Transnational Corporations and Economic Development in Developing Countries.

Assessing the Effect of Foreign Direct Investment on Economic Growth in Developing Countries with an Extended Solow Model.

Lizentiatsarbeit eingereicht bei

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Table of content

List of Abbreviations

EU	European Union
FDI	Foreign direct investment
IMF	International Monetary Fund
GDI	Gross domestic investment
GDP	Gross domestic product
HIC	Heavily indebted countries
LDC	Least developed countries
OECD	Organisation for Economic Co-operation and Development
TNC	Transnational corporations
UNCTAD	United Nations Conference on Trade and Development

…you must open up the economy and allow all the foreign companies to come in and operate freely.

"It seems to me that more people now are realizing that this is, in fact, a new kind of imperialism where the weapon used is really capital - capital that can be used to impoverish countries to the point where they have to beg for help and when they beg, then you can impose conditions on them, and then one of the conditions, of course, is that you must open up the economy and allow all the foreign companies to come in and operate freely. And these foreign companies are huge companies, huge banks. They will come and they will compete with the small firms and small banks, and these banks will eventually fail and be absorbed by the big foreign banks, and we will have no more banks of our own.

They are, of course, saying that we will get the best service, the people with the most amount of money, but we will be just workers in foreign companies. We will have no independence anymore, and as in the case of the banana republics, when the economy is totally dependent on foreign-owned businesses, they dictate the political future of the country. We have to accept. If they don't like a person to become a President, for example, they can mount an operation that will bring down that person, as they have done in some countries. And this means that we have no more independence. You know, when our politics is determined by foreign investors in the country, then where is the independence?"

Datuk Seri Dr. Mahathir bin Mohamad
Prime Minister of Malaysia from 1981 to 2003 (1999)

SECTION I

Introduction and Research Design

1 INTRODUCTION

Since World War II trade between developing and industrialized countries has expanded and borrowing from rich countries to the poor areas of this world increased. The links between these differing groups of economies intensified subsequently and made these two groups increasingly dependent from each other. But despite increasing wealth and industrialization of the First World, only part of the developing countries managed to sufficiently grow economically to catch up with the advanced nations. Many of the developing countries that were poor at that time are still poor today compared with industrialized countries. The scarcity of capital and skilled labor causes a low level of per capita income and prevents developing countries from realizing economies of scale from which many richer nations benefit (Krugman and Obstfeld 2000). Neoclassical growth theories assume that less developed countries should exhibit larger growth rates than industrialized economies, so that they will eventually catch up with the later. While this convergence can be observed for some Asian and some Latin American countries, many other countries and especially African countries have economic growth rates that would virtually take them hundreds of years to catch up with industrialized countries.

Several kinds of attempts have been made by wealthy nations to reduce the discrepancy of income levels between poor and rich countries. To finance domestic investment, developing countries rely on capital flows from abroad, typically in the form of loans that developing countries receive from other governments or from international organization like the Worldbank or the International Monetary Fund. As a consequence of unprofitable investments many developing countries are heavily indebted and frequently even unable to pay interests, not to mention to pay back the loans they once received. In addition, a financial crisis or rising interest rates for loans can dramatically worsen the economic situation of indebted developing countries.

Apart from loans, investments in these countries are financed by foreign capital from private companies. This kind of equity finance is usually referred to as foreign direct investment (FDI). In this case, foreign companies, particularly transnational corporations (TNCs), invest in developing countries but usually remain the sole owners of these investments.

The number and size of TNCs have significantly increased since the late 1970s and have caused a shift from an international economy to a globalized economy. The economic activities of TNCs have therefore been the subject of a series of sociological and economic research studies, which tried to assess the effects of TNC activities on the development process in countries of the Third World. However, the findings of these studies have been quite contradicting. While some studies concluded that the activities of TNCs are beneficial for developing host economies others concluded that these activities are harmful for the development process of these Third World countries. The uncertainty resulting from these contradicting findings is an obvious reason for further analysis on the subject.

This study tries to contribute to the scientific understanding of how economic development of developing countries is affected by the presence and the activities of transnational corporations. New is that the effects of TNC activities on economic development shall be assessed based on an exogenous economic growth model, which will be extended to account for TNC activities.

How is this study organized?

In Section I the research objectives, the research question and the hypotheses are introduced. Section II starts with a discussion of development-theories followed by a rather descriptive illustration of the current trends in FDI and the expansion of TNCs. The second part of Section II reviews empirical analyses on the subject at stake. The section closes with an introduction to the models of economic growth theory including an extensive description of the Solow-model, which provides the necessary methodological background.

The first part of Section III provides a detailed description on how the basic Solow-model can be extended by FDI followed by the definitions and descriptions of the variables used in this analysis. In the last part of Section III the empirical analysis and the regression results are presented.

Section IV summaries the results and provides an outlook on further analysis.

2 RESEARCH OBJECTIVE, RESEARCH QUESTION AND HYPOTHESES

2.1 Introduction

Despite the efforts of the developing countries and international organizations or the economic activities of TNCs, developing countries have remained poor and the progress in development is marginal. There are legion of possible causes that might hinder development or result in underdevelopment in the Third World and many scientific studies tried to determine these causes for deadlock in development. The current public and scientific attention has focused on transnational corporations, the major players in the world economy, as possible source of delayed development or even underdevelopment (while other opinions claim the opposite).

However, this interest is not particularly new. Since the early seventies various research projects focused their analysis on the relationship between FDI - a measure for the activity by and presence of TNCs - in developing countries and the economic development of these poor host countries. The findings of these analyses are quite contradicting. Some assume beneficial effects resulting from FDI on economic development while others claim that FDI hinders economic development. Differences in these research results can be attributed to the diverging theoretical approaches, differences in data (for instance due to different data quality or differences in the composition of the sample, like varying sets of countries), diverging model set-ups, theory-based assumptions or the interpretation of empirical results, just to name a few.

Two dominant strains of theories pursue differing explanations for these sharply diverging long-run growth patterns. One strain argues that the answer lies in economic and political features of developing countries and the way these have changed over time in response to both world events and internal pressures. That is that the low economic growth rate and development is home-made due to political instability, insecure property rights, and misguided economic policies (Barro and Sala-i-Martin 1995; Krugman and Obstfeld 2000). The other theoretical strain's main argument is that underdevelopment is a consequence of differential distribution of power between the Northern industrialized countries of the centre and the Southern countries of the periphery. Transnational corporations (TNCs) are seen as the major economic agents who are interested in maintaining the differences in development. The excerpt from the interview with the former Malaysian prime minister, Mahathir bin Mohamad, reflects this position in a rather generalized manner by emphasizing that TNCs are profit ori-

ented enterprises, which are too strong for domestic enterprises to compete with and whose activities solely serve their own interests.

Since the number of TNCs has been constantly increasing and the economic size of some TNCs trumps the size of whole economies, the trend towards an increasingly globalized economy is undamped. Therefore, the theoretical assumptions of development-theories regarding the role of TNCs in the world economy require continuous empirical analysis.

2.2 Research Objective

This study tries to contribute to the scientific understanding of how economic development of developing countries is affected by the presence and the activities of transnational corporations. Based on an exogenous economic growth model the effect of FDI on economic growth shall be assessed. Foreign direct investment is thereby a proxy for the intensity of TNC presence and activities while economic growth is a measure for economic development. The model equation for the linear regression in the empirical analysis will be derived from an extended Solow-model. For this empirical analysis, statistical data from the *PENN-World Tables* and the UNCTAD's *World Investment Report* for the years 1980 to 1990 will be used to compile the necessary data set.

Methodological objective

A methodological approach, which is less common in sociology shall be used for this empirical analysis. Instead of formulating a linear regression model based on a reasonable compilation of dependent and independent variables, the regression model shall be derived from an exogenous neoclassical growth model. For this purpose the basic Solow-model will be extended by foreign capital as additional input factor. The methodological objective is to test an economic growth model in a sociological study

Explorative approach

The scientific approach is rather explorative. It is not clear if the Solow-model can be extended in a reasonable way in order to capture the effects of FDI on economic growth. A regression equation derived from an extended Solow-model must satisfy the prerequisites for the interpretability of particular regression coefficients. The choice to derive the regression equation from an altered economic growth model bears significant risks, namely that not all relevant research questions (see below) might be answered or that the resulting regression model might not satisfy all theoretical prerequisites.

2.3 Research Question

2.3.1 Main research question of this study

The general research question of this study draws from the differing theoretical assumptions about the economic, political and social consequences of the presence and activities of transnational corporations in developing countries. In order to limit the focus of this study, only the effects on economic development will be analysed because it is empirically the easiest to study. All other aspects associated with development in general are therefore beyond the present scope of analysis. The general research question for this study is:

General research question

How is economic development in developing countries affected by TNC presence and activities in theses countries?

As will be outlined later in this text, currently the best indicator for TNC presence and activities is foreign direct investment. Economic development comprises not only chances in income but also changes in the technological and formal structures of an economy. An increase in per capita income is usually seen as the primary prerequisite for all other factors of economic development. Therefore economic growth is taken as the indicator for economic development. Based on this theoretical concept the main research question of this study can be formulated:

Main research question

What are the effects of foreign direct investment on economic growth in developing countries?

The subject deserves special attention for four reasons:

1) The number and the size of TNCs have significantly increased during the last decades and the geographical expansion of TNCs by the means of foreign direct investment has risen to new heights. It is of general interest to understand the economic and social consequences of this transnationalization process and its effects on world trade, on particular world regions or on particular countries.
2) Despite the significant inflows of equity capital to developing countries, these countries grow economically at very slow pace or are even affected by economic recession. It is therefore of great interest to analyze the effects of foreign direct investment on the eco-

nomic development process in countries of the Third World to determine possible harmful or beneficial effects.

3) Research studies on the effects of foreign direct investment on economic growth have come to differing conclusions. New research on this subject can contribute to a better understanding of the empirical and theoretical problems underlying these contradicting empirical findings.
4) The poverty and misery in many regions of the world imply the moral obligation to determine and to remedy the causes for the awful conditions affecting a major part of world population. The determination of possible causes by scientific analysis is only a small but important contribution to overcome these inequalities in the world.

2.3.2 Related questions

Related to the main research question are three more specific questions that refer to findings in earlier studies. Empirical results from earlier studies indicate that it is necessary to distinguish between *foreign capital inflow* and *foreign capital stock*. This distinction allows to determine long- and short-term effects. According to that, the first related question focuses on the short-term effect, while the second related question focuses on the long-term effects of FDI on economic growth. The third related question refers to the assumption that there are differences in the productivity of foreign and domestic capital.

Related question 1

What effects do foreign direct investment inflows have on economic growth in developing countries?

Related question 2

What effects do the foreign capital stocks have on economic growth in developing countries?

Related question 3

Is there a difference in productivity between foreign and domestic capital?

A major argument of *dependencia* and *world system theory* is, that TNCs tend to repatriate their above-average profits from their investments in developing countries, causing decapitalization in the underdeveloped host economy. Therefore, the fourth related question focuses on reinvested earnings.

Related question 4

How do reinvested earnings affect economic growth in developing countries?

2.4 Theoretical concept

The crucial variables in this analysis are economic development and TNC activities and presence. The two variables require a theoretical concept since both cannot be directly measured. This paragraph will outline the theoretical concept while all other variables for the empirical analysis will be defined and described later in this text.

2.4.1 TNC activities and presence

The effect of TNC presence and activities in developing countries on economic development cannot be comprehensively determined. Much of the effects will, for example, depend on country-, industry-, and firm-specific characteristics, on government policies of the host economy or on the kind of investment undertaken (Dunning 1992, p. 263). The effects on economic development can therefore vary a lot. TNC activities in developing countries do not only imply a transfer of foreign capital to the host economy but also, for example, the transfer of technology and management knowledge or the exploitation of the labor force or corruption which constitute positive respectively negative effects of TNC activities. Accounting for all direct and indirect effects would increase the complexity to a point where an empirical analysis is impossible. But the primary limitation for the assessment of TNCs activities in the world economy is constrained by the availability and quality of data. Dunning (Dunning 1992, p. 7) suggested that the best indicator for the overall or sectoral economic significance of TNC activity is value added that is created by these corporations outside their national boundaries. Indeed only three indices for TNC activities are available which limits a comprehensive analysis. The three indices are the FDI in- and outward stocks, FDI in- and outflows and the income earned. FDI offers the only means to measure the effects of TNC activity and the level of global international production (Dunning 1992; UNCTAD 1999, p. xx). Since most studies on this research subject (some of which will be reviewed later in this text) use FDI as an indicator for TNC activities and presence, this indicator will be applied for this study too.

2.4.2 Economic development

The process of economic development is a result of increases in per capita income, gains in efficiency in production, changes in domestic demand, improvements in legal, administrative, and commercial infrastructure and other factors (Dunning 1992, p. 272). New growth theories

and early development-theories tended to focus on economic growth as the dominant factor for economic development. Equating economic growth with economic development made per capita income the predominant indicator while most other aspects of economic development were seen to depend on the level and changes of per capita income (Lexikon Dritte Welt 1993, p. 206; Menzel 1993). The main argument for this theoretical assumption is that the necessary accumulation of capital can only be achieved by an increase of the saving rate. But the lack of a per capita income which exceeds the amount necessary to satisfy basic needs and allows saving constitutes a vicious circle since savings lead to greater prosperity, which in turn leads to higher saving rates. Due to a low saving rate, worn out means of production cannot be replaced or modernized and labor productivity cannot be increased which, prevents development in other areas described by other indicators.

The focus on the single indicator of economic growth rate is a narrow perspective on economic development since it neglects other aspects inherent to this economic process (Woll 1996). But Bornschier & Chase-Dunn (1985, p. 63) point out that other measures of economic change, like for example changes in the labor force composition by sector or the consumption of energy are highly correlated with per capita income and would yield similar empirical results. This study and the studies, which are reviewed in this text, use the growth rate of per capita income as a proxy for economic development. In this study economic development is therefore measured identically.

2.5 Hypotheses

The hypotheses have been formulated to reflect scientific findings on this subject. Since these findings are contradicting, the reverse causation hypotheses would be applicable too. Each hypothesis is followed by the null hypothesis.

Main Hypothesis

Foreign direct investment has a positive effect on economic growth in developing countries.

Null hypothesis: Foreign direct investment has no effect on economic growth in developing countries.

Related Hypothesis 1

Foreign direct investment inflows have a positive effect on economic growth in developing countries.

Null hypothesis: Foreign direct investment inflows have no effect on economic growth in developing countries.

Related Hypothesis 2

Foreign direct investment stocks have a positive economic effect on economic growth in developing countries.

Null hypothesis: Foreign direct investment stocks have no effect on economic growth in developing countries.

Related Hypothesis 3

Foreign capital is less productive than domestic capital.

Null hypothesis: There is no difference in capital productivity.

Related Hypothesis 4

The larger the share of reinvested earnings in FDI inflows the stronger the positive effect of FDI inflows on economic growth in developing countries.

Null hypothesis: The share of reinvested earnings does not affect the effect of FDI inflows in developing countries.

2.6 Motivation

The journal article by de Soysa & Oneal (1999) with its reference to important studies on this subject by Bornschier et al. (1985; 1978), Firebaugh (1992; 1996) and Dixon & Boswell (1996a; 1996b) which was given to me by my supervisor Professor Carlo C. Jaeger at EAWAG caught my attention. The Sociological Institute of the University of Zurich - and Professor Volker Bornschier in particular – has significantly contributed to the scientific discussion on the effects of TNC activities and foreign direct investment on the development process of Third World countries. As a student at this institute it was a natural choice to use this subject.

…für die Staatsform in China bin ich nicht verantwortlich.

"Wir verkehren auf der Welt mit sehr vielen sündigen Menschen. Ich bin für die Demokratie in der Schweiz, für die Staatsform in China bin ich nicht verantwortlich. Man muss investieren, dann wird auch in China vieles freier."

***Christoph Blocher**, entrepreneur, billionaire, strategic head of the Swiss Popular Party, and newly elected federal council of the Swiss government in an interview in late November 2003 when asked why he does business with China despite of human rights violations and the contempt of democracy in China (Nussbaumer and Szöllösy 2003)*

Section II

State of the Art: Theory and Empirical Analysis

3 THEORIES OF DEVELOPMENT, TRANSNATIONAL CORPORATIONS AND FOREIGN DIRECT INVESTMENT

3.1 Introduction

Developing countries received a substantial amount of loans from industrialized nations since World War II - around US$ 2.1 trillion at the end of 1996 (Krugman and Obstfeld 2000). Most of the developing countries rely heavily on capital inflows from abroad to finance their domestic investment. Such foreign capital will typically be in the form of loans or equities. As a consequence of unprofitable investments with loaned capital many developing countries are heavily indebted, which makes them extremely vulnerable to international lending crises. In contrast to that, equity finance leaves developing countries less vulnerable to the risk of foreign lending crises. However, equity finance might include other risks. Since the last lending crises many developing countries cannot get new loans because they belong to the group of the heavily indebted countries (HIC) and most are close to default, which makes them no more eligible for new loans. Capital by transnational corporations (TNCs) in the form of foreign direct investment (FDI) is the only source of new capital available to many developing countries.

For decades researchers have tried to explain the significant differences in development of the countries across the world and have proposed differing strategies on how these differences can be overcome. *Theories of modernization*, dominated by economists, assume endogenous causes for the development backlog in the Third World and propose a transition path comparable to the historical path of development of the First World, while researchers in the field of *dependencia* and *world system theory* argue that there are exogenous causes for underdevelopment.

The following section shall give a brief review of the theories of development and modernization followed by a description of the dimension and characteristics of TNC activities in the

world. The last part outlines the trends of foreign direct investment flows and the accumulation of foreign capital in the different world regions.

3.2 Theories of development

The persistent lack of economic growth, increasing poverty and slow technological progress in countries of the so called Third World gave rise to a series of social and economic theories in the wake of the fifties, which tried to find the causes of underdevelopment in these countries. Analyses based on theses theories ascertain different causes and assume differing sets of indicators for underdevelopment. Nevertheless they agree on some indicators: Low per capita income, high propensity to consume, low investment/saving rate, low capitalization and low labor productivity, low industrialization (rural economies), high unemployment rate, insufficient public infrastructure and development, high population growth rate, inadequate health care and inadequate education just to name a few (Nohlen and Nuscheler 1993, p. 33).

Theories of development are normative theories and no universally valid definition can be applied. Each theory emphasizes a preferred path of economic and social development, causes of underdevelopment, strategies for transformation and for launching and maintaining processes of development. In the realm of the academic debate on underdevelopment two major theories require special attention. The *dependencia theory* and the *theories of modernization* (Lexikon Dritte Welt 1993, p.206).

Terminology

The distinction between developed and underdeveloped regions is accompanied by a certain terminology. *Modernization* theorist often use the concepts of *modernity* and *tradition* to express the differences in levels of development. In *dependencia theory* the idea of regional hierarchy is emphasized by the term *periphery* for the less and underdeveloped regions and *centre* for the developed respectively industrialized regions of this world. Other terms used are *core* and *periphery*, *North* and *South* or *metropole* and *satellites* (Chase-Dunn 1989, pp. 201-202). In this paper *centre* and *periphery* is used.

3.2.1 Dependencia

In the mid sixties a series of social and economic studies were published which focused on the subject of *dependencia* (dependence) in their analyses. The aim of the *dependencia theory* was to provide a theoretical explanation for underdevelopment and to develop strategies on how this underdevelopment could be overcome. Underdevelopment was linked to foreign trade and international relations. Contrary to *new growth theories,* which were dominant in the field of economics and which argued that underdevelopment is a consequence of endoge-

nous entailed deficits to modernize, *dependencia theory* focused on exogenously caused reasons of underdevelopment. Underdevelopment was no more primarily seen as status of lagging behind the state of development achieved by industrialized countries and as a consequence of poor integration into the system of the modern world, but rather as a consequence of high integration of peripheral countries into a world economy, which is dominated by capitalistic (industrialized) countries of the centre (Lexikon Dritte Welt 1993, p.162-166). Underdevelopment was seen as a consequence of differential distribution of power between the northern industrialized countries of the centre and the southern countries of the periphery. For the advocates of this theory, underdevelopment neither resulted from scarcity of resources and capital nor from excessive population growth, climatic and ecological disadvantages, cultural backwardness, or reluctance to work, but rather from imperialism. Imperialism was seen as the cause for the inability of the countries of the Third World to develop because imperialism keeps these countries underdeveloped in order to exploit their resources and to use them as markets for the goods of industrial mass production (Nohlen and Nuscheler 1993, p.46). That is, underdevelopment was not seen as the result of a historically independent evaluation but as a consequence of a colonialistic-imperialistic penetration and of an asymmetry of world trade which was forced upon these countries for centuries (Mansilla 1986, p.92). Further arguments, summarized for example by Mansilla (1986, p. 92-93), are that underdevelopment can not be seen as an early stage of a historical evolution which precedes modernity, but rather as a process which is linked to development and which evolves simultaneously to development, while the fate of the underdeveloped regions in this process is to reduce the total costs of the developed regions. The internal structure of the economy of the periphery is thereby shaped by the development and the expansion of the centre, which limits the ability of the dependent countries to grow. The dynamics and the goals of the centre influence and deform all economic and social areas of the periphery and prevent the emergence of a genuine national identity and a self-determined path of development. The pattern of this asymmetry is mainly based on a deterioration of the terms of trade that guarantees a persistent flow of resources from the periphery to the centre resulting in a severe shortage of capital in peripheral countries and a degradation of these countries to mere supplies of commodities. That is in *dependencia theory* the wealth and the far advanced level of development of the centre is based on the exploitation of the periphery.

Two major approaches

Within *dependencia theory* two major approaches emphasize slightly differing causes for underdevelopment and strategies to overcome it.

The first approach, which is based in a marxist point of view, stresses the deterioration of the terms of trade and the exploitation of the periphery by the centre as the main causes for underdevelopment. Unequal exchange forces developing countries to increase exports to maintain the level of imports. This can only be achieved by a constant increase of the burden on the labor force, paralleled by a decrease of the purchasing power. Transnational corporations are seen as one of the major reasons for this process because they transfer their profits out of developing countries and thereby cause decapitalization in the host economies. Due to these terms of trade, peripheral countries are not able to develop in accordance with the needs of their society. Therefore the exclusion of these countries from the world market by a socialist revolution is seen as a way out of dependent development (Boeckh 1993; Lexikon Dritte Welt 1993, p. 163).

The second approach emphasizes the structure of the relations between economies of the periphery and the centre and the alignment of the peripheral economies with the needs of the economies of the centre. Structural change results from changing conditions of the world market. These structural changes tend to trigger only a partial modernization, which affects only the respective sectors of export, but subordinates other sectors of the society to this respective export sector without integration. This lack of integration can lead to structural heterogeneity. While societies of the centre are seen as fully integrated in a capitalist manner, peripheral societies are characterised by this structural heterogeneity. With the presence and interaction of differing social structures in peripheral countries the dynamic in productivity and growth of the countries of the centre cannot be achieved (Lexikon Dritte Welt 1993, p. 163-164). In addition - as in the Marxist approach - foreign investment and particularly transnational corporations are seen as dominant actors in this process of impeded development. Transnational corporations repatriate their above-average profits from their investments in developing countries, causing decapitalization in the underdeveloped host economy. This impairs capital accumulation as well as productivity, which can only be compensated by increasing the rate of exploitation of the labor force and causes constantly diminishing real per capita income. The political actions taken by transnational corporations are regarded to support the process of uneven economic development, resulting in great intranational inequalities in the periphery. The integration of peripheral economies into the global economic system dominated by TNCs, which influence the process of political decision making on an international level, puts pressure on the host economies to comply with international economic policies. Once Third World countries have achieved a certain level of industrialization, the most dynamic economic sectors within these economies are dominated by TNCs, which pursue in-

terests in global profitability. These interests and the transnational linkages can undermine the goals of domestic economic policies. If monopolistic trade patterns come together with formal or informal political control by the dominant TNCs, effective state actions can be negatively affected (Evans 1985, pp. 194-195).

Political decisions, especially those affecting economic policies can be influenced by foreign investors. If foreign companies dominate specific economic sectors – usually new sectors for the respective economy - within the host economy, they can control domestic decision making to some extend. The creation of new economic sectors and the operations by TNCs entail an administrative, technological and financial reorganization of the home market – tailored to the capitalistic economic system of the center – resulting in new forms of political and social control. This reformation can leave the host with less strategic control over the production system and the economic development process, and can therefore lead to a decrease of domestic economic autonomy (Cardoso and Faletto 1976, pp. 191-192). The integration into the global economic system and the economic dominance of TNCs in the host economy within particular sectors is accompanied by a transformation of the economic system towards an industrial capitalistic system. This forces host countries to create a political basis to cope with the requirements imposed by this process. Participation of the masses in this process depends on the one hand on how strongly the (modern) economic system is controlled by the state or on how close the ruling class cooperates with foreign investors for their own benefit. On the other hand it depends, for example, on how strongly the working class is marginalized by the economic development process (pp. 195-199).

Evans (1985) outlines that transnational linkages and the presence of TNCs can – depending on the type of industry – stimulate the development of new state capacities and can lead to an expansion of the state's role into areas which were otherwise preserved of private capital (p. 195). Intensive penetration of the host economy by TNCs in the field of extractive industries can accordingly lead a rise of the state apparatus with increased control over the respective industries and with a more dominant position over the overall economy (p. 197). However, this expansion of the state's role not necessarily results in greater capacity, but can also result in ineffective intervention, corruption and capture by other social actors (p. 200). The expansion of the state's role has the effect of stronger involvement of the state with the TNCs rather than exclusion, which potentially increases the state's capacity in organizational terms and in terms of power relative to local actors like labor and domestic capital. This involvement provides TNCs also with the possibility to influence political and economic decisions, especially in the case of conflicts when the state apparatus is in the crucial position to mediate relations

between and interest of local actors and TNCs (p. 204). Since the TNCs are often sitting astride key sources of government revenues and foreign exchange, the state apparatus can find itself deciding in favor of TNCs and to the disadvantage of local actors (p. 216).

Other forms of political influence are blunt corruption. Developing countries, which are often prone to corruption, might offer TNCs various ways to influence political and economic decisions. In "predatory" states, as Evans (1989) calls them, where everything is for sale – not only political decisions, but also legal judgments, licenses or appropriations – those with enough money can get what ever they seek. However, such predatory states bear also high risks for foreign investors. But generally, rent seeking politicians and the domestic bourgeoisie might give hand to serve the interest of TNCs operation in the country. If TNCs and domestic private elites are involved in corruption, the state is handicapped or even incapable of formulating and implementing goals as well as acting autonomously since decisions are up for sale (p. 571).

TNCs can influence electoral battles by financing electoral campaigns. This does not only happen in developing countries, but also in industrial countries like the US, where large foreign corporations can donate funds to the preferred presidential candidate. TNCs also dispose of the sufficient financial means to influence public opinion through TV-spots, advertisement or articles in print media and can therefore lobby in their own interest.

The sum of these negative effects mentioned earlier is seen to persistently prevent industrialization of the underdeveloped countries (Chase-Dunn 1989, p.236; Lexikon Dritte Welt 1993, p. 163-164), while the ambiguous effects of the state's involvement with TNCs might result in beneficial or disadvantageous developmental effects.

Criticism

Contrary to the Marxist approach, which has been widely questioned regarding the theoretical base of its assumptions and which was criticized for its lack of empirical evidence, the structuralist approach provided the base for a number of empirical studies. Particularly studies by Bornschier et al. (Bornschier and Chase-Dunn 1985; Bornschier, Chase-Dunn, and Rubinson 1978) back the thesis of the structuralist approach. Since the main thesis of these studies gave rise to the research question and empirical analysis of this paper, they will be discussed in a comprehensive form later in this section.

The Marxist approach was not only criticized for its lack of empirical studies but also in regard of its unbalanced focus on the deterioration of the term of trade without further investigation of the historical evolution of development in the Third World. Especially the assumption that prior to the European colonial expansion, all countries disposed of the same amount

of natural resources and intellectual potential and that all flaws of the historical evolution in the Third World are caused by the capitalistic and imperialistic penetration has been widely criticized (Lexikon Dritte Welt 1993, pp. 163-164; Mansilla 1986, pp. 94-95).

Critics of *dependencia theory* stress that a major deficit of the theory is its generalization of the postulated relationship between the centre and the periphery since advocates of this theory claim that all negative effects that hamper development account for all countries of the periphery regardless of the state of development and the geographical location or other equally relevant factors (Boeckh 1993, p. 111; Lexikon Dritte Welt 1993, p. 165; Mansilla 1986, pp. 94-95). Another aspect is that the political and social order and hierarchical structure in peripheral countries, which are solely seen as a result of dependent capitalistic development, have not adequately been covered by research (Lexikon Dritte Welt 1993, pp. 164-165).

Though the countries of the centre are held responsible for the underdevelopment and the misery in the peripheral countries, yet they are seen as embodying the positive and normative values of successful development and reflecting the positively emphasized achievements of modernity. This is seen as a quasi contradiction (Mansilla 1986, p. 95).

3.2.2 Theories of Modernization

Theories of modernization have been competing theories to *dependencia*. Proponents of the *theories of modernization* argue that endogenous factors cause underdevelopment and that the expansion of global capitalism is the driving (exogenous) factor for development. It is assumed that underdeveloped societies can develop by imitation and alignment to developed societies. Tradition and modernity represent the starting point and goal of this process. Traditional values, traditional practices and social as well as political structures are exogenously modernized, while any restriction to this process of development is endogenously caused (Lexikon Dritte Welt 1993, p. 478; Menzel 1993).

Early *theories of modernization*, namely the new growth theories, focused on economic growth as the dominant factor for development. Equating economic growth with development respectively industrialization made per capita income the predominant indicator while most other factors were seen to depend on low per capita income or being caused by low per capita income (Lexikon Dritte Welt 1993, p. 206; Menzel 1993). The necessary accumulation of capital should be achieved by an increasing the saving rate. The main argument is that the lack of a per capita income which exceeds the amount that is necessary to satisfy basic needs and allows saving constitutes a vicious circle since savings lead to greater prosperity which in turn leads to higher saving rates. Due to a low saving rate, worn out means of production can not be replaced or modernized and labor productivity can not be increased which prevents de-

velopment in other areas described by other indicators[1]. New growth theory suggested that income should be redistributed in favor of the upper income classes in order to increase the saving rate. Once a certain level of development is reached, income can be redistributed back and democratic institutions established (Herkenrath 2003, p. 44; Menzel 1993). These early *theories of modernization* have been criticized because of their focus on a single factor and of their over-emphasis of tradition as the opposite of modernity.

Theories of modernization consider underdevelopment to be an early stage of development from tradition to modernity. The focus is on the factors that delay or hamper development and not on the causes of underdevelopment itself. Underdevelopment is simply seen as a given fact and the question what has been causing underdevelopment is not asked. The major question is focusing on what is causing the lack of progress in development. The lack of progress in development is blamed on endogenous factors, while in contrast to *dependencia*, exogenous factors are attributed a positive function. Especially transnational corporations are promoted since their presence in developing countries can contribute to the accumulation of capital, provide a transfer of technology, knowledge and management skills, create jobs, contribute to a diversification of the economy and ensure the diffusion of social and political values of the centre. Further, *modernization theories* emphasize the role of the centre as a model for the periphery. It is therefore proposed that developing countries follow the path of development of the countries of the centre. (Herkenrath 2003, pp. 48-49; Kiely 1998, pp. 46-49; Lexikon Dritte Welt 1993, pp. 478-482 and 169).

Criticism

As in the case of *dependencia theory* it is criticized that in *modernization* theories the modern societies of the centre are seen as the point of reference for the process of development and that the capitalistic system, as well as the values and achievements of the centre are proclaimed as the sole goal of development. In addition, for all countries of the periphery the same path to modernity is assumed, regardless of the social and cultural structures of the respective countries. Regarding the assumed benefits of the presence of transnational corporations in peripheral countries, *theories of modernization* have been criticized especially by *dependencia* theorists for being very sided and indifferent about the fact that transnational corporations operate for profit in these countries and that they have an incentive to preserve conditions for profitable operations.

[1] For a brief explanation of the correlation between saving rate and per capita income see Worldbank. 1999. "Why do saving rates vary across countries?" *World Bank Policy and Research Bulletin* 10:1-4.

