkage between foreign technological imports and the productivity increase in developing countries into the model by assume that the rate of technological growth is a positive function of foreign capital imports. we formally show that a developing country's economic growth rate increases as foreign technology imports increase.

In the second part of the paper, we conducted empirical tests on the model predictions. Using the panel data for a sample of more than 50 developing countries and variable-intercept panel regression methods, we are able to show that there is indeed a strong positive statistical relationship between a country's foreign capital imports and long-run economic growth.

Appendix Definitions and Sources of Variables

$\dot{Y}/Y$: Average annual growth rate of GDP. Source: World Tables, World Bank, 1992.

$\dot{S}_f/S_f$: Average annual change of the share of foreign capital import in GDP. This variable is calculated based on data from two sources: data on the dollar value of foreign capital are from United Nations' International Trade Statistical Yearbook; and the share of total import in GDP is from Summers and Heston (1991).

$\dot{S}_h/S_h$: Average annual change of the share of home investment in GDP. This is calculated as the log difference of share of home investment in GDP, and the share of home investment in GDP in turn in calculated by subtracting S_f from the share of total investment in GDP. The latter is from Summers and Heston data set.

$\dot{N}/N$: Average annual growth rate of population. Source: Summers and Heston data set.

INFLAT: Average annual inflation rate, computed as the log-difference of CPI. Source: *International Financial Statistics*, CD-ROM, June, 1993. GDP deflator data from the World Bank were used to extend inflation series for Malawi.

EXCPREM: Average black market exchange rate premium. Source: World Bank, *World Development Report*, 1991. [Computer file].

TOT: Change in terms of trade, calculated as the log difference of the net terms of trade in a time period. Sources: World Bank, World Development Report, 1991 dataset.

F.CONSUM: Annual average change in the share of foreign consumption import in GDP. Sources: UN's International Trade Statistical Yearbook, and Summers and Heston.

GDP(t-1): Real GDP 5 years before current 5-year period. This variable is used here as an substitution for the initial GDP level in Mankiw's single period regression model. Source: Summers and Heston (1991).

SCHOOL: Primary school enrollment as percentages of age group. Source: same as above.

EXPORT: Average annual growth rate of export, weighted by the share of export in GDP. Source: Summers and Heston.

References

[1] Amsden, Alice, 1989, *Asia's Next Giant: South Korea and Late Industrialization.* Oxford University Press.

[2] Arrow, K.J. 1962. "The Economics Implication of Learning by Doing." *Review of Economic Studies*, 29 (June). pp. 155-173.

[3] Barro, R. 1991. "Economic Growth in a cross section of countries." *Quarterly Journal of Economics.* May.

[4] Blomstrom, Magnus, Robert E. Lipsey, and Mario Carlos Zejan. 1992. "What explains developing country growth?" NBER working paper no. 4132.

[5] Bochove, Conelis A. van., 1982, *Imports and Economic Growth.* The Hague: Marinus Nijhoff Publishers.

[6] Devarajan, Shanta and Heng-fu Zou, 1993, "Export, Foreign Technology Imports, and Long-run Growth", mimeo, Policy Research Department, The World Bank.

[7] Esfahani, Hadi S. 1991. "Exports, Imports, and Economics Growth in Semi-industrialized Countries," Journal of Development Economics, 35(1), pp. 93-116.

[8] Fischer, Stanley. 1993. "The role of macroeconomic factors in growth." unpublished paper, Department of Economics, MIT.

[9] Grossman, G. M., and Helpman, E. 1991. *Innovation and Growth in the Global Economy.* Cambridge, MA: MIT Press.

[10] Hsiao, Cheng. 1986. *Analysis of Panel Data.* Cambridge University Press.

[11] Islam, Nazrul, 1992, "Growth Empirics: A Panel Data Approach " unpublished paper, Department of Economics, Harvard University.

[12] Jones, L. and R. Manuelli, 1990. "A Convex Model of Equilibrium Growth." *Journal of Political Economy*, October.

[13] Kaldor, N. 1967. *Strategic Factors in Economic Development.* Ithaca, NY: Cornell University Press.

[14] ________. 1978. "Causes of the Slow Rate of Growth in U.K." *Essays in Economic Theory.* London: Duchworth.

[15] King, R. and Rebelo, S. 1990, "Public Policy and Economic Growth." *Journal of Political Economy*, October.

[16] Levine, Ross, and Renelt David, 1992, "A Sensitivity Analysis of Cross-Country Growth Regressions," *The American Economic Review*, 82:942-63.

[17] Lucas, R.E., Jr. 1988. "On the Mechanics of Economic Development." *Journal of Monetary Economics.* No. 22, pp. 3-42.

[18] Mankiw, G., D. Romer, & D. Weil, 1991." A Contribution to the Empirics of Economic Growth." *Quarterly Journal of Economics.*

[19] Romer, P. 1986. "Increasing Returns and Long-Run Growth." *Journal of Political. Economy.* 94. pp. 1002-1037.

[20] Solow, R. 1956. "A contribution to the theory of economic growth." *The Quarterly Journal of Economics*, 70 (February): 65-94.

[21] _______ 1957. "Technical Change and The Aggregate Production Function." *The Review of Economics and Statistics* 39, pp. 312-320.

[22] ______ 1970. *Growth Theory: An Exposition.* New York And Oxford: Oxford University Press.

[23] Summers, Robert, and Alan Heston, 1991, "The Penn World Table (Mark 5): an Expanded Set of International Comparisons, 1950-1988," *The Quarterly Journal of Economics*, May 1991, pp. 327-68.

[24] United Nations Conference on Trade and Development, *Handbook of International Trade and Development Statistics*, NY: United Nations Publication. Various years.

[25] United Nations, International Trade Statistical Yearbook. 1992. United Nations Statistical Office.

[26] Uzawa, H. 1965. "Optimum Technological Change in an Aggregative Model of Economic Growth." *International Economic Review* 6 (January). pp. 18-31.

[27] The World Bank, *World Development Report*, various years.

[28] The World Bank, International Economics Dept. 1990, *World Tables of Economic and Social Indicators, 1950-1988*, Computer file. Ann Arbor, MI: Inter-university Consortium for Political and Social Research (distributor), 1990.

[29] Zou, Heng-fu, "Product Innovation, Capital Accumulation and Endogenous Growth." mimeo, Policy Research Department, The World Bank, 1993.

Chapter 2

Different Sectors of Exports and Economic Growth

2.1 Introduction

The different effects of manufacturing export and primary export on economic growth have long been observed in the development economics literature. There is a general belief that, in developing countries, policies aimed at promoting industrial exports tend to bring rapid economic growth, while relying on primary exports leads to stagnation.

Three theories have been advanced in support of this view. The first is that the forward and backward linkages are inherently low for primary goods export production relative to manufacturing exports. For example, Hirschman (1958, pp. 109-110) stated that "agriculture certainly stands convicted on the count of its lack of direct stimulus to the setting up of new activities through its linkage effects; the superiority of manufacturing in this respect is crushing." Seers (1964) also observed the low linkage effects of the petroleum industry in small countries, while Baldwin (1966) fined the low linkages of copper mining in Northern Rhodesia (now Zambia). The second theory is that the world demand for primary exports is both price and income inelastic, and grows very slowly. Therefore, attempts to increase primary exports would only result in lower export prices and a transfer of income from developing countries to developed ones (Nurkse 1961, Prebish 1962, Myrdal 1957). This theory is captured in a North-South trade model developed by Taylor (1991), in which the South (the developing region) is assumed to specialize in production of a primary good for which the market is perfectly competitive, while the North is assumed to specialize in an industrial good for which the market is not perfectly competitive (markup pricing). When the South expands its primary export, due to improved labor productivity or some other reasons, the price of primary good in the world market will decrease and the South may end up being hurt by its own export increase. On the other hand, the demand for industrial goods is both price and income elastic. An increase in industrial product export will benefit the North. The model also suggests that the main reason for the rapid economic growth of the NIC's (Newly Industrialized Countries) is that they have learned to produce and export industrial products. The policy implication of the model is that policies focusing on promoting manufacturing exports will have a positive impact on economic growth while those focusing on primary exports expansion may hurt the economy. The third theory is that reliance on primary exports impedes industrialization process, and inhibits the accumulation of technical skills and the growth of factor productivity in developing countries.

These observations and theories, however, have never been empirically tested. Most empirical researches on the relationship between exports and economic growth generally treat export as one single sector, which amount to assuming implicitly that all types of exports have exactly the same impact on economic growth[1].

In this chapter we focus on the relationship between exports and economic growth, explicitly treating different sectors of exports separately. We test the following hypothesis: in developing countries, manufacturing export always generates a higher positive impact on output growth than primary export. we first derive a theoretical framework based on production function modeling of traded and non-traded sectors. Based on this framework, we use a data set of 53 developing countries to empirically

[1]Edwards (1993) provides a good review of the empirical literature on the relationship between export and growth.

study the effects of the two sectors of exports on GDP growth. Sensitivity analysis proposed by Leamer (1985) are conducted to assess the robustness of the empirical results.

The main finding from this chapter is that promoting manufacturing exports is not always a better strategy than relying on primary goods exports for developing countries. Contrary to the prevailing belief of the superiority of manufacturing exports over primary exports, our empirical results show that the growth of primary exports had a much larger positive effect on GDP growth than the manufacturing export growth until the beginning of 1980s. A one percent increase in the growth rate of primary export sector would bring about 1.5 percent increase in the growth rate of GDP, while the impact of the manufacturing export growth on the GDP growth was much smaller. Only after 1980, the manufacturing export has been inserting a greater effect on economic growth than primary export. Thus, one can not say *a priori* which export sector is superior over the other in promoting economic growth. World market conditions are very important in determining the relationships between the two sectors of exports and GDP growth.

There are five sections in this chapter. Section 1 presents the theoretical framework and the model specifications. Section 2 reports the basic results from regressions. Section 3 discusses various interpretations of the empirical results. Section 4 tests the robustness of the findings. Section 5 concludes.

2.2 A Three-Sector Production Function Model

The three-sector model outlined in this section is an extension of the two-sector production function model developed by Feder (1983). The basic idea of this model is that exports contribute to aggregate output in two fundamental ways: first, the export sector generates positive externalities on non-export sector, through more efficient management techniques and improved production technology. Second, the factor productivity in the export sectors are higher than those in non-export sector, due to, among other things, a more competitive environment in which exports operate.

Thus, a shift of resources from non-export sector to export sector will have a positive net effect on aggregate output.

Assume the economy consists of three distinctive sectors: one producing manufacturing export goods (M), the second producing primary export goods (P), and the third producing non-traded goods (N).

$$N = F(K^n, L^n, M, P), \tag{2.1}$$

$$M = G(K^m, L^m), \tag{2.2}$$

$$P = H(K^p, L^p), \tag{2.3}$$

where

K^n, K^m, K^P=capital stocks in respective sectors,

L^n, L^m, L^p=labor forces in respective sectors.

The justification for including the export sectors as inputs in the non-traded sector is that the export sectors generate beneficial effects on the rest of the economy, such as the demonstration effect of efficient and internationally competitive management, the introduction of improved production techniques, training of higher quality labor, steadier flow of imported inputs, etc. These beneficial effects can be viewed as externalities, since they are not reflected in market prices.

The resource constraints are given by:

$$K = K^n + K^m + K^p, \tag{2.4}$$

$$L = L^n + L^m + L^p. \tag{2.5}$$

Aggregate GDP (Y) is the sum of outputs in the three sectors N, M, and P:

$$Y = N + M + P. \tag{2.6}$$

We assume that the factor productivity in the manufacturing exporting sector differ from the non-traded sector by a factor δ, i.e.,

$$G_k = (1+\delta)F_k, \qquad G_\ell = (1+\delta)F_\ell \tag{2.7}$$

where the subscripts denote partial derivatives.

Similarly, the factor productivity in the primary exporting sector differ from that in the non-traded sector by a factor θ:

$$H_k = (1+\theta)F_k, \qquad H_\ell = (1+\theta)F_\ell \tag{2.8}$$

The signs of δ and θ indicate which sector has higher marginal factor productivity. For example, positive δ and θ imply higher factor productivity in the two export sectors relative to the non-export sector. Furthermore, if $\delta > \theta$, then the manufacturing export sector has higher factor productivity than the primary export sector.