3.2.3 World system theory

World system theory is not a coherent theory but rather a set of competing theoretical approaches, which emerged in the 1970s. *World system theory* draws from many theoretical aspects of *dependencia theory* but accounts for a wider range of social and economic concepts and therefore goes beyond the framework of *dependencia theory* (Bornschier 2002 p. 138). National development is not the isolated process of a particular country but a process, which takes place within a global system and is therefore influenced by this very global system. *Modernization* and *dependencia theory* tend to be limited to economic development respectively on the peripheral and semi-peripheral regions of the world, while *world system theories* expand their view on the economic, political and cultural structure of the world system. In *world system theory*, underdevelopment is determined by economic, political, and social forces that are beyond the range of influence of the affected societies. The economic dimension is constituted by world trade and a globalizing economy represented by transnational corporations. This economic dimension affects the political dimension regarding the power structures. Political regimes, international organizations or military alliances are elements of this dimension, but also the political power structure within a country. The cultural dimension reflects the cultural integration. The cultural integration, which is related with aspects of the economic and political dimension, specifies the global diffusion of norms and values (Bornschier and Chase-Dunn 1985, p. 10; Herkenrath 2003, p. 54).

As in *dependency theory*, transnational corporations are of great importance in *world system theory*. TNCs are seen as the strongest agent in the world system who is promoting the hierarchical order in the world division of labor and therefore favoring a capitalistic world order. TNCs are central institutions in the world-economy that cause an internalization of economic relations, which were previously regarded as international. They constitute a new organizational form of the world economy (Bornschier and Chase-Dunn 1985, p. 14). Regarding the political dimension, a power shift from states in national economies to a transnational economy is assumed. Nations are still significant, but are only one unit within this system besides other nations and relevant political and economic institutions. Political regimes and international institutions constitute a political order in the world system, but this order can be subjected to economic interest and power.

Contrary to *dependencia theory*, *world system theory* considers the whole social world structure with its institutions and dynamics. Dependence is no longer seen as a permanent state of a particular country because countries can move up or down in the economic and political hierarchy constituted by the concept of centre and periphery. That is, countries of the centre are

subject to social change too. Social change in the centre affects the whole social system of the world due to the dominant position of the centre (Bornschier 2002, p. 188).
This broad perspective of *world system theory* overcomes many of the shortcomings of *dependencia theory*.

3.3 Transnational corporations

3.3.1 Definition

There are several definitions for transnational corporations (TNCs). A widely accepted general definition is as follows:

A Multinational or transnational enterprise is an enterprise that engages in foreign direct investment (FDI) and owns or controls value-adding activities in more than one country.
(Dunning 1992, p. 3)

Other definitions are more specific and request that a certain share of revenues must be achieved in other countries than the home country, or that a share of investments must be allocated in a minimum number of foreign countries, or that subsidiaries it owns or controls must be of a specified size and number in order to call an enterprise *transnational* or *multinational* (Dunning 1992, p. 3; Woll 1996, p. 492).
The definition, which is accepted by the United Nations Conference on Trade and Development (UNCTAD) includes a specific requirement regarding the share of assets controlled by the parent enterprise.

Transnational corporations are incorporated or unincorporated enterprises comprising parent enterprises and their foreign affiliates. A parent enterprise is defined as an enterprise that controls assets of other entities in countries other than its home country, usually by owning a certain equity capital stake. An equity capital stake of 10% or more of the ordinary shares or voting power for an incorporated enterprise, or its equivalent for an unincorporated enterprise, is normally considered as an threshold for the control of assets.
(UNCTAD 2002b, p. 291)

Bornschier and Chase-Dunn (1985, p. xii) provide the following definition:

1. They are business firms producing commodities or services for profit.
2. They are organizational entities with a *single division of labor* under the effective control of a centralized hierarchy[2].

[2] emphasized in italics in original

3. Organizational subunits are located and operating in different countries.
4. These corporations are among the leading firms in the countries where they are active.

Bornschier and Chase-Dunn are advocates of TNC-critical theories and their definition includes also sociological aspects which addresses issues at stake in this analysis that is after all motivated by research of Bornschier et al. (Bornschier and Chase-Dunn 1985; Bornschier, Chase-Dunn, and Rubinson 1978).

TNCs usually engage in multiple economic activities across national boundaries, while much of the cross border markets are internalized, that is, they are transacting the goods and services internally. This distinguishes TNCs from other transnational institutions like large non-government organizations (NGOs) or international organizations. Most TNCs are nationally controlled, but internationally owned and, as pointed out in #2 of Bornschier and Chase-Dunn's definition, this control is based on a hierarchical order and centralized. Theories critical towards TNCs assume that TNCs play a central economic and political role in the countries in which they operate. Number 4 in Bornschier and Chase-Dunn's definition focuses on this specific characteristic of TNCs which will be address in more detail further below (Bornschier and Chase-Dunn 1985, p. xii; Dunning 1992, p. 4; Herkenrath 2003, p. 21).

3.3.2 TNCs in the world economy

TNCs play an important role in world trade and investment. For example in the US half of the imports can be regarded as transactions between branches of TNCs, that is, the seller and buyer are presumably owned and controlled by the same firm (Krugman and Obstfeld 2000, p. 173). Globally about half of all foreign trade can be accounted to intra-firm trade, while the share for overall foreign trade where TNCs are involved is estimated to be even larger at about two third. That is, as the World Investment Report (WIR) from 1995 points out, international production by TNCs increasingly influences the size and nature of cross border transactions, while this process shapes the nature of the world economy. TNCs have become the central organizers of economic activities and major actors in shaping the international division of labor (UNCTAD 1992, p. 1; UNCTAD 1995, p. 2). *Table 3.1* provides an overview over some key-indicators for international production. International production denotes the production of goods and services in countries that is controlled and managed by firms headquartered in other countries. Outward FDI stock and global sales of foreign affiliates are thereby two generally accepted proxy indicators of international production.

Table 3.1

Year	TNCs	Foreign Affiliates	Total FDI outward stocks	Sales of foreign affiliates	World exports	Employees
1990	35'000	150'000	US$ 1.7 trillions	US$ 4.4 trillions	US$ 2.5 trillions	24 millions
1995	40'000	270'000	US$ 2.7 trillions	US$ 7 trillions	US$ 5.8 trillions	-
2001	65'000	850'0000	US$ 6.6 trillions	US$ 19 trillions	US$ 8 trillions	54 millions

Key-indicators for international production

Source: World Investment Reports (UNCTAD 1992; UNCTAD 1995; UNCTAD 1996; UNCTAD 1997; UNCTAD 2002b)

Outward FDI stock refers to the value of capital and reserves in another economy attributable to a parent enterprise resident in the economy. Inward FDI stock in the reporting economy is the value of capital and reserves in the economy attributable to a parent enterprise resident in a different economy.

The data reveals that between 1990 and 2001 the number of TNCs nearly doubled and that the number of foreign affiliates increased more than fivefold. Sales of foreign affiliates are more than twice as large as world exports in 2001. A decade earlier differences were significantly less. These figures reflect a trend which started decades earlier, but considerably increased since the eighties. TNCs have been present since the nineteenth century but they grew in significance in the 1950s. Their growth is merely a consequence of a set of economic conditions. Particularly US-based TNCs responded to the growing economic challenge they faced from Japan and Europe with a new strategy. The new strategy focused on the establishment of production and sales bases in foreign countries. European and Japanese companies subsequently implemented this strategy too, which manifests a visible feature of the process of globalization (Kiely 1998, p. 47)

3.3.3 The 100 largest TNCs

While the number of TNCs and their foreign affiliates appears quite large only a small number of TNCs dominate the scene. The world 100 largest non-financial TNCs in the year 2000 account for 11% of total foreign assets, 14% of total foreign sales and 14% of total employment by TNCs of the 65'000 transnational corporations estimated world wide (UNCTAD 2002b, p. 85). *Table 3.2* provides an overview on the key-figures of the 100 largest non-financial TNCs. These corporations, headquartered mainly in the USA, United Kingdom,

Germany, Japan, the Netherlands and some other developed countries as well as some Asian tiger states, control the lion share of foreign operations.

Table 3.2

Year	Foreign assets	Foreign sales	Foreign employment
1996	US$ 1.8 trillions (4.2)	US$ 2.1 trillions (4.1)	US$ 5.9 millions (11.8)
1997	US$ 1.8 trillions (4.2)	US$ 2.1 trillions (3.9)	US$ 6 millions (11.6)
1999	US$ 2.1 trillions (5.1)	US$ 2.1 trillions (4.3)	US$ 6 millions (13.4)
2000[3]	US$ 2.5 trillions (6.3)	US$ 2.4 trillions (4.8)	US$ 7.1 millions (14.2)

Key-figures of the 100 largest non-financial TNCs (figures of total values, that is domestic and foreign assets, respectively sales or employees in parentheses)

Source: World Investment Reports (UNCTAD 1999; UNCTAD 2002b)

The list of the top 100 TNCs is dominated by few industries – namely automotive, electronics and electrical equipment, petroleum, chemical and pharmaceutical industry – while the chemical and pharmaceutical industry dominates the group with more than 20% of the entries. In regard to foreign assets, TNCs from the petroleum industry are leading the list (UNCTAD 1999, p. 82; UNCTAD 2002b, p. 94). Examples of the UNCTAD's *World Investment Report 2002* top 100 TNCs list are Vodafon (UK), General Electric (US), ExxonMobil (US) or General Motors (US) just to name a few.

As illustrated in *Table 3.2*, in the year 2000, about 40% of the top 100 TNCs' total assets were located abroad, while 60% remained in the home country. Foreign sales made up half of the total sales. It is interesting to note the fact that a corporation can be called transnational or multinational by definition which does not necessarily imply that the main share of their total sales, total assets or employment takes place or is located abroad.

Employment by TNCs compared to the estimated total world labor force is rather moderate in regard to their dominance in world trade. Bornschier (2002, p. 458) estimates that in the year 1999, TNCs employed about 4% of the world labor force, while controlling more than 25% of

world trade. He considers TNCs operations rather as a problem for employment than a solution.

Regarding the largest TNCs named before, it is interesting to note, that these are not the most transnational corporations. The UNCTAD list for TNCs in terms of transnationality[4] names for example ABB (CH), Nestlé (CH) or British American Tabaco (UK), whose operations and assets are located with more than 90% in foreign countries as the most transnational corporations, while, for example, General Electric achieves only 40.3% transnationality and General Motors 31.2% (UNCTAD 2002b, pp. 86 and 97).

Some of the largest TNCs have the size of economies or are even larger. If the sales volume of TNCs is compared to world GDP then the top 200 corporations accounted for more than 25% or world GDP in 1999. Since the comparison of sales and world GDP is not satisfying, UNCTAD (2002b, p. 90) suggests another approach and compares GDP to sales recalculated as value added[5]. Based on this measure, ExxonMobil ranks at position 45 in a top 100 list of world's largest "economies". In year 2000 not less than 29 TNCs can be found in this combined list, while half of the "economies" between rank 51 and 100 were TNCs. The value-added activities of the top 100 TNCs accounted for 4.3% of world GDP in 2000. The increase from 1990 to 2000 expressed in dollars was about $US 600 billion which reflects the size and dominance of these corporations in the world economy.

Table 3.3

	Value added as a percentage of world GDP	
	1990	**2000**
Top 10 TNCs	1.0	0.9
Top 20 TNCs	1.8	1.5
Top 50 TNCs	2.9	2.8
Top 100 TNCs	3.5	4.3

The concentration ratio of the largest 100 TNCs in world GDP for year 1990 and 2000

Source: World Investment Report 2002 (UNCTAD 2002b, p. 91)

[3] The boost is assumed to be a result of the height of stock market boom and cross-border merger and acquisition activities

[4] The transnationality index (TNI) by the United Nations Conference on Trade and Development (UNCTAD) is calculated as the average of the following three ratios: foreign assets to total assets, foreign sales to total sales and foreign employment to total employment UNCTAD. 2002b. "World Investment Report 2002 - Transnational Corporations and Export Competitivness." United Nations, Geneva..

[5] Value added is thereby estimated as sum of salaries and benefits, depreciation and amortization, and pre-tax income Ibid.

3.4 Foreign direct investment

3.4.1 Introduction

In the preceding part on TNCs an overview was provided on how the number of TNCs and their foreign affiliates increased over the last decades. TNCs perform this geographical expansion of their operations through foreign direct investment, as well as a though variety of non-equity relationships with host countries' enterprises (UNCTAD 1992, p. 1). Since foreign direct investment (FDI) is the primary means for the expansion of TNCs operations, FDI figures are usually used as an indicator for the size and growth of transnational corporations. This part of the text provides a definition for FDI in regard to TNCs operations and a description of FDI trends.

3.4.2 Definition

Foreign direct investment refers to *international capital flows* that allow a firm in one country to create or expand a subsidiary in another country. In contrast to other forms of transferring resources, like borrowing and lending or certain forms of portfolio investment, foreign direct investment involves the direct *acquisition of control*. The subsidiary does not simply have a financial obligation to the parent company but it is also part of the very same organizational structure (Krugman and Obstfeld 2000, p. 170f).

The internationally accepted definition of foreign direct investment is that provided in the fifth edition of the IMF's *Balance of Payment Manual* (International Monetary Fund 1993, p. 87). UNCTAD's definition is derived from this definition but is more comprehensive. Therefore the following definitions for FDI, FDI flow and stock are quoted from the World Investment Report 2002 (UNCTAD 2002b, p. 291):

FDI is defined as an investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in one economy (foreign direct investor or parent enterprise) in an enterprise resident in an economy other than that of the foreign direct investor (FDI enterprise or affiliate enterprise or foreign affiliate).

FDI implies that a significant degree of influence and control is exerted by the foreign investor or parent enterprise. FDI may be undertaken by individuals or business entities.

Foreign direct investment has three components:

1. *equity investment:* the foreign direct investor's purchase of share of an enterprise in a country other than its own.

2. *reinvested earnings:* comprise the direct investor's share (in proportion to direct equity participation) of earnings not distributed as dividends by affiliates, or earnings not remitted to the direct investor. Such retained profits by affiliates are reinvested.
3. *intra-company loans or intra-company debt-transactions:* refers to short- and long-term borrowing and lending of funds between direct between parent firms and foreign affiliate.

Flows of FDI is capital that is provided by a foreign direct investor to an FDI enterprise or capital received from an FDI enterprise by a foreign direct investor. The *FDI stock* is the value of share of capital and reserves attributable to the parent enterprise, plus the net indebtedness of affiliates to the parent enterprise.

3.4.3 Regional distribution of FDI

Table 3.4 provides an overview of the regional distribution of FDI stock (in billion US$) and the regional concentration of parent enterprises and foreign affiliates. The data reveals that most of the FDI stock is owned by and is invested in developed countries. That is, 60% stays within the developed world, while roughly 40% goes to the developing countries. Africa gets the smallest share. Nearly all of the FDI stock as well as the annual FDI flows that go to the African continent go to North African countries, South Africa and Nigeria. The largest share of FDI stock in developing countries is located in Asia, especially in the transition countries of this region (Hong Kong, Taiwan, South Korea, Singapore, Malaysia etc.). Regarding the number of TNCs, it can be observed that most TNCs are headquartered in the developed countries, while their foreign affiliates are in developing countries. The largest share of foreign affiliates in developing countries can be located in Asia, while Africa again gets the smallest share of all.

Table 3.4

Region	Parent Corporations located in economy[6]	Foreign affiliates located in economy[7]	FDI inward stock in billions of US$		FDI outward stock in billions of US$	
Year	2000[8]	2000[9]	1990	2000	1990	2000
Developed Economies	*50'250*	*100'825*	*1'383*	*4'124*	*1'630*	*5'316*
European Union	35'096	61'685	733	2'381	798	3148
North America	4'985	23'200	507	1'415	515	1'520
Developing economies	*13'492*	*494'900*	*485*	*2'002*	*90*	*751*
Africa	1'156	6'100	50	142	23	47
Latin America and Caribbean	2'022	27'577	117	613	19	121
Asia	10'289	460'668	315	1'243	47	582
Central and Eastern Europe	850	255'442	3	131	0.6	18

FDI stocks in major world regions and number of parent firms and foreign affiliates by region

Source: World Investment Report 2002 (UNCTAD 2002b, p. 270-272 and 310-317)

This trend persists already for decades. FDI stock and flows have increasingly been concentrating in the industrialized countries since the 1960s. The right hand part of *Table 3.5* illustrates the regional distribution of FDI flows as a percentage figure of world total FDI flows. FDI flows to developing countries have decreased in the last decade, mainly due to the Asian crisis. Differences in FDI flows become even more obvious when comparing per capita figures. While only US$ 11 per capita of FDI inflow went to Africa in the year 2000, nearly 200 times more flew to countries of the European Union (EU). The average FDI inflow to the EU increased tenfold within ten years, while FDI inflow to Africa did not even double between 1990-2000. Though differences in inflows for the last decade are not as severe for other de-

[6] Represents the number of parent companies in the economy shown.
[7] Represents the number of foreign affiliates in the economy shown.
[8] Not all data is from 2000 but varies between 1995 and 2001
[9] Not all data is from 2000 but varies between 1995 and 2001

veloping regions as for Africa, the amount of per capita inflows is still drastically lower than for the developed world. It is necessary to mention that figures on FDI flows and stocks for the year 2000 tend to be larger than expected by assumptions based on the growth path. Figures for 1999 and 2001 tend to be smaller. These exceptionally larger figures are assumed to be a result of the height of stock market boom and cross-border merger and acquisition activities. Nevertheless, the trends and the differences in magnitudes of FDI stocks and flows that went to these regions of the world are pretty much the same if data for other years than 2000 are compared.

Table 3.5

Region	FDI flows per capita in $US				FDI flows as percentage of world total			
	Inward		***Outward***		***Inward***		***Outward***	
Year	1990-1994	2000	1990-1994	2000	1990-1994	2000	1990-1994	2000
Developed Economies	*162.9*	*1'429*	*250*	*1'480*	*65.3*	*82.3*	*87.8*	*92.2*
European Union	212	2'147	296	2'571	38.2	54.2	46.8	70.2
USA	143	1'062	196	583	18.2	20.2	22.1	12.0
Developing economies	*16*	*49*	*7*	*23*	*32.6*	*15.9*	*12.1*	*7.6*
Africa	6	11	4	2	2.0	0.6	0.8	0.1
Latin America and Caribbean	45	186	11	43	10.1	6.4	2.0	1.6
Asia	13	38	7	25	20.4	9.0	9.3	5.9
Central and Eastern Europe	17	79	1	12	2.1	1.8	0.1	0.3

FDI flows in absolute values as per capita figures and FDI flows as percentage of world total flows by region

Source: World Investment Report 2002 (UNCTAD 2002b, p. 265)

Comparing FDI flows as percentage share of gross fixed domestic investment (GDI) to the regions portrayed, it turns out that the differences are far less. In the first half of the last decade, FDI inflows expressed as percentage share of GDI were even larger in developing than in industrialized countries. This percentage share increased in all regions during this period, but

experienced a boost for the years 1999 and 2000. That is, for the early nineties, FDI inflows were of about the same magnitude relative to GDI in all regions, while differences became larger by the end of the decade. If FDI instock is expressed as a share of gross domestic product (GDP), developing countries tend to show a stronger presence of FDI instock. This presence of FDI instock relative to GDP increased for all regions.

Table 3.6

Region	FDI flows as percentage of gross fixed domestic investment				FDI stocks as percentage of gross domestic product			
	Inward		***Outward***		***Inward***		***Outward***	
Year	1990-1995	2000	1990-1995	2000	1990	2000	1990	2000
Developed Economies	*3.6*	*25*	*5.5*	*25.9*	*8.1*	*17.1*	*9.6*	*22.1*
European Union	5.5	50.1	7.7	60.0	10.1	30.3	11.6	40.1
North America	4.5	19.8	6.1	11.4	8.0	13.5	8.1	14.5
Developing economies	*5.7*	*13.4*	*2.5*	*5.8*	*13.0*	*30.9*	*2.9*	*11.9*
Africa	4.9	8.1	2.3	0.8	10.7	25.2	5.9	9.2
Latin America and Caribbean	7.4	20.7	1.2	2.4	10.4	30.9	1.8	6.2
Asia	5.2	11.6	3.0	7.4	14.8	31.6	2.7	15.2
Central and Eastern Europe	4.8	18.2	0.2	2.8	1.7	18.9	0.4	2.7

FDI flows as a percentage share of GDI and FDI stocks as percentage of GDP by region

Source: World Investment Report 2002 (UNCTAD 2002b, p. 319-336)

Summarizing the facts, it can be observed that, while the less developed countries of the world receive less FDI than the developed countries - either expressed in total amount of FDI or in per capita figures – differences in FDI compared to indicators for the domestic economy – such as GDI or GDP – tend to be much less. That is, differences in total amounts of FDI flows or stocks are large, but differences in regard to the size of the host economy are significantly smaller.

3.4.4 FDI as measure for TNC activity and data quality

The assessment of TNCs activities in the world economy is constrained by the availability and quality of data. Dunning (Dunning 1992, p. 7) suggested that the best indicator for the overall or sectoral economic significance of TNCs activities is *value added* that is created by these corporations outside their national boundaries. Indeed, only three indices for TNCs activities are available which limits a comprehensive analysis. The three indices are the FDI in- and outstocks, FDI in- and outflows and the income earned. A good statistical source for these indices is the *World Investment Report* (WIR) published by the *United Nations Conference on Trade and Development* (UNCTAD), which is probably the most comprehensive and comparable set of data on FDI and TNCs. Other data is available from the *OECD*, the *World Bank* or private institutions like *J.P. Morgan*. The WIR and all other statistical data sets face problems regarding the data consistency. For example many countries fail to report reinvested earnings as part of FDI flows. By definition, FDI is made to establish a lasting interest in or effective management control over an enterprise in another country. As a guideline, the IMF suggests that investments should account for at least 10% of the voting stock to be counted as foreign direct investment, though many countries set a higher threshold. FDI data does not represent a complete picture of international investment in an economy. Balance of payment data on FDI do not include capital raised in the host economies, which has become an important source of financing investment projects in some developing countries (Dunning 1992; UNCTAD 1999). Another problem is that foreign direct investment data is limited because it captures only cross-border investment flows involving equity participation and omits non-equity cross-border transactions such as intra-firm flows of goods and services.

Nevertheless, data on FDI offer - despite of these problems - the only means to measure the dimension of global international production and the effects of TNC activity (Dunning 1992; UNCTAD 1999, p. xx).

3.5 The role of TNCs and FDI in world economy

3.5.1 Introduction

The two preceding parts draw a rough picture of the importance of multinational firms in world trade and investment. Their tremendous growth in number and size represents a qualitative shift in the world economy. Kiely (1998, p. 47) points out that an international economy, which is based on trade between nations, has existed since at least the seventeenth century. In this economically non-closed system, nation-states are the core units. They shape the trading relations of this system by uni- or multilateral trade policies for the movement of capital, labor and goods. The qualitative shift in the world economy takes place from an inter-

national economy to a global economy that is characterized by the dominance of investment flows by TNCs, whose mobility bypasses national boundaries. Bornschier & Chase-Dunn (1985, p. 13) emphasize that TNCs are the first institutions that have tried to centrally plan production on a global scale and that the revolutionary aspect of TNCs is not their size, but rather their vision, in which the whole world is seen as a terrain for their operations. The centralization of control and decision making does not only affect the production and distribution of goods and services, but it also changes the organization of the worldwide division of labor in which these production and distribution process takes place[10]. Changes in the division of labor resulted from the relocation of production from industrialized countries to the developing countries. This relocation of labor is seen as a consequence of an increase in labor costs, which is associated with decreasing profits. Development in transportation and communication supported this process of a globalized economy. It is therefore assumed that the emergence of this global economy has enormous implications on countries of the Third World (Kiely 1998, p. 47). Within this global economy, the operations of TNCs amount to a large part of world trade – meanwhile, their sales are more than twice the amount of world exports – which allows them to exert a significant amount of control over world trade. TNCs are therefore seen as the protagonists of the global economy (Bornschier 2002, p. 453). It is necessary to mention that the importance of TNCs in the world economy is not a completely new phenomenon. In a historical perspective, the ratio of world gross domestic product to the stock of foreign investment has been comparable to today's ratio in the year 1914. But the two World Wars caused a severe drop in FDI. A new significant increase in FDI started not until the 1970/80s. The so-called globalization characterized by high economic integration is therefore not as new as often proclaimed (Bornschier 2002, p. 457; Maddison 2001, p. 125).

3.5.2 The effects of TNCs operations and FDI

There are differing assumptions regarding the implications of this global economy for the countries of the Third World. The advocates of a global economy's general claim is that FDI and TNC presence is beneficial in the Third World, since they foster domestic investment, lead to industrialization, provide a transfer of technology as well as management knowledge and promote an efficient and undistorted system of market economy. FDI helps accelerating the process of development in the host countries. Production linkages are seen as the most important factor for this process, while these linkages can be backward, forward and hori-

[10] The world wide division of labor is the division of an entire production process into several sup-processes which are then carried out by specialized workers or machines. This division can take place within a manufacturing plant or a company, within an

zontal. Backward linkages exist when foreign affiliates acquire goods or services from domestic firms, while forward linkages are when foreign affiliates sell goods and services to domestic firms. Horizontal linkages cover competitive activities between domestic firms and foreign affiliates. Besides the claimed economic benefits of these linkages, these linkages are marked by beneficial externalities such as sustained exchanges of information, technology, skills and other assets (UNCTAD 2001). Of course, all of these assumed beneficial effects of TNCs operations depend on country-, firm-, and industry-specific characteristics and the kind of FDI undertaken as well as on non-economic factors like political autonomy, cultural identity, industrial safety and environmental protection (Dunning 1992, p. 263).

The sum of these assets is assumed to be the key to economic growth in the host countries. That is, FDI fosters economic growth and the operations of TNCs in developing countries increase the pace on the path to industrialization.

Another key question in regard of the effects of FDI on development is whether TNCs crowd in or whether they crowd out domestic capital. When TNCs crowd in domestic investment, then their presence, for example, stimulates new downstream or upstream investment that would not have taken place in their absence (e.g. domestic capital formation, new goods accompanied by knowledge transfer etc.). The opposite effect, crowding out, would occur when TNCs displace domestic producers or when their operations thwart investment opportunities of domestic economic agents. Since developing countries often lack a considerable and well established entrepreneurship, a displacement of domestic firms by TNCs would rather be considered a negative effect (Agosin and Mayer 2000, p. 1). The findings of Agosin and Mayer's analysis indicate that the operations of TNCs can either crowd out or crowd in domestic capital or lead to an almost balanced effect. TNCs presence in Latin America, where economic liberalization is the most far-reaching, crowding out appears to be the norm, while crowding in is strong in Asia where state policies regarding foreign investment are the least liberal. The effect of crowding in and crowding out seems to be balanced in Africa. But crowding in or crowding out does not seem to be associated with particular foreign investment policies, at least not in a verifiably manner (p. 14-15).

Critics of TNCs' operations stress that the globalization of production leads to disadvantages for the developing countries. Investments by TNCs in the Third World are seen to promote an uneven industrialization and to lead to an exploitation of the cheap labor force and resources of the host economies. TNCs operations are assumed to primarily promote dependence rather

economy or on an international level. The division of labor leads to an increase in productivity due to specialization and concentration.

than beneficial linkages. Many countries in the Third World are highly indebted and cannot get new loans since the last debt crisis. These are generally the poorest countries and most of them depend on TNCs as providers of resources, capabilities and markets, as creators of jobs and wealth, and as suppliers of foreign currencies (Dunning 1992, p. 284). Further above, *Table 3.1* to *Table 3.6* illustrated the importance of TNCs and FDI in world trade. The data makes obvious that the developing countries - countries of the periphery - are more penetrated by FDI than the rich countries of the centre. The economies of these peripheral countries are therefore under stronger control by TNCs from industrial countries.

During the last three decades, there has been a series of empirical analyses on the effects of TNC activities on development and prosperity. Some of these analyses will be reviewed later. According to Bornschier (2002, p. 472-476), three theoretical viewpoints regarding the effects of TNCs activities can be distinguished, which will be briefly outlined as follows.

The optimistic viewpoint

This viewpoint is strongly influenced by the theories of modernization. According to the optimistic viewpoint, TNCs are the driving force for a catch-up process in development. They dispose of the necessary means to compensate for the acute scarcity of capital in developing countries, which is the key factor for the lack of development. They do not only provide the necessary financial means, but also spur productivity and efficiency by modernizing the economy. A strong presence of TNCs and a large FDI stock is desirable because the stronger the presence the faster developing countries can catch up. The process of modernization can be accompanied by inequalities. These inequalities are not necessarily caused by TNCs activities and foreign capital, but are inherent to this transition process. The source of capital does therefore not matter since *capital is capital,* as Firebaugh (1992, p. 108) puts it. At a later stage of development the inequalities will disappear, which justifies TNCs activities, even if they increased the inevitable inequalities. That is - *growth first, redistribution later*.

The pessimistic viewpoint

The pessimistic viewpoint stresses the differing interests of TNCs and the host economies. TNCs are profit seeking business that aim to optimize capital accumulation, while the host economies try to focus on catching up in development. Advocates of this viewpoint argue that the foreign affiliates are not only doing business in the host economies, but are also involved in the political economy of these countries where they try to influence the domestic governments in a way that serves best for their business interests. This kind of political lobbying is pursued everywhere in the world by economic agents, but in developing countries TNCs are more likely to be successful, because they can use the dependence of the host economies on

foreign capital, their economic dominance and other externalities of TNC presence as a lever for their interests. TNCs are seen to profit from a division of labor, which concentrates the most profitable and important tasks in the countries of the centre (where they are usually headquartered) and relocate labor-intensive and specialized tasks to peripheral countries. But these interests often differ from the objectives of the host economies for their development process and a diversification and sophistication of production. TNCs thereby try to maintain a certain level of underdevelopment, because the differing levels of development serve their interests. From this assumption it can be concluded that inequalities are caused by the presences of TNCs and are not inherent to the transition process. That is, the speed of convergence is slower the higher the host economy is penetrated by TNCs.

The advocates of the pessimistic viewpoint agree on the assumption that foreign capital spurs economic growth, but consider it to be less productive than domestic capital in the long term. That is, a strong presence of TNCs increases the amount of less productive investments. The differential productivity of foreign and domestic investment is attributed to insufficient linkages between foreign affiliates and the domestic economy.

In order to attract foreign investors, developing countries try to meet the prerequisites regarding trade policies and infrastructure. If the trade policies and the infrastructure is tailored to the requirements of the TNCs, disadvantages for the domestic economy can arise. Since this new infrastructure is financed by domestic capital, investments for the domestic economy can no more be accomplished to the extent necessary. Liberalization of trade policies can lead to disadvantages for domestic firms since they are faced with new competitors, which are backed by their parent companies.

The pessimistic viewpoint stands in opposition to the optimistic viewpoint put is subject to the same undifferentiated generalization of the role TNCs and the effects of their presence in the periphery.

The skeptical viewpoint

The skeptical viewpoint can be seen as an adjustment of the pessimistic viewpoint. It assumes the same direct and indirect effects of TNCs presence on the development of peripheral countries but attributes a larger capacity of the domestic political institutions to act in accordance with the objectives of catching-up in development and domestic economic interests. If the host economy can successfully prevail its interests against the interest of the TNCs and effectively pursues its political agenda, inequalities caused by the presence of TNCs can be reduced or omitted and the speed of convergence is less likely to be slowed down.

4 REVIEW OF RESEARCH ON THE EFFECTS OF TNCS PRESENCE IN DEVELOPING COUNTRIES

4.1 Introduction

Based on the differing theoretical approaches on the effects of TNCs activities in developing countries, a number of empirical analyses are available. Empirical studies which are based on the skeptical or pessimistic viewpoint, tend to outnumber those based on the optimistic viewpoint. The following part presents a series of studies, which are linked to each other resulting from a scientific debate on the subject at stake. They will be presented in the chronological order they were published, starting with the two studies by Bornschier & Chase-Dunn & Rubinson (1978) and Bornschier & Chase-Dunn (1985), followed by Firebaugh's study (1992; 1996) and the study by Dixon & Boswell (1996a; 1996b), while the last study is from de Soysa & Oneal (1999).

All studies assessed the effects of TNCs presence on economic growth in a cross-country analysis. Some assessed the effects of TNCs presence on inequality, such as income inequality. Since in this analysis only the effects on economic growth can be assessed, the review of previous studies is limited to this aspect.