Now differentiate equations (1)–(3) to get

$$\dot{N} = F_k\dot{K}^n + F_\ell\dot{L}^n + F_m\dot{M} + F_P\dot{P}, \tag{2.9}$$

$$\dot{M} = G_k\dot{K}^m + G_\ell\dot{L}^m, \tag{2.10}$$

$$\dot{P} = H_k\dot{K}^p + H_\ell\dot{L}^p, \tag{2.11}$$

where a dot over the variable indicates its time derivative. Thus, $\dot{K}^n, \dot{K}^m$, and $\dot{K}^p$ are gross investments in the three sectors respectively, $\dot{L}^n$, $\dot{L}^m$, and $\dot{L}^p$ are sectoral changes in labor force. F_m and F_p are the marginal externality effects of the two export sectors on the output of non-exports.

Using eqs. (7)-(11) in equation (6) yields

$$\begin{aligned}
\dot{Y} &= F_k\dot{K}^n + F_\ell\dot{L}^n + F_m\dot{M} + F_P\dot{P} + (1+\delta)F_k\dot{K}^m + (1+\delta)F_\ell\dot{L}^m \\
&\quad +(1+\theta)F_k\dot{K}^p + (1+\theta)F_\ell\dot{L}^p \\
&= F_k(\dot{K}^n + \dot{K}^m + \dot{K}^p) + F_\ell(\dot{L}^n + \dot{L}^m + \dot{L}^p) + \delta(F_k\dot{K}^m + F_\ell\dot{L}^M) \\
&\quad +\theta(F_k\dot{K}^p + F_\ell\dot{L}^p) + F_m\dot{M} + F_p\dot{P}.
\end{aligned} \tag{2.12}$$

Recall that eqs. (7) and (10) imply

$$F_K\dot{K}^m + F_\ell\dot{L}^m = \frac{1}{1+\delta}(G_k\dot{K}^m + G_\ell\dot{L}^m) = \frac{\dot{M}}{1+\delta} \tag{2.13}$$

and similarly, equations (8) and (11) imply

$$F_K\dot{K}^p + F_\ell\dot{P}_m = \frac{1}{1+\theta}(H_k\dot{K}^p + H_\ell\dot{L}^p) = \frac{\dot{P}}{1+\theta} \tag{2.14}$$

Using (4), (5), (13) and (14) in equation (12) yields

$$\dot{Y} = F_k\dot{K} + F_\ell\dot{L} + (F_m + \frac{\delta}{1+\delta})\dot{M} + (F_p + \frac{\theta}{1+\theta})\dot{P}. \tag{2.15}$$

Dividing both sides of equation (2.15) by Y yields

$$\begin{aligned}\dot{Y}/Y &= F_k(\dot{K}/Y) + F_\ell(\dot{L}/Y) + (F_m + \frac{\delta}{1+\delta})(\dot{M}/M)(M/Y) \\ &+(F_p + \frac{\theta}{1+\theta})(\dot{P}/P)(P/Y). \end{aligned} \tag{2.16}$$

Following Bruno (1968), we assume that a linear relationship exists between the real marginal productivity of capital and labor in a given sector and average output per unit of capital and per laborer in the economy, i.e.,

$$F_k = \alpha(Y/K), \qquad F_\ell = \beta(Y/L).$$

And let

$$\gamma_1 = F_m + \frac{\delta}{1+\delta}, \qquad \gamma_2 = F_p + \frac{\theta}{1+\theta} \tag{2.17}$$

then equation (2.16) becomes

$$\dot{Y}/Y = \alpha(\dot{K}/K) + \beta(\dot{L}/L) + \gamma_1(\dot{M}/M)(M/Y) + \gamma_2(\dot{P}/P)(P/Y). \tag{2.18}$$

The left side of the equation (2.18) is the growth rate of GDP. The first two terms in the right-hand-side are the growth rates of labor and capital, respectively. The third and fourth terms on the right side of the equation are growth rate of manufacturing exports and that of primary exports, respectively, weighted by the sector's share in GDP. The weighted rates of export growth make intuitive sense, because they properly discount the influence of growth in the sectors with small original share of GDP.

In equation (2.18), the parameters α and β are measures of the marginal productivity of capital and labor in the non-export sector. The parameters γ_1 and γ_2 measure the overall effects of the manufacturing exports and primary exports on economic growth, respectively. As shown in equation (2.17), these effects are through two channels: one is by the factor productivity difference δ and θ, and the other is the externalities generated by the export sectors on the non-export sector (F_m and F_p). Thus, equation(2.18) provides a theoretical framework that enables us to study the contributions of the two export sectors to the rate of economic growth. In what follows, we use this framework to test our hypothesis.

2.3 Primary Empirical Results

Table 1 shows a variety of regressions based on equation (2.18). In each regression, the dependent variable is the annual growth rates of real GDP. The independent variables are the annual average growth rates of capital and labor, that of manufacturing exports weighted by the share of manufacturing export in total GDP, and of primary exports weighted by its share in GDP. Note that equation (2.18) does not call for a constant term as an independent variable in the regression, i.e., according to the model, if all the four variables on the right hand side are zero, the growth rate of GDP would be zero except for some random errors. In all the regressions, we exclude the constant term.[2]

The data are from the United Nations, the World Bank, Summers and Heston (1991), and some other sources. The Summers-Heston data have been widely used in growth empirical studies. In this study, whenever possible, we always try to use direct national income account assembled and published by the UN or the World Bank. The reasons to choose national account data instead of Summers-Heston data are discussed in the previous chapter of this dissertation.

For the definitions of all variables and data sources, please see Appendix 1. The

[2]we also run regressions including the constant terms, which are not shown here. The results do not differ very much from those without constant terms.

Table 1: Basic Results

Variables	(1) 1965-88	(2) 1965-72	(3) 1973-80	(4) 1981-88	(5) 1965-80	(6) 1973-88
$\dot{K}/K$	0.366 (10.775)	0.192 (2.836)	0.481 (8.993)	0.329 (4.727)	0.320 (7.132)	0.431 (10.660)
$\dot{L}/L$	0.520 (5.406)	1.195 (4.911)	0.307 (1.880)	0.365 (2.922)	0.758 (5.139)	0.330 (3.347)
$(\frac{\dot{M}}{M})(\frac{M}{Y})$	0.949 (2.948)	1.052 (1.465)	-0.183 (0.402)	1.866 (3.922)	0.333 (0.767)	0.988 (2.938)
$(\frac{\dot{P}}{P})(\frac{P}{Y})$	1.374 (5.017)	1.557 (2.888)	1.431 (4.499)	0.463 (0.850)	1.691 (5.554)	1.080 (0.296)
$\bar{R}^2$	0.860	0.885	0.917	0.775	0.889	0.850
No. of Obs.	159	53	53	53	106	106
Sum of Squared Residuals	2.910	1.130	0.499	.861	1.827	1.533

Note: Dependent variable is $\dot{Y}/Y$. The figures in parentheses are the absolute values of t-statistics.

data do not include OECD countries, since many development economists argue that the development process in developing countries are different from that of developed countries. We also exclude major oil producers from our sample (as defined by World Bank in World Development Report). Countries with a population less than 1 million in early 1980s are excluded from the sample because the determination of their real income may be dominated by idiosyncratic factors. Thus, our sample includes 53 developing countries. A list of countries is in Appendix 2.

The data cover the period of 1965-1988, which is further divided into three subperiods: 1965-72, 1973-80, and 1981-88. Each country in the sample has three observations. Each observation corresponds to one of the three time periods. Thus our sample has a total number of 159 observations. The reason for using period average data rather than annual time-series data is that annual data on the structure of exports are not available for many of the countries in the sample.[3] I had to choose between having fewer countries with annual time-series data in the sample on one hand, and having larger number of countries but reducing the number of observations for each country (using period average data rather than annual time series data) on the other. I opted for the latter, because the loss of information from using period average data rather than annual time series data is more than compensated by having more countries in the sample.

Regression 1 is pooled cross-country regression covering all the three periods, i.e., it takes the form

$$\begin{aligned}(\dot{Y}/Y)_{tj} &= \alpha(\dot{K}/K)_{tj} + \beta(\dot{L}/L)_{tj} + \gamma_1[(\dot{M}/M)(M/Y)]_{tj} \\ &\quad + \gamma_2[(\dot{P}/P)(P/Y)]_{tj} + \varepsilon_{tj} \qquad (2.19)\end{aligned}$$

While regressions 2 – 4 are cross-country regressions for each time period with the

[3]There are two sources where data on the structure of exports are available: (1) World Bank's World Development Report (WDR), and (2) UNCTAD's Handbook of International Trade and Development (HITD). The second source has more observations than the first one. I use data from HITD.

following specification:

$$
\begin{aligned}
(\dot{Y}/Y)_{tj} &= \alpha_t(\dot{K}/K)_{tj} + \beta_t(\dot{L}/L)_{tj} + \gamma_{1t}[(\dot{M}/M)(M/Y)]_{tj} \\
&\quad + \gamma_{2t}[(\dot{P}/P)(P/Y)]_{tj} + \varepsilon_{tj} \qquad (2.20)
\end{aligned}
$$

where t denotes time, $t = 1, 2, 3$; and j denotes country, $j = 1...53$.

All the adjusted R^2s in table 1 have surprisingly high values, ranging from 0.775–0.917, which shows that our model specification fits data fairly well.

In regression 1, the estimated coefficients for $\dot{K}/K$ and $\dot{L}/L$ are both positive and very significant, suggesting that the marginal productivity of labor and capital in the non-traded sector are positive. This conforms to what people have expected. But the surprise is in the estimated coefficients for $(\dot{M}/M)(M/Y)$ and $(\dot{P}/P)(P/Y)$. Although both are positive and statistically significant at better than the 5% level, the estimated coefficient of primary exports γ_2 is much larger than that of manufacturing exports γ_1. This result indicates that the growth of primary export is more important than that of the manufacturing export for economic growth—while a one percent increase in the weighted growth rate of the manufacturing export sector brings about 0.95 percent increase in GDP growth rate, a one percent increase in the weighted growth rate of primary-goods export would bring about 1.35% increase in the growth rate of GDP. Thus, expanding the primary-goods export sector brings faster GDP growth than expanding manufacturing sector, contrary to what many development economists suggested.

However, the results from regressions 2–4 tell a totally different story. In regression 2, the estimated γ_1 is small and with a t-value of 1.465—it is not significant even at 10 percent level, while γ_2 becomes larger than that in regression 1 and is statistically significant with a t-value of 2.888. In regression 3, γ_1 becomes negative although not statistically significant while γ_2 remains large and significant with a t-value of 4.499. In period 1981-88 (regression 4), the result is exactly the opposite of the earlier periods' regressions: γ_1 is much larger than that in regression 1 and very significant, while the estimated γ_2 is small and not significantly different from zero. The story emerging from regressions 2–4 is that in the first two time periods covered by the data, expansion of primary exports generate extra positive contributions to the economic growth in developing countries, in addition to that from labor and capital increases. The manufacturing exports do not generate a higher overall growth rate. In the last time period, manufacturing export sector replaces the primary exports as the main engine of growth.

Thus, the results from the pooled regression (regression 1) and that from separate period regressions (regressions 2–4) are very different. Which one should we accept? In order to determine this, we have conducted a Chow-test to see if there are structural changes among the three time periods.

The null hypotheses are:

$$H_0^1 : X_1 = X_2, \quad H_1^1 : X_1 \neq X_2.$$
$$H_0^2 : X_2 = X_3, \quad H_1^2 : X_2 \neq X_3.$$

Where X_i are the coefficients in three periods (subscript i denotes time period). We first run two unrestricted regressions: one combining the first two periods and the other combining the last two periods. The results of these two unrestricted regressions are presented in regressions 5 and 6 in Table 1. Regressions 2–4 are the restricted ones. We use the sum of squared residuals presented in Table 1 to calculate F-statistics. The F-statistics for testing null hypothesis H_0^1 is:

$$F_1(4, 98) = 2.98$$

which is larger than the critical value 2.46 for 5 percent level, so the null hypothesis that the coefficients for the period 1965-73 are not different from the coefficients for period 1973-80 is rejected.

Similarly, the F-statistics for testing null hypothesis H_0^2 is:

$$F_2(4, 98) = 2.76$$

which is also larger than 2.46. We reject the null hypothesis that $X_2 = X_3$.

Therefore, we can reject the results from regression 1, and accept the results from regressions 2–4, which indicate that the effects of the two exports sectors on economic growth are indeed different. But contrary to the arguments presented in the beginning of this chapter, empirical evidence shows that in the two early time periods, primary exports generated a greater positive impact on the growth rate of GDP than manufacturing exports, either through higher positive externalities or higher factor productivity, or both. Only in the last time period, the result is reversed.

How do we explain this empirical finding? I can think of the following three conceivable explanations.

(1) The results suggest that there is a dynamic pattern of change in the roles of the two export sectors play in economic development. In the early stages of economic development, the primary exports play a more important role in promoting the aggregate GDP growth than the manufacturing export, while only in higher stage of economic development the growth of manufacturing export sector is more important than that of primary export.

(2) The results suggest that the impact of the two export sectors on GDP growth is determined by the world demand conditions. There is no dynamic trend of change shifting from primary export to manufacturing export. The changed pattern of the third time period from the earlier two can be explained by the changed world market conditions. The rise of protectionist policies in the developed countries since the end of 1970s can be viewed as a demand shock in the world market, which creates more difficulties in the primary export sector than manufacturing export sector.

(3) Some people may argue that the differences in the estimated coefficients of the two export sectors simply reflect the increased share of manufacturing exports in total exports. According to this interpretation, the reason that the manufacturing sector has little impact on GDP growth in the two early time periods is that the sector is simply too small to have an impact.

Which explanation is more accurate? I take up this issue in the next section.

2.4 Different stages of economic development, world market environment, or artifact?

In order to test the different interpretations, I divide the 53 developing countries into three groups according to their level of economic development, then run regressions for each group of countries for three time periods. I use per capita GDP as proxy for a country's level of economic development. Thus the low income countries are assumed to be in an early stage of their economic development, while relatively high income countries are supposed to be at a higher development stage. The idea is to check if there is a dynamic pattern of change in the two export sectors from low income group to the higher ones while holding the world market condition constant (i.e., within the same time period). The existence of such a pattern within the same period is an evidence support the first explanation.

Because any cut-off point for income levels is arbitrary, we divide the sample evenly into three income groups according to their per capita GDP (IRGDP) at the beginning of each period. Such a division serves a practical purpose: it ensures similar degrees of freedom for all regressions so that we can compare regression results across income groups. The per capita income data is taken from Summers-Heston (1991) data set. Dummy variables for countries in South America, sub-Saharan Africa, and Asia are also included in the regressions to test whether there are regional effects.

The regression results are presented in Table 2. Before getting to our main concerns, we note that (1) most estimated coefficients for regional dummies are not statistically significant; and (2) all the regressions have vary high adjusted R^2's— in most of the regressions, around 90 percent of the variation in the GDP growth rate across countries are explained by the model. Both are strong evidence that our model specification captures the variations in GDP growth rates very well.

We also note that the overall pattern of the estimated coefficients for manufacturing exports and primary exports across income groups are very similar to that in Table 1. None of the estimated coefficients for manufacturing exports in the first two periods (regressions 7–12) is significant at 5 percent significance level, while five out of

Table 2: Regressions by Income Levels*

Variables	1965-1972			1973-1980			1981-1988		
	(7) Low Income	(8) Mid. Income	(9) High Income	(10) Low Income	(11) Mid. Income	(12) High Income	(13) Low Income	(14) Mid. Income	(15) High Income
$\dot{K}/K$	0.137 (1.088)	0.567 (6.887)	0.548 (4.791)	0.265 (1.690)	0.519 (4.996)	0.598 (4.685)	0.105 (1.387)	0.428 (2.908)	0.773 (3.184)
$\dot{L}/L$	1.918 (3.480)	0.102 (0.312)	0.572 (1.585)	2.016 (1.964)	0.234 (0.571)	-0.070 (0.191)	0.899 (1.884)	0.388 (0.933)	-0.212 (0.621)
$(\frac{\dot{M}}{M})(\frac{M}{Y})$	-10.887 (1.054)	-2.131 (2.553)	0.552 (0.632)	1.894 (0.312)	-0.311 (0.476)	0.153 (0.179)	3.639 (1.931)	0.709 (2.396)	1.171 (2.590)
$(\frac{\dot{P}}{P})(\frac{P}{Y})$	3.306 (2.385)	2.450 (6.312)	0.137 (0.158)	2.012 (2.809)	1.322 (2.079)	1.602 (2.246)	0.630 (0.756)	0.649 (0.597)	0.180 (0.435)
S.AMERICA	-0.232 (1.434)	0.056 (0.952)	-0.017 (0.252)	-0.165 (0.524)	0.002 (0.039)	-0.004 (0.055)	-0.202 (1.616)	-0.109 (0.959)	-0.001 (0.030)
AFRICA	-0.187 (1.333)	-0.274 (4.057)	-0.006 (0.047)	-0.207 (1.418)	0.006 (0.114)	None	-0.043 (0.426)	-0.063 (0.571)	0.237 (2.760)
ASIA	0.031 (0.218)	0.069 (1.143)	-0.102 (0.710)	-0.118 (0.752)	0.012 (0.163)	-0.077 (0.540)	0.281 (2.214)	-0.021 (0.224)	-0.116 (0.974)
$\bar{R}^2$	0.885	0.979	0.939	0.860	0.951	0.881	0.910	0.736	0.946
No. of Obs.	18	18	17	18	18	17	18	18	17

Note: Dependent variable is $\dot{Y}/Y$. The figures in parentheses are the absolute values of t-statistics. Variables S. AMERICA, AFRICA, and ASIA are dummy variables for South American countries, sub-Saharan Countries, and Asian countries respectively. In regression (12) there is no sub-Saharan African countries in the subsample.

* The income cut-off points are:
For period 1965--72: Low income countries: IRGDP<$335; Middle income countries: $335<IRGDP<$620; High income countries: IRGDP>$520.
For period 1973--80: Low income countries: IRGDP<$493; Middle income countries: $493<IRGDP<$1150; High income countries: IRGDP>$1150.
For period 1973--80: Low income countries: IRGDP<$1050; Middle income countries: $1050<IRGDP<$2375; High income countries: IRGDP>$2375.
Please note that the figures are in U.S. dollars evaluated not according to exchanges rates, but by PPP method.

six estimated coefficients for primary exports are positive and significant—indicating that in the first two periods the growth of primary exports is very closely linked with GDP growth. The results for the 1981-88 period are exactly the opposite of those of the earlier periods. The coefficients for manufacturing exports are all positive and significant, while none of the coefficients for primary exports are significant.

Compare to the results from regressions 2–4, one also see the same pattern of change for the same group of countries moving across the three time periods. The three regressions for countries in the low income group in three periods (7, 10, 13 in Table 2) demonstrate once again a clear tendency of decreasing role for primary exports and increasing role for manufacturing exports. The estimated coefficients for manufacturing exports for the low income group are -10.887 (not significant) , 1.894 (not significant), and 3.639 (significant) for the three time periods—a change from negative to positive and insignificant to significant, while the estimated coefficients for primary exports are 3.306 (significant), 2.012 (significant), and 0.630 (not significant)—turning from large and significant to small and insignificant. However, for the group of high income developing countries, the tendency is not so clear-cut. In the regression for period 1973-80, the estimated γ_1 is too high and the estimated γ_2 is too low to fit the same pattern. A plausible explanation for this irregularity may be that the high income developing countries as a group were hit particularly hard by the 1973 oil shock (a supply shock, not a demand shock) because their manufacturing exports relied more heavily on foreign oil.

However, the results in Table 2 do not seem to support the "dynamic pattern of change" hypothesis. Comparing the three regressions within a same time period, one does not see a strong pattern of change in the two exports sectors across different levels of income. Only in the first time period, there is a clear trend of an increasing γ_1 and a decreasing γ_2 from low income group to the high ones. In the other two time periods, the pattern is simply not there.

Table 3 lists real GDP per capita of each group of countries at the beginning of each of the three time periods, measured at 1985 international dollars. It shows that the average real per capita GDP for the low income group in 1980 is much lower than these for the middle and high income groups in 1965. Recall that the estimated coefficients on manufacturing exports for middle and high income groups are insignificant for the first two periods and that for the low income group for the last period is positive and significant. It indicates that the changing impacts of the two export sectors on economic growth are not determined by a country's income level. So the first explanation is not a valid one.

Now what about the third explanation that the increasing impact of manufacturing export on GDP growth simply reflects the sector's increasing share in GDP? Table 4 clearly shows that it is not the case. Table 4 presents the shares of the two export sectors in total output for each group of countries for the three time periods. We note that the share of manufacturing export in GDP for the low income group in the last period is lower than that for the other two groups in the first two periods. It is clear that the increased positive impact of manufacturing export on GDP growth is not correlated with the sector's share in GDP. Furthermore, in the last period, the shares of primary export in GDP are very large. If the third explanation is true, then how could one explain the estimated insignificant coefficients on primary export growth rate in the regressions?

In fact, the data in Table 4 clearly shows that the changes in the estimated coefficients of the two export sectors in the last period arise more likely from some external shock common to all developing countries than from internal structure differences. Clearly, the rising protectionist tide [4] since the end of 1970s changed the world market demand conditions for exports from developing countries. However, explanations of how this demand shock influences the relationship between the two export sectors and output growth is beyond the scope of this chapter.

To sum up, the results in this section seem to indicate that there is no empirical support for assigning *a priori* superiority to one export sector over the other. World market conditions are very important in determining the outcome. Expanding primary exports could be a very effective strategy in promoting economic growth when world market is more open and favorable, while promoting manufacturing exports

[4]See Bhagwati 1988, pp 43-60.

Table 3: Group-Average GDP Per Capita, Measured in 1985 Constant Dollars

	Low Income Group	Mid. Income Group	High Income Group
1965	$648	$1362	$2877
1973	$752	$1572	$3720
1981	$804	$2071	$4481

Note: The data are calculated based on the variable RGDPCH in Summers and Heston 1991.

Table 4: Ratio of The Values of Exports to GDP

	Low Income Group		Mid. Income Group		High Income Group	
	Prim. Exp. /GDP	Manu. Exp./GDP	Prim. Exp. /GDP	Manu. Exp./GDP	Prim. Exp. /GDP	Manu. Exp./GDP
1965-72	0.110	0.007	0.104	0.013	0.148	0.040
1973-80	0.097	0.011	0.157	0.025	0.140	0.037
1981-88	0.075	0.010	0.108	0.027	0.135	0.058

Note: All the figures are period average share of an export sector in total GDP. For the sources of the data, see Appendix 1.

and "niche-seeking" is a better strategy when facing a adverse world demand shock.

2.5 Sensitivity Analysis of the Estimated Coefficients

How robust are the results from regressions in Tables 1 & 2? Are the conclusions sensitive to alterations of model specification? In this section, I address this issue.

In a sensitivity analysis of cross-country growth regressions, Levine and Renelt (1992) tested the robustness of the estimated coefficients of a vast array of variables in the literature, using a variant of Leamer's extreme-bounds analysis. They found that the cross-country statistical relationships between economic growth rates and almost every particular policy indicator considered by the profession, such as trade, fiscal, and monetary variables, are fragile. Their study raises a serious question on how reliable is any results from cross-country growth regression studies. In this section, I conduct a sensitivity analysis similar to Levine and Renelt's to test the robustness of my results from regressions 2 – 4. The purpose of the sensitivity analysis is to test how sturdy are the estimated coefficients when we change the model assumptions by introducing many new variables into the regression.

Our sensitivity analysis uses equation of the form

$$\begin{aligned}(\dot{Y}/Y)_{tij} &= \alpha_{ti}(\dot{K}/K)_{tij} + \beta_{ti}(\dot{L}/L)_{tij} + \gamma_{1,ti}[(\dot{M}/M)(M/Y)]_{tij} \\ &\quad + \gamma_{2,ti}[(\dot{P}/P)(P/Y)]_{tij} + \Gamma_z Z + \varepsilon_{tij} \qquad (2.21)\end{aligned}$$

where t and j, as before, denote time and country respectively, and i denotes income group: i=1,2,3.