4.2 Bornschier & Chase-Dunn

Earlier studies of empirical cross-national analysis on the relationship of foreign capital respectively TNC presence and economic development came to contradictory findings. Due to these differing results, Bornschier, Chase-Dunn and Rubinson (Bornschier, Chase-Dunn, and Rubinson 1978, henceforth BCDR) reanalyzed this relationship with some empirical improvements[11]. They used a larger sample of developing countries in their analysis than previous studies had done to assess possible interactions between foreign investment and region and between foreign investment and the level of development. They assessed the effect of *investment dependence* which they defined as the extent, to which a country's economy is penetrated and controlled by direct private foreign capital investment on economic development, measured as the growth rate of gross national product per capita (pp. 653). BCDR assume that some of the contradictory findings in former studies may be due to using measures of FDI flow instead of measures of FDI stocks. While inflows of foreign capital can increase the rate of economic growth in the short-run due to capital formation and demand as foreign

[11] This summary is based on Bornschier et al.'s article and book: Bornschier, V., C. Chase-Dunn, and R. Rubinson (1978). "Cross-national Evidence of the Effects of Foreign Investment and Aid on Economic Growth and Inequality: A Survey of Find-

corporations purchase land, labor and materials, the long-term cumulative effects can lead to a reduction of the growth rate (pp. 666-667).
Several regressions have been performed using all countries or dummy-coded groups of countries ordered by geographical regions like Latin America, Asia, Africa, and by the level of development.

Equation 4.1

$$\frac{y_{1975}}{y_{1960}} = \beta_0 + \beta_1 \frac{K_{F_{1967}}}{\sqrt{SIZE \times L}} + \beta_2 \frac{\Delta K_F}{Y} + \beta_3 s_D + \beta_4 \log(Y_{1960}) + \beta_5 DEVEL + \sum \beta_6 REGION$$

Equation 4.1: Sample size = 76 countries. The dependent variable is the growth rate of GNP per capita for the years 1960 to 1975 (expressed as a ratio of GNP per capita in 1975 to GNP per capita in 1960). The stock of foreign capital – which is a measure for the penetration of the economy by foreign capital - is weighted by the square root of the product of energy consumption - which is a measure for the size of the economy and therefore denoted by SIZE - and total population (generally *L* refers to labor force). Capital formation, in the equation denoted with s_D as domestic saving, is a percentage of GNP and averaged over the time period. Logged GNP is included to control for the prior correlation between *GNP* and the recent foreign capital flow K_F.

The effects of foreign capital penetration proved to be negative in all geographic regions, though the degree of the negative effect varied between regions. Within a particular region, the effect was more negative for richer countries than within poor countries. Based on the regression results BCDR conclude that the relationship between foreign capital penetration and growth does not vary by geographical region. The flow of foreign direct investment has a short term effect of increasing the relative rate of economic growth, while the stock of foreign direct investment has a cumulative effect of decreasing the relative rate of economic growth of countries, independent of the geographical region.
The authors assume that TNCs, in order to avoid overcapacities, are unlikely to make investments in a particular country that will severely affect the accumulation process of higher profits within that country. But overcapacities are likely to occur as the capital and knowledge of these corporations are mostly sector specific and there are few incentives to move to other sectors within the same country. According to BCDR, these profit oriented TNCs will look for new investment opportunities in other countries when faced with actual or potential overcapacities. These overcapacities may result from an expansion of activities of these TNCs

ings and a Reanalysis." American Journal of Sociology **84**(3):651-683 *and* Bornschier, V. and C. Chase-Dunn (1985). Transnational Corporations and Underdevelopment. New York: Praeger.

within a particular country to a point where market saturation is approached and/or political risks increase because of high penetration and visibility. This affects the particular country adversely, as the relative increase of net investment not only slows down in the long-run, but it may even become negative because TNCs may start transferring more money out of these penetrated countries than they have ever brought into these countries (Bornschier and Chase-Dunn 1985, p. 81f).

In *Transnational Corporations and Underdevelopment* (1985) Bornschier and Chase-Dunn (henceforth BCD) incorporated a number of improvements in their previous model. Their new sample of countries consisted now of 103 countries[12]. In addition they used a somehow different measure for the penetration by TNCs and included other control variables.

Equation 4.2

$$PEN = \frac{K_{F_{1967}}}{\sqrt{K \times L}}$$

Equation 4.2: This is the *PEN* measure, while *PEN* denotes *foreign capital penetration*: Total stock of FDI is measured in million U.S. dollars on the base of the year 1967 (first year for which these data were available). The total capital stock, in billion U.S. dollars, is multiplied by the country's population in millions in order to correct for differences in average capital intensity (and then taken the square root). Population is used as a proxy for the labor force denoted with *L*.

The analysis consisted of a series of separate regressions for the whole sample, for particular regions and levels of development. New in the list of independent variables, compared to the previous analysis, is the squared log of GDP per capita, which takes the non-linear shape of the relationship between the level of development and penetration into account as penetration is not evenly distributed among countries of differing level of development. Exports is included to control for the income growth effect of penetration independently of the access to the world market. BCD assume that penetration by TNCs does not cause the growth of exports and that therefore, export is no intervening variable between investment dependence and growth.

[12] The data set was carefully compiled at the sociological institute of the University of Zurich: Ballmer-Cao, Thanh-Huyen and Jürg Scheidegger. 1979. "Compendium of Data Based on the Study of MNCs, Economic Policy and National Development." in *Sondernummer des Bulletins des Soziologischen Instituts, Universität Zürich*. Zürich: Soziologisches Institut, Universität Zürich.

Equation 4.3

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100 = \beta_0 + \beta_1 PEN + \beta_2 \frac{\Delta K_{F_{1967-1973}}}{GDP_{1965-1970}} + \beta_3 \log y_{1965} + \beta_4 \log(y_{1965})^2 + \beta_5 \frac{S_D}{GDP} + \beta_6 \frac{EXPORT}{GDP} + \beta_7 SIZE$$

Equation 4.3: N=103 countries. The dependant variable is the average annual real growth rate of GNP per capita in percentage unites for the years 1965 to 1977. The independent variables in the linear regression are the PEN measure defined earlier in this section, the flow of foreign capital for the period from 1967 to 1973 weighted by the average GDP for the years 1965 to 1970. Further included are the logged GNP per capita in year 1965 and the square of this term. Other independent variables are domestic capital formation which denotes domestic saving weighted by GDP averaged for the years 1965, 1970 and 1973, Exports weighted by GDP (EXPORTS), as well as size of the economy in 1967 measured as the logged energy consumption in thousand tons of coal equivalent (SIZE).

For all samples the PEN measure showed a negative effect of TNC penetration on economic growth, except in the sample of the fifteen richest countries. PEN has an overall negative effect on economic growth and based on the regression results, it is the most significant single predictor for economic growth in the peripheral countries. The effects of domestic savings, export and market size generally proved to be positive, although only exports and market size are statistically significant for the group of less developed countries (=whole sample without the 15 rich countries). BCD note that capital formation is of less importance for peripheral countries than is generally assumed, which supports the assumption that many problems of these countries are due to a lack of effective demand, which is seen as the long-term consequence of the unequal distribution of income.

The newer regression results by Bornschier et al. support their earlier findings that the stock of direct foreign investment (expressed by the PEN variable) proved to have a negative effect on economic growth for the developing countries. Fresh capital formation by TNCs – that is FDI inflow – has a positive effect.

4.3 Glenn Firebaugh

In 1992 an article by Glenn Firebaugh[13] appeared in the *American Journal of Sociology* in direct correspondence to the analyses by Bornschier et al. (Bornschier and Chase-Dunn 1985; Bornschier, Chase-Dunn, and Rubinson 1978). Firebaugh (1992) reanalysis BCD's models because he disagrees on BCD's findings that foreign direct investment retards and distorts development in the Third World. While Firebaugh does not doubt that FDI is "not as good" (p. 116) as the home-grown variety, he certainly denies that FDI has negative effects on economic growth[14]. He directs his criticism towards the PEN-researchers' theoretical argument and their empirical foundations. He observed that foreign capital stock and flows affect the numerator and denominator of the foreign investment rate. He therefore argues that the regression equation needs to be modified and provides another interpretation of the negative regression coefficient for the PEN variable in regard to the capital stock (denominator).

Firebaugh first replicates BCD's study and then introduces another model setup to prove that foreign investment does not harm developing countries' economies. He starts with the assumption that one of the following three differing positions on foreign investment's effect on economic growth must be true (pp. 108-109):

1. "Capital is capital. Foreign investment's effect is positive and the same size as that of domestic investment."
2. "Foreign investment on balance tends to promote growth, albeit its effect is often not as large as that of domestic investment."
3. "Foreign investment reduces growth."

He empirically tests these three positions using the same data set used by BCD in *Transnational Corporation and Underdevelopment* (Bornschier and Chase-Dunn 1985). Firebaugh argues that the crucial independent variable is the investment rate, which is defined by the change in capital relative to the initial stock of capital. For consistency with BCD's analysis, he leaves all other variables as compiled in the data set, but suggests three ways to calculate the investment rate (Firebaugh 1992, p. 109):

[13] This summary is based on Firebaugh's article in AJS: Firebaugh, G. (1992). "Growth Effects of Foreign and Domestic Investments." American Journal of Sociology **98**(1): 105-130.

[14] He names several possibilities he found in the literature, such as: FDI, compared to domestic investment, is less likely to contribute to public revenues (TNCs avoiding taxes in various ways), less likely to encourage the development of indigenous entrepreneurship, more likely to use inappropriate capital intensive technology, less likely to reinvest profits in the host economy. Further they can stimulate inappropriate consumption patterns and thereby lowering domestic savings (pp. 106-107).

Equation 4.4

$$\gamma_{I_{\%}} = \left[\frac{K_{1973} - K_{1967}}{K_{1967}}\right] \times 100$$ As a simple percentage increase for 1967 to 1973

Equation 4.5

$$\gamma_{I_{ann}} = \left[\sqrt[6]{\frac{K_{1973}}{K_{1967}}} - 1\right] \times 100$$ As *annual* rate of change[15]

Equation 4.6

$$\gamma_{I_{annz}} = \left\{\left[\ln \frac{K_{1973}}{K_{1967}}\right] \times \frac{1}{6}\right\} \times 100$$ As the *continuous-time* analogue to *Equation 4.5*

His first model uses the same control variables as in BCD's model, but excludes the PEN-measure. This means that in Firebaugh's first model no measure for the stock of foreign capital is included.

Equation 4.7

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}} - 1\right) \times 100 = \beta_0 + \beta_1 \gamma_{I_F} + \beta_2 \gamma_{I_D} + \beta_3 \log y_{1965} + \beta_4 \log(y_{1965})^2 + \beta_5 \frac{EXPORT}{GDP} + \beta_6 SIZE$$

Equation 4.7: N = 76 countries (developing countries only). Firebaugh performs three regressions using his three measures for the investment rate for foreign and domestic investment. For every form of the investment rate two regressions were performed, one including $(YN)^2$ and the second without. The dependant variable is the average annual real growth rate of GNP per capita in percentage unites for the years 1965 to 1977. The independent variables in the linear regression are the investment rates for domestic and foreign investment as defined earlier. Further the logged GNP per capita (also as squared term) as of 1965, export weighted by GDP averaged for the years 1965 and 1970 as well as market size (SIZE) which is a measure for the size of the economy defined as the logged energy consumption in 1967 in thousand tons of coal equivalent.

[15] Can be derived from compound interest formula, where the basic equation can be solved for the percentage change denote by *p* in the equation (*n* denotes number of years):

$$K_t = K_0 \times \left[1 + \frac{p}{100}\right]^n$$ *rearranging and solving for* p results in $p = \left[\sqrt[n]{\frac{K_t}{K_0}} - 1\right] \times 100$

Firebaugh's results contradict the findings by the PEN-researchers. The regression coefficients for the foreign and domestic investment rate are both positive in every instance and the coefficient for domestic investment is about three times the coefficient of foreign investment, that is, foreign investment is "not as good as" domestic investment (p. 110). The later result does therefore also contradict his first assumption that "capital is capital".

But a model without the PEN-variable does not take BCD's argument of the diverging long-term and short-term effects of foreign investment into consideration. In order to determine if "[...] LDCs [will] eventually prosper more - enjoy higher levels of income per capita - with or without foreign investment", he concludes that he "must determine foreign investment's total (direct + indirect) long-run effects on GNP/c" (p. 111). He stresses that a long-run effect is nothing but an accumulation of short-run effects. Since the PEN-researchers' results and Firebaugh's results support the assumption of positive effects of foreign direct investment, Firebaugh asks, why the short run effects add up to a negative long-run effect. According to Firebaugh, the PEN-researchers formalize their thesis by assuming a chain of cause and effect, starting with foreign capital, followed by domestic capital and then GNP growth ("foreign capital--> domestic capital--> GNP growth" (p. 111)). If it holds that foreign capital harms LDCs by severely depressing their domestic investment (decapitalization) as the PEN-researchers claim, he wonders, how the path coefficient from *accumulated foreign capital* to *accumulated domestic capital* can be negative if domestic investment has empirically been proved to have positive effects? Firebaugh's argumentation is based on Harrod-Domar's model as is BCD's (Bornschier and Chase-Dunn 1985, pp. 81-82), however, he comes to an opposing conclusion. Following Firebaugh, in the Harrod-Domar model foreign saving augments domestic savings and thus accelerates economic growth. Due to these contradictory assumptions, Firebaugh regresses *accumulated foreign capital* on *accumulated domestic capital* to test for decapitalization-thesis and *accumulated foreign capital* on *accumulated total capital* to test for the augmentation-thesis.

Equation 4.8

$$\log(K_D) = \beta_0 + \beta_1 \log(K_F) + \Sigma\beta_i Controls \qquad \text{Decapitalization}$$

Equation 4.9

$$\log(K_{total}) = \beta_0 + \beta_1 \log(K_F) + \Sigma\beta_i Controls \qquad \text{Augmentation}$$

Equation 4.8 and Equation 4.9: The independent variable is either *accumulated foreign capital as of 1967* or *accumulated foreign capital as of 1973* or *accumulated foreign capital as of 1973 with additional time lag of six years*. Other independent variables are the PEN-controls Size, Export, domestic and foreign investment rate (without log(y) and log(y^2)). The dependent variable is either *accumulated domestic capital* for the decapitalization test or *accumulated total capital* for the augmentation test as of 1967 or 1973 respectively. For the model with the six year time lag, domestic accumulated capital as of 1973 is regressed on foreign accumulated capital as of 1967. Capital is in dollars per capita and logged to reduce skewness. *Accumulated total capital* denotes total foreign stock plus 18-year accumulation of domestic stock. The regressions for each dependent variable are done twice - the first time including the *PEN-controls* and the second time without.

The coefficient for *accumulated foreign capital* is positive in every setup of the model and statistically significant and thus supports Firebaugh's assumption of augmentation and not decapitalization (p. 115)[16].

By estimating the long-run economic effect of foreign investment on economic development, Firebaugh's regression results indicate that *accumulated foreign investment* boosts *accumulated total investment*. Since there are differences in the amount of *accumulated total investment* between countries, some of the long-run economic effect of foreign investment is indirect through its positive effect on total investment (p.116).

The regression results for the long-run economic effects of foreign investment show that the total effect of foreign investment is positive, while the coefficient for the direct effect (effect of foreign capital) is negative, but very small and, depending on the model-setup, statistically not significant. Firebaugh emphasizes that the negative coefficients for the direct effect are consistent with the previous finding, that foreign investment is *not as good* as domestic investment, but that it does not mean that foreign capital has a negative effect on economic growth as the PEN researchers state. As an explanation for this contradictory result, Firebaugh claims that the previous PEN-studies are based on a faulty premise. He states that a negative coefficient for stock, while controlling for flow does *not* mean that investment has a long-run adverse effect (p.118).

The negative coefficient for foreign stocks derives from the logic of the way the investment rate is calculated. In *Equation 4.10* the investment is reprinted in a generalized form[17]:

[16] He only proved that accumulated foreign investment augments accumulated *total* investment

Equation 4.10

$$\gamma_{I_{\%}} = \left[\frac{K_{t+\Delta t} - K_t}{K_t} \right] \times 100$$

Equation 4.10: Generalized equation for investment rate

From the mathematical logic of the equation it follows that, while holding one of the terms - either the denominator (*stock*) or numerator (*flow*) - constant and increasing the other, the investment rate drops or rises. According to Firebaugh, "a positive flow coefficient and a negative stock coefficient indicate a beneficial investment effect, [while] a negative flow coefficient and a positive stock coefficient indicate an adverse investment effect"[18] (p. 118) if flow and stock are entered separately into the regression equation. From Firebaugh's point of view, the BCD-model is ill-designed to measure long-run effects. Since the dependent variable is the growth rate of per capita GNP, the model is a growth rate model and not a long-run effects model.

In the course of his analysis, Firebaugh repeats BCD's analysis, but separates the numerator and denominator of the investment rate and enters them as individual regression variables. In addition, he adds the domestic capital stock into the equation.

Equation 4.11

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}} - 1 \right) \times 100 = \beta_0 + \beta_1 \Delta K_{F_{1965-1977}} + \beta_2 PEN + \beta_3 \Delta K_{D_{1965-1977}} + \beta_4 K_D$$
$$+ \beta_5 \log y_{1965} + \beta_6 \log(y_{1965})^2 + \beta_7 \frac{EXPORT}{GDP} + \beta_8 SIZE$$

Equation 4.11: The dependant variable is the average annual growth rate of per capita GNP. The model uses two investment rate numerators and two denominators. The former represented by foreign respectively domestic capital flow and the later by foreign respectively domestic capital stock. Foreign stock is denoted by *PEN* as defined by BCD. The delta sign indicates the flow effects (numerator). Controls are again the PEN-controls. The model is calculated once including the $\log(y)^2$ control and once without. All regression coefficients for the basic equation are highly significant.

Miraculously it turns out that the regression coefficient for domestic stock is negative too as for the foreign stock. Firebaugh concludes that "there is no real mystery here, since a negative

[17] As suggested by Firebaugh (p. 109). Note that the numerator *flow* refers to change in capital stock for a particular time period and the denominator *stock* to the accumulated capital as of a particular moment in time.
[18] This principle holds for all three ways to calculate the investment rate.

stock slope paired with a positive flow slope implies a beneficent investment effect" (p. 122). The PEN-researchers' growth models are based on change in the dependent variable (growth rate) over the short run and the coefficient for stocks turned out to be negative. Just as it should be, as Firebaugh explains, since while holding flow constant, the greater the stock the lower the investment rate and the smaller the stock the higher the overall investment rate and the faster the growth. According to Firebaugh, PEN-researches simply overlooked this mathematical fact.

4.4 Dixon & Boswell

Dixon and Boswell's article in the *American Journal of Sociology* (Dixon and Boswell 1996a) provides a reassessment of Glenn Firebaugh's (Firebaugh 1992) study in the same journal a few years before[19]. Dixon and Boswell (hereafter D&B) take another look at the role of foreign capital in the growth process of developing countries. Their findings support capital dependency theory and are thereby contrary to Firebaugh's conclusion. Their analysis "shows that foreign capital dependence diminishes economic growth, enhances income inequality, and very probably impairs domestic capital formation, *all irrespective of denominator effects*" (p. 514, emphasis in italics in original). D&B base their analysis on Firebaugh's allegation that the PEN-researchers claim that foreign investment is *bad* and, as he assumes, not as good as domestic investment. They agree that Firebaugh provides an empirically correct comparison of foreign and domestic investment's effects on economic growth rate and that foreign investment is approximately three times less productive and therefore not as good as the domestic variety. But they think that Firebaugh "misinterprets the theoretical issue at stake by ignoring the fundamental conceptual distinction between foreign investment and foreign capital penetration" (pp. 545-546). For the PEN-researchers, *penetration* is a measure for the proportion of the *total capital stock* in a country that is controlled by TNCs (Bornschier and Chase-Dunn 1985, p. 59), that is penetration refers to the *accumulated foreign capital* in relation to the overall economy. Investment on the other hand denotes short-term inflow or long-term *accumulation of foreign capital* (Dixon and Boswell 1996a, p. 546). While D&B note that the assumption that foreign investment is *not as good* as domestic investment is widely acknowledged, they do not understand where Firebaugh got the notion that foreign investment is *bad*. According to D&B, Firebaugh did fail to distinguish between *foreign investment* and *dependency,* that is, the extent to which a developing country's economy is controlled by foreign investors. The meaning of *bad* is not consistent in Firebaugh's article, as on the one hand

he relates *bad* to the negative effect of foreign investment in reducing growth (=smaller economic growth rate) and on the other hand he relates it to lowering output (=negative economic growth rate). D&B emphasize that "no world-system or dependency theory asserts that foreign capital penetration causes economic recession" (p. 547), but that *penetration* is associated with a lower growth rate as a consequence of differential productivity of foreign and domestic capital. Thus, an economy with a greater share of foreign capital in regard to total capital is assumed to grow slower than an economy with a smaller share. D&B assume that there are other effects that impede growth apart from differential productivity. By distinguishing between *penetration* and *capital investment,* the additional negative drag effect from capital penetration can be attributed to *negative externalities* (p. 548). Negative externalities are seen as a disarticulation effect of various mechanisms[20]. Therefore D&B propose that the distinction must be made between "negative externalities of foreign capital penetration" and "differential productivity of foreign and domestic investment" to take both possibilities of negative effects - decrease of economic growth *and* lowering of output - into account (p. 548). For the empirical test, they suggest the use of two alternative indicators for penetration to the original PEN-indicator[21]: *PEN2* which reflects the assumption that foreign ownership exerts economic control and *PEN3* which is a somewhat less proximate to this notion of control (p. 549).

Equation 4.12

$$PEN2 = \frac{K_F}{K_{total}}$$

Equation 4.13

$$PEN3 = \frac{K_F}{GDP}$$

Equation 4.12 and Equation 4.13: The two alternative and simpler PEN indicators as suggested by D&B (p. 549)

[19] This summary is based on Dixon & Boswell's article in AJS: Dixon, W. J. and T. Boswell (1996). "Dependency, Disarticulation, and Denominator Effects: Another Look at Foreign Capital Penetration." American Journal of Sociology **102**(2): 543-562.

[20] According to D&B, these disarticulation effects typically are a lost of linkage and multiplier effect, repatriation of profits, shifting tax burdens, sectoral imbalance, over-urbanization, inappropriate technology etc. and are more likely to occur and to be more severe with foreign ownership than with domestic (pp. 548-549).

[21] Form now on referred to as *PEN1*. Remember that *PEN* is defined as the ratio of foreign capital stock to the geometric mean of domestic stock and population. D&B think that the geometric mean complicates the measure and obscures its interpretation. Their two alternative indicators emphasize their understanding of penetration as control over an economy (p. 549).

D&B agree with Firebaugh regarding the origin and interpretation of the denominator effects, as mentioned earlier, but they don't think "that a growth-inducing effect from the foreign investment *rate* must preclude any independent impact of foreign capital *penetration*" (p. 551, emphasis in italics in original). For D&B only capital penetration can carry the negative externalities associated with foreign economic control. Therefore, to empirically test their assumption, they suggest a model that estimates the negative effects of foreign capital penetration net of differential productivity and denominators effects.

Equation 4.14

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}} - 1\right) \times 100 = \beta_0 - \beta_1 P + \beta_2 \gamma_{I_F} + \beta_3 \gamma_{I_D} + \Sigma \beta_i Controls$$

Equation 4.14: The parameter *P* is signed negative to capture the expected negative externalities form foreign capital penetration. *P* denotes *PEN2* respectively *PEN3*, which were defined earlier. The investment rates are measured as an annual rate of change ($\gamma_{I_{ann}} = \left[\sqrt[9]{(K_{1973}/K_{1967})} - 1\right] \times 100$) as Firebaugh suggested (Firebaugh 1992, p.109). *Controls* denotes the *PEN*-controls market size, export and $\log(y_{1965})$. The model setup is identical to the Firebaugh's setup quoted for *Equation 4.7* except for the *P* parameter.

The inclusion of foreign and domestic investment rate immunizes against denominator effects and considers the differential productivity of these two types of investment. The regression coefficient for either *PEN2* or *PEN3* turned out significantly negative as hypothesized and therefore support the assumption that higher penetration levels cause lower growth rates (but not necessarily a negative growth rate). D&B conclude that the inclusion of the *P*-parameter into *Equation 4.7* allows to reveal the disadvantageous externalities carried by foreign capital penetration (p. 554).

Based on *Equation 4.8* and *Equation 4.9*, Firebaugh empirically tested BCD's decapitalization thesis and conclude that *accumulation of foreign capital* promotes *domestic investment,* while BCD's findings indicate that *foreign penetration* inhibits *domestic capital formation*. D&B criticize that Firebaugh mistakes *domestic capital formation* with its long-run *accumulation* - while the decapitalization thesis is about formation - and that his analysis is influenced by the contemporaneous correlation between domestic and foreign capital stocks (p. 555). They suggest to include *accumulated domestic stock* into Firebaugh's regression equations to test for capital formation and simultaneously absorbing the effects underlying the contemporaneous correlation between domestic and foreign stock. The modified regression equation is:

Equation 4.15

$$\log(K_D) = \beta_0 + \beta_1 \log(K_F) + \beta_2 \log(K_D) + \Sigma\beta_i Controls$$

Equation 4.16

$$\log(K_{total}) = \beta_0 + \beta_1 \log(K_F) + \beta_2 \log(K_D) + \Sigma\beta_i Controls$$

Equation 4.15 and Equation 4.16: N=76 countries. The modified replication of Firebaugh's decapitalization test (Firebaugh 1992, p.114-117) now includes accumulated domestic capital. The dependent variable denotes domestic capital accumulation as of 1973 respectively total accumulated capital as of 1973. The independent variables are market size, export and as additional control variable logged population as of 1965.

The regression coefficient for the *accumulated foreign stock* is nearly ten times the value of the standard error. Once *domestic accumulated capital* is included, the regression coefficient of the *accumulated foreign stock* drops to virtually zero. D&B note that neither theirs nor Firebaugh's models "provide even a hint of evidence that foreign capital accumulation depresses domestic capital formation" (p. 556). Their conclusion is more theoretical: Foreign capital penetration can hinder domestic capital formation directly and indirectly. Limiting the availability of local capital, for example by repatriation of profits or constraining spin-offs, represents *direct decapitalization,* while *indirect decapitalization* refers to the effect of foreign capital penetration to reduce economic growth. As economic growth is a promoting factor for domestic capital investment, a reduction of the economic growth rate caused by foreign capital penetration has a dampening effect on domestic capital investment. Both forms of decapitalization entail lost investment opportunities resulting in slower rates of capital formation, but as D&B point out, not necessarily in a decline in capital (p. 556). This reciprocal effect of domestic investment and economic growth is a simultaneity bias. As a brief sketch D&B propose a model where economic growth and domestic investment enter this model as endogenous variables to detect these direct and indirect effects. But they cannot detect evidence of direct decapitalization and can expose only a small indirect decapitalization.

4.5 Firebaugh's comment and Dixon & Boswell's reply

Firebaugh commented on D&B's reassessment of his preceding study. Subsequently, D&B replied to Firebaugh's comment. Firebaugh's comment will be presented first followed by D&B's reply[22].

4.5.1 Firebaugh

As criticism of D&B's findings, Firebaugh emphasizes that a negative coefficient for the PEN-measure reflects only a relative effect of foreign investment and does only indicate that foreign capital investment is less beneficial than domestic investment, while its absolute effect is positive. He starts his argumentation for the differential productivity claim with three logical possibilities of foreign capital investment's effects (Firebaugh 1996, p. 564):

1. *Domestic stock* is better than *foreign stock* is better than *zero*
2. *Domestic stock* is better than *zero* is better than *foreign stock*
3. *Zero* is better than *domestic stock* is better than *foreign stock*

Possibility #3 can be rejected from the beginning since nobody claims that domestic investment has a negative effect. First Firebaugh empirically tests for logical possibility #2 (adverse effect) followed by #1 (beneficial effect). He criticizes that so far the *total share of foreign capital investment* within an economy has not been taken into account. These absolute shares are very small for most of the countries in the PEN-data (ratio of domestic to foreign capital is about 10 to 1 for the countries in the PEN-dataset). If the assumption is correct that a bigger amount of capital stimulates economic growth more than a smaller amount, then the differential productivity of domestic and foreign capital is no surprise. A modified model should therefore take note of unequal capital shares. Firebaugh uses total investment rate instead of the separated terms and includes an interaction term (adjustment term) to account for the disproportionate shares of domestic and foreign stock.

The logic of the adjustment term is, that "the greater the ratio of foreign stock to total stock, the smaller the impact of investment rate on economic growth rate *if* foreign investment is *less beneficial* than domestic investment" (p. 566, emphasis in italics in original). According to Firebaugh, a negative coefficient for the adjustment term indicates that foreign investment is less beneficial and a positive coefficient that it is more beneficial than domestic capital.

[22] Both comments appeared in AJS. Quotes and indicated page numbers refer to these to articles: Dixon, W. J. and T. Boswell (1996). "Differential Productivity, Negative Externalities, and Foreign Capital Dependency: Reply to Firebaugh." American Journal of Sociology **102**(2): 576-584.
Firebaugh, G. (1996). "Does Foreign Capital Harm Poor Nations? New Estimates Based on Dixon and Boswell's Measures of Capital Penetration." American Journal of Sociology **102**(2): 563-575.

Equation 4.17

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}} - 1\right) \times 100 = \beta_0 - \beta_1\gamma_I + \beta_2\left[\gamma_I \times PEN2\right] + \Sigma\beta_i Controls$$

Equation 4.17: N = 78 countries. γ_I denotes *total investment rate* and γ_I**PEN2* is the *adjustment term* (interaction term). The total investment rate instead of the separate terms for domestic and foreign investment rate allows to capture potential differences in the returns to foreign and domestic investment and thus tests for the hypotheses that foreign investment is less beneficial than the domestic variety. *Controls* are three variables of the PEN-controls: Market size, Export ratio and *log*(y).

The adjustment term is negative and the findings are therefore consistent with the test for differential productivity. If all or only parts of the controls were included, *investment rate*, the *adjustment term* and *market size* explained in either case more than half of the variance in economic growth rates among the countries in the sample. Firebaugh thinks that the negative slopes for the *PEN-indicator* in D&B's model is an artifact of the failure to control adequately for differential productivity. Following Firebaugh, countries do only get penetrated when foreign capital exceeds the 50% share hurdle (p. 568)[23]. The *PEN* ratio slopes do therefore only explain part of the penetration effect as in none of the countries in the sample foreign capital exceeds domestic capital. The *PEN* ratio can either be increased by an increase in foreign capital stock or by a decrease of domestic capital stock, while the former is generally assumed. Firebaugh claims that D&B's own estimates imply that a gain in penetration caused by increased foreign capital stock spurs economic growth. To isolate the net gain effects of foreign capital, domestic capital must be held constant in the *PEN* ration. Firebaugh claims that a one percent increase in *PEN* causes an increase of foreign capital investment well above one percent for all the countries in the sample. The positive investment rate effect is always larger, which implies that the positive *rate* effect of increasing penetration outpaces the negative *ratio* effect, which reflects the negative effect of differential productivity (pp. 568-569)[24]. As economic growth spurs domestic savings, the indirect effect of foreign stock through domestic saving must therefore be positive as well. This opposes D&B's interpretation of the negative slope for the *PEN* ratio as a reflection of negative externalities.

In a second step Firebaugh adds the *PEN* measure to his investment rate model, *Equation 4.17*, to test for these two differing explanations of the negative *PEN* ratio coefficient.

[23] he does not indicate who defined 50% as the hurdle for penetration.

[24] See *Equation 4.14* in this text for the regression model. Note, that Firebaugh used total investment rate instead of the separated terms to avoid the different base problem. The adjustment term captures the differential productivity of domestic and foreign capital.

Equation 4.18

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0-\beta_1\gamma_I+\beta_2 P+\Sigma\beta_i Controls$$

Equation 4.18: Two regressions have been calculated with a deferring measure for the *PEN* variable denoted by *P*. For the first regression *PEN2* was used and for the second *PEN3*. There is only a single control variable, namely market size. Regression results did not vary by omitting the other controls

Equation 4.19

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0-\beta_1\gamma_I+\beta_2\left[\gamma_I\times PEN2\right]+\beta_3 P+\Sigma\beta_i Controls$$

Equation 4.19: Two regressions have been calculated. This time the adjustment term is included. For the first regression *PEN2* was used and for the second *PEN3*. There is only a single control variable, namely market size. Regression results did not vary by omitting the other controls

Based on this empirical test Firebaugh concludes that, if the negative *PEN* coefficient stems from greater returns to domestic capital, then the effect should disappear when adjusting for different rates of return. On the other hand, if the effect arises from some other source - such as negative externalities associated with foreign capital - then the *PEN* ration effect should remain even after the adjustment term is added (p. 570). Independent of whether *PEN2* or *PEN3* is used as *PEN*-variable, the *PEN* ratio coefficient becomes positive (though not significant) if the adjustment term is included, while it is negative when the adjustment term is omitted. To avoid criticism that his model is not comparable to D&B's model because of the differing investment terms, Firebaugh replicates D&B's model:

Equation 4.20

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0+\beta_1\gamma_{I_F}+\beta_2\gamma_{I_D}+\beta_3\left[\gamma_I\times PEN2\right]+\beta_4 P+\Sigma\beta_i Controls$$

Equation 4.20: N= 76 countries. See *Equation 4.17* and *Equation 4.18* for an explanation of variables. Firebaugh performed four regressions following the same procedure as in *Equation 4.18*. The interaction term reflects different dollar-for-dollar returns for foreign and domestic investment. The investment mix is measured by *PEN2*.