Z is a set of variables chosen from a pool of variables identified by past studies as potentially important explanatory variables of growth. The sensitivity analysis involves varying the subset of Z-variables included in the regression to find the widest range of estimates for γ_{1ti} and γ_{2ti}. In particular, we compute the regression results for all possible linear combinations of Z-variables. If, in any of the regressions, the statistically significant γ's in last section become insignificant after adding the Z-variables, or vice versa, or any of the originally significant γ's changes sign, one may feel skeptical about the original results in regressions 2 – 4, because alterations in the conditioning information set change the statistical inferences that one draws regarding the relationship between the growth rate of output and that of each of the two exports sectors. In such a case, I would call the results fragile. If, however, for all possible linear combinations of Z-variables included in the regression, the estimated γ's do not change their statistical significance, i.e., they do not become statistically insignificant if they were found to be significant in previous section, or vice versa, nor does any of the significant estimates changes sign, then we can say that our results are robust.

The pool of variables from which I choose Z-variables are the average inflation rate (AVINFT), average black-market foreign exchange premium (AVEXCPM), the initial level of real GDP per capita in the beginning of each time period (IRGDP), the initial primary-school enrollment rate (PRIM), the average annual rate of population growth (POP), change of the terms of trade (TOT), an index for the number of successful coups in a country (COUPS), and an index for political democracy (DEMO). The reason for choosing these variables as the basis of the conditioning information set is that they have been used frequently by the profession in empirical studies of the determinants of economic growth.

Table 5 presents the sensitivity tests for each of the three periods for the two export variables $(\dot{M}/M)(M/Y)$ and $(\dot{P}/P)(P/Y)$. There are 12 regressions in Table 5. They are divided into three time periods. Regressions 16–19 test the robustness of regression 2 in Table 1; regressions 20–23 test the results of regression 3; and regressions 24–27 test that of regression 4. By comparing the estimated coefficients for $(\dot{M}/M)(M/Y)$ and $(\dot{P}/P)(P/Y)$ in Table 5 with that in regressions 2—4 in Table 1, one can see that none of the estimated coefficients which were not significant at 5 percent significance level in Table 1 becomes significant now. And none of the significant coefficients in Table 1 becomes insignificant, except in one case (γ_2 in regression 23 becomes insignificant at 5 percent level, but remains significant at 10 percent level). Thus, we can conclude that the results concerning the relationships

Table 5: Sensitivity Analysis

Variables	1965-1972				1973-1980				1981-1988			
	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)
$\dot{K}/K$	0.200	0.301	0.350	0.311	0.501	0.544	0.479	0.507	0.230	0.326	0.272	0.247
	(2.671)	(3.155)	(3.611)	(2.516)	(7.965)	(8.838)	(7.545)	(5.960)	(3.101)	(4.334)	(3.642)	(2.810)
$\dot{L}/L$	0.661	0.889	0.749	0.474	0.428	0.238	0.117	0.223	0.359	0.731	0.882	0.977
	(2.257)	(3.080)	(1.094)	(0.675)	(1.829)	(1.215)	(0.438)	(0.725)	(1.420)	(3.970)	(2.672)	(2.376)
$(\frac{\dot{M}}{M})(\frac{M}{Y})$	0.453	0.912	0.912	-0.106	-0.120	-0.448	0.236	-0.025	2.263	1.659	1.630	1.719
	(0.597)	(0.859)	(0.859)	(0.075)	(0.215)	(0.800)	(0.486)	(0.036)	(4.368)	(3.085)	(3.297)	(3.097)
$(\frac{\dot{P}}{P})(\frac{P}{Y})$	1.457	2.533	2.533	2.112	1.343	0.867	0.905	0.950	0.723	0.028	0.266	0.538
	(2.784)	(4.203)	(4.203)	(3.244)	(3.236)	(2.005)	(1.973)	(1.853)	(1.367)	(0.046)	(0.422)	(0.800)
AVINFT	0.133		0.500	0.428	-0.077		-0.016	-0.0003	-0.121		-0.101	-0.076
	(0.579)		(2.650)	(1.687)	(0.802)		(0.198)	(0.003)	(2.135)		(0.060)	(0.999)
AVEXCM		-0.037	-0.164	-0.223		-0.092	-0.126	-0.128		-0.101	-0.076	-0.092
		(0.386)	(1.387)	(1.600)		(1.756)	(1.863)	(1.682)		(2.465)	(1.710)	(1.939)
IRGDP	-0.00003			-0.00006	0.00002			-0.00002	-0.00003			-0.00004
	(0.396)			(0.648)	(0.550)			(0.463)	(1.740)			(1.937)
POP			0.207	0.618			0.445	0.317			-0.145	-0.269
			(0.273)	(0.716)			(1.452)	(0.827)			(0.417)	(0.702)
PRIM	0.002			0.005	-0.0004			0.0001	0.001			0.002
	(1.894)			(2.324)	(0.692)			(0.069)	(1.635)			(1.583)
TOT		0.231		0.022		-0.033		-0.026		0.116		0.046
		(2.468)		(0.204)		(0.717)		(0.505)		(1.341)		(0.477)
COUPS		0.013		-0.029		0.010		0.007		-0.010		-0.015
		(0.546)		(1.046)		(0.421)		(0.261)		(0.714)		(0.653)
DEMO1			-0.006	-0.013			-0.005	-0.005				
			(1.004)	(1.858)			(1.226)	(1.069)				
DEMO2											0.001	0.008
											(0.111)	(0.637)
No. of Obs.	47	39	36	35	51	47	46	45	51	47	49	45
$\bar{R}^2$	0.908	0.930	0.936	0.940	0.915	0.921	0.925	0.917	0.801	0.821	0.808	0.821

Note: Dependent variable is $\dot{Y}/Y$. The figures in parentheses are the absolute values of t-statistics. AVINFT is average inflation rate. AVEXCPM is average black-market foreign exchange premium. IRGDP is initial real GDP at the beginning of a period. POP is the annual population growth rate. PRIM is the primary-school enrollment rate at the beginning of each period. TOT is the log-difference of the terms of trade. COUPS is the number of successful coups in each period. DEMO1 is the index of political democracy, this data is only available for the first two periods. DEMO2 is the index of political democracy for the last period. For the sources of the data, see Appendix 1 between economic growth and the two export sectors in the three periods are robust, with the exception that the role of primary export sector on economic growth may be not as strong as what regression 3 indicates.

Incidentally, as was pointed out earlier, all the variables in the conditioning information set are the ones that have been demonstrated by the profession as having significant correlation with the growth of GDP. However, these relationships turn out to be fragile, as shown in Table 5. Among the Z-variables in Table 5, the best performing variable is the average annual inflation rate—only in two out of nine regressions is its estimated coefficient statistically significant. Only one out of nine estimated coefficients is significant for the following three variables: black market foreign exchange premium, the initial primary-school enrollment rate, and the change in terms of trade. None of the estimated coefficient for the rest of the variables (initial per capita real income, population growth rate, the number of coups in a period, and the index for political democracy) is significant. The results support the findings in Levine and Renelt's paper (1992).

2.6 Conclusions

In this chapter, we discuss the effects of manufacturing exports sector and the primary exports sector on economic growth in developing countries. We first develop a theoretical framework based on augmented production function that enables us to separate the two export sectors. Using data from 53 developing countries for the period of 1965–1988, we test the hypothesis that promoting manufacturing exports generates superior results than expanding primary exports.

The empirical results reject the hypothesis. Although we do find manufacturing export and primary export are indeed very different in terms of their impacts on economic growth, empirical evidence does not support the arguments that, comparing to primary export growth, growth of manufacturing export contributes more to GDP growth. Contrary to this theory, the growth of primary export had a greater impact on economic growth than that of manufacturing export in developing countries prior to 1980s. Only after 1980, this situation has been reversed.

Our findings indicate that there is no *a priori* superiority of one export sector over the other. Which export sector is more conducive to growth depends on a countries particular economic structure. Furthermore, world market conditions are very important in determining the relationships between the two sectors of exports and GDP growth. Expanding primary exports could be a very effective strategy in promoting economic growth when world market is more open and favorable, while promoting manufacturing exports and "niche-seeking" may be a better strategy when a country is facing a adverse world demand shock.

Appendix 1. Definitions and Sources of Variables

$\dot{K}$/K: average annual growth rate of capital stock. Source: World Bank (Nehru) data set.

$\dot{L}$/L: average annual growth rate of labor force. Source: Source: World Bank, *World Development Report*, 1991. [Computer file].

$\dot{M}$/M: average annual growth rate of manufacturing exports, calculated as follows:

$$\dot{M}/M = CEXP + CSMEXP$$

where CEXP is the average annual change in the volume of total exports, from UNCTAD data (for the countries data taken from UNCTAD, Handbook of International Trade and Development Statistics) calculated as log difference of volume of export index, and CSMEXP is change of the share of manufacturing exports in total exports in total exports, calculated as log-difference of share of manufacturing exports in total exports at the end of a period (say 1972) and that as the beginning of a period (say 1965),then divided by the number of years in the period. Data for the share of manufacturing exports are from UNCTAD, *Handbook of International Trade and Development Statistics*, NY: United Nations Publication. Various years.

M/Y: the ratio of manufacturing exports to GDP, calculated as follows:

$$M/Y = CSMEXP \times EXPGDP$$

where CSMEXP is defined as in above, and EXPGDP is the ratio of total exports in GDP, from Summers and Heston (1991).

$\dot{P}$/P: average annual growth rate of primary exports, calculated in the similar way as $\dot{M}/M$.

P/Y: the ratio of primary exports to GDP, calculated in the similar way as M/Y.

AVINFT: Average annual inflation rate, computed as the log-difference of CPI. Source: *International Financial Statistics*, CD-ROM, June, 1993. GDP deflator data from the World Bank were used to extend inflation series for the Central African Republic, Chad, and Malawi.

AVEXCPM: Average black market exchange rate premium. Source: World Bank, *World Development Report*, 1991. [Computer file].

IRGDP: Initial real per capita GDP for each time period, measured in 1985 international dollar. Source: Summers and Heston (1991).

POP: Average annual population growth rate. Source: World Bank, 1990, *World Tables of Economic and Social Indicators, 1950-1988*, [Computer file]. Ann Arbor, Michigan: Inter- university Consortium for political and Social Research.

PRIM: Primary school enrollment as percentages of age group. Source: same as above.

TOT: Change in terms of trade, calculated as the log difference of the net terms of trade in a time period. Sources: World Bank, World Development Report, 1991 data set.

COUPS: Index of the number of successful coups in a period. Source: Variable 9.2 in Gurr. Ted R. *Polity II: Political Structures and Regime Change, 1800-1986*, [Computer file]. Boulder, CO: Center for Comparative Politics [Producer], 1989. Ann ARBOR, MI: Inter-University Consortium for Political and Social Research [distributor], 1990.

DEMO1: Index for Political Democracy from 1965-1980. Source: Variable 6.2 "DEMOC" in Gurr. Ted R. *Polity II: Political Structures and Regime Change, 1800-1986*, [Computer file]. Boulder, CO: Center for Comparative Politics [Producer], 1989. Ann ARBOR, MI: Inter-University Consortium for Political and Social Research [distributor], 1990.

DEMO2: Index for Political Democracy from 1981-88. Source: Gastil, Raymond, *Freedom in the World*, 1980-88, NY: Freedom Press.

Appendix 2. The List of Countries in the Sample and Regional Dummy Variables

Country	Dlatin	Dsafric	Dasia	Country	Dlatin	Dsafric	Dasia
Cameroon	0	1	0	Argentina	1	0	0
Ethiopia	0	1	0	Bolivia	1	0	0
Ghana	0	1	0	Brazil	1	0	0
Ivory Coast	0	1	0	Chile	1	0	0
Kenya	0	1	0	Colombia	1	0	0
Madagascar	0	1	0	Ecuador	1	0	0
Malawi	0	1	0	Paraguay	1	0	0
Mali	0	1	0	Peru	1	0	0
Mauritius	0	1	0	Uruguay	1	0	0
Rwanda	0	1	0	China	0	0	1
Senegal	0	1	0	India	0	0	1
Sierra Leone	0	1	0	Indonesia	0	0	1
Sudan	0	1	0	Israel	0	0	0
Tanzania	0	1	0	South Korea	0	0	1
Uganda	0	1	0	Malaysia	0	0	1
Zaire	0	1	0	Pakistan	0	0	1
Zambia	0	1	0	Philippines	0	0	1
Costa Rica	1	0	0	Sri Lanka	0	0	1
Domini. Rep.	1	0	0	Thailand	0	0	1
El Salvador	1	0	0	Algeria	0	0	0
Guatemala	1	0	0	Egypt	0	0	0
Haiti	1	0	0	Greece	0	0	0
Honduras	1	0	0	Morocco	0	0	0
Jamaica	1	0	0	Portugal	0	0	0
Mexico	1	0	0	South Africa	0	0	0
Nicaragua	1	0	0	Turkey	0	0	0
Panama	1	0	0				

References

[1] Balassa, Bela, "Exports and Growth: Further Evidence", *Journal of Development Economics* 5, no.2, 1978, 181-189.

[2] Baldwin, R.E., 1966, *Economic development and export growth: A study of northern Rhodesia, 1920-1966.* Berkeley and Los Angeles, CA: University of California Press.

[3] Bhagwati, Jagdish, *Protectionism* Cambridge, MA: MIT Press, 1988.

[4] Bruno, Michael, 1968, "Estimation of factor contribution to growth under structural disequilibrium," *International Economic Review*, Feb.

[5] de Melo, Jaime and Sherman Robinson , "Productivity and Externalities: Models of Export-led Growth," working paper 387, The World Bank, 1990.

[6] Edwards, Sebastian, 1993, "Openness, Trade Liberalization, and Growth in Developing Countries," *Journal of Economic Literature*, 31:1358-93.

[7] Feder, Gershon, 1982, "On Exports and Economic Growth," *Journal of Development Economics*, 12:59-73.

[8] Gray, Patricia and Singer, Hans W., 1988, "Trade policy and Growth of Developing Countries: Some New Data," *World Development*, 16:395-403.

[9] Helleiner, Gerald K. 1990, "Trade Strategy in Medium-term Adjustment," *World Development*, 18(6), pp. 879-97.

[10] Gurr. Ted R. *Polity II: Political Structures and Regime Change, 1800-1986*, [Computer file]. Boulder, CO: Center for Comparative Politics [Producer], 1989. Ann Arbor, MI: Inter-University Consortium for Political and Social Research [distributor], 1990.

[11] Hirschman, Albert, 1958, *The strategy of economic development.* New Haven: Yale University Press.

[12] Jodice, D.A., and C. Taylor. 1983, *World Handbook of Political and Social Indicators*, Third Edition. New Haven: Yale University Press.

[13] Kavoussi, Rostam M., 1985, "Export expansion and economic growth: further empirical evidence," *Journal of Development Economics*, 14:241-50.

[14] Leamer, Edward, 1983, "Let's take the Con Out of Econometrics," *The American Economic Review*, 73:31-43.

[15] ———, 1985, "Sensitivity Analysis Would Help," *The American Economic Review*, 75:308-13.

[16] Levine, Ross, and Renelt David, 1992, "A Sensitivity Analysis of Cross-Country Growth Regressions," *The American Economic Review*, 82:942-63.

[17] Machaely, Michael, 1984, "Exports and growth: an empirical investigation," *Journal of Development Economics*, 4:49-53.

[18] Myrdal, G., 1957, *Economic Theory and Under-Developed Regions*, London.

[19] Nurkse, R., 1961, *Equilibrium and Growth in the World Economy*, G. Haberler and R.M. Stern, eds. Cambridge, MA.

[20] Prebish, R., 1962, "The Economic Development of Latin America and its Principal Problems," *Economic Bulletin for Latin America*, Feb., pp. 1-22.

[21] Ram, Rati, 1985, "Exports and economic growth: some additional evidence," *Economic Development and Cultural Change*, 36:51-72.

[22] Seers, D. 1964, "The mechanism of an open petroleum economy," *Social and Economic Studies*, 13:233-242.

[23] Summers, Robert, and Alan Heston, 1991, "The Penn World Table (Mark 5): an Expanded Set of International Comparisons, 1950-1988," *The Quarterly Journal of Economics*, May 1991, pp. 327-68.

[24] Taylor, Lance, 1991, *Income Distribution, Inflation, and Growth*, Cambridge, MA: MIT Press.

[25] Tyler, William, "Growth and Export Expansion in Developing Countries," *Journal of Development Economics* 9, 1981, pp.121-130.

[26] United Nations Conference on Trade and Development, *Handbook of International Trade and Development Statistics*, NY: United Nations Publication. Various years.

[27] The World Bank, *World Development Report*, various years.

[28] The World Bank, International Economics Dept. 1990, *World Tables of Economic and Social Indicators, 1950-1988*, Computer file. Ann Arbor, MI: Inter-university Consortium for Political and Social Research (distributor), 1990.

Chapter 3

Income Inequality, Government Spending, and Savings Rates in China

3.1 Introduction

In this paper, we study the determinants of gross domestic savings rates in China. It is a well known fact that China, like most other east Asian countries, has a high savings rate, which may have been one of the important factors behind the country's recent rapid economic growth. However, looking at savings data at China's provincial level, one finds that there are huge differences across different provinces. As Table 3.1 shows, in 1993, while some provinces (such as Beijing, Jiangsu, and Zhejiang) had gross savings rates well over 50 percent, other provinces (such as Guizhou and Xizang) only saved less than 30 percent. In this paper, we study the factors that determine the differences in savings rates among China's provinces.

Although most studies on savings behavior focus on private savings, we choose to focus on gross domestic savings rate in this study, which is defined as gross product in a province minus gross domestic consumption. We make this choice because currently savings by the government sector and the state-owned enterprises sector still make up

Table 3.1: Gross savings rates in China's provinces (as % of GDP), 1993

Province	Savings rate
Beijing	64.1
Jiangsu	58.3
Zhejiang	55.5
Shanghai	55.1
Shangdong	54.5
Tienjin	54.3
Hebei	51.8
Hainan	50.4
Henan	47.7
Liaoning	46.8
Guangdong	45.6
Shangxi	40.6
Fujian	40.6
Xinjiang	40.5
Jilin	39.3
Hubei	38.9
Yunnan	38.9
Sichuan	38.8
Heilongjiang	36.6
Jiangxi	36.3
Neimenggu	35.8
Guangxi	34.4
Qinghai	33.6
Anhui	32.4
Sha'ngxi	32.3
Hunan	30.8
Ningxia	30.5
Guizhou	27.4
Xizang	15.1

Source: Statistics Yearbooks of the above provinces (in Chinese), 1994.

a significant portion of China's total savings, despite the trend of gradual declining in their shares of total income since the start of the economic reform in 1978. According to Chinese statistics, in the late 80s and early 90s, savings generated by the government and the state-owned enterprises still amounted to about 20% of China's total national income, or about half of China's total gross domestic savings. If we exclude the savings by the government and the state-owned enterprises, we would be throwing away valuable information on China's savings behavior in this important period.

We start by recognizing that the gross domestic saving consists of two separable components: state sector savings (including both the government and the state-owned enterprises) and individual savings.[1] The difference in provincial savings rates are traceable to the differences in the factors that determine government savings, and those that determine individual savings among the provinces. Then we develop a model specification using elements of Keynesian consumption function, life-cycle hypothesis, income distribution theory of savings behavior, and other past empirical studies of savings rates. Using a panel data set containing 5 years' annual data for 28 of China's 30 provinces, we test the model specification with different statistical methods. We also conduct sensitivity analysis to test the robustness of our empirical estimates.

Our main findings are: first, the difference in China's provincial savings rates are determined by two factors. One factor is the income disparity between rural and urban population. We find that savings rates are both positively correlated with the degree of income inequality between rural and urban population and with percentage of urban population in a province's total population. These results indicate that people in rural areas save smaller fractions of their income than their urban counterparts, and the difference in their propensity to save is due to the fact that the per capita disposable income for urban population is more than twice of that for rural population

[1] Normally, in a capitalist economy, there should also be a third component, business savings. In China, since the state-owned enterprises still account for the lions share of the business sector in China, which is part of the state sector, we do not consider a separate business sector.

in most Chinese provinces.

The other factor determining the savings rates in China's provinces is the share of total income by the state sector, which includes both the government revenues and the after-tax profits retained by the state-owned enterprises. An increase in the state-sector's share of income tends to reduce the gross savings rate.

The second major finding is that the life-cycle hypothesis has little explanatory power for the differences in savings rates in China. In other words, our study find that the life-cycle hypothesis seems not to be applicable to individual savings behavior in China during late 1980s' to early 1990s'.

The third finding is that inflation does not have significant impacts on savings rates in China.

The remainder of this paper is organized in five sections. In the next section, we develop a model specification of the determinants of China's savings rates. The third section discusses the data set, the variables, and the statistical methods used in the study. The fourth section presents empirical results. The fifth section conducts a sensitivity analysis to test the robustness of the empirical results in the previous section. Section Six discuss results and implications, and concludes.

3.2 The Modal Specification

In this section, we develop a framework for our empirical study. we draw from the literature a set of hypotheses that can be tested using available data. We have two related objectives in mind in conducting this study: (1) to increase our empirical understanding of the factors behind the diverse savings rates in different provinces in China, and (2) to test some theoretical hypothesis that are important and controversial.

From national accounting system, we know that total consumption is the sum of private consumption C_p and the state sector's consumption C_s [2]:

$$C = C_p + C_s \tag{3.1}$$

Expressed in terms of the ratio of consumption to total income,

$$C/Y = C_p/Y + C_s/Y \tag{3.2}$$

Implying,

$$S/Y = 1 - C_p/Y - C_s/Y \tag{3.3}$$

In the next two subsections, we discuss the terms C_p/Y and C_s/Y in equation (3.3) respectively.

3.2.1 Determinants of the private consumption

Let's first discuss the determinants of individual consumption C_p. There are a rich set of theories and past empirical studies that we can draw on to develop our empirical model specification, such as life-cycle hypothesis (LCH), income distribution as a determinant of aggregate savings rate, savings for purchasing consumer durable goods, and inflation's impact on aggregate savings, etc. We will discuss them in this section.

Life-cycle hypothesis (LCH)

The life-cycle hypothesis is the most well known theory concerning individual savings behavior. According to the hypothesis, individuals always try to maximize their life-time utility by smoothing their current consumption and future consumption. Thus, individuals save during their working years, and dis-save during their childhood and retirement.

There are always questions as to whether LCH can explain the savings behavior in non-market economies, where people are not allowed to make their life-time consumption and savings decisions freely. Indeed, as Modigliani himself said in 1970:

[2]In this paper, the state sector includes both the government sector and state-owned enterprises sector at provincial level (i.e., it does not include the central government).

> ...the life cycle model does not purport to represent a universal theory of individual and aggregate savings formation and wealth holding, but is instead basically designed to apply to private capitalistic economies in which at least the level of income, consumption, and accumulation transactions occur through markets.

In a recent study of China's personal savings rate, however, Modigliani and Cao (1996) find strong evidence showing Chinese savers behaved as described by LCH. Using time series data for the forty-year period from 1953 to 1993, they find that the individual savings rate in China during the period was positively correlated with the growth rate of real per capita income and negatively correlated with dependency rate (i.e., the ratio of the number of children aged below 15 to that of working population aged between 15 and 60). Based on these findings, they conclude that LCH is applicable to Chinese economy.

Although we find it hard to believe that people in China under the centrally planned economic system during the most part of the forty-year period could freely allocate their life-time income and choose between current and future consumption according to LCH, we will nonetheless start by accepting the claim made by Modigliani and Cao and incorporate LCH as explanatory variables of individual savings rates in our empirical study. In Modigliani and Cao's study, they use two variables to test LCH: one is the growth rate of per capita income (g), and the other is the ratio of children under age 15 to the working population aged between 15 and 60 (C/W). We will use the same two variables in our modal specification to test Modigliani and Cao's results.

Income distribution between rural and urban populations

Several theories suggest that income distribution affects individual's savings behavior. One very influential model of savings involving income distribution is by Kaldor (1960). Kaldor's theory, especially in the Pasinetti (1962) formulation, postulates that a society consists of two hereditary classes: the workers earning their income from labor and do not save, and the capitalists earning only property income and save all their income. Thus transfers of income from the workers to the capitalists would increase savings rate of the society. In China the demarcation between workers and capitalists is not applicable yet, because the vast majority of properties (both productive capital and commercial buildings and housing stocks) are still owned by the state. The stock market is still in the budding stage. Many studies have found, however, that the most significant inequality in China is income inequality between urban and rural populations (see Khan, Griffin, Riskin, and Zhao, 1992). As Table 3.2 shows, despite the substantial increase in farmers' incomes since 1978, people in rural areas still receive much less income than those in urban areas. As one can see from Table 3.2, in most Chinese provinces, the per capita disposable income in urban areas is more than twice of that in rural areas in 1993. Chinese statistical data further suggest that people in rural China have little money left for savings after meeting their basic needs.[3] In 1994, a typical rural household in China spent a little over half of its annual disposable income on purchasing basic food alone[4]. If one add the additional money needed for the household to pay for basic clothing, housing, and medical expenses, one can imagine that not much of this household's income was left for saving.