The regression results cast doubts on the correctness of D&B's interpretation of the negative slope for the *PEN* ratio as the sign for the *PEN* ratio coefficient is positive when the adjustment term is included. According to Firebaugh, there is no evidence for harmful effects of foreign capital for LDCs. While there seems to be no doubt that domestic capital yields higher return than foreign capital, Firebaugh doubts that there are negative externalities associated with foreign capital. That is, there is no evidence that foreign capital crowds out domestic capital. Firebaugh emphasizes that, even *if* foreign capital reduces domestic capital, there would still to be answer to what extent it does so and that there is still need to determine to what extent the relative returns on foreign and domestic capital differ.

4.5.2 Dixon & Boswells reply to Firebaugh

Dixon and Boswell stick to their claim that there *are* negative externalities associated with foreign capital investment. They reformulate their theory empirically and analytically to demonstrate that Firebaugh's central results - that there are no negative externalities associated with foreign capital investment - are wrong due to the misinterpretation of statistical interaction. They even claim that Firebaugh's result, if correctly interpreted, provides evidence for negative externalities and that penetration actually reduces domestic capital.

They support Firebaugh's opinion about the importance to control for the relative size of domestic and foreign capital to get a clear picture of differences in productivity. Contrary to Firebaugh's criticism they emphasize that they did control for these relative shares in their model[25], accomplished by controlling for the ratio of foreign to total capital stock (by including the *PEN2* measure). Firebaugh's argument to dismiss negative externalities is based on non-significant penetration estimates. But D&B think that Firebaugh misinterprets the estimated results for *PEN2* and the total investment rate because he transformed the previously additive equation into a non-additive equation by including the *PEN2* measure, the total investment rate and the adjustment term (which is the product of *PEN2* and the total investment rate)[26]. The results of a non-additive specification must be interpreted differently from ordinary additive models, because the observed estimates for the constituent terms apply only when the other constituent variable equals zero (Dixon and Boswell 1996b, p. 578). By rearranging the terms in *Equation 4.19* - resulting in *Equation 4.21* - they demonstrated that in the new equation the effects attributed to *PEN2* are no longer carried solely by the adjustment term (β_3) alone but by β_2 *and* β_3.

[25] See *Equation 4.14* in this text for the model setup.
[26] See *Equation 4.18* in this text.

Equation 4.21

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0+\beta_1\gamma_I+\left[\beta_3+\beta_2\gamma_I\times PEN2\right]\times P+\beta_5\ln(E)$$

Equation 4.21: Equals *Equation 4.19* but terms are rearranged to demonstrate that the effects attributed to *PEN2* must not solely be carried by β_3. There is only one control variable: energy production. The same key substantive conclusions about investment effects can be reached whether the other control variables are included or omitted.

The *PEN2* effects is only then solely carried by β_3 if total investment rate equals zero. But a total investment growth rate of exactly zero is very unlikely and none of the countries' total investment growth rate in the sample equals zero. D&B's assumption is that, if the investment rate rises, so does the weight of the negatively signed β_2 until it eventually exceeds the positively signed β_3 and therefore produces a negative net effect for *PEN2*. According to D&B, this happens at a relatively low investment rate of 4.3%, a value exceeded by 80% of the cases in the sample. In many cases this conditional *PEN2* effect is quite small compared to its conditional standard error. However, if investment rates reach 8%, the conditional *PEN2* effect exceeds twice the value of its conditional standard error (pp. 578-579)[27]. The penetration effect is obviously transformed into a conditional effect that varies according to the level of investment and does not disappear as Firebaugh concluded.

D&B suggest to interpret the effects of investment rates as a function of penetration[28]. For that purpose, the terms in the equation have to be rearranged once more to reflect the reverse relationship between *PEN2* and total investment rate.

Equation 4.22

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0+\left[\beta_1+\beta_2P\right]\times\gamma_I+\beta_3P+\beta_4\ln(E)$$

Equation 4.22: The terms are now rearranged to reflect that the effects of the investment rates.

The growth effects of total investment are diminished by rising penetration because of the weight of the negatively signed β_2 estimate. That is, the more penetrated a country the less productive its overall investment. According to D&B, this effect can only become negative if

[27] The average investment rate in the sample is 6.7%, the maximum 16.2%.
[28] Before *PEN2* was a function of the effects of total investment rate.

more than one-third of all capital is foreign owned (when β_2 becomes larger than β_1)[29]. This is a fairly relevant observation, as it indicates, that foreign capital penetration can somehow inhibit or even block productivity of total investment. However, it does not reveal if penetration does equally condition the productivity of either domestic or foreign capital investment or if one is affected more than the other. To overcome this lack of clarity, D&B introduce product terms consisting of foreign and domestic investment rates, each multiplied by foreign capital penetration[30].

Equation 4.23

Foreign investment rate:

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0+\beta_1\left[P\times\gamma_{I_F}\right]+\beta_2 P+\beta_3\gamma_{I_F}+\beta_4\gamma_{I_D}+\Sigma\beta_i Controls$$

Equation 4.24

Domestic investment rate:

$$\left(\sqrt[12]{\frac{y_{1977}}{y_{1965}}}-1\right)\times 100=\beta_0+\beta_1\left[P\times\gamma_{I_D}\right]+\beta_2 P+\beta_3\gamma_{I_F}+\beta_4\gamma_{I_D}+\Sigma\beta_i Controls$$

Equation 4.23 and Equation 4.24: The investment is entered separately as domestic respectively foreign investment instead as total investment into the equation. Each model has been calculated once using the *PEN2* measure for *P* and once *PEN3*. Controls are market size, exports and $\log(y_{1965})$.

Their finding is that growth effects of foreign investment are not a function of penetration (*Equation 4.23*). But the corresponding model with the domestic investment rate (*Equation 4.24*) reveals that foreign penetration does condition the productivity of domestic investment. That is, an increase in foreign ownership is associated with declining returns to growth. This finding holds whether *PEN2* or *PEN3* is included as *PEN* measure.

[29] From my point of view D&B denote the wrong coefficients. According to D&B "another rearrangement of terms in the equation illustrates this symmetry [of reverse relationship] by decomposing investment effects into β_1 plus β_3 weighted by levels of penetration. [...] It is evident that, as penetration rises, the negatively valued estimate for the product term (β_3) now diminishes the growth effects of overall investment rates" (p.579). I think instead of β_3 they mean β_2.

[30] Introducing separate adjustment terms allows to avoid problems of colinearity. Firebaugh introduced a single adjustment term (interaction term) into D&B's original model (that is *Equation 4.14* in this text) to control for differing returns to domestic and foreign capital. But, according to D&B (p. 580) the adjustment term does not capture the interaction between differing returns and penetration as the adjustment term is a product of *PEN* and total investment and not of *PEN* and domestic investment respectively foreign investment.

D&B claim that their findings prove that capital dependency cannot simply be interpreted as merely differential productivity. The highest productivity levels are associated with the largest share of domestic capital, while the productivity of foreign investment remains fixed, irrespective of the relative size of the share of foreign ownership. This result is inconsistent with Firebaugh's claim that the negative effects of foreign penetration amount only to a reduced economic growth rate, solely due to differential productivity of domestic and foreign capital. And this actually means, that foreign penetration has an effect on domestic capital formation.

4.6 Indra de Soysa & John R. Oneal

Indra de Soysa & John R. Oneal (1999) presented a reanalysis of Firebaugh's (1992; 1996) and Dixon & Boswell's (1996a; 1996b) studies in the *American Sociological Review*[31]. Their results contradict Firebaugh's as well as Dixon & Boswell's findings. Instead of using the PEN-data set, de Soysa & Oneal (henceforth DSO) used latest data available from the United Nations and World Bank to compile a sample of 114 countries, which cover the time period from 1980 to 1991. In this sample, 97 countries are less developed countries. Firebaugh and D&B used a sample that covered the years from 1967 to 1973 with 76 LDCs. DSO calculate the investment rate as suggested by Firebaugh (1992, p.109) as a simple percentage change in foreign or domestic stocks in constant dollars over a particular time period and as an annual compound growth rate (de Soysa and Oneal 1999, p. 770):

Equation 4.25

$$\gamma_{I_{\%}} = \left[\frac{K_{1990} - K_{1980}}{K_{1980}} \right] \times 100$$

Equation 4.26

$$\gamma_{I_{ann}} = \left[\sqrt[10]{\frac{K_{1990}}{K_{1980}}} - 1 \right] \times 100$$

Equation 4.25 and Equation 4.26: See text to *Equation 4.4 and Equation 4.5* for explanations.

[31] The following explanations are based on de Soysa& Oneal's article in: de Soysa, I. and J. R. Oneal (1999). "Boon or Bane? Reassessing the Productivity of Foreign Direct Investment." American Sociological Review **64** (October): pp. 766-782.

DSO run a total of four regressions using Firebaugh's measures for foreign investment rate respectively domestic saving rate. DSO's findings for the replication of Firebaugh's simple regression equation (*Equation 4.27*) are similar to those in Firebaugh's article (1992). This holds independent from the way the investment rate is calculated and the sample composition (all countries or only the LDCs).

Equation 4.27

$$\left(\sqrt[11]{\frac{y_{1991}}{y_{1980}}} - 1\right) \times 100 = \beta_0 + \beta_1 \gamma_{I_F} + \beta_2 \gamma_{I_D} + \beta_3 \log(Y_{1980}) + \beta_4 OPEN + \beta_6 \log(y_{1980})$$

Equation 4.27: N = 114 countries. The control variables are the *natural logarithm of GDP as of 1980* as the size of economy real GDP using purchasing power parities. The did use not energy consumption because the amount of energy used does not provide information how efficiently it was converted into output), *openness* measured as ratio of trade to GDP (instead of *expo*rt) and the *natural logarithm of GDP per capita as of 1980*

The results for the replication of D&B's penetration effect model (*Equation 4.28*) are different from D&B's results. Their results indicate no significant effect of FDI on economic growth for the selected time range. That is, there is no evidence for negative externalities. DSO included domestic capital penetration, measured as ratio of capital from domestic sources to GDP, as a modification of the model.

Equation 4.28

$$\left(\sqrt[11]{\frac{y_{1991}}{y_{1980}}} - 1\right) \times 100 = \beta_0 + \beta_1 P + \beta_2 \gamma_{I_F} + \beta_3 \gamma_{I_D} + \beta_4 \log(Y_{1980}) + \beta_5 OPEN + \beta_6 \log(y_{1980}) + \beta_7 PEN_{Dom}$$

Equation 4.28: N = 97 countries (LDCs only). The control variables are the *natural logarithm of GDP as of 1980* as the size of economy, *openness* measured as ratio of trade to GDP (import+export/GDP), the *natural logarithm of GDP per capita as of 1980*, and the *domestic capital penetration*[32] denoted by PEN_{Dom}. *P* denotes either *PEN2* or *PEN3*, which were defined earlier.

DSO assume that the differences between their and D&B's findings may be the result of a change in the nature of FDI compared to the earlier period analyzed by D&B and subsequently a change of its effects on economic growth on the one hand and due to differing quality of data on the other hand. They point out that there has been a shift from foreign invest-

[32] Domestic capital penetration = $\left[\frac{K_{D_{1980}}}{GDP_{1980}}\right] \times 100$

ments in extractive industries to manufacturing and services between 1967 and 1980, resulting in possibly more beneficial links between foreign enterprises and the host economies (de Soysa and Oneal 1999, p. 774).

So far, DSO's replication of previous research supports Firebaugh's findings of differential productivity of capital and rejects D&B's assumption of negative externalities of foreign capital. According to DSO, foreign capital would only adversely affect economic growth if it "were less productive *and* displaced domestic capita" (p. 775, emphasis in italics in original). However, DSO doubt that foreign capital is less productive than domestic capital. The coefficients of foreign and domestic investment rates cannot be directly compared because the two kinds of capital differ in absolute dollar values and therefore, an equal change in investment rates in percentage does not equal the change measured in absolute dollar values. This is because domestic capital outscores foreign capital in absolute dollar value by a ratio of 13:1 (p. 775). That is, an increase of 1% of domestic capital adds 13 times more to the total capital stock than does foreign capital. For a correct interpretation of the regression results, the regression coefficient for the foreign investment rate must be multiplied by 13. For a better understanding: The regression coefficient for DSO's replication of Firebaugh's model is 0.25 for the annualized domestic and 0.051 for annualized foreign investment rate. An increase of 1% in domestic investment boosts growth by 0.25 percent and analogous 0.051 percent for foreign investment. But as the ratio of domestic to foreign capital is 13:1, a 1% increase in foreign investment does actually boost growth by 0.66% (13x0.051=0.66) instead of 0.051%. These results indicate that foreign investment is even 2.6 times more productive than domestic investment. The authors do not make any assumption on the reasons of this surprising outcome, though it would be of great interest to find the causes for this differential productivity.

In a second step of their empirical analysis, they address the question, if on the one hand foreign investment attracts, displaces or does have no effect on domestic investment and on the other hand, if domestic investment encourages or discourages foreign investment. According to their findings, a long-run effect of a permanent increase in the rate of foreign direct investment is to increase the flow of domestic capital by factor 2.89, while the long-run effect of domestic investment is only 0.17 (pp. 776-778). That is, FDI is not only 2.6 times more productive than domestic investment, but does also significantly foster domestic capital. Based on these results DSO conclude that domestic and foreign capital are not rival but complementary (p. 778).

5 ECONOMIC GROWTH THEORY

5.1 Introduction

This section provides a comprehensive description of the most prominent model of economic growth theory, the Solow-model. An extension of this model will later be used to derive a regression equation for the empirical analysis. Economic growth theory thereby serves as a methodology to develop an appropriate regression equation for the analysis at stake. The Solow-model and other models of economic growth theory have extensively been tested and provide an interesting methodological approach for the development of models in sociology. A comprehensive presentation of the Solow-model with the necessary explanations on how the basic equations can be derived and on which assumptions they are based is hard to find. The following section provides not only the necessary knowledge on how the Solow-model can be used for a statistical analysis and for the subsequent formulation of the empirical model but also bridges the gap in the illustration of this model in textbooks.

5.2 Neoclassical growth theory

To explain the long-term development of the economy has been one of the main interest of economic theory. The wealth of nations and the discrepancies between the standard of living between nations result from a development process that started in the past. Some countries have been successful in increasing their real per capita incomes like for example South Korea or Taiwan, while others see a decline of their real per capita income like for instance countries in the sub-Sahara zone. Researchers in macro-economic theory developed mathematical models in order to explain economic development respectively economic growth. The aim of these models is to explain long-term growth and long-term trends in economic development, while using only few determinants (Bretschger 1998).

First *neoclassical* growth models have been developed by Solow (1956) and Swan (1956). Taking growth rates of savings and population as exogenously determined, Solow and Swan showed that these variables could explain long-run levels of income per capita in market economies. The inherent logic of the model proposes that the higher the saving rate the richer the country and the higher the population rate and therefore, the faster the growth of population the poorer the country. Up to this time economic models based on general equilibrium theory have been dominating in economic theory. In these models the product space and technology were given. Firms were merely considered as placeholders for technological possibili-

ties that were available to everyone. There were no specific assumptions about perfect competition.

Neoclassical growth theory stresses that the basic prerequisite to sustain a positive growth rate of output per capita in the long run, are continual advances in technological knowledge in the form of new goods, new markets and new processes. Thus, economic growth involves a two-way interaction between technology and economic activity, that is, technological progress transforms the very economic system that creates it (Aghion and Howitt 1998, p. 1). Without any technological progress the effects of diminishing returns would cause economic growth to cease, a proposition that can be demonstrated using a model developed by Solow and Swan.

New growth theory is especially relevant when research focuses on developing countries. Traditional growth models assumed that labor must be thought as homogenous, that is, any unit of labor can be exchanged with any other unit. New growth theories assume that labor is not homogenous and that there are differences in quality between labor units and that these differences in quality affect productivity of physical capital. Subsequently, human capital was included into the models to account for potential differences in productivity.

The introduction to neoclassical growth models in the next part of this section does mainly draw form literature by Aghion & Howitt (1998), Mankiw, Romer and Weil (1992), David Romer (1996), Barro & Sala-i-Martin (1995), and Bretschger (1998). For better readability the exact sources are not always indicated.

5.2.1 The basic model setup

A basic neoclassical model is based on an aggregated production function exhibiting constant returns in labor and reproducible capital. In a very simplified setup the production function can be written as a function of capital alone: $Y=F(K)$, where Y denotes output and K capital. All other factors are given. The first assumption is that capital and labor are fully and efficiently employed. The problem in this proposition is that there are diminishing returns to the accumulation of capital as a theoretically infinite equipment of people with the same capital goods without inventing new uses of the capital results sooner or later in redundancy with few exceptions. The marginal product of capital is strictly decreasing in the stock of capital. Formally expressed this means: $F'(K) > 0$ (the first derivative is positive (=positive slope)) and $F''(K) < 0$ (second derivative is negative, that is, there is a maximum and the slope is diminishing (=marginal product)). The only driving force for capital growth is capital accumulation, as population growth and technological change are assumed to be absent. This actually means that output can only grow if the stock of capital increases. As in real life people save a frac-

tion *s* of their gross income *Y*, and a fraction δ of the capital stock disappears as a result of depreciation. The saving rate *s* and depreciation δ are assumed to be constant in the model.
The amount of capital in existence at a given date determines the rate of change of the capital stock at that date. The *steady-state* is reached when savings equals depreciation referred to as *unique stable, stationary state of the economy*. When savings are bigger than depreciation, then the capital stock will be increasing. When savings are smaller, then the capital stock decreases. When capital is scarce then, it is very productive. As a consequence, national income will be large in relation to the capital stock, which will induce people to save more to offset the wear and tear on existing capital. Increased saving causes the capital stock to rise, so does the national income *Y*. Because of diminishing returns, national income will grow slower than the stock of capital, that is, savings do also grow slower than depreciation. Where depreciation catches up with savings, the stock of capital will cease rising at the level K^*. In the absence of population growth and technological change, diminishing returns will eventually reduce economic growth to zero. Output will reach its stationary level exactly then, when K reaches its stationary level K^* so that $Y^* = F(K^*)$. Any attempt to increase growth by simply encouraging people to save more will therefore fail and will have no long-run effects on the growth rate.

5.2.2 Fundamental dynamic equation for the capital stock

The neoclassical growth model by Solow (1956) is the usual starting point for nearly every analyses of growth. The Solow-model can be divided into three parts: An aggregated saving function, an aggregated production function and an aggregated finance sector. The base model has only two inputs - physical capital and labor (technology will be added later). The aggregated production function is as follows:

Equation 5.1

$$Y(t) = F(K(t)),L(t))$$

Equation 5.1 can also be formulated as a Cobb-Douglas production function instead of an aggregated production function where α denotes the physical capital's share in income.

Equation 5.2

$$Y(t) = K(t)^{\alpha} L(t)^{1-\alpha} \qquad \text{| while } 0 < \propto < 1$$

Y(t) denotes the flow of output produced at time *t*. The production function depends on time *t* to reflect the effects of technological progress (not yet introduced), that is, the same amount of labor and physical capital yield higher output today than it did for example fifty years ago. *K(t)* denotes physical capital and *L(t)* is labor. Labor equals population, which grows at an exogenously given exponential rate *n*.

Equation 5.3

$$L(t) = L(0)e^{nt}\,L(t)$$

We assume a closed economy, where output equals income and where savings *S(t)* equal the amount invested *I(t)*. The saving rate *s(t)* is given exogenously. Further, capital and labor in production can each be substituted vice versa. There is perfect competition and constant returns to scales are assumed. As in reality capital can wear out, in the model denoted by a constant depreciation rate $\delta\ (\delta > 0)$.

A production function is neoclassical if the following three properties are satisfied:

1. $K > 0$ and $L > 0$. $F(\cdot)$ must exhibit positive and diminishing marginal products with respect to each input
2. $F(\cdot)$ exhibits constant returns to scale
3. The marginal product of capital (or labor) approaches infinity as capital (or labor) goes to zero and approaches zero as capital (or labor) goes to infinity.

The last condition is part of the Inada-conditions, which can be expressed mathematically:

$f' > 0,\ f'' < 0$ --> *the slope of the curve for y = f(k) is positive and decreasing.*

$f'(0) = \infty$ --> *the slope will be infinite when K equals zero.*

$f'(\infty) = 0$ --> *the slope will equal zero when K is infinite.*

The condition of constant returns to scale implies that output can be written as *Equation 5.4*. Dividing this equation by *L* allows to express the production function in an intensified form *Equation 5.5*.

Equation 5.4

$$Y(t) = (K(t), L(t))$$

$$Y(t) = L(t) \cdot F(K(t)/L(t), 1) = L \cdot f(k) \qquad \text{| divide by } L(t)$$

Equation 5.5

$$y(t) = f(k(t)) \qquad \text{| while } k(t) = \frac{K(t)}{L(t)} \text{ and } y(t) = \frac{Y(t)}{L(t)}$$

or expressed as per capita production function in a Cobb-Douglas case.

Equation 5.6

$$y(t) = k(t)^{\alpha}$$

Saving function

People in this economy save a constant fraction of output $s \cdot Y(t) = S(t)$. As mentioned earlier, saving equals investment, $S(t) = I(t)$. *Equation 5.7* combines the production function, the saving function and financing function of the model. A dot on top of variable expresses differentiation with respect to time:

Equation 5.7

$$\underbrace{S(t)}_{1.} = \underbrace{s \cdot Y(t)}_{2.} = \underbrace{s \cdot F(K(t), L(t))}_{3.} = \underbrace{I(t) + dK(t)}_{4.} = \underbrace{\dot{K}(t) + dK(t)}_{5.}$$

Equating the third and last term of the equation above in *Equation 5.8*:

Equation 5.8

$$s \cdot F(K(t), L(t) = \dot{K}(t) + dK(t) \qquad \text{| divide by } L \text{ and rearrange}$$

Equation 5.9

$$\frac{\dot{K}(t)}{L(t)} = s \cdot f(k(t)) - \delta k(t) \qquad \text{| substitute the left hand side:}$$

$$\dot{k}(t) = \frac{d(K(t)/L(t))}{dt} = \frac{\dot{K}(t) \cdot L(t)}{L(t)^2} - \frac{K(t) \cdot \dot{L}(t)}{L(t)^2}$$

$$\frac{\dot{K}(t)}{L(t)} = \dot{k}(t) + \frac{K(t) \cdot \dot{L}(t)}{L(t)^2}$$

Equation 5.10

$$\dot{k}(t) + \frac{K(t) \cdot \dot{L}(t)}{L(t)^2} = s \cdot f(k(t)) - \delta k(t) \qquad \text{| resolve left hand side and rearrange:}$$

$$\frac{K(t) \cdot \dot{L}(t)}{L(t)^2} = \underbrace{\frac{\dot{L}(t)}{L(t)}}_{n} \cdot \frac{K(t)}{L(t)} = nk(t)$$

rearranging the equation and substituting with the growth rate terms results in

Equation 5.11

$$\dot{k}(t) = s \cdot f(k(t)) - (n + \delta) \cdot k(t)$$

and *Equation 5.11* expressed in Cobb-Douglas form:

Equation 5.12

$$\dot{k}(t) = s \cdot k(t)^{\alpha} - (n + \delta) \cdot k(t)$$

Equation 5.11 is the fundamental equation of the Solow-Swan model. This non-linear equation only depends on *k(t)*. The term *(n+δ)* can be thought of as the effective depreciation rate for the capital/labor ratio, *k(t)=K(t)/L(t)*. If the saving rate, *s*, decreases to zero, then *k(t)* would likewise decline partly due to the depreciation of *K(t)* at the rate *δ* and partly due to the growth of *L(t)* at the rate *n* (Barro and Sala-i-Martin 1995, p. 18).

Figure 5.1 illustrates the curves for the production function *y(t) = f(k(t))*, the investment function *s·f(k(t))* and for the effective depreciation *(n+δ)·k*. The curve for *s·f(k(t))*, gross investment, looks very much like the production function, but is somewhat lower due to the multiplication by the positive fraction *s*. The course of the curves are as implied by the Inada-conditions. Both, the production function as well as the investment function start from the origin (as *f[0] = 0*) and both have a positive and decreasing slope. Consumption per person, denoted by *c*, equals the vertical distance between the *s·f(k(t))* and the *f(k(t))* curve.

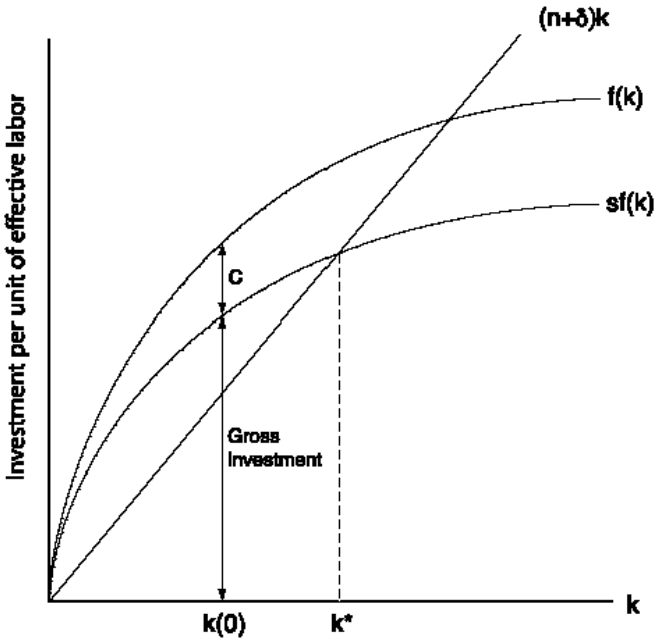


Figure 5.1

$(n+\delta)\cdot k$ is effective depreciation, also denoted as *break-even investment*. $s\cdot f(k)$ is gross investment, also denoted as *actual investment*.
At the intersection of the effective depreciation line and the actual investment curve, depreciation and investment are equal, hence this is the steady state of the economy, where all per capita magnitudes are constant and the *levels* of K, C, and Y grow at the rate n of the population.

5.2.3 Steady state

The steady state is defined as the situation where the various quantities grow at constant rates. For the Solow-Swan model, this is exactly where the investment function equals the effective depreciation of *K*. Graphically illustrated this is, where in *Figure 5.1* the curve of the investment function intersects the straight line of effective depreciation of *K(t)* (for $k \geq 0$). For the steady state *k(t)* is denoted as k^*. *Equation 5.13* follows from *Equation 5.11,* where $\dot{k} = 0$.

Equation 5.13

$$s \cdot f(k^*) = (n + g) \cdot k^*$$

Or in the Cobb-Douglas form pursuant to *Equation 5.12,* the equation for the steady state can be solved as follows

Equation 5.14

$$s \cdot k^{\alpha} = (n + g) \cdot k^* \qquad | \text{ rearrange}$$

$$k^{*(1-\alpha)} = \frac{s}{(n + \delta)} \qquad | \sqrt[1-\alpha]{\ }$$

Equation 5.15

$$k^* = \left[\frac{s}{(n+\delta)}\right]^{1/(1-\alpha)}$$

In the steady state, per capita output and per capita consumption are also constant since *k(t)* is constant, that is, *k(t)*, *y(t)* and *c(t)* do not grow in the steady state.

Equation 5.16

$$y^* = f(k^*)$$

Equation 5.17

$$c^* = (1-s)\cdot f(k^*)$$

As the per capita magnitudes are constant in the steady state, the levels of capital, output and consumption - *K(t)*, *Y(t)* and *C(t)* - grow only at the rate of population growth, *n*. Changes in *s*, *n* or δ have effects on the per capita *levels* of the various quantities in the steady state. For example, an increase in *s* results in an upward shift of the investment curve and therefore in a higher steady state level. And an increase in *n* or δ moves the $(n+\delta)\cdot k(t)$ line upward and subsequently leads to a lower steady state level (Barro and Sala-i-Martin 1995, p. 19).
This Solow-model can only explain the growth rate of an economy on its path to the steady state, but not beyond. Only the introduction of an exogenous technology factor can lead to an increase of *Y(t)*. It is important to note that changes in the level of technology, which has not been introduced yet, in *s*, *n* and δ do not affect the steady state growth rates of per capita output, capital and consumption, all of which are equal to zero. The accumulation of physical capital cannot account for either the growth over time in output per person nor the geographic differences in output per person. Therefore, this model cannot provide explanations of the determinants of long-run per capita growth (Romer 1996, p.19).

5.2.4 Including Technological Progress

The Solow-model without a technology factor might not be suitable to explain long-run per capita growth. However, it explains the transition path to the steady state determined entirely by exogenous variables. The observed long-run growth in output per person can only be ex-

plained if a technological change is assumed - a factor that continually offsets the dampening effect of diminishing returns and subsequently enables the economy to grow in per capita terms in the long-run. Therefore, income of an economy on its steady state growth path can only be increased if technological progress is added as an additional *exogenous* variable to the model, denoted by *A*. *A(t)* is a productivity parameter that reflects the current state of technological knowledge, which grows at the constant exponential rate *g*.

Equation 5.18

$$A(t) = A(0)e^{gt}$$

Extending *Equation 5.1* by the additional technology factor results in *Equation 5.19*:

Equation 5.19

$$Y(t) = A(t) \cdot F(K(t), L(t))$$

Labor and capital augmenting technological progress

Technology is generally improved by activity in research and development done by for example universities. For the Solow-model it is assumed that technology improves exogenously and not through research and development financed by the government or private enterprises of this economy. Which factors are affected by the technological progress introduced into the model? Technological progress can lead to a reduction in the relative amount of labor input to produce the same output or to a reduction in the relative amount of capital input to produce the same output - the former often referred to as *labor-saving* and the later as *capital-saving technological progress*. Technological progress, like an invention for instance, that does not save relatively more of neither labor nor capital is called *neutral* or *unbiased* (Barro and Sala-i-Martin 1995, p. 133). Generally speaking, that is, technological progress is neutral if more output can be produced without increasing the amount of inputs. There are three popular definitions of neutral technological progress: The neutral technological progress by Hicks, by Harrod and by Solow (Barro and Sala-i-Martin 1995; Bretschger 1998).

According to Hicks, technological progress is neutral if the ratio of marginal products remains unchanged for a given *capital-labor* ratio, *k(t)=K(t)/L(t)*.

Equation 5.20

$$\frac{F_{K,0}}{F_{L,0}} = \frac{F_{K,t}}{F_{L,t}} = \text{constant}$$

$F_{K,t}$ for instance denotes the marginal product of K at time t. *Hicks neutral* implies a constant distribution of income for the two factors over time. The production function for *Hicks neutral* is as in *Equation 5.21* where *A(t)* represents an index of the state of technology.

Equation 5.21

$$Y(t) = A(t) \cdot F(K(t), L(t))$$

But it is also possible that income is unevenly distributed on these two factors. In this case the effect of technological progress is not product-augmenting but factor-augmenting. Harrod defines an innovation as neutral if the relative input shares, $K \cdot F_K / L \cdot F_L$, remain unchanged for a given *capital-output* ratio *v(t)*, where *v(t) = K(t) / Y(t)*. The production function is as follows, where *A(t)* represents an index of technology:

Equation 5.22

$$Y(t) = F(K(t), A(t) \cdot L(t))$$

This form is called *labor-augmenting* technological progress. That is, technological progress raises output in the same way as an increase in the stock of labor.
Solow defines an innovation as neutral if the relative input shares, $L \cdot F_L / K \cdot F_K$, remain unchanged for a given labor to output ratio, *L(t) / Y(t)*. That is, technological change is purely capital augmenting if the marginal product of labor is unchanged for a constant labor to input ratio, *L(t) / Y(t)*.

Equation 5.23

$$Y(t) = F(A(t) \cdot K(t), L(t))$$

This production function is called *capital-augmenting* because a technological improvement increases production in the same way as an increase in the stock of capital.