Base on the above stylized fact, we propose the following hypothesis of the relationship between income distribution and savings rate, which is in the spirit of the Kaldorian modal, if not in its form: rural population in China only save a small fraction of their income because of their low levels of income, while urban population in China have a high propensity to save given their high income levels. The rationale behind this hypothesis is the following: imagine that there is an income threshold (e.g., the minimum income needed to meet a person's basic needs) below which savings are a low fraction of income (or zero) and above which they are a higher fraction, then because people in rural China have much lower average income than urban population, a much higher proportion of rural population may fall below this

[3]By "basic needs" we mean items like the basic amount of food to maintain a level of nutrition for a person to survive and be productive, the basic clothing to keep a person warm, and the basic shelter.

[4]See China Statistical Yearbook 1995, p. 279, p. 282.

Table 3.2: Income disparity between rural and urban populations, 1993

Province	Rural per capita personal income (yuan)	Urban per capita personal income (yuan)	The ratio of urban/rural personal incomes
Xizang	521	2504	4.81
Guizhou	579	2006	3.46
Sichuan	698	2179	3.12
Hubei	783	2345	2.99
Guangxi	885	2612	2.95
Sha'ngxi	653	1920	2.94
Hunan	852	2444	2.87
Xinjiang	778	2229	2.87
Ningxia	667	1907	2.86
Anhui	725	2026	2.80
Hainan	992	2774	2.80
Qinghai	673	1879	2.79
Hebei	804	2201	2.74
Henan	696	1793	2.58
Guangdong	1674	4277	2.55
Shangdong	953	2338	2.45
Shangxi	718	1715	2.39
Fujian	1211	2605	2.15
Neimenggu	829	1712	2.07
Jiangxi	870	1786	2.05
Jiangsu	1267	2526	1.99
Jilin	892	1761	1.98
Zhejiang	1746	3371	1.93
Liaoning	1161	2065	1.78
Beijing	1855	3296	1.78
Heilongjian	1028	1746	1.70
Tienjin	1593	2579	1.62
Shanghai	2727	4057	1.49

Source: Statistics Yearbooks of the above provinces (in Chinese), 1994.

income threshold and therefore save a much lower fraction than those living in urban China.

We can think of two ramifications of this income-threshold hypothesis. First, savings rates should be positively related to the degree of income inequality between rural and urban populations, as measured by the ratio between average per capita disposable income in urban area and that in rural area, because transfers of income from those who are below the income threshold (mostly rural population) to those who are above income threshold (mostly urban population) would increase aggregate savings rate should increase.

The second ramification of our hypothesis is that savings rates should be positively related with the percentage of population living in urban area, because if we hold the degree of inequality constant, the higher the percentage of urban population in a province's total population, the more people are there who are above the income threshold and have higher propensity to save, so that the higher is the savings rate.

We will incorporate these two variables (the ratio of urban per capita disposable income to rural per capita disposable income, U/R, and the proportion of population living in urban areas, $URBAN$) in our model specification to test the above hypothesis[5].

Saving for purchasing consumer durables.

Studies of savings behavior in East European countries under communists' regimes have identified the desire to purchase consumer durable goods as the main reason for individuals savings in these countries[6]. This may also be applicable to China because of the similarities between those economies and China's. Like those countries during 1970s' and 80s', the Chinese society is still largely a cash-only society. There is virtually no consumer credit available. This de facto "credit rationing" means that people have to save first if they plan to purchase big item consumer durable goods,

[5] Our income threshold hypothesis is similar to that embodied in an aggregate equation for the linear expenditure system.

[6] See Lukaszewicz (1983) for example.

such as color TV sets, refrigerators, or wash machines. Take TV sets for example, in 1994, a 20 inch color TV set cost about RMB4000-5000 yuan, which is more than the RMB 3502 yuan of annual total income for an average urban worker in that year [7]. In order to buy a color TV set, most families have to plan ahead and save for several years. The same is true for purchasing other durable goods. Thus we should expect a positive relationship between this year's expenditure on consumer durables and the savings rate of last year or the year before. Notice that this motive is different from the one proposed by LCH. But the two are not mutually exclusive.

Inflation rate

Many people have argued that an increase in inflation would lead to higher savings rate. For example, Deaton (1977) presents theoretical model of a positive relationship between inflation and saving rate based on price illusion, and finds strong empirical evidence supporting his model. Deaton's main reason is: when an individual consumer goes to a store and finds the prices of the goods he/she intends to buy are higher, he/she has no possible means to distinguish whether this is a relative price change or an absolute change. He or she tends to buy less amount of the goods. "Consequently, there is a mass illusion that all goods are relatively more expensive so that, as each consumer attempts to adjust his purchases, real consumption falls, and if real income is maintained, the saving ratio rises. Certainly, as mistakes are discovered, attempts will be made to rectify them, but if inflation continues to accelerate and if expectations lag behind reality, the saving ratio will remain abnormally high." (Deaton, 1977, p. 899)

Modigliani and Cao (1996) also argue that inflation affects personal savings in China, although their offer a different explanation from Deaton's. They argue that since inflation tends to reduce the purchasing power of individual's current wealth, each individual has to increase their current year's saving to make up for the loss of purchasing power of their wealth in order to preserve their intended level of future

[7]See *China Statistical Yearbook 1995*, p. 278.

consumption.

The two arguments are different theoretically, but they should yield same type of result at empirical level, since both suggesting a positive relationship between inflation rate (p) and savings rate.

Now putting the factors discussed so far together, we have the following relationship between S_p/Y (the ratio between individual savings and total income) and the variables discussed above, taking into account the negative impact of the share of the state sector's income (Y_s) in total income (Y) on S_p/Y (everything else being equal, the higher the state sector's share of total income, the lower the ratio between individual savings and the total income):

$$\begin{aligned}(S_p/Y)_t &= \beta_1 URBAN_t + \beta_2 (U/R)_t + \beta_3 g_t + \beta_4 (C/W)_t + \beta_5 DG_{t+1} \\ &\quad + \beta_6 P_t + \beta_7 (Y_s/Y)_t \end{aligned} \tag{3.4}$$

where $URBAN$ is the proportion of urban population in total population in a province, U/R is the ratio of per capita disposable income of urban population to that of rural population, g is the growth rate of per capita GDP, C/W is the dependency rate used by Modigliani and Cao (1996), DG_{t+1} is the future durable goods consumption (measured as the expenditure on durable goods in the next year), and P is inflation rate.

Now inserting equation (3.4) into the following income identity,

$$C_p/Y = 1 - S_p/Y$$

we have

$$\begin{aligned}(C_p/Y)_t &= 1 - [\beta_1 URBAN_t + \beta_2 (U/R)_t + \beta_3 g_t + \beta_4 (C/W)_t + \beta_5 DG_{t+1} \\ &\quad + \beta_6 P_t + \beta_7 (Y_s/Y)_t] \end{aligned} \tag{3.5}$$

Equation (3.5) relates individual consumption with a group of determinants of individual savings.

3.2.2 Determinant of the state sector's consumption

Next we discuss the state sector's consumption, C_s. We assume that the state sector's consumption is proportional to the income and revenue it receives. Unlike individuals who have a life-cycle from childhood, to economically active adulthood, ending at retirement period, and therefore have to make choices between their current and future consumptions to maximize life-time utilities, the state sector can expect to receive revenues year after year. Thus we have

$$C_s = c_s Y_s \tag{3.6}$$

or

$$C_s/Y = c_s Y_s/Y \tag{3.7}$$

where $c_s$is the state sector's propensity to consume out of its income, which is Y_s.

Now we can combine equation (3.5) and equation (3.7) to obtain the overall modal for the gross savings rate. Substitute equations (3.5) and (3.7) into equation (3.3), we have

$$\begin{aligned}(S/Y)_t &= \alpha(Y_s/Y)_t + \beta_1 URBAN_t + \beta_2(U/R)_t + \beta_3 g_t + \beta_4(C/W)_t \\ &\quad + \beta_5 DG_{t+1} + \beta_6 P_t \end{aligned} \tag{3.8}$$

where

$$\alpha = \beta_6 - c_s$$

We expect α to be negative because β_6 is negative and c_s is positive; β_1 and β_4 should be negative, and the rest of $\beta's$ should be positive. Equation (3.8) says that the gross savings rates in China's provinces are determined by the proportion of the income received by the state sector at provincial level, the dependency rate, the expenditure on consumer durable goods next year, the urban/rural income ratio, the percentage of urban population in total population, and inflation rate. In what follows, we will use equation (3.8) to conduct empirical study of the savings behavior in China's provinces.

3.3 Issues of data, measurement, and statistical method

In this section, we briefly discuss our data set, measurement of the variables, and statistical method used for the study.

First, about the data set. The data is assembled from the statistical yearbooks of China's provinces. The data set includes 28 "provincial level administrative regions" (we will simply call all of them as provinces thereafter) out of the total 30 in China. "Provincial level administrative regions" include not only normal provinces, but also autonomous regions and three municipalities (Beijing, Shanghai, and Tianjin). While a province or an autonomous region is similar to a state in the United States (except for the fact that the autonomous regions have much higher percentage of minorities in their populations), the three municipalities are similar to Washington, D.C. in that these three are metropolises with the majority of their populations living in urban areas and working in nonagricultural sectors. In our studies, we will run two sets of regressions based on equation (3.8) using full sample data and sub-sample data (i.e., excluding the three municipalities), in order to see if their inclusion would produce biased estimates for the urban-rural inequality variables.

We have a panel data set: there are 5 annual observations (1989-93) for each of the 28 provinces, except for Hebei province, which only has data for 1989-92 (four observations). This panel data set enables us to test our hypothesis with more information than studies with either cross-sectional or time-series data alone. Thus, instead of using simple OLS model where all the differences not captured by independent variables across the different units are assumed away, we can allow for individual effect in panel estimations.

There is, however, a further choice between fixed-effects and random-effects specifications within panel data estimation. The fixed-effects specifications assume that differences across units can be captured in differences in the constant terms. Under fixed-effects specification, equation (3.8) becomes:

$$(S/Y)_{it} = C_i + \alpha(Y_s/Y)_t + \beta_1 URBAN_t + \beta_2(U/R)_t + \beta_3 g_t + \beta_4(C/W)_t + \beta_5 DG_{t+1} + \beta_6 P_t + \varepsilon_{it} \quad (3.9)$$

Where C_i is the province-specific constant term, which changes across provinces but remains constant over time for each provinces, and ε is the error term.

On the other hand, the random-effects model assumes individual specific constant terms are randomly distributed across cross-sectional units and are uncorrelated with other independent variables. i.e.,

$$(S/Y)_{it} = C + \alpha(Y_s/Y)_t + \beta_1 URBAN_t + \beta_2(U/R)_t + \beta_3 g_t + \beta_4(C/W)_t + \beta_5 DG_{t+1} + \beta_6 P_t + u_i + \varepsilon_{it} \quad (3.10)$$

Where u_i is the random disturbance characterizing the ith observation and is constant through time. In our study, we will run regressions based on both fixed-effects and random-effects models, and conduct Hausman tests to see which one is more appropriate for our empirical data.[8]

Before presenting our empirical results, we need to discuss issues of variable-specifications and measurements that are important.

The first variable needs to be discussed is the proportion of national income received by the state sector. The income received by the state sector actually include two related but separate parts, one is the government tax revenue, and the other is the retained income by state-owned enterprises and by other state-owned non-profit units (such as hospitals, schools, libraries, and cultural and entertainment institutions). In Chinese official statistics, until 1992, the two parts were called "budgetary revenue" and "extra-budgetary revenue" respectively.[9] However, in 1993, in an effort to make Chinese industries closer to be a true corporate sector separated from the government,

[8]See Hausman and Taylor (1981) and Chamberlain (1978).

[9]See *Finance Yearbook of China 1994*, compiled by China's Ministry of Finance, p. 408, p. 419, p.428, p.429.

the Chinese government made a major reform of its revenue-collecting system and excluded the retained income by state-owned enterprises from the "extra-budgetary revenue" item. And Chinese statistics stopped reporting the retained income by state-owned enterprises accordingly. Thus, we only have official data for the retained income by the state-owned enterprises up to 1992. The data for 1993 are extrapolated based on the assumption that the proportion of the retained income received by state-owned enterprises in total "extra-budgetary revenue" remained the same in 1993 as those in the years of 1989-92.