Technological progress must be labor-augmenting

If a constant rate of technological progress is assumed, only *labor-augmenting* technological change turns out to be consistent with the existence of a steady state. That is, only Harrods concept of technological progress is compatible with the prerequisite of constant growth rates of the various quantities in the long run.

Let γ_K denote the growth rate of capital *K(t)* and γ_Y the growth rate of output *Y(t)*.

Equation 5.24

$$\gamma_Y = \gamma_K = \frac{s}{v} = \text{constant}$$

As the Solow-model assumes a constant saving rate, the condition in *Equation 5.24* is only met if *v(t)* is constant too. Subsequently, technological progress may not have any *capital-augmenting* effect because this would result in an increase of the capital-output ratio *v(t)*, *v(t)=K(t) / Y(t)*. From this follows that technological progress does only comply with the concept of steady state if it is Harrod-neutral respectively solely *labor-augmenting*.

Technological progress in a Cobb-Douglas production function is a special case. Each Cobb-Douglas production function with one of the three types of Hicks-, Harrod-, and Solow -neutral technological progress can be transformed into a qualitatively equal function. The Cobb-Douglas production function is therefore independent of the definition of technological progress (Bretschger 1998, p.37).

Equation 5.25

Hicks: $$Y \cong \tilde{A}_{Hi} \cdot K^{\alpha} L^{1-\alpha}$$

Equation 5.26

Harrod: $$Y = K^{\alpha} \cdot (A_{Ha} \cdot L)^{1-\alpha} = A_{Ha}^{1-\alpha} \cdot K^{\alpha} \cdot L^{1-\alpha} = \tilde{A}_{Ha} \cdot K^{\alpha} \cdot L^{1-\alpha}$$

Equation 5.27

Solow: $$Y = (A_{So} \cdot K)^{\alpha} \cdot L^{1-\alpha} = A_{So}^{\alpha} \cdot K^{\alpha} \cdot L^{1-\alpha} = \tilde{A}_{So} \cdot K^{\alpha} \cdot L^{1-\alpha}$$

Cobb-Douglas form of the Solow-model with technology factor

There does not seem to be a consistent formulation of the Cobb-Douglas production function including the technology factor. For example, Barro & Sala-i-Martin (1995) and Bretschger (1998) use *Equation 5.28* while Mankiw et al. (1992) and Aghion & Howitt (1998) use *Equation 5.29*. In this text the later is used, but the explanations above show that the deferring functions are qualitatively equal.

Equation 5.28

$$Y(t) = A(t) \cdot K(t)^{\alpha} \cdot L(t)^{1-\alpha} \qquad \text{| while } \; 0 < \propto < 1$$

Equation 5.29

$$Y(t) = K(t)^{\alpha} \cdot (A(t) \cdot L(t))^{1-\alpha}$$

A(t)L(t) represents the number of *effective units of labor*. *A(t)* and *L(t)* are assumed to grow exogenously at the rates *g* respectively *n* as expressed by *Equation 5.3* and *Equation 5.18*. That is *A(t)L(t)* grows at the rate *n+g*.

The per capita Cobb-Douglas form of *Equation 5.19* can be derived from *Equation 5.29* as illustrated below, which results in *Equation 5.30*:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}$$

$$Y(t) = K(t)^{\alpha} \cdot \frac{A(t)L(t)}{\left[A(t)L(t)\right]^{\alpha}} \qquad \text{| rearrange}$$

$$\frac{Y(t)}{A(t)L(t)} = \left[\frac{K(t)}{A(t)L(t)}\right]^{\alpha}$$

Equation 5.30

$$y(t) = k(t)^{\alpha}$$

Growth rate of the capital stock per effective unit of labor

The *growth rate* of the *capital stock* per *effective unit of labor* can be derived from the basic equation. *A(t)L(t)* represents the number of *effective units of labor*, which grows at the rate *n+g*. Let *k(t)* be the *capital stock* per *effective unit of labor,* that is *k(t)=K(t)/(A(t)L(t))*. Analogous, *y(t)* is *income* per *effective unit of labor*, *y(t)=Y(t)/(A(t)L(t))*. Each economy saves an amount *S(t)* of its income *Y(t)*, while s_K denotes the fraction of *Y(t)* that is saved (resp. in-

vested), that is $S(t)=s_K Y(t)$. And as in the model without the technology factor, δ denotes the constant *depreciation rate* of *capital*. A dot over variables denotes differentiation with respect to time.

$$\dot{K}(t) = S(t) - \delta K(t)$$
$$\dot{K}(t) = s_K \cdot Y(t) - \delta K(t) \quad | \text{ while } S(t) = s_K Y(t)$$
$$\frac{\dot{K}(t)}{A(t)L(t)} = s_K \cdot \frac{Y(t)}{A(t)L(t)} - \delta \frac{K(t)}{A(t)L(t)}$$

Equation 5.31

$$\frac{\dot{K}(t)}{A(t)L(t)} = s_K \cdot f(k(t)) - \delta k(t)$$

Solving the left hand side of Equation 5.31

For rephrasing the left hand side of *Equation 5.31* consider the following:

$$\dot{k}(t) = \frac{d\left[\frac{K(t)}{A(t)L(t)}\right]}{dt}$$

$$\dot{k}(t) = \frac{\dot{K}(t)\left[A(t)L(t)\right]}{\left[A(t)L(t)\right]^2} - \frac{K(t)\left[\dot{A}(t)L(t)\right]}{\left[A(t)L(t)\right]^2}$$

$$= \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)}{\left[A(t)L(t)\right]^2}\left[A(t)\dot{L}(t) + \dot{A}(t)L(t)\right]$$

$$= \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)\left[A(t)\dot{L}(t)\right]}{A(t)L(t) \times A(t)L(t)} - \frac{K(t)\left[\dot{A}(t)L(t)\right]}{A(t)L(t) \times A(t)L(t)}$$

$$= \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)}{A(t)L(t)} \times \underbrace{\frac{\dot{L}(t)}{L(t)}}_{=n} - \frac{K(t)}{A(t)L(t)} \times \underbrace{\frac{\dot{A}(t)}{A(t)}}_{=g}$$

$$= \frac{\dot{K}(t)}{A(t)L(t)} - \frac{K(t)}{A(t)L(t)} \times (n+g)$$

Equation 5.32

$$\frac{\dot{K}(t)}{A(t)L(t)} = \dot{k}(t) + \frac{K(t)}{A(t)L(t)} \times (n+g)$$

Substituting the right hand side of *Equation 5.32* into *Equation 5.31* and solving for $\dot{k}(t)$ results in the equation for the *growth rate* of the *capital stock* per *effective unit of labor*, *Equation 5.33*:

$$\dot{k}(t) + \frac{K(t)}{A(t)L(t)}(n+g) = s_K y(t) - \delta k(t) \qquad \text{| rearrange}$$

Equation 5.33

$$\dot{k}(t) = s_K \cdot y(t) - k(t)(n+g+\delta)$$

This equation can also be written in Cobb-Douglas form by inserting *Equation 5.30* into *Equation 5.33*:

Equation 5.34

$$\dot{k}(t) = \underbrace{s_K \cdot k(t)^{\alpha}}_{Term1} - \underbrace{k(t)(n+g+\delta)}_{Term2}$$

Equation 5.34 is the fundamental equation of the basic textbook Solow-model.
Term 2 of *Equation 5.34* can be thought of as the *effective depreciation rate* of the *capital-labor ratio*. *Equation 5.33* (resp. *Equation 5.34*) implies that a *steady state* value k^* is reached if *term1* and *term2* are equal in magnitude. This condition can be mathematically expressed as follows:

Equation 5.35

$$s_K \cdot k(t)^{\alpha} = k(t)(n+g+\delta)$$

If $\dot{k}(t) = 0$, then *k(t)* is constant - and therefore denoted as k^* - and *K(t)* grows at the constant rate *(n+g+δ)*. The steady state *capital-labor ratio* is related positively to the rate of *savings* and negatively to the rate of *population growth*. The central predictions of the textbook Solow-model concern the impact of *saving* and *population growth* on *real income* (Mankiw, Romer, and Weil 1992, p. 410, henceforth MRW). For empirical purposes, the *steady state* of *per labor income* can be calculated by first solving *Equation 5.35* for k^*, which results in Equation 5.36:

Equation 5.36

$$k^* = \left[\frac{s_K}{n+g+\delta}\right]^{\frac{1}{1-\alpha}}$$

To find the steady state of income, *Equation 5.36* is substituted into the production function (*Equation 5.29)*:

$$Y(t) = \left[A(t)L(t) \times \left[\frac{s_K}{n+g+\delta}\right]^{\frac{1}{1-\alpha}}\right]^{\alpha} \times \left[A(t)L(t)\right]^{1-\alpha}$$

Taking logs and solving for logged *per labor income* results in *Equation 5.37*:

$$\ln(Y(t)) = \alpha \ln\left[A(t)L(t) \times \left[\frac{s_K}{n+g+\delta}\right]^{\frac{1}{1-\alpha}}\right] + (1-\alpha)\ln(A(t)L(t))$$

$$= \alpha \ln(A(t)L(t)) + \frac{\alpha}{1-\alpha}\ln\left[\frac{s_K}{n+g+\delta}\right] + \ln(A(t)L(t) - \alpha \ln(A(t)L(t))$$

$$= \ln(A(t)L(t)) + \frac{\alpha}{1-\alpha}\ln(s_K) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta)$$

$$\ln(Y(t)) - \ln(L(t)) = \ln(A(t)) + \frac{\alpha}{1-\alpha}\ln(s_K) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) \qquad \text{| while } A(t)=A(0)e^{gt}$$

Equation 5.37

$$\ln\left[\frac{Y(t)}{L(t)}\right] = \ln(A(0)) + gt + \frac{\alpha}{1-\alpha}\ln(s_K) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta)$$

MRW (1992, pp. 410-411) argue that the term *ln(A(0))* not only reflects technology, but also resource endowment, climate, institutions, and so on. Due to this assumption it may differ across countries. For the empirical analysis based on this equation they suggest that *ln(A(0)) = a + ε*, while *a* is a constant and *ε* is a country specific shock. *Logarithmic income per labor* at a given time – MRW suggest *time* 0 for simplicity – is as follows:

Equation 5.38

$$\ln\left[\frac{Y(t)}{L(t)}\right] = a + \frac{\alpha}{1-\alpha}\ln(s_K) - \frac{\alpha}{1-\alpha}\ln(n+g+\delta) + \varepsilon$$

This is the empirical specification MRW use for their own empirical analysis of the basic Solow-model. The term *gt* in *Equation 5.37* equals zero because *t=0*. It is assumed that s_K, n and g are independent of ε and that δ is constant across countries[33].

For this analysis, which will include FDI as an additional input factor, the same empirical specifications will be assumed as MRW applied for the basic Solow-model. That is an equation of the basic Solow-model including FDI should be of a similar structure as *Equation 5.38*.

5.3 Absolute and conditional convergence

Absolute convergence takes place when poorer countries grow faster than richer ones and *conditional* convergence when a country grows faster the further it is from its steady state. The concept reflects the transitional dynamics of the model, though the assumptions made for a model with *absolute* or *conditional* convergence differ significantly. For the reason of simplicity one can consider only two countries with the same production function, the same technology and with the same values for the parameters *s*, *n*, and δ that determine the steady state capital to labor ratio. Thus, the economies have the same steady state level k^* and y^*. The only difference between the two economies is the initial quantity of capital per person. The model implies that the country that begins with the lower level of output per capita has a higher growth rate of output per capita. The hypothesis for this model with *absolute* convergence is that the two countries' levels of output per capita will tend to converge. Empirical tests for this hypothesis turn out far better when the sample includes a homogenous group of countries like the OECD or the continental US-states, but *absolute* convergence does not apply for a heterogeneous sample (Barro and Sala-i-Martin 1995, pp. 25-30). To allow for heterogeneity, the assumptions on equal parameter values and same steady state positions must be dropped. A concept of *conditional* convergence with the assumption of differing steady states assumes that an economy grows faster the further it is from its steady state value. When a homogeneous samples and a broad cross section of countries is empirically tested, the results are similar

[33] MRW argue that there is no reason to expect δ to vary and that data on this variable could be hardly obtained.

to those in the model with *absolute* convergence (Barro and Sala-i-Martin 1995; Mankiw 1995). But again the model does not predict convergence in all circumstances. That is, a poor country may grow at a slower rate than a rich country. In particular the model does not predict the *rate* of convergence. Generally the predictions of convergence are twice the rate that actually occur (Mankiw 1995, p. 285). Growth rates can therefore vary from country to country, either because of differences in parameter determining their steady state or because of differences in initial positions.

In a study by Mankiw, Romer and Weil (1992) the textbook Solow-model was tested with reference to the disparities in economic growth observed between different countries. Under perfect competition in the market of final goods and under the assumption of constant returns to scale the coefficient α and $(1-\alpha)$ should equal the shares of capital and labor in income - which the authors assumed to be about one third for α for the US (Aghion and Howitt 1998; Mankiw, Romer, and Weil 1992). Though the model proved successful for the regressions explaining the variation in income, the estimated impacts of saving and labor force growth are much larger than the model predictions for α. The results show that differences in saving and population growth account for a large part of the cross-country variation in *income per capita*. This contradicts the common claim that the textbook Solow-model "explains" cross-country variation in labor productivity largely by appealing to variations in *technologies* (Mankiw, Romer, and Weil 1992, pp. 413-415). While the observed variables in the model may be able to account for most of the cross-country variation in real income, it could not predict the large differences in the real world. MRW question the assumption that all countries operate with the same production function. Poor countries do probably not only have low saving and high population growth, but they may also lack advanced production technologies. Existing differences in the production function would indicate that poor countries must be using vastly inferior technology to that of rich countries. The meaning of this assumption actually is that poor countries could be producing much more output without increasing the quantities of their capital or their labor. If this were the case, then the incentives to imitate technology used by rich countries would be tremendous. But imitating technology is not necessarily easy. To adopt the best available technology, an economy may need a skilled labor force (Mankiw 1995, pp. 283-284). This is a first argument that induces to think about the inclusion of human capital into the production function. Second it is argued that there is little empirical support for constant returns to physical capital. Long-run growth can not simply be driven by the replication of existing physical capital, such as plants and equipment like machines. As already mentioned, technological change must play a significant role (Aghion and Howitt 1998, p.

33). But beside technological change as an engine of growth, other factors affect productivity and lead to the accumulation of other forms than physical capital: human capital. Human capital generally denotes knowledge, skills, on-the-job-training etc. For a first test of an extended Solow-model with FDI, human capital is omitted as input factor. Later scientific analysis based on such a model should include human capital.

5.4 Why an exogenous growth model?

Recent empirical research has demonstrated that an augmented Solow-model provides a fairly good description of cross-country data on output per worker (see i.e. Grunlach 1995; Mankiw, Romer, and Weil 1992; Murthy and Ukpolo 1999). It is to mention that modifications of the standard augmented Solow model have led to an improvement of the empirical results. Of course the exogenous growth model has its critics. One of the main arguments against the exogenous growth model (and especially the Solow-model) is that it cannot explain the persistence of economic growth throughout most parts of the world. On the other hand it can explain international differences in growth rates as the result of convergence to different steady states. With reference to endogenous growth it is argued that it does not significantly improve empirical results compared to exogenous growth (i. e. Grunlach 1994; Mankiw 1995; Mankiw, Romer, and Weil 1992). Therefore, an exogenous growth model is sufficient for this research work.

After all, there is no more important topic in economics than how to raise the standard of living of the world's poor.

"When I went to graduate school, almost 30 years ago, I initially thought about specializing in development. After all, there is no more important topic in economics than how to raise the standard of living of the world's poor. But in the mid-1970's, development economics was just too depressing to pursue. Indeed, it might as well have been called non-development economics. No third world nation had made the transition to advanced-country status since 19th-century Japan. Circa 1975 it seemed that the club of nations with decent living standards was no longer accepting new members. Now we know that the club isn't that exclusive, after all. South Korea and several smaller Asian economies have made a full transition to modernity. How was this improvement achieved? […] I believe in free trade, […] not because I have any fond feelings about multinational corporations, but because every one of those development success stories was based on export-led growth. And that growth is possible only if rising economies can expand into new markets. [T]he promise of export-led growth has failed in too many places. […] Latin nations have liberalized, privatized and deregulated, with results ranging from disappointing (Mexico) to catastrophic (Argentina). Open world markets, it seems, offer the possibility of economic development — but not an easy, universal recipe. We are not, it turns out, condemned to live forever on a planet where only a small minority of the global population has a decent standard of living. Will this good news continue? Growing tensions over world trade worry me [a]nd if the major economic powers stop honoring the rules that preserve open global markets, the chances of future development in poor nations will be much reduced. But none of this cancels the fact that over the past 25 years more people have seen greater material progress than ever before in history. That's something to celebrate."

***Paul Krugman**, Professor of Economics and International Affairs at Princeton University in his New York Times column (Krugman 2003)*

SECTION III

Model Extension and Empirical Results

6 EXTENDING THE BASIC SOLOW MODEL WITH FDI

6.1 Introduction

The Solow-model is a good framework for understanding the differences in the economic well-being of nations. The Solow-model emphasizes that differences in savings, technological progress and population growth explain cross-country differences in income per capita. For this empirical analysis, the Solow-model is therefore an appropriate methodological and theoretical base.

The results of cross country statistical analysis based on the Solow-model can be improved if the textbook Solow-model is extended by human capital. The model setup with human capital is usually referred to as *augmented Solow-model*. For the purpose of this analysis a basic – or textbook – Solow-model is used, which will be extended with foreign direct investment instead of human capital. Foreign direct investment must reasonably be included into the model, not only in regard to economics, but also in regard to the subject at stake. That is, a regression equation derived from this extended model must provide a basis to assess the effects of foreign direct investment on economic growth. This is done by including the FDI stock into the basic production function and by accounting for retained profits and reinvested earnings in the saving function. The following part of this chapter discusses how FDI can be included into the basic Solow-model and how a linear regression equation can be derived.

6.2 The Extended Model

The setup for the investment function and the basic production function of this extended Solow-model is based on the ideas of Dr. Ottmar Edenhofer (Potsdam Institute for Climate Impact Research).

In this extended Solow-model the FDI stock is added to the basic production function as an additional capital form. The model is a pragmatic approach to assess the effects of domestic and foreign investment on economic growth. For an empirical analysis based on a Solow-model it is assumed that the economies in the sample are in steady state. Since investments yield larger returns in developing and transition countries than in industrialized countries, capital from the latter flows to these poorer countries. This trend will eventually stop when investments yield the same returns regardless where they are invested.

The production function

The foreign direct investment stock is denoted by *Z(t)*. All other variables are the same as in the basic Solow-model.

Equation 6.1

$$Y = F(K(t), Z(t), A(t)L(t))$$

This basic production function can also be written in Cobb-Douglas form and as *per effective unit of labor* form:

Equation 6.2

$$Y(t) = K(t)^{\alpha} Z(t)^{\beta} A(t)L(t)^{1-\alpha-\beta}$$

Equation 6.3

$$y(t) = k(t)^{\alpha} z(t)^{\beta}$$

Growth rate of the physical capital stock per effective unit of labor

In the basic Solow-model savings, *S(t)*, equal a certain share of income, s_K, which is saved. That is, $S(t) = s_K Y(t)$. It is assumed that there are *returns* to foreign direct investment and that a share of these returns is reinvested in the host economy, while the other part is invested elsewhere or skimmed off. The basic saving function can now be extended based on this assumption.

Equation 6.4

$$S_K(t) = s_K Y(t) - r \cdot Z(t) + s_Z \cdot r \cdot Z(t)$$

The term $r \cdot Z(t)$ denotes the returns to the FDI stock expressed as the share *r* of the FDI stock, while the term $s_Z \cdot r \cdot Z(t)$ denotes the share of returns to the FDI stock that is reinvested. This share of reinvested *returns* is denoted by s_Z. A value of $s_Z=1$ means that all *returns* are reinvested.

The growth rate of the *physical capital stock* per *effective unit of labor* can be derived from the basic production function. In principle, this is done in the same way as for the basic Solow-model shown in the previous section. Change in the *physical capital stock* is expressed by *Equation 6.5*.

Equation 6.5

$$\dot{K}(t) = S_K(t) - \delta K(t)$$

Substituting *Equation 6.4* into *Equation 6.5* results in *Equation 6.6*

Equation 6.6

$$\dot{K}(t) = s_K Y(t) - r \cdot Z(t) + s_Z \cdot r \cdot Z(t) - \delta K(t)$$

As shown in the previous section, the left hand side of *Equation 6.6* can be solved by first dividing the equation by the *effective unit of labor* and then derivate the left hand side in respect to time, which results in *Equation 6.7* (see 5.2.4):

$$\frac{\dot{K}(t)}{A(t)L(t)} = \frac{s_K Y(t)}{A(t)L(t)} - \frac{r \cdot Z(t)}{A(t)L(t)} + \frac{s_Z \cdot r \cdot Z(t)}{A(t)L(t)} - \frac{\delta K(t)}{A(t)L(t)}$$

Equation 6.7

$$\frac{\dot{K}(t)}{A(t)L(t)} = \dot{k}(t) + k(t)(n + g)$$

Insert *Equation 6.7* and *Equation 6.3* into *Equation 6.6* (divide by *A(t)L(t)* first) and rearrange to get the equation for the growth rate of the *capital stock* per *effective unit of labor* (*Equation 6.8*).

$$\dot{k}(t) + k(t)(n+g) = s_K y(t) - r \cdot z(t) + s_Z \cdot r \cdot z(t) - \delta k(t)$$

$$\dot{k}(t) = s_K y(t) - r \cdot z(t) + s_Z \cdot r \cdot z(t) - k(t)(n+g+\delta)$$

Equation 6.8

$$\dot{k}(t) = s_K k(t)^{\alpha} z(t)^{\beta} - r \cdot z(t) \cdot (1 - s_Z) - k(t)(n+g+\delta)$$

Equation 6.8 is the fundamental equation of this extended Solow-model with FDI. The rate of change of the *capital stock* per *effective unit of labor* equals the sum of the right hand side terms. In the steady state $\dot{k}(t)$ equals zero and *k(t)* is constant, that is, $k(t) = k^*$. This condition is satisfied if the sum of these three terms equals zero as expressed by *Equation 6.9*.

Equation 6.9

$$s_K k^{\alpha} z^{\beta} = k(n+g+\delta) + r \cdot z \cdot (1 - s_Z)$$

The steady state for the *capital stock* can now be determined by multiplying this equation by *k* and solving for *k**. The asterisk that usually denotes the steady state variables has been omitted in this section for better readability:

$$s_K k^{\alpha} z^{\beta} = k(n+g+\delta) + \frac{k}{k} r \cdot z \cdot (1 - s_Z)$$

$$s_K k^{\alpha} z^{\beta} = k\left[n+g+\delta + \frac{z}{k} r \cdot (1 - s_Z)\right]$$

$$\frac{k^{\alpha}}{k} = \frac{n+g+\delta + \frac{z}{k} r \cdot (1 - s_Z)}{s_K z^{\beta}}$$

Equation 6.10

$$k^* = \left[\frac{n+g+\delta + \frac{z}{k} r \cdot (1 - s_Z)}{s_K z^{\beta}}\right]^{\frac{1}{\alpha - 1}}$$

To see the models implications concerning the magnitude of the effects of change in *saving rates, Equation 6.10* can be inserted into *Equation 6.2* to solve for the level of *y(t)* on the balanced growth path expressed by y^* (steady state).

Equation 6.11

$$Y(t) = \left[\left[\frac{n + g + \delta + \frac{z(t)}{k(t)} r \cdot (1 - s_Z)}{s_K z(t)^{\beta}} \right]^{\frac{1}{\alpha - 1}} \cdot A(t)L(t) \right]^{\alpha} \cdot Z(t)^{\beta} (A(t)L(t))^{1-\alpha}$$

Taking logs and rearranging the equation so that only *ln(y)* stands on the left hand side results in *Equation 6.12:*

$$\ln(Y(t)) = \alpha \ln(A(t)L(t)) + \frac{\alpha}{\alpha - 1} \ln \left[\frac{n + g + \delta + \frac{z(t)}{k(t)} r \cdot (1 - s_Z)}{s_K z(t)^{\beta}} \right] + \beta \ln(Z(t)) + \ln(A(t)L(t)) - \alpha \ln(A(t)L(t)) - \beta \ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha - 1} \ln \left(n + g + \delta + \frac{z(t)}{k(t)} r \cdot (1 - s_Z) \right) - \frac{\alpha}{\alpha - 1} \ln \left(s_K z(t)^{\beta} \right) + \beta \ln(Z(t)) + \ln(A(t)L(t)) - \beta \ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha - 1} \ln \left(n + g + \delta + \frac{z(t)}{k(t)} r \cdot (1 - s_Z) \right) - \frac{\alpha}{\alpha - 1} \ln(s_K) - \frac{\alpha}{\alpha - 1} \ln(z(t)^{\beta}) + \beta \ln(Z(t)) + \ln(A(t)L(t)) - \beta \ln(A(t)L(t))$$

while $\frac{z(t)}{k(t)} = \frac{Z(t)}{A(t)L(t)} \cdot \frac{A(t)L(t)}{K(t)} = \frac{Z(t)}{K(t)}$

$$\ln(Y(t)) = \frac{\alpha}{\alpha - 1} \ln \left(n + g + \delta + \frac{Z(t)}{K(t)} r \cdot (1 - s_Z) \right) - \frac{\alpha}{\alpha - 1} \ln(s_K) - \frac{\alpha}{\alpha - 1} \ln(z(t)^{\beta}) + \underbrace{\beta \ln(Z(t)) - \beta \ln(A(t)L(t))}_{\ln(z(t)^{\beta})} + \ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha - 1} \ln \left(n + g + \delta + \frac{Z(t)}{K(t)} r \cdot (1 - s_Z) \right) - \frac{\alpha}{\alpha - 1} \ln(s_K) - \frac{\alpha}{\alpha - 1} \ln(z(t)^{\beta}) + \ln(z(t)^{\beta}) + \ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha - 1} \ln \left(n + g + \delta + \frac{Z(t)}{K(t)} r \cdot (1 - s_Z) \right) - \frac{\alpha}{\alpha - 1} \ln(s_K) + \left(1 - \frac{\alpha}{\alpha - 1} \right) \ln(z(t)^{\beta}) + \ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha - 1} \ln \left(n + g + \delta + \frac{Z(t)}{K(t)} r \cdot (1 - s_Z) \right) - \frac{\alpha}{\alpha - 1} \ln(s_K) + \left(1 \cdot \frac{\alpha - 1}{\alpha - 1} - \frac{\alpha}{\alpha - 1} \right) \ln(z(t)^{\beta}) + \ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha-1}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)-\frac{\alpha}{\alpha-1}\ln(s_K)-\left(\frac{1}{\alpha-1}\right)\ln(z(t)^{\beta})+\ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha-1}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)-\frac{\alpha}{\alpha-1}\ln(s_K)-\frac{\beta}{\alpha-1}\ln(z(t))+\ln(A(t)L(t))$$

$$\ln(Y(t)) = \frac{\alpha}{\alpha-1}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)-\frac{\alpha}{\alpha-1}\ln(s_K)-\left(\frac{\beta}{\alpha-1}\ln\left(\frac{Z(t)}{L(t)}\right)-\frac{\beta}{\alpha-1}\ln(A(t))\right)+\ln(A(t))+\ln(L(t))$$

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \frac{\alpha}{\alpha-1}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)-\frac{\alpha}{\alpha-1}\ln(s_K)-\frac{\beta}{\alpha-1}\ln\left(\frac{Z(t)}{L(t)}\right)+\frac{\beta}{\alpha-1}\ln(A(t))+\ln(A(t))$$

alter the signs of the fractions (multiply by –1) and rearrange:

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln(A(t))-\frac{\beta}{1-\alpha}\ln(A(t))+\frac{\alpha}{1-\alpha}\ln(s_K)+\frac{\beta}{1-\alpha}\ln\left(\frac{Z(t)}{L(t)}\right)-\frac{\alpha}{1-\alpha}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)$$

$$\ln\left(\frac{Y(t)}{L(t)}\right) = \ln(A(t))\left[1-\frac{\beta}{1-\alpha}\right]+\frac{\alpha}{1-\alpha}\ln(s_K)+\frac{\beta}{1-\alpha}\ln\left(\frac{Z(t)}{L(t)}\right)-\frac{\alpha}{1-\alpha}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)$$

while $A(t) = A(0)\cdot e^{gt}$

Equation 6.12

$$\ln\left(\frac{Y(t)}{L(t)}\right) = (\ln(A(0))+gt)\cdot\left[1-\frac{\beta}{1-\alpha}\right]+\frac{\alpha}{1-\alpha}\ln(s_K)+\frac{\beta}{1-\alpha}\ln\left(\frac{Z(t)}{L(t)}\right)-\frac{\alpha}{1-\alpha}\ln\left(n+g+\delta+\frac{Z(t)}{K(t)}r\cdot(1-s_Z)\right)$$

Income per labor at a given time – for simplicity it is reasonable to choose time *0* – is as expressed by *Equation 6.13*:

Equation 6.13

$$\ln\left(\frac{Y}{L}\right) = \underbrace{\ln(A)\cdot\left[1-\frac{\beta}{1-\alpha}\right]}_{Term1}+\frac{\alpha}{1-\alpha}\ln(s_K)+\frac{\beta}{1-\alpha}\ln\left(\frac{Z}{L}\right)-\frac{\alpha}{1-\alpha}\ln\left(n+g+\delta+\frac{Z}{K}r\cdot(1-s_Z)\right)$$

Analogous to MRW (1992, pp. 410-411), it is assumed that the marked term in this expression, *Term1*, equals a constant *a* plus a variable called "country specific shock" *ε,* which can be regarded as an error term.

Equation 6.14

$$\ln(A)\cdot\left(1-\frac{\beta}{1-\alpha}\right)=a+\varepsilon$$

The final equation for this analysis is as follows:

Equation 6.15

$$\ln\left(\frac{Y}{L}\right)=a+\frac{\alpha}{1-\alpha}\ln(s_K)+\frac{\beta}{1-\alpha}\ln\left(\frac{Z}{L}\right)-\frac{\alpha}{1-\alpha}\ln\left(n+g+\delta+\frac{Z}{K}r\cdot(1-s_Z)\right)+\varepsilon$$

This equation looks fairly equal to the regression equation used by MRW (1992, p. 411) for their analysis, which is reprinted in the previous section of this paper as *Equation 5.38*. This has two advantages. On the one hand, the regression results obtained from statistical analysis based on this equation can be compared to the regression results from MRW's original journal article in regard to regression coefficients for the domestic investment rate s_K. On the other hand, the terms in this final regression equation match the main variables used in the regression equations of earlier research by Bornschier et al. (1985; 1978), Firebaugh (1992; 1996), Dixon & Boswell (1996a; 1996b) or de Soysa & Oneal (1999).

$$\underbrace{\ln\left(\frac{Y}{L}\right)}_{Dependent}=a+\underbrace{\frac{\alpha}{1-\alpha}\ln(s_K)}_{Term1}+\underbrace{\frac{\beta}{1-\alpha}\ln\left(\frac{Z}{L}\right)}_{Term2}-\underbrace{\frac{\alpha}{1-\alpha}\ln\left(n+g+\delta+\frac{Z}{K}r\cdot(1-s_Z)\right)}_{Term3}+\varepsilon$$

These earlier studies included the *average annual growth rates* for *income per capita*, *domestic capital stock* and *foreign capital stock*. For the comparison of empirical results it is reasonable that the variables in this new regression equation are equal or at least comparable in their meaning to those in earlier analyses by these researchers. Since this regression equation is based on an economic growth model, growth rates for the capital stocks enter the regression in a somewhat other way. For example, the *FDI instock* enters the equation in *per capita,* respectively *per labor force* form (*Term2*). The fact that the term is in per capita form can be

looked at as an improvement because the effect of the presence of foreign capital on economic growth is estimated in regard to the size of the population and not only in regard to its absolute size or relative to the size of the host economy (PEN-variable). Since the *Z/L* ratio (*Term2*) enters the equation logged, it can be considered to represent a growth rate. The same accounts for the dependent term *Y/L* (Dependent) if an exponential growth rate for *Y/L* and *Z/L* is assumed. As an explanation, consider the following simplified example:

$$Y(t) = Y(0) \cdot e^{xt}$$

Where *x* is the growth rate of *Y(t)*. The first differentiation of *ln(Y(t))* with respect to time equals the growth rate of *Y(t)*. First, taking logs

$$\ln\big(Y(t)\big) = \ln\big(Y(0)\big) + x \cdot t$$

and then, differentiate with respect to time,

$$\frac{d \ln Y(t)}{dt} = 0 + x$$

while $\ln\big(\dot{Y}(0)\big)$ equals zero because there is no temporal change. That is, the derivative of the logged term of Y(t) equals its exponential growth rate.

In *Term3,* the domestic to foreign capital stock ratio, *Z/K*, captures the effect of the ratio of foreign to domestic capital stock. The studies mentioned above used a variable called *PEN* to measure how strong an economy is 'penetrated' by foreign capital. This variable was either formed as a foreign capital stock to GDP ratio or as foreign capital stock to total capital stock ratio. The *Z/K*-ratio does therefore not provide an identical measure for *PEN*, but since the variable enters the regression in a conglomerate with other variables, the effects of the single indicators in *Term3* cannot be estimated separately anyway. But, analogous to MRW's analysis, *Term3* can be considered as *effective depreciation rate* in this model that is also affected by the magnitude of the *Z/K*-ratio.

The model cannot satisfy all requirements formulated by the PEN-researchers, like for example, the measure for the level of penetration. But despite the fact that for some variables no separate estimates can be obtained, the model includes all required variables. With the inclu-

sion of a technology factor and population growth it allows an even more comprehensive analysis.

7 VARIABLES

In this section the definitions for the variables used in the empirical analysis are provided. For each variable data-source and reliability are given. Some variables have been defined earlier, like for example FDI or TNC, but are provided here again.

7.1 Foreign direct investment

Definition

The internationally accepted definition of foreign direct investment is the definition provided by the IMF (International Monetary Fund 1993). The definition used by UNCTAD is derived from the IMF's definition but is more comprehensive. Therefore, the following definitions for FDI, FDI flow and stock are quoted from the World Investment Report 2002 (UNCTAD 2002b, p. 291):

FDI is defined as an investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in one economy (foreign direct investor or parent enterprise) in an enterprise resident in an economy other than that of the foreign direct investor (FDI enterprise or affiliate enterprise or foreign affiliate).

FDI consists of three components:

1. *Equity capital* is the foreign direct investor's purchase of shares of an enterprise in a country other than its own.
2. *Reinvested earnings* are profits, which are not distributed as dividends or remitted to the direct investor but reinvested by the affiliates
3. *Intra-company loans* or *intra-company debt transactions* are short or long-term borrowing and lending of funds between the direct investor or parent enterprise respectively and the affiliate enterprise.

FDI stock

FDI stock is the value of the share of capital and reserves (including retained profits) attributable to the parent enterprise, plus the net indebtedness of affiliates to the parent enterprise. Data on FDI stocks is presented at book value or historical cost (except for New Zealand in 2001), reflecting prices at the time when the investment was made. Inward stock in the reporting economy is the value of the capital and reserves in the economy attributable to a par-

ent enterprise resident in a different economy. Outward stock refers to the value of capital and reserves in another economy attributable to a parent enterprise resident in the economy.

FDI flow

In/Out-flows of FDI in the reporting economy comprise capital provided (either directly or through other related enterprises) by a foreign direct investor to an enterprise resident in the economy (called FDI enterprise).

Parent enterprise

Parent enterprises are enterprises that control assets, usually equity capital stakes, of other entities in countries other than its home country. The threshold for the control of assets is determined by an equity capital stake of 10 percent or more of the ordinary share or voting power.

Foreign affiliate

A foreign affiliate is an incorporated or unincorporated enterprise in which an investor, who is resident in another economy, owns a stake that permits a lasting interest in the management of that enterprise. Foreign affiliates include subsidiary enterprises (an entity from another country owns more than 50% of the shareholder's voting power), associate enterprises (an entity from another country owns at least 10%, but not more than 50% of the shareholder's voting power) and branches (wholly or jointly owned unincorporated enterprise in the host country, which can be a permanent establishment or office of the foreign investor, or land, immovable equipment and structure, or mobile equipment, which resides for at least one year in the host economy). The same 10-percent threshold for exerting control as for the parent enterprise is assumed for the foreign affiliate.

Source

The data on FDI is from the *United Nations Conference on Trade and Development* (UNCTAD) which publishes data on FDI and TNCs in its annual *World Investment Report* and which is accessible on the internet (UNCTAD 2003).

Reliability

The data on FDI stocks in the UNCTAD's World Investment Report is generally reported by the national statistical bureaus of the countries listed in the report. Only few of these bureaus calculate FDI from all three components, as the internationally accepted definition would suggest. In most cases, only two of the three components are included. Another problem is the method used by the UNCTAD to estimate FDI stocks. In some cases, FDI flow values are added up to estimate the stock values starting from differing years depending on the availability of flow data for the respective country. In other cases, flow values are subtracted from stock values to estimate earlier FDI stocks. For some countries both ways to estimate FDI

stocks are applied. In addition, the stock as well as flow data are reported in current dollars and not in constant dollars of a particular year. Missing cases pose another problem.

7.2 Gross domestic product

Definition

GDP is the measure for the total output of goods and services for final use occurring within the domestic territory of a given country, regardless of the allocation to domestic and foreign claims. Gross domestic product at purchaser prices is the sum of gross value added by all resident producers in the economy plus any taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. The residency of an institution is determined on the basis of economic interest in the territory for more than a year (Worldbank 2002).

Source

Data on GDP is from the PENN-World Tables 6.1 (Heston, Summers, and Aten 2002) and the data is in constant 1996 US dollars.

Reliability

Data is generally collected from the statistical agencies of countries. They use different definitions, methods and reporting standards than suggested by international guidelines. Many statistical offices, especially those in developing countries, face severe limits in the resources, time, training and budgets required to produce reliable and comprehensive series of national accounts. Another problem is the extent of unreported economic activity in the informal or secondary economy. In developing countries a large share of agricultural output is either not exchanged, because it is consumed within the household, or not exchanged for money. Industrial output is usually measured through regular censuses and surveys of firms. But much industrial production is organized in unincorporated or owner-operated ventures that are not captured by surveys. In addition, the activity and the value of the black market and illegal activities can only be estimated.

7.3 Gross domestic investment

Definition

Gross domestic investment consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including commercial and industrial buildings, offices,

schools, hospitals and private residential dwellings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales (Worldbank 2002).

Source
Data on GDI is from the PENN-World Tables 6.1 (Heston, Summers, and Aten 2002) and is provided as a percentage share of GDP.

Reliability
Investment data may be estimated from direct surveys of enterprises and administrative records or based on the commodity flow method using data from trade and construction activities. While the quality of data on public fixed investment depends on the quality of government accounting (which tend to be weak in developing countries), measures of private fixed investment by small, or unincorporated enterprises are usually very unreliable (Worldbank 2002).

7.4 Domestic capital stock

The domestic capital stock is cumulated gross domestic investment. Bornschier & Chase-Dunn (Bornschier and Chase-Dunn 1985, p. 91) suggest cumulating gross domestic investment over a period of 18 years. They assume that an investment is worn out after about 18 years or earlier. For this analysis gross domestic investment is consecutively cumulated, but depreciated on a yearly base. For the *depreciation rate* a value of 5% is assumed.

Source
Data on GDI is from the PENN-World Tables 6.1 (Heston, Summers, and Aten 2002) and is provided as a percentage share of GDP.

Reliability
This indicator is a proxy for the domestic capital stock. Sine it is derived from data on gross domestic investment it is affected by the same reliability issues.

7.5 Population

Definition
Total population counts all residents regardless of legal status or citizenship. Refugees not permanently settled in the country of asylum are generally considered to be part of the population of their country of origin.

Source
Data on GDP is from the PENN-World Tables 6.1 (Heston, Summers, and Aten 2002). The data on population in the PWT 6.1 data set is from the World Banks *World Development Indicators 2001*.

Reliability

Population estimates are usually based on national population censuses, but the frequency and quality of these vary by country. Most countries conduct a complete enumeration no more than once a decade. Pre-census and postcensus estimates are interpolations or extrapolations based on demographic models. Errors and undercounting occur even in high-income countries; in developing countries such errors may be substantial because of limitation to transportation, communications, and other resources required to conduct a full census. More-over, the international comparability of population indicators is limited by differences in the concepts, definitions, data collection procedures and estimation methods used by national statistical agencies and other organizations that collect population data (Worldbank 2002).

7.6 Labor Force

Definition

Total labor force comprises people who meet the International Labour Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both, the employed and the unemployed.

Source

The PENN-World Tables 6.1 data set does not provide data on the labor force. As a proxy for the labor force the figure was derived from the data on income per worker, which is included in the dataset. For this purpose, data in income per capita was multiplied by population and then divided by income per worker.

Reliability

While national practices vary in the treatment of such groups as the armed forces and seasonal or part-time workers, in general the labor force includes the armed forces, the unemployed and first-time job-seekers, but excludes homemakers and other unpaid caregivers and workers in the informal sector. In some countries data on the labor force refers to people above a specific age, while in others there is no specific age provision. In developing countries, where the household is often the basic unit of production and all members contribute to output, but some at low intensity or irregular intervals, the estimated labor force may be significantly smaller than the numbers actually working.

8 EMPIRICAL ANALYSIS AND RESULTS

8.1 Introduction

In the preceding part the regression equation for the analysis has been derived from an extended Solow-model (see Chapter 6) and the data and the variables have been outlined (see Chapter 7). Since the inclusion of the variables into the model has been illustrated in the section on economic growth models and the section on the extended Solow-model, only brief explanations will be provided where necessary.

Linear regression analysis will be used to assess the effects of TNC activities on economic growth. The units of this analysis are nation-states. The period of time covered is from 1980 to 1990. The foreign capital stock and the domestic capital stock are cumulated from FDI inflows respectively gross domestic investment since 1970. For the domestic capital stock a depreciation rate of 5% is assumed, while the foreign capital stock is compiled by the UNCTAD who does not account for depreciation.

Below the regression equation (*Equation 6.15*) that was derived from the extended Solow-model is quoted. The indices of the variables indicate the year(s) covered by the respective variable. Most of the assumptions and the temporal structure regarding the variables are borrowed from MRW's analysis (Mankiw, Romer, and Weil 1992), where some variables are the average of the entire period, while other variables cover the last value of the respective time period. *Y/L* denotes per capita income respectively income per worker as of 1990. The domestic saving rate is the average of the years 1980-1990 expressed as percentage of GDP.

$$\ln\left(\frac{Y_{1990}}{L_{1990}}\right) = a + \frac{\alpha}{1-\alpha}\ln(s_{K_{1980-90}}) + \frac{\beta}{1-\alpha}\ln\left(\frac{Z_{1990}}{L_{1990}}\right) - \frac{\alpha}{1-\alpha}\ln\left(n_{1980-90} + g + \delta + \frac{Z_{1990}}{K_{1990}} r \cdot (1 - s_Z)\right) + \varepsilon$$

MRW assume a growth rate of 5% for the term $g+\delta$. The variable n is the average population growth rate of the respective country in percentages for the years 1980 to 1990. Z is the foreign capital stock and L the labor force respectively population as of 1990.

Returns to FDI, denoted by r, are assumed to be 5% of the foreign capital stock. This estimate is probably a little larger in non-OCED-member states. But since most foreign capital is invested in the countries of the First World, a return rate of 5% seems a reasonable estimate.

Reinvested earnings, s_Z, expressed as percentage share of the returns to the foreign capital stock is, are assumed to amount between 20% and 80%. In *dependencia* and *world system theory* reinvested earnings are a crucial variable, since in these theories it is assumed that the

repatriation of profits is an important mechanism accounting for a negative growth effect. Due to this theoretical assumption all regression calculations are done twice: once assuming that 20% of the returns to foreign capital are reinvested and a second time, assuming that 80% of the return to foreign capital are reinvested. Data availability for reinvested earnings is very limited and the figures significantly vary and differ between countries and years. A small sample of OECD and developing countries has been chosen to estimate this upper and lower value for the share of reinvested earnings to FDI returns[34].

Some countries in the PWT 6.1 data set have been excluded from the analysis. These are the countries for which oil production is the dominant industry as well as (former) planed economies. Data on the sample used in this analysis can be found in Appendix A.

8.1.1 The models

To assess the effects of FDI on economic growth, while accounting for the level of development, the whole sample is divided into several sub-samples. The description below outlines the differences between these sub-samples. All regression calculations are done for the sample in *per capita* values and for *per worker* values. This allows to account for differing population structures of the countries in the sample.

To account for the differing levels of income and the differing amounts of FDI per capita respectively per worker between the countries in the sample, the sample has been divided into several sub-samples for the analysis:

Model 1, 3, 5, and 7

The whole sample is divided into four sub-samples representing different groups of income. The classification for the income categories is taken from the World Bank's *World Development Indicators 2002* data set (Worldbank 2002). The income categories are *high* income, *high and upper middle* income, *lower middle and low* income, and *low* income countries.

For model 1 and 5 the lower estimate of 20% for the share of reinvested earnings is applied, while for Model 2 and 7 the upper estimate for the share of reinvested earnings of 80%.

Model 1 and 3 are based on *per worker values* and Model 5 and 7 are based on *per capita values*.

Model 2, 4, 6, and 8

Instead of analyzing the sample with respect to the level of income, the sample can be analyzed in regard of the amount of foreign capital per worker respectively per capita. For this

[34] Data on reinvested earnings is available from the IMF's Balance of Payments Statistics Yearbook series (International Monetary Fund. 1992. *Balance of Payments Statistics Yearbook*, vol. 43. Washington: IMF.). See Appendix B for the country sample.

purpose, the *mean* and *median* values for the *FDI inward stock per capita* respectively *FDI inward stock per worker* are used to divide the sample into two sub-samples. The *mean* of foreign capital *per capita* in 1990 is US$ 726 and the *median* is US$ 151. For foreign capital *per worker* the *mean* in 1990 is US$ 1517 and the *median* US$ 354. The sample for all countries, for which the *FDI inward stock per capita* respectively *FDI inward stock per worker* value is below the mean or median, is denoted as *low* and the sample for all countries with values above the mean and median is denoted as *high* in the regression result tables. For Model 2 and 6 the lower estimate of 20% for the share of reinvested earnings is applied while for Model 4 and 8 the upper estimate for the share of reinvested earning of 80%. Model 2 and 4 are based on *per worker values* and Model 6 and 8 are based on *per capita values*.

8.1.2 Unrestricted and restricted model

Recalling the theory, the steady state is defined as the situation where the various quantities grow at constant rates. For the *textbook Solow-model*, this is exactly where investments equals the effective depreciation of capital. In the steady state, per capita output is constant since *k(t)* is constant, that is, *k(t)* and *y(t)* do not grow in the steady state. In a regression analysis the coefficients for the investment and the depreciation term of the textbook Solow-model must equal zero to satisfy the steady state condition. Analogous to the textbook Solow-model for the *extended* Solo- model with *FDI*, the sum of the coefficients for domestic investment, foreign investment and the depreciation term must equal zero. It is therefore necessary to test the extended Solow-model in its restricted form to account for the prerequisites of the steady state. Only if the unrestricted *and* restricted models provide statistically significant and reasonable regression results, this extended Solow-model can be considered successful.

The values for α, which denotes domestic capital's share in income, and β, which denotes foreign capital's share in income, can be calculated from the regression coefficients as follows:

Equation 8.1

$$\alpha = \frac{reco1}{1 + reco1}$$

Equation 8.2

$$\beta = \frac{reco2}{1 + reco1}$$

reco1 denotes the regression coefficient for the first variable in the regression equation and *reco2* denotes the regression coefficient for the second variable in the equation. MRW (1992, p. 415) assume that the domestic capital's share in income, α, is about one third. Since there are no estimates for foreign capital's share in income, the model provides a means to estimate this share. However, a value for foreign capital's share in income should be within reasonable boundaries.

8.1.3 Marginal productivity

Part of this analysis is the assessment of the productivity of domestic as well as foreign capital (see the related question #3 in Section I). De Soysa & Oneal (1999, p. 775) claim that foreign capital is more productive than domestic capital. According to DSO the median ratio of domestic to foreign capital among the less developed countries is 13:1. Therefore, the effect of foreign investment is 13 times the effect of domestic investment on the base of a dollar for dollar comparison.

Productivity denotes the value of output produced per unit of input used. The level of productivity increases if more goods or services can be produced with the same or less amount of inputs. Input factors are usually labor, capital, land or materials, respectively any combination of these factors. The productivity is generally increased by specialization, technological innovation, investments in physical and human capital or a more sophisticated division of labor, which allow to produce the same amount of goods at lower costs.

Since the regression equation in this analysis controls for the ratio of domestic to foreign capital, any "differential productivity" - as Firebaugh calls it - of domestic and foreign capital cannot be assessed as suggested by DSO. However, the marginal productivity of foreign and domestic capital can be estimated instead of productivity. Marginal productivity is the increase in the value of output that can be produced by adding one more unit of a particular input, while holding other inputs constant. The higher the productivity of a production-factor, the higher the income that may be expected. Under competitive conditions, the equilibrium price of a factor of production, like wages for labor and interest for capital will eventually become equal with its marginal productivity because the more of a particular factor input is added, while all others factors remain constant, the less the employment of an additional unit of that factor input contributes to output as a whole.

The marginal productivity for each country can be derived from the production function and the estimated share of domestic capital and foreign capital in income as presented further below. A larger marginal product will usually attract more investments than a smaller. Com-

paring the marginal productivities allows to assess differences in returns to the respective capital employed.

Marginal productivity of domestic capital

The marginal product of domestic capital equals the first derivation of the production function written in Cobb-Douglas form with respect to domestic capital. The production function from *Equation 6.3* is quoted below, but since it is assumed that the countries are in the steady state, the function is independent of time:

$$y = k^{\alpha} \cdot z^{\beta} \qquad \text{| derivate with respect to domestic capital}$$

$$\frac{\Delta y}{\Delta k} = \alpha \cdot k^{\alpha-1} \cdot z^{\beta} \qquad \text{| multiply by } \frac{k}{y} \text{ and rearrange}$$

$$\frac{k}{y} \cdot \frac{\Delta y}{\Delta k} = \frac{\alpha \cdot k^{\alpha} \cdot z^{\beta}}{y} \qquad \text{| } k^{\alpha} \cdot z^{\beta} \text{ equals } y\text{; rearrange}$$

Equation 8.3

$$\frac{\Delta y}{\Delta k} = \alpha \cdot \frac{y}{k}$$

Equation 8.3 denotes the marginal productivity of domestic capital.

Marginal productivity of foreign capital

The marginal productivity of foreign capital can be calculated analogous to the marginal productivity of domestic capital as presented above. The marginal product of foreign capital equals the first derivation of the production function written in Cobb-Douglas form with respect to foreign capital.

$$y = k^{\alpha} \cdot z^{\beta} \qquad \text{| derivate with respect to foreign capital}$$

$$\frac{\Delta y}{\Delta z} = \beta \cdot k^{\alpha} \cdot z^{\beta-1} \qquad \text{| multiply by } \frac{z}{y} \text{ and rearrange}$$

$$\frac{z}{y} \cdot \frac{\Delta y}{\Delta z} = \frac{\beta \cdot k^{\alpha} \cdot z^{\beta}}{y} \qquad \text{| } k^{\alpha} \cdot z^{\beta} \text{ equals } y\text{; rearrange}$$

Equation 8.4

$$\frac{\Delta y}{\Delta z} = \beta \cdot \frac{y}{z}$$

Equation 8.4 denotes the marginal productivity of domestic capital.

Data and time period

The average values of the *y to k* and *y to z* ratios for the entire time period (1980-1990) will be calculated for each country to control for extraordinary large or small values instead of using the values of 1990 as for other variables.

Based on the values for domestic as well as foreign capital's share in income, which are estimated for each sample, the marginal productivity for the respective sample of countries can then be estimated according to *Equation 8.3* and *Equation 8.4*.

8.2 Regression Results

The two tables on the next four pages summarize the statistical results for this analysis. *Table 8.1* and *Table 8.2* present all estimates for the models using *per worker* values, while *Table 8.3* and *Table 8.4* present all estimates for the models using *per capita* values from the statistical data set.

Table 8.1

Dependent variable is ln(GDP per worker in 1990)									
	Model 1					***Model 2***			
	All income categories	*High income*	*High and upper middle income*	*Lower middle and low income*	*Low income*	*Median of FDI per worker*		*Mean of FDI per worker*	
						high	*low*	*high*	*low*
Observations	96	21	36	60	35	48	48	29	67
ln(I/Y)	0.63	0.35[a]	0.63	0.51	0.42	0.51[b]	0.66	0.87	0.64
	(0.11)	(0.23)	(0.18)	(0.14)	(0.15)	(0.21)	(0.15)	(0.24)	(0.14)
ln(Z/L)	0.25	0.08[b]	0.14	0.26	0.15	0.28	0.22	0.27	0.25
	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.07)	(0.05)	(0.09)	(0.04)
ln(n+g+δ+Z/Kr(1-s_Z))	-1.83	0.06[a]	-1.17	-1.83	-2.19[c]	-1.20	-2.98	-0.81[c]	-2.53
	(0.35)	(0.40)	(0.36)	(0.66)	(1.20)	(0.43)	(0.76)	(0.43)	(0.62)
Constant	4.17	10.61	6.94	3.83[b]	2.89[a]	5.68	1.61[a]	7.46	2.67[a]
	(1.03)	(1.23)	(1.14)	(1.81)	(3.18)	(1.36)	(2.16)	(1.70)	(1.75)
R^2	0.84	0.14	0.66	0.65	0.38	0.67	0.68	0.65	0.68
s.e.e	0.43	0.14	0.27	0.48	0.41	0.39	0.50	0.28	0.51
Restricted Regression									
ln(I/Y)-ln(n+g+δ+Z/Kr(1-s_Z))	0.77	0.22[a]	0.73	0.58	0.44	0.62	0.82	0.83	0.75
	(0.09)	(0.20)	(0.13)	(0.14)	(0.15)	(0.15)	(0.13)	(0.14)	(0.12)
ln(Z/L)-ln(n+g+δ+Z/Kr(1-s_Z))	0.26	0.08[b]	0.15	0.25	0.13	0.35	0.23	0.30	0.26
	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.07)	(0.05)	(0.10)	(0.04)
Constant	6.55	9.40	7.90	6.57	7.19	5.75	6.75	6.04	6.59
	(0.21)	(0.56)	(0.37)	(0.27)	(0.30)	(0.65)	(0.36)	(1.05)	(0.29)
R^2	0.83	0.13	0.66	0.64	0.37	0.71	0.66	0.66	0.69
s.e.e	0.44	0.14	0.26	0.49	0.41	0.37	0.51	0.28	0.50
Implied α	0.44	0.18	0.42	0.37	0.30	0.38	0.45	0.45	0.43
Implied β	0.15	0.06	0.08	0.16	0.09	0.22	0.13	0.16	0.15

Regression results for the models with logged income per worker. Share of reinvested earnings is lower estimate, 20%.

Standard errors in parentheses
All regression coefficients significant at the 0.01 level or better if not otherwise indicated
[a] not significant
[b] significant at the 0.05 level
[c] significant at the 0.1 level

Table 8.2

Dependent variable is ln(GDP per worker in 1990)									
	Model 3					***Model 4***			
	All income categories	*High income*	*High and upper middle income*	*Lower middle and low income*	*Low income*	*Median of FDI per worker*		*Mean of FDI per worker*	
						high	*low*	*high*	*low*
Observations	96	21	36	60	35	48	48	29	67
ln(I/Y)	0.67	0.35[a]	0.70	0.53	0.43	0.60	0.64	1.03	0.63
	(0.11)	(0.23)	(0.18)	(0.14)	(0.15)	(0.19)	(0.14)	(0.23)	(0.13)
ln(Z/L)	0.24	0.08[b]	0.13	0.24	0.14	0.33	0.23	0.28	0.25
	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.08)	(0.05)	(0.10)	(0.04)
ln(n+g+δ+Z/Kr(1-s_Z))	-1.70	0.09[a]	-1.08	-1.54[b]	-1.95[c]	-1.10	-3.00	-0.76[c]	-2.48
	(0.36)	(0.4)	(0.38)	(0.70)	(1.21)	(0.42)	(0.75)	(0.45)	(0.60)
Constant	4.67	10.71	7.37	4.65	3.57[a]	5.5	1.24[a]	7.57	2.50[a]
	(1.03)	(1.21)	(1.15)	(1.75)	(3.18)	(1.32)	(2.12)	(1.80)	(1.68)
R^2	0.83	0.14	0.63	0.64	0.37	0.69	0.70	0.63	0.71
s.e.e	0.44	0.14	0.27	0.49	0.41	0.39	0.48	0.29	0.49
Restricted Regression									
ln(I/Y)-ln(n+g+δ+Z/Kr(1-s_Z))	0.78	0.22[a]	0.75	0.58	0.44	0.64	0.82	0.87	0.75
	(0.10)	(0.20)	(0.13)	(0.14)	(0.15)	(0.15)	(0.13)	(0.15)	(0.12)
ln(Z/L)-ln(n+g+δ+Z/Kr(1-s_Z))	0.25	0.08[b]	0.14	0.25	0.12	0.33	0.23	0.27	0.25
	(0.03)	(0.04)	(0.04)	(0.04)	(0.05)	(0.07)	(0.06)	(0.10)	(0.04)
Constant	6.60	9.43	7.95	6.60	7.20	5.88	6.77	6.26	6.61
	(0.21)	(0.55)	(0.38)	(0.28)	(0.30)	(0.66)	(0.36)	(1.09)	(0.29)
R^2	0.83	0.12	0.64	0.64	0.37	0.69	0.66	0.63	0.69
s.e.e	0.45	0.14	0.27	0.50	0.42	0.38	0.51	0.29	0.51
Implied α	0.44	0.18	0.43	0.37	0.30	0.39	0.45	0.47	0.43
Implied β	0.14	0.06	0.08	0.16	0.08	0.20	0.13	0.14	0.14

Regression results for the models with logged income per worker. Share of reinvested earnings is upper estimate, 80%.

Standard errors in parentheses
All regression coefficients significant at the 0.01 level or better if not otherwise indicated
[a] not significant
[b] significant at the 0.05 level
[c] significant at the 0.1 level

Table 8.3

Dependent variable is ln(GDP per capita in 1990)									
	Model 5					***Model 6***			
	All income categories	*High income*	*High and upper middle income*	*Lower middle and low income*	*Low income*	*Median of FDI per capita*		*Mean of FDI per capita*	
						high	*low*	*high*	*low*
Observations	102	21	39	63	36	51	51	31	71
ln(I/Y)	0.55	0.72[b]	0.58	0.49	0.33	0.50	0.54	0.71	0.54
	(0.09)	(0.32)	(0.20)	(0.10)	(0.12)	(0.17)	(0.12)	(0.25)	0.10
ln(Z/L)	0.25	0.09[c]	0.15	0.22	0.14	0.30	0.23	0.43	0.25
	(0.02)	(0.05)	(0.04)	(0.03)	(0.04)	(0.05)	(0.05)	(01.0)	(0.3)
$\ln(n+g+\delta+Z/Kr(1-s_Z))$	-2.14	-0.11[c]	-1.62	-1.64	-1.64[a]	-1.80	-2.79	-1.65	-2.65
	(0.31)	(0.56)	(0.42)	(0.51)	(1.14)	(0.36)	(0.68)	(0.48)	(0.50)
Constant	2.54	9.90	4.84	3.59	3.39[a]	3.03	0.89[a]	2.78[a]	1.22[a]
	(0.90)	(1.767)	(1.35)	(1.40)	(2.80)	(1.16)	(1.93)	(1.88)	(1.38)
R^2	0.86	0.15	0.62	0.66	0.36	0.76	0.68	0.69	0.75
s.e.e	0.40	0.21	0.34	0.40	0.36	0.35	0.45	0.33	0.42
Restricted Regression									
$\ln(I/Y)-\ln(n+g+\delta+Z/Kr(1-s_Z))$	0.74	0.55[c]	0.81	0.52	0.34	0.74	0.72	0.87	0.71
	(0.08)	(0.28)	(0.14)	(0.10)	(0.12)	(0.13)	(0.11)	(0.14)	(0.10)
$\ln(Z/L)-\ln(n+g+\delta+Z/Kr(1-s_Z))$	0.26	0.09[a]	0.17	0.22	0.12	0.32	0.21	0.44	0.24
	(0.02)	(0.05)	(0.4)	(0.03)	(0.04)	(0.06)	(0.05)	(0.10)	(0.04)
Constant	5.87	8.15	6.89	6.10	6.50	5.38	6.17	4.01	6.01
	(0.16)	(0.76)	(0.43)	(0.20)	(0.22)	(0.47)	(0.28)	(1.00)	(0.23)
R^2	0.84	0.14	0.60	0.65	0.36	0.74	0.63	0.70	0.70
s.e.e	0.43	0.21	0.34	0.40	0.36	0.37	0.48	0.33	0.46
Implied α	0.43	0.35	0.48	0.34	0.25	0.43	0.42	0.47	0.42
Implied β	0.21	0.05	0.09	0.15	0.09	0.18	0.12	0.24	0.14

Regression results for the models with logged per capita income as dependent variable. Share of reinvested earnings is lower estimate, 20%.

Standard errors in parentheses
All regression coefficients significant at the 0.01 level or better if not otherwise indicated
[a] not significant
[b] significant at the 0.05 level
[c] significant at the 0.1 level

Table 8.4

Dependent variable is ln(GDP per capita in 1990)									
	Model 7					***Model 8***			
	All income categories	*High income*	*High and upper middle income*	*Lower middle and low income*	*Low income*	*Median of FDI per capita*		*Mean of FDI per capita*	
						high	*low*	*high*	*low*
Observations	102	21	39	63	36	51	51	31	71
ln(I/Y)	0.62	0.72[b]	0.75	0.47	0.33	0.68	0.57	0.99	0.57
	(0.09)	(0.32)	(0.19)	(0.10)	(0.12)	(0.17)	(0.12)	(0.23)	(0.10)
ln(Z/L)	0.23	0.08[a]	0.12[b]	0.21	0.13	0.25	0.22	0.37	0.23
	(0.03)	(0.05)	(0.05)	(0.03)	(0.04)	(0.06)	(0.05)	(0.11)	(0.03)
$\ln(n+g+\delta+Z/Kr(1-s_Z))$	-2.00	-0.10[a]	-1.48	-1.46	-1.46[a]	-1.60	-2.72	-1.27	-2.54[a]
	(0.32)	(0.56)	(0.46)	(0.50)	(1.15)	(0.40)	(0.70)	(0.50)	(0.51)
Constant	3.15	9.95	5.65	4.12	3.88[a]	4.20	1.16[a]	4.71	1.61
	(0.91)	(1.74)	(1.35)	(1.36)	(2.78)	(1.16)	(1.98)	(1.79)	(1.41)
R^2	0.85	0.15	0.58	0.65	0.35	0.72	0.67	0.64	0.73
s.e.e	0.41	0.20	0.35	0.40	0.36	0.38	0.45	0.36	0.43
Restricted Regression									
$\ln(I/Y)-\ln(n+g+\delta+Z/Kr(1-s_Z))$	0.76	0.55[c]	0.87	0.52	0.34	0.80	0.73	0.97	0.71
	(0.08)	(0.28)	(0.16)	(0.10)	(0.12)	(0.15)	(0.11)	(0.16)	(0.10)
$\ln(Z/L)-\ln(n+g+\delta+Z/Kr(1-s_Z))$	0.25	0.08[a]	0.14	0.21	0.12	0.28	0.21	0.37	0.24
	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)	(0.06)	(0.05)	(0.10)	(0.04)
Constant	5.93	8.20	7.02	6.12	6.49	5.63	6.19	4.51	6.03
	(0.17)	(0.74)	(0.43)	(0.20)	(0.22)	(0.50)	(0.28)	(1.04)	(0.23)
R^2	0.84	0.14	0.58	0.65	0.35	0.72	0.63	0.65	0.70
s.e.e	0.43	0.21	0.35	0.41	0.36	0.38	0.48	0.35	0.46
Implied α	0.43	0.35	0.46	0.34	0.25	0.44	0.42	0.49	0.42
Implied β	0.14	0.05	0.07	0.14	0.09	0.16	0.12	0.19	0.14

Regression results for the models with logged per capita income as dependent variable. Share of reinvested earnings is upper estimate, 80%.