For the variable "the proportion of population living in urban area," we have difficulty finding good data because, as many scholars have noted, the definition of urban population in China is very arbitrary and controversial (see Chan, 1994, and Wu, 1994). There are different versions of estimates concerning the size of China's urban population. The data published by the State Statistical Bureau defines "urban" population as those who reside in cities and towns which are officially-designated as "urban." This definition tends to underestimate the real size of the urban population because part of the officially classified "rural" population are working in industrial sector and residing in industrialized-towns that are not designated as "urban area" by the government. In view of this, we will use the variable "the proportion of working population that are in nonagricultural sector" as approximate for "the proportion of population living in urban area." We believe that this variable more accurately reflects the true population distribution between rural and urban areas.

For variable DG_{t+1}, "future purchase of consumer durable goods," the ideal measure would be the amount of money spent on purchasing consumer durable goods in year $t+1$. But such data are not available. The closest approximation we are able to get is the number of color TV sets purchased annually for all the 28 provinces in the data set. So we use the one-period-lead value of the number of color TV purchased, TV_{t+1}, as an approximation of the future purchase of consumer durable goods, i.e., we will run regression of current year's savings rate on the number of TV sets purchased in the next year. The reason that we use one-year-lead instead of two or three years leads is basically due to our desire to maintain the degree of freedom in our penal data regressions: we only have 5 observations for each province in our data set, we do not want to discard two or more observations out of the five.

3.4 The Results

Table 3.3 presents the result from panel data estimation. First, let's discuss our model choice. We include both F-statistic and χ^2 statistic at the bottom of the table. The F-statistic is for testing whether the panel data regression or OLS fits our data better, while χ^2 statistic is for the Hausman test to see whether fixed-effects panel data regression or random-effects panel data regression is the better modal specification for the data. The result from the two tests show that random-effect panel data regression modal is the best choice: the critical value for $F(27, 105)$ and $F(24, 93)$ at 5 percent significant level is about 1.68, much smaller from the F values in Table 3.3, which are 25.82 and 30.99 respectively, so we should definitely reject OLS modal and accept panel data regression. On the other hand, the critical value for $\chi^2(7)$ at 5 percent level is 14.07, much larger than the values in Table 3.3 (11.48 and 9.42 respectively), so we should accept random-effect modal and reject fixed effects modal.

The estimated coefficients shown in Table 3.3 are the ones from random-effects model. There are two columns in Table 3.3. The first column is the results from full-sample panel regression, and the second column is the results from the sub-sample regression excluding the three municipalities. As we indicated in the previous section, the reason to run the sub-sample regression is to see if the inclusion of these three municipalities, where over two thirds of their populations are in non-agricultural sectors, will distort our estimates for the urban-rural inequality variables. Looking at Table 3.3, the results from the two regressions are very similar. It seems that the inclusion of the three municipalities does not change the estimated coefficients very much. By the way, note that the $\overline{R}^2s$ are very high for both regressions, indicating that the model captures the savings behavior very well.

Now let's look at the estimated coefficients. First, the coefficient for Y_s/Y, the

Table 3.3: Panel data random-effects regressions

Dependent variable: savings rate (t-statistics are in parenthesis)		
Model of Est.	Full sample	Excluding 3 Muni.
No. of obs.	139	124
Y_s/Y	-0.46 (5.41)	-0.52 (5.59)
U/R	2.97(3.03)	2.65(2.82)
$URBAN$	0.52 (7.09)	0.45 (4.52)
g	0.10 (2.11)	0.10 (2.34)
C/W	-0.03 (0.28)	-0.02 (0.19)
TV_{t+1}	0.15 (0.86)	0.31 (1.58)
P	-0.07 (1.36)	-0.05 (0.90)
C	19.64(2.70)	22.97(3.18)
R^2	0.95	0.95
$\overline{R}^2$	0.94	0.93
Test of restrictions	$F(27,105) = 25.82$	$F(24,93) = 30.99$
	$\chi^2(7) = 11.48$	$\chi^2(7) = 9.42$

state sector's income share, has the predicted sign and is statistically significant. For every one percentage point increase in the proportion of national income received by the government or state-owned corporate sector, aggregate savings rate would decrease by about half a percentage point. This result confirms our hypothesis that the state sector consumption spending is proportional to the incomes it receives.

Second, our hypothesis that the income disparity between rural and urban incomes is an important factor determining savings rates in China is born out by the empirical results. The estimated coefficients on both variables, *URBAN* (the percentage of nonagricultural working population in total working population), and U/R (the ratio of per capita personal disposable income in urban area to that in rural area), have the predicted signs and are statistically very significant. The results indicate that the higher the income disparity between farmers and non-farmers is, the higher is the savings rate. If U/R increase by 1, savings rate would increase by 2.97 percentage point. On the other hand, savings rates are positively related with the proportion of work force in nonagricultural sectors. Those provinces with higher proportion of their work forces in nonagricultural sectors tend to have higher savings rates: other things being equal, every one percentage point increase in the proportion of work force in non-agricultural employment would increase savings rate by more than half a percentage point.

Third, the results for the coefficients on the two variables related with LCH are mixed. The estimated coefficient on the growth rate of per capita income is positive and statistically significant. But the estimated coefficient for the dependency rate has a very low t-statistic in both regressions, indicating that this coefficient is not statistically significant. It appears that our empirical result is somewhat different from Modigliani and Cao's (1996). Further investigation reveals that the difference between our result and Modigliani and Cao's is due to the inclusion of the two variables related to income distribution in our regression: *URBAN* and U/R. As Table 3.4 shows, when we run panel data regression without the two variables, the results are very similar to Modigliani and Cao's: the estimated coefficients on both income growth and dependency rate are very significant. Moreover, even the magnitude of the two

Table 3.4: Panel Date Random-effects Regression (without *URBAN* & *U/R*)

Dependent variable: savings rate (t-statistics are in parentheses)	
No. of obs.	139
Y_s/Y	-0.31 (3.24)
g	0.22 (4.68)
C/W	-0.44 (3.76)
P	0.03 (0.58)
TV_{t+1}	0.50 (2.64)
C	59.45 (11.03)
R^2	0.93
$\overline{R}^2$	0.91

estimated coefficients on dependency rate are very similar: 0.44 from Table 3.4, and 0.46 from Modigliani and Cao's regression (for the period of 1958-93). Once we add NAD and U/R into the regression, the coefficient on dependency rate becomes insignificant. Apparently, the relationship between dependency rate and the Chinese savings rates found in Modigliani and Cao's study is not robust, once we account for the impact of income inequality variables, the relationship disappears.

This result casts some doubt on the applicability of LCH in individual savings behavior in China's recent history. As we know, dependency rate is an important variable for testing LCH.[10] According to LCH, those who work are savers, and those who are too young to work are dis-savers. Consequently, dependency rate should be closely associated with observed savings rate: at the aggregate level, after controlling for other variables, a higher dependency rate (i.e., a larger proportion of children in the total population) should lead to a lower savings rate. Our empirical results indicate, however, that this inverse relationship between savings rate and dependency rate is not robust in China.

Fourth, the coefficient on the variable TV_{t+1} has the right sign, but is statistically insignificant at 5 percent significance level. The result seems to reject our hypothesis that one of the major reasons for individuals in China to save is for purchasing consumer durable goods. But we think the result is not conclusive, due to possible measurement problem involved with this variable. Remember that we use "the number of next year's color TV purchased per one hundred households" as an approximation for "the future purchase of consumer durables." There are problems with this

[10]There is a considerable literature on the relationship between dependency rates and savings rates. Modigliani (1965) first specified tests of LCH based on dependency rates and found a significant negative relationship between the two. Leff (1969) is another major contributor to this literature. Although Leff's study focuses on aggregate savings rates instead of private savings, his theoretical reasoning is similar to Modigliani's: "Children constitute a heavy charge for expenditure ... Because they contribute to consumption but not to production, a high ratio of dependents to the working age population might be expected to impose a constraint on a society's potential for savings." (1969, p. 887). Other notable contribution to this literature include: Modigliani (1970), Gupta (1971, 1975), Adams (1971), and Leff (1971, 1980). There is a consensus view that the there is a robust relationship between dependency rate and savings rate in developed market economies, although people disagree on whether the same relationship exists in low income countries. For example, Gupta's estimates (1971) indicate that that for low income countries, the dependency rate is not a significant determinant of aggregate savings rates.

approximation. First, color TV sets are only one of many consumer durable items for which people have to save money for, and we cannot expect a single item of consumer durables to reflect people's purchasing pattern accurately. Second, this variable only measures the quantity of TV sets purchased, omitting the wide variation in quality and size of these TV sets, which would lead to wide variation in the amount of money need to be saved to buy them. However, despite all these problems involved with data and measurement, the coefficient has the correct sign and is almost statistically significant at 5 percent significance level in the regression using the smaller sample (i.e., excluding the three municipalities). The result suggests that there may be a significant relation between current savings rate and future expenditure on durable goods. We need better data for this variable in future studies.

Fifth, the coefficient on the inflation variable has the wrong sign and is statistically insignificant. Empirical evidence seems not to support the hypothesis that higher inflation induce higher savings. This result is similar to what Modigliani and Cao found from their study.

3.5 Tests of the robustness of the estimation

In this section, we address the question: how much confidence can we have in the empirical results found in the previous section? As Cooley and LeRoy (1981, p. 825) argued, economic theory usually does not provide a complete and unique specification of which conditioning set of information should be held constant when one conducts statistical tests on the relation between the dependent variable and the independent variables of primary interest. Therefore, many alternative regression specifications may have equal theoretical justification, but the estimated coefficients on the independent variables of primary interest in these specifications may depend on the conditioning set of information. For our study, it is reasonable to ask: will the relation between the savings rate and rural/urban income inequality or the relation between the savings rate and the state sector's share of total income change if we introduce new variables into the regression?

We conduct a sensitivity analysis similar to the extreme-bounds analysis used by Levine and Renelt (1992), which is a variant of the method originally proposed by Leamer (1983). The basic idea of our sensitivity analysis is to test the robustness of the estimated coefficients when we change the model specifications by adding many new independent variables into the regression. If an estimated coefficient found statistically significant in the previous section becomes insignificant or changes sign after new variables are added into the regression, then we say the estimated coefficient is fragile because its result is sensitive to alterations in the conditioning set of information. If the estimated coefficient maintains its statistical significance regardless of the changes in the conditioning set of information, we say the estimate is robust and we can have confidence in the conclusions.

The regression for the sensitivity analysis has the form

$$\begin{aligned}(S/Y)_{it} &= C + \alpha(Y_s/Y)_{it} + \beta_1 URBAN_t + \beta_2(U/R)_t + \beta_3 g_t + \beta_4(C/W)_t \\ &\quad + \beta_5 TV_{t+1} + \beta_6 P_t + \Gamma_z Z + u_i + \rho_{it} \qquad (3.11)\end{aligned}$$

It is easy to see that equation (3.11) is same as equation (3.10) with the exception of the additional term $\Gamma_z Z$, where Z is a set of variables chosen from a pool of variables that are likely to provide conditioning information to our base regression. We will run a series of regressions based on equation (3.11), only changing the Z-variables. Each regression will produce a set of estimated coefficients (α and β's). The sensitivity analysis is to test if any of the α or β's that are statistically significant in the previous section turns to insignificant or changes sign in any of the regressions. If it does not, then we can conclude with confidence that our empirical findings are robust.

In order to preserve a reasonable degree of freedom and hence a reasonable level of the precision of the estimates, we restrict the number of Z-variables to be included in any one regression to no more than three. Consequently we limit the total number of independent variables included in any one regression to be nine. The pool of variables from which we choose Z-variables are: the level of real per capita GDP (RGDP), the ratio of government budget deficit to GDP (GDEF), birth rate (BIRTH), population growth rate (GPOP), and the ratio of nonagricultural output to GDP (INDP). We choose these variables for the pool of the conditioning information set because they are indicators of a province's economic, fiscal, demographic situations.