Standard errors in parentheses
All regression coefficients significant at the 0.01 level or better if not otherwise indicated
[a] not significant
[b] significant at the 0.05 level
[c] significant at the 0.1 level

9 DISCUSSION OF REGRESSION RESULTS

9.1 Introduction

The discussion of the regression results is structured into several parts. The first part will cover the results for the models based on *per worker* values provided in *Table 8.1* and *Table 8.2*. After a general inspection of the results in regard of their statistical quality, the results for the unrestricted Model 1 and 3 (income categories) will be analyzed followed by Model 2 and 4 (FDI shares). The results will then be compared between the models assuming a reinvestment rate for the returns to FDI of 20% and those assuming 80%. In a second step, the restricted models will be analyzed in the same order. In the second part, the models based on *per capita* values will be analyzed analogous to the order of the models based on *per worker* values. In the third part, the results between the models based on *per capita* values (Models 1 through 4) and *per worker* values (Models 5 through 8) will be compared to account for differences in regard of population respectively labor force.

9.2 Regression results for the per worker models

9.2.1 Unrestricted models

Except for the sample of *high income* countries, the regression coefficients for all other samples are significant at least at the 0.1 level or better (usually at the 0.01 level) and the adjusted R-square terms indicate a good model fit. The bad model fit and the non-significant coefficients for the *high income* sample are very likely because of the small size of the sample containing only 21 countries. Due to the poor quality of the results for this sample, they have to be omitted in the analysis. The effect of domestic and foreign investment is positive in all models and samples, that is, foreign and domestic investments have a positive effect on economic growth. The coefficient of the effective depreciation rate is negative for all models and samples (except for the excluded *high income* sample) and its negative effect increases the poorer the countries in the sample are, respectively the less foreign capital per capita or per worker a countries has.

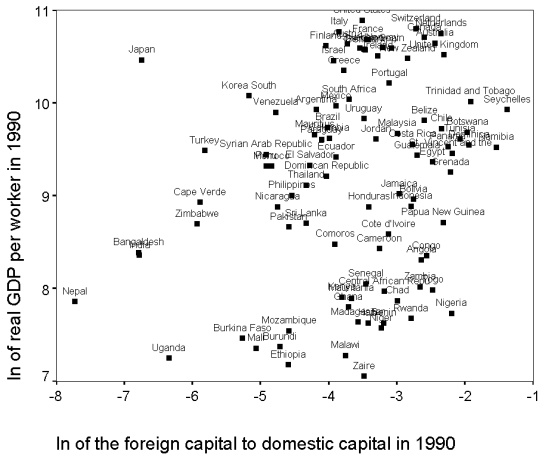
Model 1

The effect of domestic investment is larger than the effect of foreign capital per worker in every instance. The coefficients have the expected sign for the statistically significant samples. There are differences in the magnitude of the respective coefficients between the four income samples. For example, the effect of domestic investment is significantly lower for the *low income* countries compared to the *high and upper middle income* countries, while foreign

capital seems to affect the economic growth rate for both samples fairly equal. The effect of foreign capital is strongest for the sample of *low and lower middle* income countries. For the *high and upper middle income* countries the effect of foreign capital is only one fourth of the effect of domestic investment, while for the sample of *low and lower middle income* countries it is half and for the sample of *low income* countries a little less than one third. Based on these findings it can be assumed that foreign capital is more beneficial for richer developing countries than for the poorest.

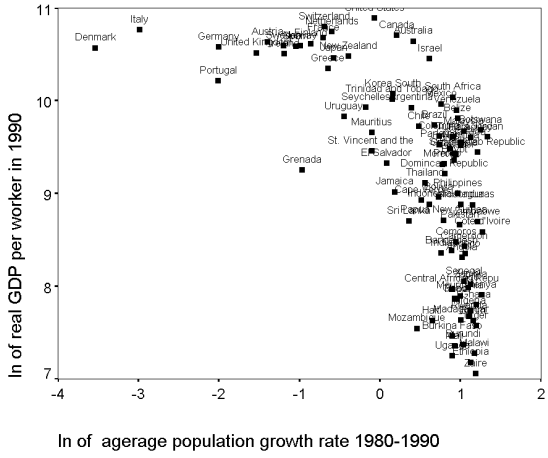
The negative effective depreciation rate is larger for poorer countries than for richer. Since only the population growth rate, n, and the ratio of foreign to domestic capital, Z/K, change, while all other variables, δ and g as well as s_Z, in the depreciation term are constant, different magnitudes are caused by high population growth or/and a high ratio of foreign to domestic capital. Since there is only a weak correlation between income and the ratio of domestic to foreign capital, most of the effect can be attributed to population growth. See *Figure 9.1* and *Figure 9.2* below for a graphical illustration.

Figure 9.1



Scatterplot for logged real GDP per worker and logged foreign to domestic capital ratio.

Figure 9.2



Scatterplot for logged real GDP per worker and the logged average population growth rate.

Model 3

The results for Model 3, the model with the upper estimate for the share of reinvested earnings (80%), are very similar to those in Model 1, though the values for the coefficients for domestic investments tend to be a little larger, while the values for foreign investments are a little smaller. But most of the differences are marginal. As in Model 1, the effect of domestic investment on economic growth is significantly lower for the *low income* countries compared

to the *high and upper middle income* countries, while foreign capital seems to affect the economic growth rate for both samples fairly equal. For the sample of *low and lower middle* income countries, the effect of foreign capital is strongest and about half the magnitude of the domestic investment. For the *high and upper middle income* countries the effect of foreign capital on economic growth is less than one fifth and for the sample of *low income* countries a little less than one third of the effect of domestic investment. The coefficients for the effective depreciation rate have the expected sign and their negative effects become larger the poorer the countries in the samples are.

Comparing the results for Model 1 and Model 3

A larger share of reinvested earnings (20% versus 80%) slightly increases the magnitude of the coefficients for the domestic investment and very moderately lowers the coefficients for foreign capital per worker in the regression results for all samples. Since a 80%-share of reinvested earnings results in a smaller effective depreciation rate than a share of 20%, the regression coefficients for the negative effect of the depreciation is smaller in Model 3 than in Model 1. The differences between the effect of the domestic investment rate and the effect of foreign capital are very similar in both models for the respective samples. However, the difference is largest for the sample of *high and upper middle income* countries in Model 3 where the larger rate of reinvestment results in a strong increase of the effect of the domestic investment rate.

Model 2

The *median* of foreign capital per worker is US$ 354 and the *mean* is US$ 1'517. For countries, which have an amount of foreign capital per worker below the *median,* the domestic investment rate has a much stronger effect on economic growth than for those above the *median*. The effect of foreign capital is stronger for countries above the *median* than for those below. For the sample based on the *mean* of foreign capital per worker, the effect of the domestic investment rate is significantly larger for the countries above the *mean* than for those below, while the effect of foreign capital on the economic growth rate is only a little less smaller for the countries below the *mean.* The effect of the domestic investment rate is always two to three times larger than the effect of foreign investment for the sample based on the *mean* as well as the sample based on the *median* of foreign capital per worker. The effect of the effective depreciation rate is always negative and it becomes larger for countries with less foreign capital per worker.

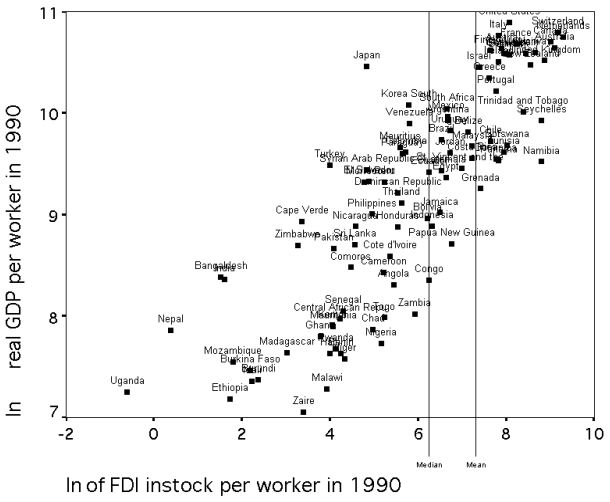
These results somehow contradict the results of Model 1 and Model 3. Rich countries tend to have more FDI per worker than poor countries, which has already been outlined in Section

3.3. The scatterplot in *Figure 9.3* graphically illustrates this relationship. For the statistically significant samples in Model 1 and 3, the effect of domestic investment on economic growth was larger for richer countries than for poorer countries. On the other hand, the effect of foreign capital on economic growth was largest for the *lower middle and low income* countries, which represent the lower two third of the total sample in regard to per worker income. Based on this observation it can be assumed that the effect of foreign capital on economic growth for the countries above the *mean* should be smaller than for those countries below the *mean*. Since the countries in the high and upper middle income sample in Model 1 and Model 3 are pretty much the same as in the sample of countries with foreign capital per worker above the *mean*. One should bear in mind that the division of the total sample relative to the *mean* or *median* of FDI per worker is a rather arbitrary decision and the statistical results should be interpreted with care. In this case, it leads to rather unfortunate results since it assigns for instance high income countries like for example Japan to the sample of countries with an amount of FDI per worker below the *mean* respectively *median*. In *Figure 9.3*, the mean and the median are marked for better understanding. On closer inspection it becomes obvious that the division of the sample along these two lines might probably lead to a distortion. Excluding for example Japan from the sample of countries below the *median*, increases the effect of foreign capital from 0.22 to 0.25 and decreases the effect of domestic investment from 0.66 to 0.60, which is a significant change for the exclusion of a single country. *Figure 9.4* equals *Figure 9.3*, but instead of country names the income categories of the respective countries are indicated[35]. *Figure 9.4* illustrates that some *lower middle income* countries like for example Tunisia or Namibia have a larger FDI instock per worker than *upper middle income* countries. On the one hand, this might reflect the actual position of a particular country in the world economy in regard of income and foreign capital stock. On the other hand, this position can result from exceptionally high values for a particular year (in this case 1990) since the dependent and some of the independent variables in the regression equation are based on the values of the final year of the time period (1980-1990) analyzed and not an average values. Therefore, it is very likely that some countries are not correctly represented. Fact is, that for many countries in the data set, the foreign capital stock is based on estimates for certain years or has been calculated backwards by the UNCTAD. The conflicting findings can therefore also result from incorrect FDI data. If better data on FDI was available, the latter supposed cause for these conflicting findings would be easier to verify. For the earlier supposed cause

[35] According to these income categories the total sample has been split into the respective sub-samples for Model 1, 3, 5 and 7

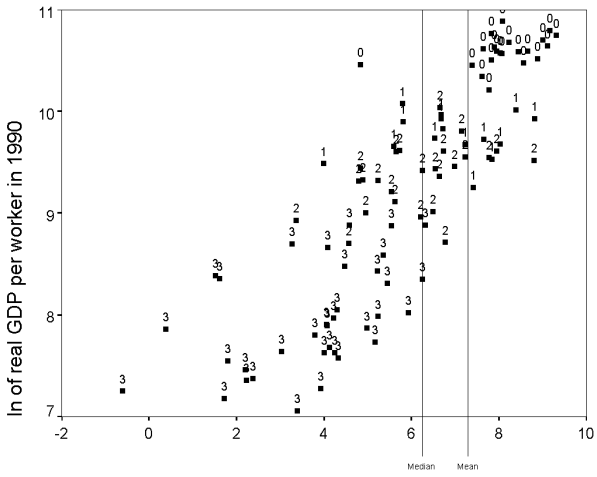
another statistical method for the analysis, like for example time series analysis, would probably lead to other results.

Figure 9.3



Scatterplot of logged real GDP per worker on logged FDI instock per worker in 1990 with country names indicated.

Figure 9.4



Scatterplot of logged real GDP per worker on logged FDI instock per worker in 1990 with income category indicated.

0=high income
1=upper middle income
2=lower middle income
3=low income

Model 4

For the sample based on the *median* of foreign capital per worker, the effect of the domestic investment rate is slightly larger for countries below the *median* than for those above, while the effect of foreign capital on economic growth is significantly smaller. For the sample based on the *mean* of foreign capital per worker, the effect of domestic investment is much larger for the countries above the *mean* than for those below. The coefficients for foreign capital per worker are nearly equal in magnitude. For both samples the effective depreciation rate has the correct sign and the coefficient for countries below the *mean* or *median* of foreign capital per worker is always more negative than for countries above the *mean* respectively *median*.

Comparing the results for Model 2 and Model 4

The range of foreign capital per worker reaches from $US zero to $US 12'000. That is, compared to the maximum the *median* marks a very small figure ($US 354). If the sample is analyzed in regard to the *median* of foreign capital per worker, an increase in the share of reinvested earnings leads to an increase in the effect of the domestic investment rate as well as the effect of foreign capital per worker for the countries above the *median*. The changes in the

magnitudes of the effects for the countries below the *median* are very moderate. The effect of the domestic investment rate is slightly smaller and the effect of foreign investment is slightly larger. An increase in the share of reinvested earnings lowers the negative effect of the effective depreciation rate for the countries above the *median,* but slightly increases it for the countries below the *median*. The same behavior can be observed for the sample based on the *mean* of foreign capital per worker ($US 1517). But in this sample, the coefficient for the domestic investment rate for the countries above the *mean* increases tremendously, while all other coefficients change in a manner comparable to the sample based on the *median* of foreign capital per worker.

9.2.2 Restricted models

General inspection

The model fit for the restricted models, the adjusted R-square term, is very similar to those in the unrestricted models. As for the unrestricted models, in the sample for the *high income* countries the coefficients are not significant and the model fit is very weak. The same can be observed for the *low income* sample where the model fit is rather moderate as in the unrestricted model. However, the values for α and β sum up to less than zero in all samples, as required by the theory. Domestic capital's share in income is around the expected one third only for some of the samples based on income categories, but it tends to be too large for the samples based on the amount of foreign capital per worker.

Model 1

The share of domestic capital in income becomes smaller the poorer the countries in the sample are. The domestic capital's share in income for the sample of *high income and upper middle income* countries is too large and about five times the size of foreign capital's share in income. The values for α in the *low* and *lower middle and low income* countries are of the expected magnitude and about two to three times the size of β. Based on this figures it can be assumed that for the *high and upper middle income* countries, the foreign capital's share in income is not only the smallest in absolute figures, but also the smallest compared to domestics capital's share in income for all samples. But for this sample, domestic capital contributes the largest share to income compared to the other income samples.

Model 3

For Model 3, which is analogous to Model 1, but is based on the upper estimate for the share of reinvested earnings, the regression results are basically equal to those in Model 1.

Comparing the results for Model 1 and Model 3

An increase in the share of reinvested earnings does not affect the share of domestic capital and foreign capital in income. The regression coefficients and the magnitudes of α and β for the respective sample in the two models are nearly identical.

Model 2

The share of domestic capital in income is within the expected range of one third for the countries with an amount of foreign capital per worker above the *median* value of US$ 354. However, the foreign capital's share in income for this sample is pretty large compared to domestic capital's share in income (a little less than half the magnitude of the domestic capital's share in income). For the countries below the *median,* the magnitude for α is too large and is about three times the size of β.

The values for α and β for the countries below the mean of foreign capital per worker are very similar to those for the countries above the mean and β is about one third of α in both cases.

Model 4

For Model 4, which is analogous to Model 2, but is based on the upper estimate for the share of reinvested earnings, the estimates for α and β are fairly equal. However, the values for β tend to be a little smaller.

Comparing the results for Model 2 and Model 4

An increase in the share of reinvested earnings leads to a moderate increase of the domestic capital's and to a small decrease of foreign capital's share in income for the countries with more foreign capital per worker (countries above the mean and median of foreign capital per worker), but does not affect the share of domestic and foreign capital in income for countries with less foreign capital per worker.

9.3 Regression results for per capita models

9.3.1 Unrestricted models

General inspection

Except for the samples of *high income* and *low income* countries, the regression coefficients for all other samples are significant at least at the 0.1 level or better (usually at the 0.01 level) and the adjusted R-square terms indicate a good model fit. The bad model fit and the non-significant coefficients for the *high income* sample are probably due to the small sample size of only 21 countries. Because of the poor quality of the results for this sample, they unfortunately have to be omitted in the analysis. Only some of the variables in the sample of *low income* countries are not significant and the model fit for the *low income* samples is rather mod-

erate. The effect of domestic and foreign investment is positive in all models and samples, that is, foreign and domestic investments have a positive effect on economic growth. The coefficient of the effective depreciation rate is negative for all models and samples (except for the excluded *high income* sample). For the samples based on income categories, the negative effect does not increase for samples of poorer countries. But for the samples based on the amount of foreign capital per capita its negative effect increases for samples with countries with less foreign capital.

Model 5

The effect of domestic investment is larger than the effect of foreign capital per capita in all sub-samples. The poorer the countries in the sample the smaller the effect of domestic investment, that is, domestic investment in the sample of *low income* countries yields the weakest effect on economic growth. The effect of foreign capital per capita is strongest for the sample of *lower middle and low income* countries. For this sample, the effect of domestic investment is about two times larger than the effect of foreign capital per capita, while for the sample of *high and upper middle income* countries domestic investment is nearly four times larger. That is, domestic investment compared to foreign investment affects economic growth significantly more for the samples of richer countries than for the samples of poorer countries. The coefficient for the effective depreciation rate is negative for all samples. Oddly, it is of the same magnitude for all samples regardless of the income categories, except for the *high income* sample.

Model 7

The results for Model 7, the model with the upper estimate for the share of reinvested earnings, are very similar to those in Model 5. The effect of domestic investment on economic growth is significantly larger for the sample of *high and upper middle income* countries than for the samples of poorer countries and it is about six times as large as the effect of foreign investment. The effect of domestic investment is weaker the poorer the countries in the samples are. The strongest effect of foreign capital on economic growth can be observed for the sample of *lower middle and low income* countries where it is also the strongest compared to the effect of domestic investment (about half). The coefficient for the effective depreciation rate is negative for all samples. It is of the same magnitude for all samples, except for the high income sample, for which no statistically significant regression results could be obtained.

Comparing the results for Model 5 and Model 7

Assuming a higher estimate for the share of reinvested earnings (20% versus 80%) significantly affects the coefficients for domestic investment and for foreign capital for the sample

of *high and upper middle income* countries. The effect of domestic investment is increased by nearly 50%, while the effect of foreign capital drops by about one fifth. In Model 7, the effect of domestic investment in this sample is now six times larger than foreign investment, while in the respective sample in Model 5, the effect of domestic investment was only four times larger. For the other samples, neither the magnitude nor the ratio of the effect of domestic and foreign investment is significantly affected by a change in the share of reinvested earnings, though the effect of foreign investment tends to be slightly smaller for the samples in Model 7 than in Model 5.

Since a 80%-share of reinvested earnings results in a smaller effective depreciation rate than with a share of 20%, the regression coefficients for the effective depreciation rate become less negative in Model 7 than in Model 5. Surprisingly, it does not change for the different samples of poorer and richer countries in both models.

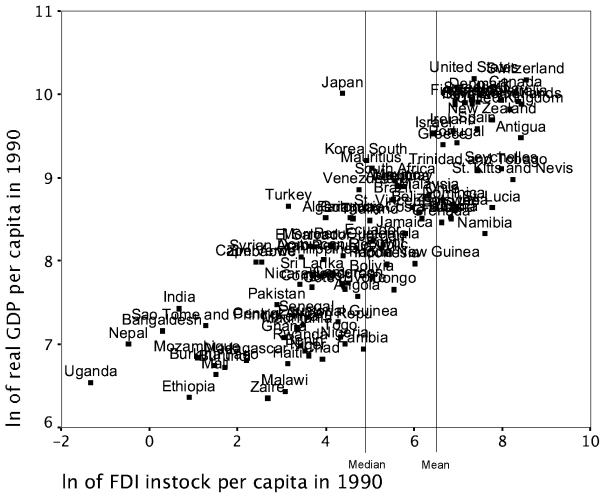
Model 6

The *median* of foreign capital per capita is US$ 151 and the *mean* is US$ 726. For countries, which have an amount of foreign capital below the *median*, the domestic investment rate has a stronger effect on economic growth than for those above the median, while foreign investment affects economic growth much stronger for countries above the *median* than for those below. For the sample based on the *mean* of foreign capital per capita, the effect of the domestic investment and the effect of foreign investment are significantly larger for the countries above the *mean* than for those below. For countries with more foreign capital (mean and median), the effect of foreign capital on economic growth is only one and a half times smaller than domestic investment, which is significantly smaller than for the countries with less foreign capital per capita.

The effect of the effective depreciation rate is always negative and the negative effect on economic growth is stronger for countries with less foreign capital per capita than for countries with more foreign capital.

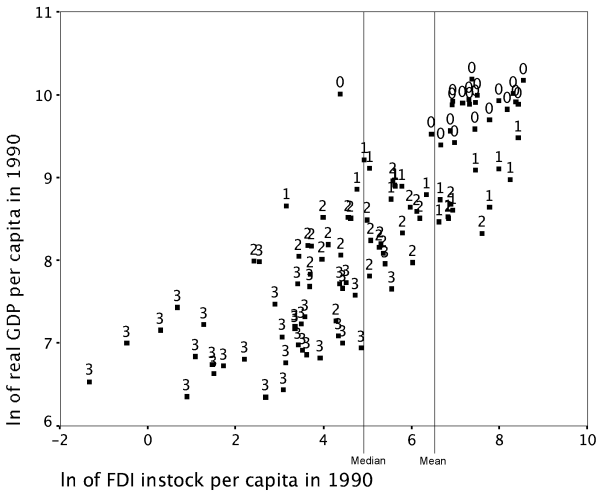
Disregarding the magnitudes of the regression coefficients, these results equal the results of Model 2. That is, the same contradictions between the results of Model 6 and the results of Model 5 and 7 can be observed as for Model 2. The two scatterplots below look fairly equal to *Figure 9.3* and *Figure 9.4*. Therefore, the same two supposed causes for the conflicting findings for the models with per worker values can be applied for the models with per capita values.

Figure 9.5



Scatterplot of logged real GDP per capita on logged FDI instock per capita in 1990 with country names indicated.

Figure 9.6



Scatterplot of logged real GDP per capita on logged FDI instock per capita in 1990 with income category indicated.

0=high income
1=upper middle income
2=lower middle income
3=low income

Model 8

For countries with more foreign capital per capita (mean and median), the effect of domestic investment on economic growth is significantly stronger than for the countries with less foreign capital. The effect of foreign investment is also larger for countries with more foreign capital than for those with less, but its effect is much stronger for the sample based on the mean of foreign capital per capita.

The effect of the effective depreciation rate is always negative and the negative effect on economic growth is stronger for countries with less foreign capital per capita than for countries with more foreign capital.

Comparing the results for Model 6 and Model 8

An increase of the share of reinvested earning from 20% to 80% leads to an increase of the positive effect of domestic investment and to a decrease of the positive effect of foreign investment on economic growth for all samples. However, the change in magnitude is smaller for the countries with less foreign capital per capita (mean or median) and quite significant for the countries with more foreign capital per capita. In Model 8, the effect of domestic investment is two and a half times larger than the effect of foreign investment for all samples, while in Model 6 the effect of domestic investment is only one and a half times larger than the effect

of foreign investment for the sample of countries with more foreign capital per capita (mean and median). For all samples the negative effect of the effective depreciation rate becomes weaker if a larger share of earnings is reinvested.

9.3.2 Restricted models

General inspection

The model fit for the restricted models is very similar as for the unrestricted models. The coefficients for the sample of *high income* countries are not significant and the model fit is very weak. The same can be observed for the *low income* sample where the model fit is rather moderate as in the unrestricted model. However, the values for α and β sum up to less than zero in all samples, as required by the theory. The domestic capital's share in income of about one third can only be observed for the *lower middle* and *low income* countries. For all other samples, α is significantly larger and in one case smaller.

Model 5

The share of domestic capital in income becomes smaller the poorer the countries in the sample are. Except for the total sample, the share of foreign capital in income is largest for the sample of *low and lower middle income* countries. For this sample it is about two times smaller than the share of domestic capital in income, while the difference is larger for all other samples in Model 5. For the sample of *high and upper middle income* countries, the share of foreign capital in income is smallest compared to domestic capital's share in income (about five times smaller).

Model 7

In Model 7, which is analogous to Model 5 but is based on the upper estimate for the share of reinvested earnings, only for the sample of *low and lower middle income* countries a share of one third for domestic capital in income can be observed. In all other samples, the estimates for α are larger and in the case of *low income* countries it is smaller. Domestic capital's share in income is seven times larger than foreign capital's share in income for the sample of *high and upper middle income* countries, while this ratio is much smaller for all other samples. The estimates for β, foreign capital's share in income, are largest for the *low and lower middle income* countries and only about two and a half times smaller than domestic capital's share in income. are fairly equal.

Comparing the results for Model 5 and Model 7

An increase in the share of reinvested earnings only leads to minor changes. Solely domestic capital's share in income is a little smaller for the sample of *high and upper middle income*

countries. This holds true for foreign capital's share in income for this sample. Domestic capital's share in income for this sample is about five and a half times larger than foreign capital's share in income. This ratio of α to β increases to six and a half if the share of reinvested earnings is 80%. All other coefficients are basically the same for the respective income related samples in Model 5 and Model 7.

Model 6

The share of domestic capital and foreign capital in income is always larger for the samples of countries with more foreign capital than for those with less, though the differences are larger for samples based on the *mean* of foreign capital per capita. For the countries with less foreign capital per capita, foreign capital contributes less to income than for the countries with more foreign capital per capita.

Model 8

Model 8, which is analogous to Model 6, but is based on the upper estimate for the share of reinvested earnings, the estimates for α, the domestic capital's share in income, are significantly larger for the samples of countries with more foreign capital than for those with less. This holds true for the foreign capital's share in income. The estimates for α are always larger than the expected one third. Foreign capital's share in income is for all samples about two and a half to three and a half times smaller than domestic capital's share.

Comparing the results for Model 6 and Model 8

A larger share of reinvested earnings slightly increases the effect of domestic capital's share in income and leads to a decrease of foreign capital's share in income for the samples of countries with more foreign capital (mean and median). For the samples of countries with less foreign capital no changes can be observed.

9.3.3 Poverty trap

If capital is scarce, it is more productive than if it is sufficiently available. However, the amount of capital available within an economy must be beyond a certain threshold to be productive. Low income leads to low savings and low savings lead to low investment. Low investment leads to low productivity and low income - where the vicious circle starts over again. Further, poverty can lead to environmental degradation, which in turn undermines the assets of the poor and exacerbates poverty, and poverty can lead to violence and conflict. The associated destruction of physical, human, social and organizational capital in turn intensifies poverty (UNCTAD 2002a, pp. 71-72). Countries in this economic state are stuck in the *poverty trap*. *Figure 9.7* below illustrates how income is related to capital.

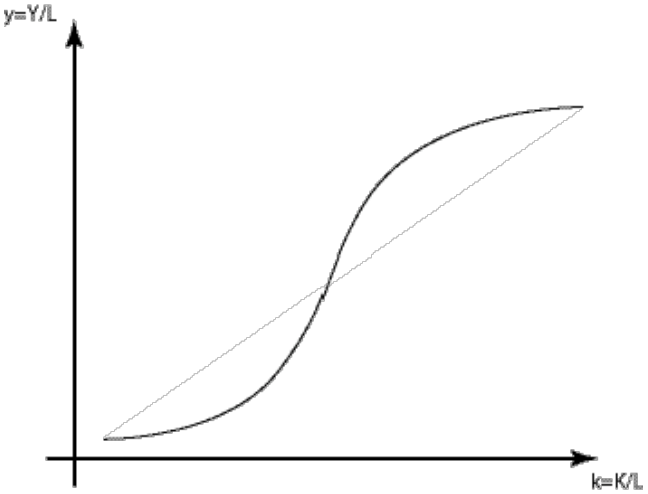


Figure 9.7

Low income earners have a high marginal propensity to consume. They will spend most of their income on consumption of necessities such as food. Thus, the marginal propensity to save is low. Since overall incomes are low, the average propensity to save will also be low and savings ratios will consequently be low. It is saving that provides funds that can be lent out to firms for investment purposes. The availability of funds for investment is thus limited. Labor productivity measured in terms of output per worker is consequently low, as capital cannot be purchased. Wages are invariably linked to productivity levels and so incomes are low: the cycle is complete.

The effect of domestic investment is weakest for the sample of *low income* countries and highest for the *high* and *upper middle income* countries in all income based models (that is Model 1 and 3 as well as Model 5 and 7). Except for the high income sample, which is statistically not significant, the regression results support the theoretical assumption of a poverty trap.

For foreign investment, the effect is fairly equal for the sample of *high* and *upper middle income* countries and for the sample of *low income* countries. The effect is strongest for the *lower middle* and *low income* sample. *Figure 9.4* and *Figure 9.6*, where the countries in the scatterplot are marked by their level of income, provide a graphical illustration of the distribution of the respective income classes. The regression results seem to confirm the assumption of a poverty trap. Poor countries receive only very few FDI and the share of returns on these foreign investments, which remain in the host economy, will be spent on requirements of basic life and business. Investment, which would go beyond of these basic requirements, are therefore not possible.

9.3.4 Marginal Productivity

Based on *Equation 8.3* and *Equation 8.4*, the marginal productivity of domestic and foreign capital has been estimated. Some countries yield exceptionally large values for the average *y to k* and *y to z* ratios. These countries have been marked as outliers and have been excluded before estimating the marginal productivities. However, for consistency a comprehensive table of all *y to k* and *y to z* ratios for all countries with the results for the entire samples including the outliers has been added in Appendix C.

Table 9.1

	Marginal productivity in % (sample without outliers)				
	Type of capital	*High income**	*High and upper middle income*	*Lower middle and low income*	*Low income*
Model 1	*Domestic*	8	24	46	44
	Foreign	148	263	1'981	1'462
Model 3	*Domestic*	8	24	46	44
	Foreign	148	263	1'981	1'300
Model 5	*Domestic*	16	32	42	36
	Foreign	124	284	1'932	1'512
Model 7	*Domestic*	16	31	42	36
	Foreign	124	221	1'803	1'512
	Type of capital	*Median high*	*Median low*	*Mean high*	*Mean low*
Model 2	*Domestic*	26	57	25	50
	Foreign	533	2'299	350	1'988
Model 4	*Domestic*	27	57	26	50
	Foreign	485	2'299	306	1'856
Model 6	*Domestic*	33	53	33	49
	Foreign	489	2'115	513	1'890
Model 8	*Domestic*	34	53	34	49
	Foreign	435	2'115	406	1'890

Marginal productivity for all samples with extreme values in the respective samples excluded

Outliers:

High income: *Japan*
High and upper middle income: *Japan* and *Turkey*
Lower middle income and low income: *Nepal, Uganda* and *Syria*
Low income: *Nepal* and *Uganda*
Median high: *Dominica*
Median low: *Nepal*, *Uganda*, *Syria* and *Nepal*

*values based on non-significant regression results

The values of marginal productivity tend to be too high for foreign and domestic capital for all samples. However, the trend of the marginal productivity regarding the income-samples is correct – the marginal productivity is larger for poorer countries where capital is rather scarce than for richer countries where plenty of capital is available. The values of the marginal productivity for domestic investment are still within acceptable boundaries, especially if more countries within the sample with very high values for the average *y to k* and *y to z* ratios would additionally be excluded. Since in some poorer countries interest rates of 200% or 500% and more are possible, a marginal productivity of about 250% for foreign capital could be possible. But these values have been estimated for the samples of *high* and *upper middle income* countries and generally one would expect such values for the sample of poorer countries. The values of over 300% are not acceptable. Since the trend is correct, these high values

might result from incorrect data on foreign capital flows and stocks (many values in the UNCTAD data set are estimates) or from false estimates of foreign and domestic capital's share in income. Based on *Equation 8.3* and *Equation 8.4*, large values for the marginal productivity result mainly from the average *y to k* respectively *y to z* ratios and to the lesser extent from the values of capital's share in income (α respectively β). The values for α are within the expected boundaries and the values for the marginal productivity of domestic capital are acceptable. Since some countries receive only very few foreign investment, at least according to the data on FDI, the calculated values of the marginal productivity of foreign capital might be correct mathematically. However, such values cannot be observed in reality.
The values of the marginal productivity for the models based on the amount of foreign capital per worker respectively per capita correctly reflect the expected trend, but are even larger than for the income-models. This might also result from the same reasons mentioned above and, in addition, from the problems outlined earlier in the discussion of the regression results for these models.
There are other reasons for these high values, which are less likely to result from insufficient data quality. Capital markets in developing countries are often inefficient. Domestic investments are probably more profitable that foreign investments but due to inefficient capital markets comparison of productivity are difficult and the marginal productivities for foreign and domestic capital are therefore either over- or underestimated. The estimated values only reflect potential marginal productivities, but investments in developing countries often involve high risk and the risk-based premium might be overestimated.

9.4 Test of Hypotheses

The hypotheses have been formulated to reflect scientific findings on this subject. Since these findings are contradicting, the reverse causation hypotheses would be applicable, too.

Main Hypothesis

Foreign direct investment has a positive effect on economic growth in developing countries.

The findings of this analysis show that foreign direct investment has a positive effect on economic growth in developing countries.

Related Hypothesis 1

Foreign direct investment inflows have a positive effect on economic growth in developing countries.

The hypotheses cannot be tested, since the regression equation derived from the extended Solow-model allows only to test for accumulated foreign capital and not for the flow of foreign capital.

Related Hypothesis 2

Foreign direct investment stocks have a positive economic effect on economic growth in developing countries.

The foreign capital stock has a positive effect on economic growth in all tested samples and hence for developing countries (and so does domestic capital). The effect of foreign capital is always weaker than for domestic capital for the per capita models as well as for per worker models. The difference between the effect of domestic and foreign capital on economic growth varies from between two times smaller to six times smaller. The differences are largest for the higher income samples and smallest for the lower middle and low income countries.

Related Hypothesis 3

Foreign capital is less productive than domestic capital.

While foreign capital's share in income is significantly smaller than domestic capital's share, the marginal productivity of foreign capital is larger than for domestic capital. Further the marginal productivity of foreign capital is larger the poorer the countries in the sample are. However, the estimated values for the marginal productivity are too large and therefore no assumptions regarding the magnitude of the differential marginal productivity can be made.

Related Hypothesis 4

The larger the share of reinvested earnings in FDI inflows the stronger the positive effect of FDI inflows on economic growth in developing countries.

A larger share of reinvested earnings leads to a very slight drop of the effect of foreign direct investment on economic growth in the regression results for the income based samples and to a larger extend for the samples based on the amount of foreign capital. The absolute value of the negative effective depreciation term in *Equation 6.15* will be smaller if the share of reinvested earnings, s_Z, is set to 80% instead of 20%. A share of 80% leads to a significantly smaller negative regression coefficient for the depreciation term and in most cases to a slightly larger effect of the domestic investment rate. Since there is no measure for FDI flows

in the regression equation, the hypothesis cannot be proved. However, a larger share of reinvested earnings lowers the negative effects of effective depreciation and can slightly boost the effect of domestic investment.

One might even be induced to consider economic systems as a sort of modern invention made in order to retain for their internal members all the gains coming from productivity growth. And of course, to some extent, economic systems are such inventions.

"[T]he enormous disparities in the wealth of the various nations that can nowadays be observed on the face of the earth […] one cannot but feel a strong emotional sense of repugnance, and rebellion, against the social injustice which they express. [O]ne might even be induced to consider economic systems as a sort of modern invention made in order to retain for their internal members all the gains coming from productivity growth. And of course, to some extent, economic systems are such inventions. […] The fragmentation of the world into numerous, separate economic systems being a fact that has to be accepted, we must be consistent and recognise that the wealth of the industrially advanced countries is something that is rooted in them and is not something of which they are depreving the poor countries. There is nothing that can be 'restored' by 'redistribution' of material goods. […] Yet it is not by a redistribution of material goods, at any given point of time, that anything will be accomplished. […] It is only by absorbing technological knowledge that the poor countries will be able permanently to increase their wealth. […] For an industrial nation, wealth is not a stock of material goods – it is a stock of technological knowledge. […] For, if, in the pre-industrial world, the main way for a country to increase its wealth was to dominate and exploit its neighbours, today it has become to emulate them and do better. [T]his should not be taken as a basis for claiming that international exploitation does not take place. Unfortunately, international exploitation has taken place in the past and is taking place today in many guises. The simple point that is made here is that no exploitation is necessarily implied by the mere fact that better technological knowledge enables a particular country to achieve higher levels of per capita incomes that are obtained in other countries."

***Luigi L. Pasinetti**, Professor of Economics (Pasinetti 1981)*

SECTION IV

Conclusions

10 SUMMARY OF RESULTS

This extended Solow-model, which has been designed for this analysis, provides a useful means to assess the effects of foreign direct investment on economic development. It is a comprehensive model for this analysis as it includes the foreign capital stock on a per capita base, reinvested earnings and the ratio of foreign to domestic capital in addition to the other variables, which are usually part of a Solow-model. The results based on the regression equation derived from this model are plausible and statistically significant for most of the samples. Generally, the results for the models based on income categories yield a good model fit and are within reasonable range. This holds true not only for the assessed effects of domestic and foreign capital on economic growth, but also for the estimated capital's share in income. The results for the models based on the amount of FDI per worker, respectively per capita, are not consistent and are not as expected. This might be due to a rather unfortunate division of the total sample along the line of the mean and median of foreign capital per worker respectively capital per worker.

Effects of foreign direct investment

Foreign capital has a positive effect on economic growth in all tested samples. The effect of foreign capital is always two to six times weaker than for domestic capital for the per capita models as well as for per worker models. However, economic growth in very poor countries seems to be affected less by the presence of foreign capital as for example in middle income countries. These countries are not only poor, but they also get very little foreign capital. The scarcity of capital in these countries might result in an economic condition where they are caught in a poverty trap. Therefore it is very likely that foreign capital can contribute only to a very small extent to economic growth. The effect of foreign capital is also weaker in higher income countries, which is likely to result from the widespread availability of capital in these countries. In addition, the high level of development in countries of the First World requires much larger financial and technological efforts to achieve productivity gains.

Concerning the effect of foreign capital on economic growth, the results for the models based on income categories are in support with the findings of de Soysa & Oneal (1999) as well as with Firebaugh (1992; 1996). They also support Firebaugh's claim that foreign capital is less beneficial than domestic capital and they indicate that the effect of foreign capital on economic growth significantly varies depending on the level of income. But the statistical findings do not indicate that the presence of foreign capital negatively affects economic growth as asserted by the PEN-researchers Bornschier et al. (Bornschier and Chase-Dunn 1985; Bornschier, Chase-Dunn, and Rubinson 1978) or Dixon & Boswell (1996a; 1996b). However, the comparison of the statistical results is limited due to the differences in the regression equations. Therefore the findings cannot be compared on an exact one by one basis.

All these studies have in common, that the time period analyzed is about ten years. Kentor (1998) analyzed the effect of investment dependence over a significantly longer period of time, namely fifty years. Studying the effect of FDI on economic growth over a longer time period allows separating the differential short-term and long-term effects. Kentor's results indicate that peripheral countries with a relatively high dependence on foreign capital exhibit slower economic growth than peripheral countries with less investment dependence (p. 1042). Foreign investments yield a positive short-term economic growth effect resulting from capital inflows and increased employment. This positive effect is followed by a lagged negative long-term effect of about 20 years later, which lasts at least 30 years. Kentor argues that this long-term effect is due to the stability of foreign investments over time since the infrastructure financed with the initial sequence of investment, will be followed by additional investments in a country dominated by foreign capital. A potential adaptation of the social and political structure by the local elite in favor of the foreign investors would make subsequent investments even more likely (pp. 1040-1041). An analysis over a comparable long period of time based on this extended Solow-model would provide further evidence on the effect of FDI on the economic development of the host countries and would allow an additional test of the model itself.

Marginal Productivity

For the models based on income categories, a larger share of reinvested earnings leads to a significant decrease of the negative effect of effective depreciation and can, in some cases, increase the effect of domestic investment on economic growth. On the other hand, the effect of foreign capital on economic growth is reduced in a negligible manner by a larger share of reinvested earnings. Based on these observations it can be assumed that reinvesting a significant fraction of earnings is beneficial for the host economy. The results for the models based on

the share of foreign capital per capita respectively worker indicate that an increase in the share of reinvested earnings significantly increases the effect of the domestic investment rate on economic growth for countries that have more foreign capital. But it only slightly affects it in a non-consistent manner for countries, which have less foreign capital. While the effect of foreign capital on economic growth is decreased by a larger share of reinvested earning, it is increased for the per worker models. The effect of effective depreciation is decreased only for the countries with more FDI and changes only marginally for the countries with less FDI. In general, the indirect positive effect of a larger share of reinvested earnings is stronger for countries with more FDI per capita or per worker (either by absolute figures or by the observation that high and higher income countries receive more FDI).

The PEN-researchers and critics of TNC presence and activities in developing countries often argue that transnational corporations repatriate most of the returns to their investments, and under certain circumstances transfer more money out of these countries than they had previously invested and thereby harm these host economies. The statistical findings of this analysis support this point of view regarding the indirect positive effect of a larger share of reinvested earnings on economic growth compared to a small share. However, rich countries and countries with more FDI per capita, respectively per worker, profit more from larger reinvestment shares.

The magnitudes of the calculated marginal productivity for foreign and domestic capital cannot really satisfy because they tend to be too large and are, in case of the lower income samples, beyond any reasonable magnitude. But the results indicate that the marginal productivity of foreign (and domestic) capital is larger for poorer countries, which usually receive less FDI than for richer countries. This is consistent with the assumption that capital is more productive if it is scarce.

The findings support the claim of de Soysa & Oneal (1999) that foreign investment is more productive than domestic investment. But since the calculated values of this analysis are not really within the expected range, no daring “exact” figures can be given for the differences in (marginal) productivity of domestic and foreign capital as by de Soysa & Oneal.

Theoretical aspects

In Section 3 theories of development and modernization have been outlined. These theories shed light on various aspects of TNCs’ operations and their effect on the development process in developing countries. The analysis presented here shows that the operations of TNCs have a positive effect on economic growth in developing countries. However, the model setup does not allow answering other developmental issues associated with the presence and operations

of TNCs in poor countries. It cannot provide answers in regard of technological and managerial spillover effects, increase or decrease of economic and social inequality within the host society, cultural decline, uncontrollable urbanization etc. as hypothesized in the theories presented earlier in this thesis. The limitation on a single parameter – economic growth – is of course a simplification. The complexity of the global economic system and the various economic, political and social impacts of this very system on developing countries pose a difficult task for analysis. Nevertheless, the model introduced here is a useful means to assess the effect of TNCs operations in developing countries on economic growth and can be extended to measure other effects. For example adding human capital to the model would allow assessing respective spillover effects.

Conclusion

Not all hypotheses could be answered in a clear cut way due to the concept of this extended Solow-model from which the regression equation was derived. Therefore, the regression results are not always comparable with results from other analyses on a one-by-one basis. Nevertheless, the model is an adequate empirical means for the analysis of the subject at stake and provides an innovative approach.

11 OUTLOOK

For the present analysis and the scientific studies on the subject of TNCs activities and their effect on development, which have been outlined in this paper, the complexity of subject had to be reduced by simplifying the relationship between TNCs activities and the development of Third World countries to the relationship between FDI and economic growth in developing countries. Development is more than just an increasing in per capita income and TNCs activities comprise more than just the transfer of assets to foreign countries. There is a large consensus that human capital is even as important as financial and physical capital. A future analysis of this subject, based on an extended macroeconomic growth model as portrayed here, should therefore include human capital. Measuring TNCs activities with regard to the transfer of technology and management knowledge and not only financial capital would also be a significant improvement. Besides, data on foreign capital flows and stocks is often not very reliable since for many countries the figures in the available data sets are based on estimates. Better data quality would considerably increase the reliability of quantitative analysis. Nevertheless, the most important improvement in a future analysis would be the inclusion of human capital into the scientific model.

12 APPENDICES

12.1 Appendix A – Data used in the empirical analysis

Data sample used in the empirical analysis. The sources are the Penn World Tables 6.1 (Heston, Summers, and Aten 2002) and the World Investment Report (UNCTAD 2003).

#	Country name	Real GDP per capita in 1990 in US$	Real GDP per worker in 1990 in US$	Average gross domestic investment rate	FDI instock per capita in 1990 in US$	FDI instock per worker in 1990 in US$	Domestic capital stock in 1990 in Mio. US$	FDI instock in 1990 in Mio. US$	Average Population growth rate since 1980
1	Algeria	4'964.53		20.50	54.19		265'478	1'355	2.97
2	Angola	1'944.12	4'084.52	6.86	110.98	233.17	14'336	1'024	2.78
3	Benin	999.84	2'068.49	8.50	33.62	69.55	3'859	159	3.18
4	Botswana	5'417.17	16'112.51	17.75	1'026.10	3'051.96	9'330	1'309	3.48
5	Burkina Faso	844.65	1'750.30	9.27	4.35	9.02	7'467	39	2.46
6	Burundi	826.78	1'599.26	9.03	5.53	10.70	3'375	30	2.82
7	Cameroon	2'266.86	4'601.04	10.12	91.00	184.71	27'087	1'044	2.86
8	Cape Verde	2'926.05	7'584.47	17.35	11.16	28.93	1'378	4	1.68
9	Central African Republic	1'377.49	2'905.03	4.44	32.42	68.38	2'300	95	2.43
10	Chad	911.72	2'625.55	6.11	50.31	144.89	5'776	289	2.53
11	Comoros	2'166.12	4'832.08	8.76	39.47	88.04	850	17	2.58
12	Congo	2'099.03	4'256.16	19.44	256.20	519.50	7'377	569	2.89
13	Egypt	3'240.59	11'688.98	9.53	210.57	759.52	131'634	11'043	2.52
14	Ethiopia	572.19	1'318.18	3.82	2.43	5.60	12'293	124	3.10
15	Ghana	1'179.77	2'452.85	5.85	21.22	44.11	12'905	315	3.31
16	Cote d'Ivoire	2'121.87	5'383.00	6.48	83.84	212.69	22'215	975	3.57
17	Kenya	1'334.95	2'732.26	9.25	28.36	58.04	29'996	668	3.54
18	Madagascar	900.37	2'084.49	2.79	8.91	20.63	3'676	104	2.74
19	Malawi	618.53	1'455.26	11.77	21.70	51.05	7'843	185	3.24
20	Mali	755.31	1'573.35	8.03	4.46	9.30	5'996	38	2.53
21	Mauritania	1'299.17	2'699.75	8.18	28.33	58.87	2'245	57	2.71
22	Mauritius	9'000.00	15'731.33	11.73	154.27	269.65	10'918	163	0.90
23	Morroco	3'547.15	11'174.67	13.62	38.13	120.12	115'716	917	2.18
24	Mozambique	924.28	1'900.38	2.37	2.95	6.06	4'073	42	1.58
25	Namibia	4'111.75	13'695.33	9.80	2'002.79	6'670.84	12'537	2'704	2.74
26	Niger	945.93	1'958.08	8.22	36.77	76.12	7'187	284	3.30
27	Nigeria	1'095.70	2'290.91	5.79	83.90	175.43	72'520	8'072	3.06
28	Rwanda	1'067.98	2'170.96	4.93	30.57	62.15	3'472	213	3.02
29	Senegal	1'504.10	3'152.00	6.07	35.25	73.88	8'150	258	2.84
30	Seychelles	8'966.19	20'602.81	12.58	2'919.43	6'708.36	811	204	0.84
31	Sierra Leone	1'283.49	3'544.78	3.12	-0.82	-2.27	1'714	-3	2.14
32	South Africa	7'786.36	23'001.01	11.48	261.97	773.86	371'437	9'221	2.47
33	Togo	1'192.51	2'947.70	6.08	76.31	188.62	3'179	268	2.99
34	Tunisia	4'937.04	15'033.21	15.24	933.64	2'842.93	60'525	7'615	2.48
35	Uganda	685.94	1'414.61	2.47	0.26	0.55	2'455	4	2.46
36	Zaire	569.58	1'164.20	7.12	14.62	29.89	17'767	546	3.30
37	Zambia	1'029.80	3'053.44	8.74	126.85	376.13	14'137	987	3.10
38	Zimbabwe	2'906.76	6'008.03	12.88	12.68	26.22	46'729	124	3.35
39	Belize	5'624.47	18'302.56	13.34	388.17	1'263.13	986	73	2.63
40	Canada	22'333.22	44'743.75	23.89	4'075.03	8'164.17	1'510'809	112'882	1.23
41	Costa Rica	4'938.83	14'149.92	14.27	483.33	1'384.77	23'047	1'447	2.74
42	Dominica	5'859.12	14'098.97	14.28	986.99	2'375.03	495	71	-0.15
43	Domincan Republic	3'156.28	10'062.78	13.10	80.38	256.27	32'186	572	2.24
44	El Salvador	3'529.18	11'294.39	5.59	41.51	132.83	15'211	212	1.09
45	Grenada	4'717.86	10'497.72	19.80	749.57	1'667.88	643	70	0.38
46	Guatemala	3'599.35	12'576.24	6.67	198.22	692.58	25'767	1'734	2.52
47	Haiti	862.98	2'066.14	7.11	22.98	55.03	4'553	149	1.92
48	Honduras	2'225.79	7'211.08	9.35	78.51	254.35	11'554	383	3.18
49	Jamaica	4'123.25	8'291.06	11.53	328.90	661.35	15'359	791	1.20
50	Mexico	7'341.75	21'411.13	16.65	274.32	800.00	1'095'418	22'424	2.15
51	Nicaragua	2'231.64	7'232.51	11.07	29.97	97.14	13'195	115	2.74
52	Panama	5'002.27	13'817.63	13.06	916.39	2'531.32	20'857	2'198	2.09
53	St. Kitts and Nevis	7'878.94		15.84	3'811.09		450	160	-0.55
54	St. Lucia	5'635.45		16.37	2'375.76		699	319	1.50
55	St. Vincent and the Grendines	5'343.71	12'869.25	9.56	450.54	1'085.03	431	48	0.91
56	Trinidad and Tobago	8'773.74	22'443.53	10.58	1'722.39	4'405.93	14'199	2'093	1.17
57	United States	26'469.72	53'887.25	19.72	1'579.76	3'216.09	13'211'099	394'911	0.94
58	Argentina	7'236.95	20'563.91	15.73	279.31	793.65	596'247	9'085	1.48
59	Bolivia	2'447.65	7'841.02	6.56	156.05	499.90	16'074	1'026	2.07
60	Brazil	6'212.27	16'984.16	19.28	251.07	686.42	2'059'412	37'143	1.97
61	Chile	6'151.45	16'799.39	13.78	768.53	2'098.83	104'937	10'067	1.63
62	Colombia	4'940.61	15'114.49	11.43	100.09	306.20	189'065	3'500	2.09
63	Ecuador	3'775.98	12'372.64	17.90	158.42	519.08	79'577	1'626	2.57
64	Paraguay	4'966.57	14'884.33	13.76	94.67	283.73	24'094	399	3.08
65	Peru	3'586.42	11'217.73	16.84	60.36	188.81	178'031	1'302	2.22

66	Uruguay	7'267.27	18'666.66	11.76	324.30	832.99	32'771	1'007	0.64
67	Venezuela	6'973.78	20'007.24	14.99	115.89	332.47	268'560	2'260	2.60
68	Bangaldesh	1'278.08	4'404.48	10.52	1.34	4.61	131'335	147	2.44
69	India	1'675.17	4'286.79	11.52	1.96	5.02	1'462'335	1'668	2.14
70	Indonesia	2'851.47	7'255.64	15.93	218.16	555.11	635'027	38'883	1.86
71	Israel	13'649.51	34'851.20	21.53	630.79	1'610.60	149'205	2'940	1.85
72	Japan	22'193.55	35'078.50	31.26	79.73	126.02	8'391'362	9'850	0.56
73	Jordan	3'472.27	14'972.31	14.66	194.10	836.97	16'726	615	3.81
74	Korea South	9'958.58	23'895.88	32.17	136.80	328.25	1'032'618	5'864	1.18
75	Malaysia	6'539.88	15'951.20	21.86	566.86	1'382.62	206'005	10'318	2.83
76	Nepal	1'089.55	2'604.47	14.30	0.62	1.47	26'205	12	2.62
77	Pakistan	1'748.25	5'814.46	11.92	17.86	59.39	188'597	1'928	2.70
78	Philippines	3'006.89	8'165.96	14.99	52.21	141.78	305'224	3'268	2.62
79	Sri Lanka	2'516.03	6'048.21	14.36	40.08	96.35	51'820	681	1.43
80	Syrian Arab Republic	3'113.17	12'683.64	13.88	30.90	125.90	51'148	374	3.36
81	Thailand	4'837.68	9'117.92	29.55	147.65	278.29	621'161	8'209	1.75
82	Austria	19'810.28	41'670.15	24.88	1'280.66	2'693.83	411'641	9'884	0.25
83	Denmark	21'790.40	39'147.18	20.87	1'788.99	3'213.98	292'919	9'192	0.03
84	Finland	20'202.05	40'950.40	27.11	1'029.35	2'086.54	291'460	5'132	0.42
85	France	19'989.82	43'717.46	24.52	1'724.10	3'770.59	3'075'766	100'043	0.50
86	Germany	19'468.41	39'486.48	22.46	1'507.21	3'056.97	3'899'886	119'618	0.13
87	Greece	11'957.09	31'333.59	21.19	777.65	2'037.83	344'338	7'902	0.52
88	Ireland	14'133.53	36'726.98	19.40	972.53	2'527.20	90'203	3'410	0.30
89	Italy	19'294.73	47'615.43	22.63	1'022.32	2'522.88	2'712'345	57'985	0.05
90	Netherlands	19'471.59	46'711.79	22.01	4'598.31	11'031.23	720'038	68'731	0.55
91	Norway	20'431.89	40'128.89	31.65	2'921.72	5'738.34	306'726	12'391	0.37
92	Portugal	12'307.72	27'380.05	19.70	1'067.80	2'375.45	237'354	10'571	0.13
93	Spain	14'469.19	39'828.53	23.02	1'696.66	4'670.30	1'425'611	65'916	0.35
94	Sweden	20'760.73	39'975.35	21.56	1'475.13	2'840.41	436'818	12'636	0.30
95	Switzerland	26'077.60	49'118.09	26.13	5'102.01	9'609.82	517'930	34'245	0.50
96	Turkey	5'740.56	13'244.47	13.66	23.49	54.18	444'591	1'320	2.38
97	United Kingdom	18'315.54	37'090.70	17.25	3'542.22	7'173.34	2'053'465	203'894	0.22
98	Australia	20'070.46	42'101.90	23.17	4'310.43	9'042.01	846'856	73'644	1.52
99	New Zealand	16'174.67	35'689.52	21.09	2'360.52	5'208.51	136'651	7'938	0.68
100	Papua New Guinea	2'880.40	6'106.51	11.93	412.18	873.82	16'097	1'582	2.21
101	Equatorial Guinea	1'424.63		3.37	72.02		270	25	4.96
102	Sao Tome and Principe	1'360.16		25.07	3.57		267	0.41	2.60
103	Antigua	13'045.37		8.20	4'557.19		516	292	0.48

12.2 Appendix B – Reinvested Earnings

Sample of countries used to estimate an upper and lower value for the share of reinvested earnings. Data is from the IMF (International Monetary Fund 1992)

Cname	year	FDI instock	Returns to FDI instock (5%)	Reinvested earnings	Share of Returns (5%)
Morroco	1984	419890014	20994501	6000000	29
Morroco	1985	439869995	21993500	3000000	14
Morroco	1986	440420013	22021001	4000000	18
Morroco	1987	499989990	24999500	13000000	52
Morroco	1988	584530029	29226501	7000000	24
Morroco	1989	751590026	37579501	13000000	35
Morroco	1990	916710021	45835501	11000000	24
Morroco	1991	1234170043	61708502	40000000	65
Rwanda	1984	118610000	5930500	6800000	115
Rwanda	1985	133229995	6661500	6700000	101
Rwanda	1986	150809997	7540500	8000000	106
Rwanda	1987	168360000	8418000	8400000	100
Rwanda	1988	189410003	9470500	8800000	93
Rwanda	1989	204949996	10247500	7600000	74
Rwanda	1990	212613998	10630700	5500000	52
Rwanda	1991	217192993	10859650	3600000	33
Mexico	1984	16818000000	840900000	215000000	26
Mexico	1985	18802000000	940100000	231000000	25
Mexico	1986	20838000000	1041900000	587000000	56
Mexico	1987	22022000000	1101100000	481000000	44
Mexico	1988	24033000000	1201650000	564000000	47
Mexico	1989	26818000000	1340900000	643000000	48
Mexico	1990	22424000000	1121200000	653000000	58
Mexico	1991	30790000000	1539500000	756000000	49
United States	1984	164583000000	8229150000	2910000000	35
United States	1985	184615000000	9230750000	-1370000000	-15
United States	1986	220414000000	11020700000	-2300000000	-21
United States	1987	263394000000	13169700000	-860000000	-7
United States	1988	314754000000	15737700000	2820000000	18
United States	1989	368924000000	18446200000	-8520000000	-46
United States	1990	394911000000	19745550000	-16280000000	-82
United States	1991	419108000000	20955400000	-20050000000	-96
Brazil	1984	22843500000	1142175000	695000000	61
Brazil	1985	25664500000	1283225000	472000000	37
Brazil	1986	27897699218	1394884961	543000000	39
Brazil	1987	31458000000	1572900000	449000000	29
Brazil	1988	32031000000	1601550000	617000000	39
Brazil	1989	34286500000	1714325000	714000000	42
Brazil	1990	37143398437	1857169922	531000000	29
Brazil	1991	38580199218	1929009961	273000000	14
Peru	1984	1135699951	56784998	20000000	35
Peru	1985	1152189941	57609497	41000000	71
Peru	1986	1181319946	59065997	28000000	47
Peru	1987	1208650024	60432501	42000000	69
Peru	1988	1217050048	60852502	36000000	59
Peru	1989	1245880004	62294000	17000000	27
Peru	1990	1302000000	65100000	8000000	12
Peru	1991	1334910034	66745502	4000000	6
Philippines	1984	2353750000	117687500	15000000	13
Philippines	1985	2600649902	130032495	10000000	8
Philippines	1986	2708899902	135444995	20000000	15
Philippines	1987	2805280029	140264001	22000000	16
Philippines	1988	2869260009	143463000	17000000	12
Philippines	1989	3072060058	153603003	56000000	36
Philippines	1990	3267929931	163396497	28000000	17
Philippines	1991	3683229980	184161499	34000000	18
Netherlands	1984	18109300781	905465039	1094000000	121
Netherlands	1985	24921400390	1246070020	659000000	53
Netherlands	1986	33354199218	1667709961	1614000000	97
Netherlands	1987	43449398437	2172469922	573000000	26
Netherlands	1988	42545500000	2127275000	1024000000	48
Netherlands	1989	52051500000	2602575000	1699000000	65
Netherlands	1990	68731000000	3436550000	2917000000	85
Netherlands	1991	72474796875	3623739844		
Portugal	1984	4324470214	216223511	9000000	4
Portugal	1985	4598509765	229925488	12000000	5
Portugal	1986	4836660156	241833008	11000000	5
Portugal	1987	5302529785	265126489	42000000	16
Portugal	1988	6224109863	311205493	46000000	15

Portugal	1989	7961000000	398050000	69000000	17
Portugal	1990	10571000000	528550000	112000000	21
Portugal	1991	13020000000	651000000	63000000	10
United Kingdom	1984	46375500000	2318775000	3449000000	149
United Kingdom	1985	64027601562	3201380078	4474000000	140
United Kingdom	1986	76282796875	3814139844	1860000000	49
United Kingdom	1987	109352000000	5467600000	5274000000	96
United Kingdom	1988	129654000000	6482700000	3838000000	59
United Kingdom	1989	150201000000	7510050000	5954000000	79
United Kingdom	1990	203894000000	10194700000	4304000000	42
United Kingdom	1991	208330000000	10416500000	5421000000	52
Papua New Guinea	1984	649067993	32453400	40700000	125
Papua New Guinea	1985	683000000	34150000	35900000	105
Papua New Guinea	1986	772807983	38640399	35700000	92
Papua New Guinea	1987	920161987	46008099	34000000	74
Papua New Guinea	1988	1081739990	54087000	37100000	69
Papua New Guinea	1989	1319180053	65959003	53100000	81
Papua New Guinea	1990	1582339965	79116998	69200000	87
Papua New Guinea	1991	1611439941	80571997	69900000	87

12.3 Appendix C – Marginal Productivity

Data of the average marginal product of foreign and domestic capital for all countries in the sample for the period of 1980 to 1990.

Country name	Mean y-k-ratio	Mean y-z-ratio
Algeria	0.53	87.03
Angola	1.13	51.57
Benin	1.42	109.31
Botswana	0.83	4.69
Burkina Faso	1.30	251.36
Burundi	1.92	182.77
Cameroon	1.35	32.56
Cape Verde	0.78	278.12
Central African Republic	2.41	54.18
Chad	1.01	27.10
Comoros	1.23	274.17
Congo	0.59	8.19
Egypt	1.36	24.97
Ethiopia	2.71	227.27
Ghana	1.30	53.40
Cote d'Ivoire	1.03	31.76
Kenya	0.98	50.28
Madagascar	3.46	192.33
Malawi	0.64	35.33
Mali	1.39	285.04
Mauritania	2.13	105.13
Mauritius	0.94	184.73
Morroco	0.76	168.21
Mozambique	3.71	614.14
Namibia	0.41	2.04
Niger	0.98	29.85
Nigeria	1.21	20.09
Rwanda	3.14	56.70
Senegal	1.47	50.44
Seychelles	0.86	5.30
South Africa	0.74	23.19
Togo	1.47	18.05
Tunisia	0.70	4.77
Uganda	7.52	1107.72
Zaire	1.41	33.54
Zambia	0.49	17.16
Zimbabwe	0.55	139.11
Belize	2.35	53.47
Canada	0.51	7.34
Costa Rica	0.74	13.24
Dominica	1.30	311.81
Domincan Republic	0.84	60.03
El Salvador	1.30	96.59
Grenada	1.09	60.71
Guatemala	1.28	26.26
Haiti	1.68	51.85
Honduras	1.05	59.29
Jamaica	0.57	14.35
Mexico	0.63	34.00
Nicaragua	0.85	85.83
Panama	0.62	4.48
St. Kitts and Nevis	1.34	42.96
St. Lucia	1.73	2.51
St. Vincent and the Grendines	1.82	79.99
Trinidad and Tobago	0.92	7.24
United States	0.58	31.55
Argentina	0.50	41.41
Bolivia	1.06	26.27
Brazil	0.50	32.77
Chile	0.92	28.82
Colombia	1.01	72.89
Ecuador	0.53	36.06
Paraguay	0.94	55.47
Peru	0.60	78.65
Uruguay	0.71	25.51
Venezuela	0.49	66.13
Bangaldesh	1.19	1130.05
India	1.05	928.05
Indonesia	1.01	17.01
Israel	0.43	24.70
Japan	0.36	389.35
Jordan	0.94	27.18
Korea South	0.47	113.43
Malaysia	0.64	12.99
Nepal	0.96	10432.59

Pakistan	1.08	139.91
Philippines	0.68	73.48
Sri Lanka	0.97	74.54
Syrian Arab Republic	0.81	38790.62
Thailand	0.46	81.61
Austria	0.40	31.16
Denmark	0.43	24.96
Finland	0.40	59.89
France	0.43	14.31
Germany	0.44	30.92
Greece	0.38	15.12
Ireland	0.60	16.36
Italy	0.44	64.33
Netherlands	0.43	9.29
Norway	0.32	9.42
Portugal	0.56	19.71
Spain	0.43	50.19
Sweden	0.47	31.96
Switzerland	0.38	12.19
Turkey	0.86	845.05
United Kingdom	0.59	11.96
Australia	0.46	9.97
New Zealand	0.48	19.31
Papua New Guinea	0.77	12.33
Equatorial Guinea	2.40	234.43
Sao Tome and Principe	0.80	349.15
Antigua	2.68	7.53

Marginal productivities for the entire samples (including outliers). This tables refers to section 9.3.4

Marginal productivity in % (with all countries of the respective sample)					
	Type of capital	*High income*	*High and upper middle income*	*Lower middle and low income*	*Low income*
Model 1	*Domestic*	8	24	50	49
	Foreign	252	522	15'304	4'346
Model 3	*Domestic*	8	24	50	49
	Foreign	252	522	15'304	3'863
Model 5	*Domestic*	16	32	45	40
	Foreign	210	555	13'823	4'313
Model 7	*Domestic*	16	31	45	40
	Foreign	210	431	12'902	4'313
	Type of capital	*Median high*	*Median low*	*Mean high*	*Mean low*
Model 2	*Domestic*	27	63	26	54
	Foreign	665	15'787	510	13'167
Model 4	*Domestic*	28	63	27	54
	Foreign	604	15'787	446	12'290
Model 6	*Domestic*	34	58	33	52
	Foreign	590	13'833	738	11'735
Model 8	*Domestic*	35	58	35	52
	Foreign	524	13'833	584	11'735

Marginal productivity for all countries in the respective sample.

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