Table 3.5 presents the result of the sensitivity analysis for the four variables that are found statistically significant in the previous section. The "base" regression is the same as the full-sample regression in Table 3. The high and low extreme bounds are the highest and lowest values of the coefficient for that particular variable from the regressions for all possible linear combinations up to three Z-variables (25 regressions in total).

One important result presented in Table 3.5 is that the relations between savings rate and income distribution variables are robust: both the positive partial correlations between S/Y and U/R and between S/Y and $URBAN$ are robust. At the lower bound, the coefficient on U/R is 2.62 with a t statistic of 2.418, and the coefficient on $URBAN$ is 0.344 with a t statistic of 3.189.

A second important result in Table 3.5 is that the relation between savings rate and income growth is not robust. In 17 our of the 25 regression, the estimated coefficient on the growth rate of per capita income are not significant. Thus, the relationship between savings rate and income growth rate found in previous section turns out to be fragile. We recall that the coefficient on g is used, along with dependency rate, to test LCH in Modigliani and Cao's study. In the previous section, we have already found the relation between savings rate and dependency rate to be fragile. Now the result from our sensitivity analysis casts further doubt on the applicability of LCH in China.

A third important finding from our sensitivity analysis is the robust positive partial correlation between savings rate and the state sector's income (Y_s/Y). At the lower bound, the coefficient on Y_s/Y is -0.346 with a t statistic of 3.52.

Finally, it is also worth noting that none of the estimated coefficients for dependency rate in the 25 regressions are statistically significant. This result confirms the empirical findings in the previous section that there is no partial correlation dependency rate and savings rate. By the way, the estimated coefficients on the other

Table 3.5: Sensitivity analysis (dependent variable: savings rate, #of obs: 139)

Variable		Coefficient	Standard Error	t-statistics	R(bar)^2	Z-variables	Robust/Fragile
Ys/Y	high:	-0.462	0.085	5.395	0.935	INDP	Robust
	base:	-0.462	0.085	5.408	0.936		
	low:	-0.346	0.098	3.520	0.935	RGDP, GDEF, GPOP	
U/R	high:	3.591	1.034	3.471	0.936	GDEF, GPOP	Robust
	base:	2.973	0.981	3.029	0.936		
	low:	2.620	1.083	2.418	0.933	RGDP, INDP, BIRTH	
URBAN	high:	0.519	0.072	7.181	0.935	GPOP	Robust
	base:	0.516	0.073	7.087	0.936		
	low:	0.344	0.108	3.189	0.935	RGDP, GDEF, BIRTH	
g	high:	0.132	0.052	2.545	0.935	GPOP	Fragile
	base:	0.098	0.047	2.106	0.936		
	low:	0.062	0.055	1.128	0.935	GDEF, BIRTH, RGDP	

two variables, TV_{t+1} and P, also remain statistically insignificant throughout the 25 regressions.

In summary, the sensitivity analysis shows that all but one of our empirical estimates in the previous section are robust. This result is remarkable given our linear modal specification. We should have confidence in our empirical results.

3.6 Discussion and Conclusion

In this paper, we set out to study the determinants of the different savings rates among China's provinces. With a modal specification using elements of Keynesian consumption function, life-cycle hypothesis, income distribution theory of savings behavior, and other theories of savings, we run regressions using panel data including 5 annual observations for each of the 28 provinces in our sample.

Our main empirical findings are as follows:

First, the difference in China's provincial savings rates are determined by two factors. One factor is the income disparity between rural and urban population. Our empirical results show that savings rates are both positively correlated with the degree of income inequality between rural and urban populations and with the proportion of work force in nonagricultural sectors. These results indicate that people in rural areas save smaller fractions of their income than their urban counterparts, and the difference in their propensities to save is due to the fact that the per capita disposable income for urban population is more than twice of that for rural population in most Chinese provinces. The empirical results support our hypothesis that there is an income threshold (the minimum level of income needed to meet a person's basic needs) in China below which savings are a low fraction of income (or zero) and above which they are a higher fraction. Transfers of population away from agricultural sector (the majority of whose income are below the threshold) to non-agricultural sectors (most of whose income are above the threshold) lead to increase in savings rate. The implication of this result is very encouraging. As our data shows that those provinces with higher percentage of their work force in industrial and service sectors are the ones located in China's coastal area and are economically most developed, such as Jiangsu, Guangdong, Zhejiang, and Shangdong, while the ones with lower percentage of their work force in nonagricultural sectors are less developed provinces located inland. Currently, there is a clear trend in China that these less developed provinces are rapidly industrializing. In the future, as these provinces become increasingly industrialized, increasing number of people will move from agricultural sector to non-agricultural sectors, thus the savings rates in these provinces will rise towards the levels of the most industrialized provinces.

The other factor determining the savings rates in China's provinces is the proportion of national income received by the state sector, which includes both the government revenues and the after-tax profits retained by the state-owned enterprises. An increase in the state-sector's income level tends to reduce the gross savings rate.

Second, our study also casts some doubt on the applicability of LCH to individual savings behavior in China. The results from our study indicate that the assumptions behind LCH are so much at odds with the political and economic conditions in China's recent history that it would be surprise to think that people in China had the freedom to make their life-cycle consumption and investment decisions based on their personal preferences. In an economy that until very recently was based on central planning system where almost all the decisions concerning consumption and investment were made by national leaders and central planners based on political reasons, and where there were severe rationing of all consumption goods (from basic food and clothing to housing) by the government, individuals did not have the luxury to allocate their life time income according to their utility functions. Therefore, their savings behavior could not follow LCH. However, it is important to point out that our empirical results do not reject the validity of LCH in other market-based economies.

Third, we find that price inflation does not affect aggregate savings rate in China's provinces. In the beginning of our study, we mentioned the two theoretical arguments for a positive relationship between savings rate and inflation rate: one is Deaton's price illusion story, and the other is wealth-erosion based on Modigliani's LCH. In light of the lack of empirical evidence for LCH in China, it is easy to understand

Table 3.6: Consumer price inflation and nominal personal income growth (1990-94)

Year	Growth rate of average urban wages	Growth rate of per capita farmer's income	Inflation
1990	10.6	14.1	3.1
1991	15.7	3.2	3.4
1992	9.4	10.7	6.4
1993	24.3	17.6	14.7
1994	34.6	32.5	24.1

Note:
1. All figures are annual percentage changes.
2. Income growth rates are nominal rates.

Source: China Statistical Yearbook, 1995.

why there should not be any wealth-erosion effect on savings from inflation. As for why there is no price illusion among Chinese consumers, the answer may rest in the fact that during the period under our study, rapid growth of nominal income might have created a "money illusion". Table 3.6 shows that while inflation rate accelerated during this period, nominal personal income rose even more rapidly. There might have a "money illusion" when the increase in people's nominal income accelerated to more than 20-30 percent a year which might have induced them to spend more. Consequently, the "money illusion" effect may have roughly canceled out the "price illusion" effect on the savings rate.

Appendix Definitions and Sources of Variables

All the following data are from the statistical yearbooks of the 28 Chinese provinces in our sample from 1989 to 1995, with the exception of C/W, which is from *China Population Statistics Yearbook* (varies years).

Definition of Variables:

- S/Y: Gross savings rate, defined as GDP minus consumption.

- Y_s/Y: The ratio of the state sector's revenue to total income at provincial level. The state sector's revenue is the sum of the government tax revenue (called "budgetary revenue" in Chinese statistics) and the retained income by state-owned enterprises and by other state-owned non-profit organizations (called "extra-budgetary revenue" in Chinese statistics).

- U/R: The degree of income inequality between urban and rural populations, defined as the ratio of per capita disposable income of urban population to that of rural population.

- $URBAN$: The proportion of urban population in total population of a province. In this study, we use data on "the proportion of nonagricultural working population in total working population" as approximate for $URBAN$ due to the lack of a clear definition for "urban population" in China.

- g: Real growth rate of per capita income of a province.

- C/W: Dependency rate, defined as the ratio of children aged below 15 to population aged between 15 and 60.

- P: Price inflation. In this study, we use implicit GDP deflator to measure price inflation in a province.

- TV_{t+1}: The number of color TV sets purchased in year $t+1$.

- $RGDP$: Real per capita GDP measured in 1989 Chinese RMB.

- *GDEF*: The ratio of government budget deficit to GDP in a province.
- *BIRTH*: The birth rate in a province.
- *GPOP*: The growth rate of population in a province.
- *INDP*: The ratio of nonagricultural output to GDP.

References

[1] Adams, N. A., 1971, "Dependency rates and savings rates: comment," *American Economic Review,* 61:472-75.

[2] Bilsborrow, R. E., 1980, "Dependency rates and aggregate savings rates revisited," *Research in Population Economics,* 2:183-204.

[3] Barro, R. and X. Sala-i-Martin, 1995, *Economic Growth,* New York: McGraw-Hill.

[4] Chan, K. W., 1994, "Urbanization and rural-urban migration in China since 1982," *Modern China,* 20:243-81.

[5] China State Statistical Bureau, various years, *China Statistics Yearbook,* Beijing: China Statistics Press.

[6] Cooley, T. F., and S. F. LeRoy, 1981, "Identification and estimation of money demand," *American Economic Review,* 71:825-44.

[7] Deaton, A., 1977, "Involuntary savings through unanticipated inflation", *American Economic Review,* 67:899-910.

[8] ______, 1983, "Savings and inflation: theory and British evidence," in *The Determinants of National Savings and Wealth,* eds. Franco Modigliani and Richard Hemming, New York: St. Martin's Press.

[9] Gersovitz, M., 1988, "Saving and development," *Handbook of Development Economics,* Vol.1, eds. H. Chenery and T. N. Srinivasan, North-Holland: Elsevier Science Publishers.

[10] Gupta, K. L. 1971, "Dependency rates and savings rates: Comment," *American Economic Review,* 61: 469-71.

[11] ____, 1975, "Foreign capital inflows, dependency burden, and saving rates in developing countries: A simultaneous equation model," *Kyklos,* 28:358-74.

[12] Hausman, J., and W. Taylor, 1981, "Panel data and unobservable individual effects," *Econometrica,* 49:1377-1398.

[13] Kaldor, N., 1960, *Essays In Value and Distribution,* London.

[14] Khan, A. R., K. Griffin, C. Riskin, Zhao R., 1992, "Household income and its distribution in China," *The China Quarterly,* No. 132.

[15] Leff, N. H., 1969, "Dependency rates and saving rates," *American Economic Review,* 59:886-896.

[16] ___, 1971, "Dependency rates and saving rates: reply," *American Economic Review,* 61:476-80.

[17] ___, 1980, "Dependency rates and savings rates: a new look," *Research in Population Economics,* 2:205-14.

[18] Leamer, E. E., 1983, "Let's take the con out of econometrics," *American Economic Review,* 73:31-34.

[19] _____, 1985, "Sensitivity analysis would help," *American Economic Review,* 75: 308-13.

[20] Levine, R., and D. Renelt, 1992, "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review,* Vol. 82, No. 4, pp. 942-963.

[21] Lukaszewicz, A., 1983, "The determinants and role of private saving in Poland," in *The Determinants of National Savings and Wealth,* eds. Franco Modigliani and Richard Hemming, New York: St. Martin's Press.

[22] Modigliani, Franco, 1965, "The life cycle hypothesis of savings, the demand for wealth and the supply of capital," paper presented to the Rome Congress of the Econometric Society.

[23] ________, 1970, "The life cycle hypothesis of saving and intercountry differences in the saving ratio," *Induction, Growth and Trade: Essays in Honor of Sir Roy Harrod*, W.A. Eltis *et al.* eds. Oxford: Clarendon Press.

[24] ________, and Cao, L. S., 1996, "The Chinese saving puzzle and the life cycle hypothesis," mimeo.

[25] Pasinetti, L. L., 1962, "Rate of profit and income distribution in relation to the rate of economic growth", *Review of Economic Studies,* vol. XXIX.

[26] Pickersgill, Joyce, 1983, "Household savings in the USSR," in *The Determinants of National Savings and Wealth,* eds. Franco Modigliani and Richard Hemming, New York: St. Martin's Press.

[27] *China Population Statistics Yearbook (*in Chinese), compiled by the Population and Employment Statistics Department, China State Statistical Bureau, various years, Beijing: China Statistics Press.

[28] Solow, R., 1956, "A contribution to the theory of economic growth", *Quarterly Journal of Economics,* 70: 65-94.

[29] Wu, H. X., 1994, "Rural to urban migration in the People's Republic of China," *The China Quarterly,* 139:669-98.